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THE BOILER MAKER

Index to Volume XVII

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QUESTIONS AND ANSWERS

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THE BOILER MAKER

JANUARY, 1917

Strength of Locomotive Boilers

Simple Formulas, Based on Well-Established Rules Generally Accepted by Engineering Authorities, for Figuring Strength of Boilers

BY WILLIAM N. ALLMAN

THE subject of "Strength of Locomotive Boilers" is one which has received considerable thought, especially during the past four years. The matter has been discussed by various railroad men and at the last convention of the Master Mechanics' Association a committee reported on the construction and inspection of locomotive boilers after going into the various methods employed by the leading railroads of the country and their final report represented the consensus of opinion from the mechanical experts of the roads investigated, and it would appear that if their recommendations were followed in the matter of construction and design good results would be obtained.

The filing of specification cards required by the Interstate Commerce Commission, as well as other various State commissions, has also made it imperative that certain calculations appertaining to strength be investigated which has caused an immense amount of labor in determining stresses in the various parts of the boilers.

The writer has had considerable experience in this work and has prepared a number of simple formulas based on well established rules which have been accepted as authorities in the engineering profession.

Boiler specification cards issued by the Interstate Commission and various State commissions call for practically the same information, and require something more than merely filling out from existing records concerning appurtenances. Careful calculations must be made to determine the strength of the shell, stays and braces, and in order to properly fill out the above-mentioned specification cards it is necessary to determine the stresses to answer the following questions:

Calculated efficiency of longitudinal and circumferential seams.

TABLE 1—AUTHORITIES ON VALUE OF RIVETS

Resistance to Shearing				Relative Value Double to Single Shear		Value Based on Driven or Initial Rivets.	Authority
Single Shear		Double Shear					
Iron	Steel	Iron	Steel	Iron	Steel		
38000	—	76000	—	2	—	Driven	Railway Master Mechanics' Association.
38000	44000	76000	88000	2	2		Proposed Government Rules; Adopted June 2, 1911.
41000	47000	82000	94000	2	2	Driven	W. C. Unwin.
				2	2		Thurston, R. H. ,Manual of Steam Boilers."
	—		—	2	—		DuBois, A. J. "Elementary Principles of Mechanics."
				2	2		Weisbach, Julius, "Theoretical Mechanics."
50000					2		Cambria Steel Company.
	85% of T.S. of plates.			—	2		Bureau Veritas (French).
40000	49000	78000	84000	1.95	1.71	Driven	Master Steam Boilermakers Association; 1905
	50000				2		International Correspondence Schools.
					2		Engineering Department, Balto. & Ohio R.R.
	85% of T.S. of plate				*1.75		British Lloyds.
40000	50000	—	—				Pencoyd Iron Works.
40000	43000 to 68000 .10c to .80c						National Tube Company.
40000	49000	74000	84000	1.85	1.85	Driven	The Baldwin Locomotive Works, Philadelphia, Pa.
38000	42000	70000	78000	1.84	1.86	Driven	Board of Boiler Rules of Massachusetts.
38000	42000	70000	78000	1.84	1.86	Driven	Hartford Steam Boiler Inspection & Insurance Co.
—	48000	—	72000	—	1.75	Driven	Maryland Steel Company.
Not specified—Rivets proportioned to thickness of plates.							Board of Supervising Inspectors, U. S. Statutes.
—	46000	—	80500	—	1.75	—	British Board of Trade.
	85% of T.S. of plate			—	—	Driven	German Lloyds.
40000	—	75300		1.85	—	Driven	Philadelphia Rules.
45000	—	90000	—	2	—	Driven	Mr. Vauclain, Baldwuin Loco. Wrks. (In Loco. Nov. 1890)
				1.75	1.75	Driven	American Locomotive Company.
				1.75	1.75	Initial	Public Service Commission. New York.
40700	—	75300	—	1.85	—		Shock (Chief Inspector, Naval Academy).
	50000						Kennedy, Alex. B. W. (Test made for British Int. of Mechanical Engineers).
—	50000				2		Carnegie Steel Company.
38000	42000	70000	78000	1.84	1.86	Driven	Boiler Inspection Law, State of Ohio
†				1.75	1.75		British Columbia Rules.
‡	§	‡	§	1.75	1.75		Province of Alberta. (Canada)
‡	§	‡	§	1.75	1.75		Province of Saskatchewan. (Canada)
38000	44000	76000	88000	2	2	Driven	American Society of Mechanical Engineers.

* Where experiments have been made, these strengths may be used.
† In iron boilers is equal to the tensile strength of the plate, other material $^{5}/_{8}$ tensile strength of plates of the same material.
‡ Iron rivets in iron plates 85% of tensile strength of plate. Iron rivets in steel plates 65% of tensile strength of plate.
§ Steel rivets in steel plates 70% of tensile strength of plate.

TABLE No. 2—SINGLE SHEAR. SHEARING VALUE OF RIVETS. (Driven Size)

Diam. of Rivet	Driven Rivet or Rivet Hole		Ultimate Shearing Strength (Lbs. per sq. in.)												
	Diam.	Area	38000	39000	40000	41000	42000	43000	44000	45000	46000	47000	48000	49000	50000
½"	9/16"	.2485	9443	9691	9940	10188	10437	10685	10934	11182	11431	11679	11927	12175	12425
9/16"	⅝"	.3068	11658	11965	12272	12578	12886	13192	13499	13806	14113	14420	14727	15033	15340
⅝"	11/16"	.3712	14106	14477	14849	15219	15590	15961	16333	16704	17075	17446	17817	18189	89560
11/16"	¾"	.4418	16788	17230	17672	18144	18556	18998	19439	19881	20323	20765	21207	21649	22090
¾"	13/16"	.5185	19703	20221	20740	21258	21777	22294	22814	23332	23851	24369	24888	25406	25925
13/16"	⅞"	.6013	22849	23451	24052	24653	25255	25856	26457	27058	27660	28261	28862	29464	30065
⅞"	15/16"	.6903	26231	26922	27612	28302	28993	29683	30373	31063	31754	32444	33134	33825	34515
15/16"	1"	.7854	29845	30631	31416	32202	32987	33772	34558	35343	36128	36914	37700	38485	39270
1"	1 1/16"	.8866	33691	34577	35464	36350	37237	38123	39010	39897	40784	41670	42556	43443	44330
1 1/16"	1⅛"	.9940	37772	38766	39760	40754	41748	42742	43736	44730	45724	46718	47712	48706	49700
1⅛"	1 3/16"	1.1075	42085	43192	44300	45407	46515	47622	48739	49837	50945	52052	53160	54267	55275
1 3/16"	1¼"	1.2272	46634	47862	49088	50315	51542	52770	53997	55224	56451	57678	58905	60133	61360
1¼"	1 5/16"	1.3530	51414	52767	54120	55473	56826	58179	59532	60885	62238	63591	64944	66297	67650
1 5/16"	1⅜"	1.4849	56426	57911	59396	60881	62365	63851	65336	66820	68305	69790	71275	72760	74245
1⅜"	1 7/16"	1.6230	61674	63297	64920	66543	68166	69789	71412	73035	74658	76281	77904	79527	81150
1 7/16"	1½"	1.7671	67150	68917	70684	72451	74218	75985	77752	79519	81287	83054	84821	86588	88355
1½"	1 9/16"	1.9175	72865	74782	76700	78617	80535	82452	84370	86287	88205	90122	92040	93959	95875
1 9/16"	1⅝"	2.0739	78808	80882	82956	85030	87104	89178	91252	93325	95399	97473	99547	101621	103695

Maximum stress of staybolts at reduced section.

Maximum stress of staybolts at root of thread.

Maximum stress of crown bar rivets at root of thread, or smallest section-top.

Maximum stress in crown stays or crown bar rivets at root of thread, or smallest section-bottom.

Maximum stress on round or rectangular braces.

Maximum stress on gusset braces.

Shearing stress on rivets.

Tension on net section of plate in longitudinal seam of lowest efficiency. It therefore becomes necessary to calculate the strength of the various seams in order to obtain their efficiency.

With reference to the subject of efficiency of boiler joints there are various modes of failures, and in this article there are seven modes of failures referred to; however, it has been found that in well designed seams that they are generally weaker under the first two named conditions—that is, tearing of plate along line of rivets in outer row or shearing of rivets; the other modes of failures generally give a higher efficiency.

The shearing value of rivets in single and double shear as specified in the rules and instructions for the inspection and testing locomotive boilers and their appurtenances as issued by the Interstate Commerce Commission specifies a value in double shear to be equal to double that of single shear, these values being as follows:

	Pounds
Iron rivets in single shear....................	38,000
Iron rivets in double shear..................	76,000
Steel rivets in single shear..................	44,000
Steel rivets in double shear..................	88,000

Table No. 1 serves to illustrate the value of rivets as figured on by several large builders of boilers, and also as given in different authorities and boiler commissions.

Table No. 2 represents the value of rivets in single shear and covers a range in shearing strength from 38,000 to 50,000 pounds, the driven rivet or rivet hole being based on 1/16 inch larger than the initial size of the rivet.

Table No. 3 covers similar information for rivets in double shear, the value being 1¾ times that of single shear. If it is desired to base the value equal to two (2) the figures shown in Table 1 can be doubled. While, as mentioned above, the Interstate Commerce Commission allows a value for rivets in double shear as twice that of single shear, it is the practice with some of the State boiler commissions to allow a maximum value of 1¾. This is also the practice in some of the boiler codes recently adopted.

It may be interesting to note the results shown in the following table, No. 4, which was presented in a report at the Master Steam Boiler Makers' Convention in 1905. From this table it will be seen that the increase for double over single shear averages considerably higher in iron rivets than in steel rivets, also that the increase is greater for machine-driven rivets than for hand-driven rivets, this being attributed to the frictional resistance of the plate, which is not so affected in the hand work.

The following table, No. 5, covers the shearing value of rivets ranging from ⅝ inch diameter up to 1¼ inches. This is based on the shearing values of 38,000 and 44,000 pounds, as covered by the Interstate Commerce Commission's rules.

TABLE No. 3—DOUBLE SHEAR = TO ¾ TIMES SINGLE SHEAR. SHEARING VALUE OF RIVETS. (DRIVEN SIZE)

Diam. of Rivet	Driven Rivet or Rivet Hole		Ultimate Shearing Strength (lbs. per sq. in.)												
	Diam.	Area.	38,000	39,000	40,000	41,000	42,000	43,000	44,000	45,000	46,000	47,000	48,000	49,000	50,0000
1/2"	9/16"	.2485	16,525	16,937	17,395	17,829	18,265	18,699	19,134	19,588	20,004	20,438	20,87[illegible]	21,306	21,744
9/16"	5/8"	.3068	20,401	20,939	21,476	22,011	22,550	23,086	23,623	24,160	24,698	25,235	25,772	26,308	26,845
5/8"	11/16"	.3712	24,685	25,335	25,984	26,633	27,282	27,932	28,583	29,232	29,881	30,530	31,180	31,831	32,450
11/16"	3/4"	.4418	29,379	30,152	30,926	31,752	32,473	33,246	34,018	34,792	35,565	36,339	37,112	37,886	38,657
3/4"	13/16"	.5185	34,480	35,387	36,295	37,201	38,110	39,014	17,110	40,831	41,739	42,646	43,554	44,460	45,369
13/16"	7/8"	.6013	39,986	41,039	42,091	43,143	44,196	45,248	46,300	47,351	48,405	49,457	50,508	51,562	52,614
7/8"	15/16"	.6903	45,904	47,113	48,321	49,528	50,738	51,945	53,153	54,360	55,569	56,777	57,984	59,194	60,401
15/16"	1"	.7854	52,229	53,604	54,978	56,353	57,727	59,101	60,476	61,850	63,224	64,999	65,975	67,349	68,722
1"	1 1/16"	.8866	58,959	61,210	62,062	63,612	65,165	66,715	68,267	69,820	71,372	72,922	74,473	76,025	75, 77
1 1/16"	1 1/8"	.9940	66,101	67,840	69,580	71,319	73,059	74,798	76,538	78,277	80,017	81,756	83,496	85,235	86,975
1 1/8"	1 3/16"	1.1075	73,649	75,586	77,525	79,462	81,401	83,338	85,277	78,215	89,154	91,091	93,030	34,967	96,906
1 3/16"	1 1/4"	1.2272	81,609	83,758	85,904	88,051	90,198	92,347	94,495	96,642	98,789	100,936	103,084	105,233	107,380
1 1/4"	1 5/16"	1.3530	89,974	92,342	94,710	97,078	99,445	101,813	104,181	106,549	108,916	111,284	113,652	116,020	118,387
1 5/16"	1 3/8"	1.4849	98,745	101,344	103,943	106,542	109,139	111,739	114,338	116,935	119,534	122,132	124,731	127,330	129,929
1 3/8"	1 7/16"	1.6230	107,929	110,770	113,610	116,450	119,290	122,131	124,971	127,811	130,651	133,492	136,332	139,172	142,012
1 7/16"	1 1/2"	1.7671	117,512	120,605	123,697	126,789	129,881	132,974	136,066	139,158	142,252	145,344	148,437	151,529	154,621
1 1/2"	1 9/16"	1.9175	127,514	130,868	134,225	137,580	140,936	144,291	147,647	151,002	154,359	157,713	161,070	164,425	167,781
1 9/16"	1 5/8"	2.0739	137,914	141,543	145,173	148,802	152,432	156,061	159,691	163,319	166,948	170,578	174,207	177,837	181,466

TABLE NO. 4

No. of Test.	Kind.	Shear.	Diameter Inches.	Area Inches.	One Rivet Pounds	Per Sq. In. Pounds.	Increase Double Over Single Per Cent.
1	Iron	Single	13/16	0.5184	22,190	42,824	.... Hand Driven
2	"	Double	13/16	0.5184	42,240	81,481	90 " "
3	"	Single	13/16	0.5184	20,430	39,409	.. Machine Driven
4	"	Double	13/16	0.5184	40,920	78,934	104 " "
5	Steel	Single	13/16	0.5184	25,840	49,845	.. " "
6	"	Double	13/16	0.5184	46,575	89,843	80 " "
7	"	Single	13/16	0.5184	25,840	49,845	.. Hand Driven
8	"	Double	13/16	0.5184	43,805	84,500	69 " "

TABLE No. 5— DATA ON RIVETS

Diameter of Rivet.	Diameter of Driven Rivet or Rivet Hole.	Area of Driven Rivet or Rivet Hole. (1/16" larger than rivet)	Shearing Value at 38,000 Lbs., Per Sq. In. (Driven Size)	Shearing Value at 44,000 Lbs., Per Sq. In. (Driven Size)
5/8"	11/16"	.3712	14,106	16,333
11/16"	3/4"	.4418	16,778	19,439
3/4"	13/16"	.5185	19,703	22,814
13/16"	7/8."	.6013	22,849	26,457
7/8"	15/16"	.6903	26,231	30,373
15/16"	1"	.7854	29,845	34,558
1"	1 1/16"	.8866	33,691	39,010
1 1/16"	1 1/8"	.9940	37,712	43,736
1 1/8"	1 3/16"	1.1078	42,085	48,730
1 3/16"	1¼"	1.2272	46,634	53,997
1 1/4"	1 5/16"	1.3532	51,414	59,541

CONSTANTS USED IN THE VARIOUS FORMULAE

A = area of driven rivet or rivet hole,
C = crushing strength per square inch,
D = inside diameter of boiler,
d = diameter of rivet holes,
e = efficiency of riveted joint,
f = factor of safety,
h = margin (distance between edge of plate and rivet hole),
L = length of repeating section in inches,
n = equivalent number of rivets in single shear in repeating section,
O = pitch of rivets,
P = boiler pressure (pounds per square inch),
R = shearing strength per square inch of plate,
r = radius of boiler,
S = shearing strength per square inch of rivet material,
s = stress in plate per square inch,
T = tensile strength of plate per square inch,
t = thickness of plate in inches.

BURSTING PRESSURE

The pressure required to rupture a cylindrical boiler is:

(1) Longitudinal seam............. $P = \frac{T t}{r} e$

(2) Circumferential seam.......... $P = \frac{2 T t}{r} e$

NOTE:—It will be noted that a circumferential seam is just twice as strong as a longitudinal seam.

While the above shows the pressure at which the boiler would fail, a pressure considerably below this must be adopted to insure safety. So far, it seems to be the object of the Interstate Commerce Commission to encourage a factor of safety of four—in fact, this has been fixed for all locomotives constructed after January 1, 1912. The question of boilers constructed before this date has now been definitely settled, and according to the existing rules of the Interstate Commerce Commission the factor of safety of all locomotive boilers which were in service or under construction prior to January 1, 1912, shall be as follows:

Effective January 1, 1915, the lowest factor of safety shall be 3, except that upon application this period may be extended not to exceed one year, if an investigation shows that conditions warrant it.

Effective January 1, 1916, the lowest factor shall be 3.25.

Effective January 1, 1917, the lowest factor shall be 3.50.

Effective January 1, 1919, the lowest factor shall be 3.75.

Effective January1, 1921, the lowest factor shall be 4.

The safe working pressure is then found by substituting the required factor of safety in formulas Nos. 1 and 2, which then become as shown in formulas Nos. 3 and 4, as follows:

(3) Longitudinal seam............. $P = \frac{T t}{r f} e$

(4) Circumferential seam.......... $P = \frac{2 T t}{r f} e$

The thickness of the plate may then be found from formula No. 5.

(5) $t = \frac{P d f}{2 T e}$

The stress in the longitudinal and circumferential seams may be found in shown in formulas Nos. 6 and 7:

STRESS IN LONGITUDINAL SEAM

(6) $s = \frac{r P}{t}$

STRESS IN CIRCUMFERENTIAL SEAM

(7) $s = \frac{r P}{2 t}$

Now referring to the process of establishing the stresses of the various parts of the boiler, in order to supply the information called for on the boiler specification cards, the first step is to ascertain the efficiency of the seams. The rules adopted by the Railway Master Mechanics' Association in 1895 cover five methods of failure for a riveted joint, the first two mentioned, as stated above, generally give the weakest condition, and, in fact, if the seams are properly designed the efficiency will always fall along the outer row of rivets. There are cases where the joint may be weaker under either of the other three conditions mentioned, especially in connection with boilers built a number of years ago, when the boiler foreman was the designer as well as the builder. Now that this work is generally performed in the drawing and designing room, standard practices are followed and standard seams are established. It may be necessary, therefore, in a good many instances, to figure all modes of failures in order to obtain the lowest efficiency.

In figuring the strength of seams, the driven diameter of the rivet is generally used, although the writer has recently come in contact with some information in connection with one of the boiler commissions who require the initial size of the rivet to be used. The allowance which is generally considered is 1/16 inch larger than the initial size of the rivet, although some practices recently adopted have reduced this to 1/32 inch increase. It would therefore be necessary in calculating the efficiencies to use the practice in vogue.

In the recent rules on "Design, Construction and Inspection of Locomotive Boilers" adopted by the Master Mechanics' Association the following rules were incorporated, and it would therefore be well to follow this practice in future calculations for strength of the shell.

Longitudinal Barrel Seams and Patches

(a) In figuring net section of plate, use the actual diameter of rivet hole.

(b) In figuring rivet shear, use the actual of the rivet after driven.

(c) In figuring stress in plate and shear in rivet, in case the barrel is not cylindrical where it joins the firebox wrapper sheet, use the maximum diameter. Surfaces subject to bending action under pressure must be adequately braced to prevent bending stresses.

(d) When boiler shells are cut out to apply steam domes or manholes, the amount of metal in flange and liner shall be equal in strength to the metal removed. When separate flange is used at base of dome, the entire net area of same shall be assumed as reinforcement. Where dome sheet is flanged direct to shell of boilers, a vertical distance of 2 inches from base of flange shall be assumed as reinforcement, using net area after rivet holes are deducted, and using 28,500 pounds tensile strength per square inch as the ultimate strength, if dome sheet is welded vertically.

(e) Investigation of the strength of seams shall be along the lines of established engineering practices, and formula for efficiency and strength, and in accordance with paragraphs (a) and (b). Investigation of the strength of the seams by the usual engineering formula is a definite and determinable problem and there shall be no variations introduced in usually accepted methods.

Formulas Nos. 8 to 15, inclusive, cover the various steps for calculating the stresses as outlined above. After obtaining the weakest condition, the efficiency is then found by dividing this value by the value of the solid plate, the latter of which is always the larger, and from this it is evident that the result will be less than one. A good designed longitudinal seam should run about 82 to 92 percent efficiency. The diamond seam such as used by the Baldwin Locomotive Works gives a very high efficiency and runs around 95 to 98 percent. The circumferential seams are considerably lower in efficiency than the longitudinal, running around 60 to 70 percent.

Method of Failures in Riveted Joints

1. Shearing of rivets.
2. Tearing of plate along line of rivets.
3. Tearing of plate between hole and edge of plate and shearing of rivet.
4. Crushing of rivet or plate in front of rivet and shearing one rivet.
5. Rivet shearing out plate in front of it and shearing one rivet.

NOTE.—There are a number of combinations which, of course, must be considered, depending on the type of seam, which also involves the shell plate and the butt straps as well. For example: In a triple-riveted seam the joint may fill by crushing the plate in front of four rivets (this is based on a repeating section) and crushing butt straps in front of rivet and with a quadruple joint a further combination can take place.

Ultimate Tensile, Shearing and Crushing Value Used

Ultimate tensile strength of steel plates based on 55,000 pounds per square inch where actual figures are available, and which of course run in excess of this figure. In most cases the ultimate tensile strength runs very close to this figure, and by using 55,000 pounds it facilitates in the calculation and brings all the figures to a common standard. Where actual figures are not available a tensile strength of 50,000 pounds is used. (This is required by the Interstate Commerce Commission rules, where actual figures are unknown.) Ultimate tensile strength of wrought iron plates based on 45,000 pounds per square inch:

Shearing stress of steel rivets (single shear), 44,000 pounds per square inch.

Shearing stress of steel rivets (double shear), 88,000 pounds per square inch.

Shearing stress of iron rivets (single shear), 38,000 pounds per square inch.

Shearing stress of iron rivets (double shear), 76,000 pounds per square inch.

Shearing stress of plate considered the same as tensile strength.

Rivets in double shear are considered to be equal to two rivets in single shear. In figuring the strength of riveted joints a unit length, or what is generally referred to as a repeating section is used, which is equal to the pitch of the outer row of rivets. The ultimate crushing value of steel plates and rivets is based on 90,000 pounds per square inch. In some authorities this value is given as 95,000 pounds.

Strength of Solid Plate

$$L \times t \times T \tag{8}$$

Shearing One Rivet

$$A \times S \tag{9}$$

Tearing Plate Along Line of Rivets

$$(O - d)\ t\ T \tag{10}$$

Tearing Plate Between Rivet Hole and Edge of Plate (One Rivet)

$$\frac{4\ T\ t\ h^2}{3\ d} \tag{11}$$

Crushing of Rivet or Plate in Front of Rivet (One Rivet)

$$(t\ d)\ C \tag{12}$$

Shearing Plate in Front of Rivet (One Rivet)

$$2\left(\frac{d}{2} + h\right) t\ R \tag{13}$$

Shearing Stress on Rivets for a Repeating Section (Pounds Per Square Inch)

$$\frac{D\ P\ L}{2\ n\ A} \tag{14}$$

Tension on Net Section of Plate in Longitudinal Seam (Figured for Seam of Lowest Efficiency)

$$\frac{D\ P\ L}{2\ (L - d)\ t} \tag{15}$$

(To be continued.)

(Continued on page 29)

Cost of Welded Tanks

Comparison of Costs of Welded and Riveted Tanks—Welding Found Preferable to Riveting in Small Units

BY W. EICHHOF

In the catalogues and bulletins of concerns manufacturing electric arc and oxy-acetylene welding appliances we find tables giving information in regard to cost of welding. We also find statements which claim that welding is cheaper than riveting. These statements are broad and should be accepted with caution.

In the first place, it depends entirely on the equipment of a shop; next to this comes the skill of the men performing the operation of riveting and welding. Then, again, we have to consider the thickness of the plate, the size of the vessels to be constructed; in fact, there are many items to be considered. What might be a cheaper process in one shop may be a more expensive one in another.

The writer had occasion to build riveted cylindrical tanks of from twenty thousand gallons capacity to sixty-five gallons capacity, and rectangular tanks from ten thousand gallons to sixty-five gallons capacity, and his personal experience is that cylindrical tanks up to two thousand gallons, constructed of ⅜-inch, ¼-inch and 3/16-inch and less material, are cheaper when welded than when riveted, with the equipment at hand when tests are made.

When tanks are constructed above this capacity the assembling of same is quite a different proposition. In the larger sizes this assembling plays a rôle in the cost of tanks. Welded tanks, to be substantial, have to be fitted with more accuracy than riveted ones, and it is this point that makes the cost of welded tanks come higher than riveted ones in the larger sizes. Then, again, the effects of the heat, causing expansion and afterwards contraction, make the welding of large tanks a very tedious job. To give an example: In a competitive test a six-thousand gallon cylindrical tank came about 15 percent higher when welded than a riveted one of the same size and material, but this was the first large tank welded in the shops. At any rate, when it comes to building small units, welding is preferable to riveting.

Take the case of plate work, such as pipe or flue work longer than, say, 8 or 10 feet, and of diameters of 16, 20, 24 and 30 inches, there is not any doubt about such work being cheaper in labor cost than when riveted. Riveting, calking and testing are the most expensive operations in riveted work. In well-executed welded work calking is not necessary and testing only a matter of form. In most cases it is not possible to determine the actual cost of riveted work when we take all items that have to be considered, such as the quantity and cost of air, fuel, etc., used. It is customary to simply charge these items to burden. This is not the case with welded work. We can determine with a certain accuracy how much electrical energy is expended in arc-welding, or how much oxygen, acetylene and filling material is used in flame-welded work.

Reliable and accurate oxygen gages, watt- and gas meters and scales give the necessary information in regard to the material and electrical energy used in welding a certain job.

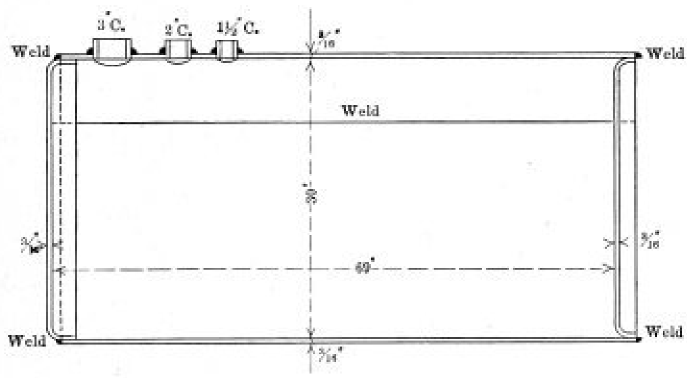


Fig. 1.—215-Gallon Welded Tank

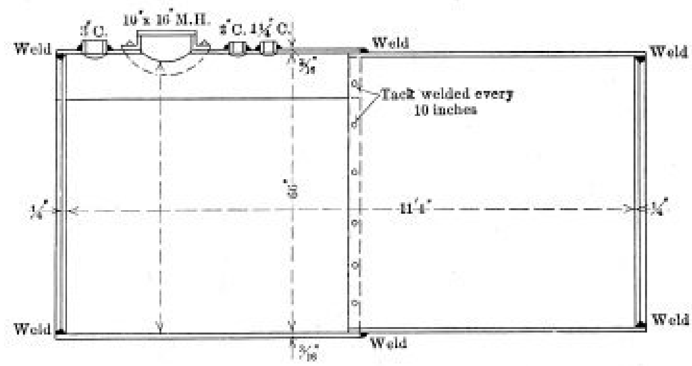


Fig. 2.—2,000-Gallon Welded Tank

It is entirely wrong to depend on tables given by manufacturers of welding apparatus when estimating welded work. These figures are mostly "laboratory" performances. I have so far failed to see such "dress parade" figures performed continuously in practical work, even by representatives of the firms giving these figures in their catalogues. Only actual tests made during an extended period give information as to which method is the most economical to use.

The welding of plate work is slowly but surely paving its way to replace riveting. Welding can be performed very cheaply, but we have to consider that there is a great difference in real good welding and bad welding, or, as I might call it, "plastering."

At the present time, a prospective buyer of a welding outfit is more interested in the question, if it is advisable for him to buy an electric arc welding outfit or a gas welding outfit.

In regard to the cost of welding with both methods:

I here give a report of a competitive test. The welding with the electric outfit was done by an expert welder sent as a demonstrator and instructor with the outfit. The gas welding was performed by a welder having had about twelve months' practical experience in welding, after taking a short instructive course in one of the best-known concerns manufacturing oxy-acetylene welding outfits in the country. He was a boy 20 years old. The tanks, as can be seen, were of the same size and material in both cases. The operations of laying out, marking, rolling and assembling were the same in both cases; in fact, were performed in the whole lot before being welded. All tanks welded by the oxy-acetylene method were gasoline-tight when tested and no rewelding had to be done. In the case of electric welding, some of the work had to be rewelded in small spots. The test was made to determine the respective cost of both methods, and can serve as a guide.

All test appliances used were constructed by first-class firms.

Electric Arc Welding

Objects welded: Six 215-gallon tanks, 3/16-inch shell, 3/16-inch heads with one 3-inch, one 2-inch and one 1¼-inch standard couplings.

Time of welding: 14 hours, at 30 cents per hour	$4.20
Kilowatts consumed: 60 kilowatts, at 2 cents per	1.20
Filling rod used: 27 pounds, at 7 3/10 cents	1.97
Total cost for six tanks	$7.37
Cost of welding one tank	$1.23
Analysis—Feet welded:	Feet
Long seam, 6 × 69 inches is equal to	34.5
Circular seam, 12 × 7 feet 10 inches is equal to	94.0
Couplings, 6 × 2 is equal to	12.0
Total	140.5
Feet welded per hour: 140.5 divided by 14	10 feet
Kilowatts per hour: 60 divided by 14	4.286
Kilowatts per foot: 60 divided by 140	0.4286
Filling rod per foot: 27 divided by 140	0.193

Oxy-Acetylene Welding

Objects welded: Six 215-gallon tanks, 3/16-inch shell, 3/16-inch heads with one 3-inch, one 2-inch and one 1¼-inch standard couplings.

Time of welding: 19¼ hours, at 30 cents per hour	$5.78
Oxygen consumed: 371 cubic feet, at .0135	5.0085
Acetylene consumed: 325 cubic feet, at .008	2.60
Filling material: 15¼ pounds, at 12 cents per pound	1.89
Total cost for six tanks	$15.2785
Cost of welding one tank	2.54
Analysis—Feet welded:	Feet
Long seam, 6 × 69 is equal to	34.5
Circular seam, 12 × 7 feet 10 inches	94.0
Couplings, 6 × 2	12.0
Total	140.5
Feet welded per hour, 140.5 divided by 19.25	7.56
Oxygen per hour, 371 divided by 19.25	19.2
Acetylene per hour, 325 divided by 19.25	16.9
Oxygen per foot, 371 divided by 140	2.65
Acetylene per foot, 325 divided by 140	2.32
Filling material per foot, 15.75 divided by 140	.1125

From these tests we see that electric arc welding is cheaper than flame welding as far as labor and material is concerned. It has to be taken into consideration that this was a competitive test, but in most cases where afterwards comparisons between the two systems were made the result was apparently in favor of electric welding as far as cost of manufacture was concerned. But there are other matters to be considered. The writer has made destructive tests on tanks to determine the reliability and strength of electrically and gas-welded tanks, and intends to write something about this in a future article. Let only this much be said, that we discarded electric welding for the present.

Riveted Tanks

Now, to compare riveted work with welded work, I give the following reports. The tanks were of the same capacity, but the construction was different in the welded than in the riveted tank. In the welded tank, the manhole was riveted on the shell the same as in the riveted one, but the flanges were replaced by pipe couplings welded on. In the welded tank some material is saved by using circles instead of flanged heads.

One 2,000-gallon, 66-inch diameter by 11 feet 4 inches long, 3/16-inch shell, ¼-inch heads, ⅜-inch rivets, as per sketch.

Labor reduced to one man. Handling of plates and tank included in labor.

	Hours	At	
Laying out	5.75	.4608	$2.65
Marking	1.25	.264	.33
Punching	12.00	.27	3.24
Bevel shear	1.00	.30	.30
Scarfing	1.5	.28	.42
Rolling	1.5	.28	.42
Assembling	4.50	.28	1.26
Riveting	16.50	.2903	4.79
Calking	3.75	.349	1.31
Testing	2.75	.349	.96
Painting	1.25	.264	.33
Inspecting	.25	.36	.09
	52.00		$16.10

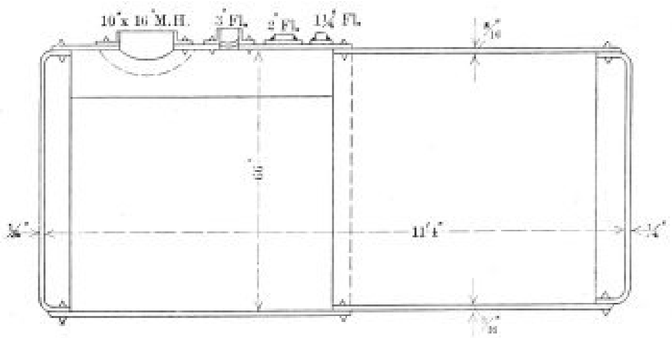


Fig. 3.—Riveted Tank. Total of 694 ¾-Inch Rivets Driven Cold

Welded Tank

One 2,000-gallon, 66-inch diameter by 11 feet 4 inches long, 3/16-inch shell, ¼-inch heads. Labor reduced to one man. Handling of material and tank included in labor.

	Hours	At	
Laying out	3.75	.33	$1.24
Punching	3.00	.27	.81
Shearing	1.00	.27	.27
Rolling	3.00	.26	.78
Assembling	8.00	.28	2.24
Riveting	1.00	.30	.30
Flame cutting	1.25	.311	.40
Flame welding	12.75	.331	4.21
Calking manhole	.50	.40	.20
Testing	.25	.40	.10
Paint	.75	.258	.19
Inspecting	.25	.36	.09
	35½		$10.83

The 2,000-gallon tanks went through the shop in the usual way. No effort was made to make a competitive test. In the case of the welded tank a competent welder laid the work out, and, as can be seen, no flanged heads were used, but circles instead. The welded tank was the first one built of that capacity, and was a new proposition at the time of construction. As I said before, all conditions should be considered, but it is my conviction that small welded tanks can be built cheaper anywhere than riveted ones.

It would be interesting to hear from other sources the experiences in the shops.

Largest Plate Mill in the World.—The Lukens Iron & Steel Company, Coatesville, Pa., a pioneer in building large plate mills, is to install what is said to be the largest plate mill in the world, making it possible to roll plates 190 inches wide. The two working rolls of the mill are to be 204 inches long by 34 inches diameter. On account of their length it was deemed necessary to use supporting rolls 50 inches in diameter to prevent undue springing of the rolls. In addition to the sixteen open hearth furnaces now in operation, this company is now installing six new furnaces of 100 tons capacity each, with prospects for two more, for which space is already arranged.

Problems in Locomotive Boiler Design*

Increased Weights in Railroad Equipment Necessitate More Economical Production of Increased Power Per Unit—Possibilities in Design of Boiler

BY GEORGE M. BASFORD†

When this club began (1901) the biggest locomotive in the world was, I believe, a Consolidation running here in Pittsburg. For a long time after that locomotives ran to size and weight. It was easy to make them bigger and heavier. But a far greater and more difficult, as well as more important, problem faces us to-day. It is the problem of forcing every pound of weight to justify itself in terms of power to serve mankind. Who has a bigger, nobler opportunity and duty than this?

When our club began, officials wouldn't listen, as they do now, to consideration of improved efficiency. Superheaters, brick arches, combustion chambers and feed water heaters are old. Their real application to our great problem came but six years ago, and they are only now beginning to be really used in this problem. To-day officials are reaching out for new things and old things in new application. They eagerly seek capacity-increasing factors. Why? Because they are facing the question of increased weights in equipment and in operation. They need more power per unit to do the world's business and do it economically.

Therefore, young men never had the opportunity or the duty that they have facing them to-day. Do they realize it? To try to make some of them see it is the object of these paragraphs.

Let us make a little list of big possibilities in locomotive development to show what lies before young railroad men right now. The items are mentioned at random, not in order of importance.

Boiler Design as a Whole

Size is only one part of this problem, instead of being the chief feature as it has been considered in the past. It is now a question of balancing all factors to make and to absorb the maximum amount of heat per unit of weight. The day of ratios between grate area, heating surface and cylinder volumes has given place to a day of providing steam to produce definite amounts of cylinder horsepower within defined limits of weight. This is revolutionary and the corralling of many a fractious heat unit must be made possible. This is your main line of activity in boilers.

Boiler Circulation

Many a bright mind is engaged in improving the movement of the water in the boiler with the promise for the future. Very little positive information is available now upon this subject. Who will put us straight on the matter of boiler circulation?

Improved Grates

Grate design is now being studied as it never has been before. Experimental developments in grates as to air openings and grate construction promise valuable improvements in the near future. Conditions requiring maximum power lead to the conclusion that air openings through the grates should be as large as the character of the coal used will permit. Thirty percent is aimed at. Recognition is waiting for a thoroughbred grate expert. The largest Pacific type passenger locomotive has 47,500 pounds tractive effort and the same grate area that was used in the same service six years ago when the tractive effort was but 32,900 pounds. This problem is a worthy one for that expert. What is he going to do about it?

Ash Pan Design

This is a vital factor in the production of heat. To provide air sufficient for intense combustion is the object of experiments now being conducted which promise a simple solution of this problem. To provide air enough for a big firebox and put the air where it is wanted is no child's play. The speed of gases at a certain point in a big firebox, working hard, is 200 miles per hour. Who is the expert who will point the way to the ash pan design to supply air enough and how will he provide air openings in the ash pan sufficient to maintain atmospheric pressure in the ash pan at maximum rate of power development?

Combustion Engineering Applied to Firebox Design

The purpose is to attain, with all fuels, the highest degree of heat intensity per unit of firebox volume. Here is where the energy is developed. This is the heat factory. It is worthy of a lifetime study. Important developments are nearly ready to be announced. Your field is nearly 70,000 fireboxes.

To burn the gases completely before they reach the flues and to accomplish this in the big firebox is another big problem. This involves grates, arches, air admission below and directly into the fire and mixing of the burning gases by division into small streams. It also involves the shape and size of the firebox and combustion chamber. All this is now being worked out on paper and in practice. Recent studies in firebox design recognizing the great importance of heat radiation and the relatively small importance of transfer of heat by convection have revealed the firebox problem in a new light. This will result in larger fireboxes, larger grates, larger combustion chambers and in new developments in the mixing of the burning gases by improvements in brick arches. Improvements already tried experimentally promise remarkable results. With all this to do, the field for combustion experts is very far from being overcrowded. Before long 100,000 fireboxes will be in service to keep this country going. A little improvement applied to each of these will save a mountain of money.

It is known that a certain sacrifice of tube heating surface for the benefit of increased firebox volume in the form of a combustion chamber is justified, but how far should this be carried? This should be investigated. Then there is the question of tube length.

Front End Draft Appliances

Here is another field of promise. To produce the pump action necessary for draft with minimum back pressure load on the cylinders will bring great credit to the one who is successful in working it out. Why should front end construction that itself consumes 33 percent of the draft produced be perpetuated?

* From a paper on Railway Clubs and Young Men, presented at a meeting of the Railway Club of Pittsburg, September 22.

† President, Locomotive Feed Water Heater Company, New York.

SUPERHEATING

This improvement is by no means finished. Those who are living with this problem are in position to lead still further their influence on cylinder performance and in the effective use of the heat from the firebox. Superheating engineers are ready to give higher superheat when railroads are prepared to use it by improvements in operation and maintenance. Great economies are available in higher superheat through increase in volume of the steam. These engineers are also ready to put to good use any increase of firebox temperature the combustion engineers can give them. Superheating, the greatest improvement the locomotive has ever seen, is not finished. It offers still greater possibilities when you are ready for them.

FEED WATER HEATING

This is now a factor in locomotive engineering and operation. It promises to take a place next to superheating in improving economy and increasing capacity with the incidental advantage of prolonging boiler and firebox life and reducing cost of boiler maintenance. Successful feed water heating means increased boiler power. It will permit of modernizing existing boilers of outclassed locomotives to render them available again in many cases for service which has outgrown them. Feed water heaters may be applied to existing locomotives under a charge to capital account and for a number of years will defer charges to operating account for replacing those locomotives by new ones. Feed water heaters will increase evaporation per pound of coal and provide economy not available in any other way because the improvement is made from otherwise wasted heat. Locomotive boilers should be relieved of the duty of heating water. It should come to them hot, leaving only the evaporation to be effected in the boiler. Feed water heating is not new, but successful locomotive feed water heating in this country has but just now been accomplished. A little later there will be more to be said on this subject. This development has been waiting for the successful heater.

WATER PURIFICATION

This becomes more important every day. Before long, people whose lives have been made miserable by water unfit to use in boilers of any kind will wonder why they ever used it in the most rigorous boiler service in the world. They will wonder why they ever paid the boiler repair bills of the past when the remedy is so easy and the returns so great. Let some of the young men tackle the problem of improving means and methods of water purification.

POWDERED FUEL

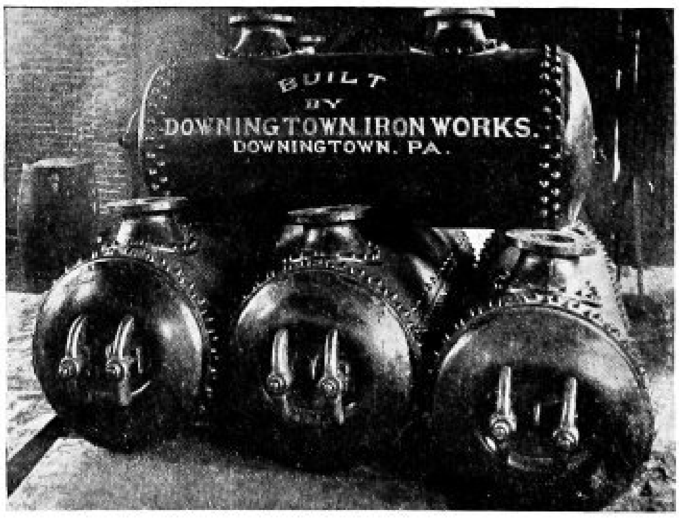
Herein lies a possibility of the use of heretofore impossible fuels with a $250,000,000 annual steam locomotive fuel bill to work on, also the possibility of increased steam making capacity and perfection of firebox operation that until recently were not hoped for. Increased hauling capacity and continuity of locomotive operation and eliminating of ash pit delay offer great promise for the future. Increased boiler capacity is a question of producing maximum calorific intensity per cubic foot of firebox volume. This is the raw material for the heating surface and superheater to work with. Speaking in general terms, pulverized fuel will transform an 80 percent boiler into a 100 percent boiler. Consider what this would mean to, say, 30,000 locomotives in this country that are deficient in boiler capacity. Here again a capital charge will put from five to ten years of new life coupled with increased capacity into a lot of old power. It will put many an outclassed locomotive back on the main line. The chief reason for buying new locomotives is to get boilers that are big enough to haul maximum tonnage over ruling grades. Increased boiler capacity resulting from fuel efficiency is the question answered by pulverized fuel. It has already shown a boiler efficiency of 77 percent with pulverized Kentucky unwashed screenings, as compared with 61.1 percent with lump coal from the same mine hand fired in the same locomotive.

Do you want more things to do? Then get into locomotive operation. Work out plans for keeping expensive locomotives in service a larger portion of the day. An average figure representing present practice is 4 hours 19 minutes' actual service out of a 24-hour day. Get into questions of organization, selecting, training and promotion of men. Who will wake up the railroads to the suicidal policy of neglect of the selection of recruits and of training these recruits in all departments? Take up the question of railroading as a business with real cooperation of all departments. Study suitability of locomotives to their working conditions. Who will show railroad managers how much money may be made in suitable roundhouses and in shops and shop equipment for maintaining big engines? No specific mention of the details of the car problems can be made on this occasion, but the car offers opportunities that are little less important than those of the locomotive.

Best locomotive records, reflecting up-to-date developments show a water rate of 14.6 pounds per indicated horsepower-hour. What may be termed unimproved locomotives produce this unit on about 24 to 30 pounds. Between these figures lie great possibilities. Between them lies your opportunity. The majority of locomotives are in or near the 24-pound class.

High-Pressure Tanks for Western Union Building, New York City

The illustration shows a few of the many high pressure tanks recently built by the Downington Iron Works, Downington, Pa., for the new Western Union Building in New York city. On account of the pressure carried, these



High-Pressure Tanks Built by the Downingtown Iron Works for the New Western Union Building in New York City

tanks represent the highest class of work in laying out, fitting, riveting and calking. These tanks give some idea of the wide variety of boiler and sheet metal work turned out by this enterprising firm, of which Mr. Charles B. Fairweather is president and general manager.

John Tangles Up in Squares and Triangles

Problem of Shearing Out Largest Squares from Miscellaneous Triangular Plates—Graphic Method and Application of Geometry

BY JAMES F. HOBART

"Confound the whole blamed business! I wish the man who invented boiler making had been imprisoned for life and then hanged to——"

"Here! Here! John! What's this all about? War in Mexico, or has your girl given you the mitten?"

"Why, it's a job of shearing plates. Some guy has brought a lot of triangular plates to the shop and wants the biggest square sheared out of each one that can be gotten out. They are all sizes, too, hardly two of them the same size, and I believe it is one whale of a job!"

"Perhaps not, John. Such things are often like singed cat—look a good deal worse than they really are—sometimes. Let's see what you have got to do."

"Well, here's one of the plates. Fig. 1 shows it. It's a little triangle, and they want me to lay out and shear the square *A*. It must be exactly square, too. They won't stand for it to be a bit rectangular, like *B* or *C*. It must be right on the square as shown at *A*. Now, there are about 220 of the plates and almost as many shapes and sizes. Confound the job, I don't see anything to stand on while I do the work!"

"Try a bit of your geometry on it, John. You have found that geometry will do lots of things, perhaps it will help here."

"Oh, say! Mr. Hobart, geometry will help here just about as much as 'watchful waiting' will. What's the use? Neither gets anything done that I can see."

"Perhaps you don't see quite right, John. Let's look at the matter again. Just slide one of the triangular plates upon a sheet of boiler plate so we can have room for a bit of a layout. Fig. 2 shows how to place the triangle *D E F*. Then find the middle of the bottom side *D F* and draw the vertical line *E G;* put the straight edge along this edge and draw a line out past *I*. Then draw another line from *E* to *H* parallel with line *G F I*. Next make *E H* and *G I* equal to *E G* and draw the line *H I*. You now have a square, each side of which is equal to the height of the triangle or equal to *E G*."

"All right, I've got it."

"Good; now draw the diagonal *H D* and the point where this diagonal cuts the line *E F* will be a corner of the square bit of plate which you are to shear out of *D E F*."

"What's that? Well, I declare! It's so, isn't it? There is the large square, *G E H I*, and the small one, *J K L M*. And they are both on the same diagonal. Say, that thing looks all right, but how does it do it?"

"Take too long to tell about it here, John; you can look it up in your geometry and study it there as fully as you choose. You will find it somewhere in Plane Geometry, about the third book probably, and perhaps in the 'Problems of Construction.' There's a whole lot of stuff there, John, which will help the boiler maker."

"Yes, but there are so many things to learn, keeps me up in the air all the time. Say, when will a fellow get so much of it in his

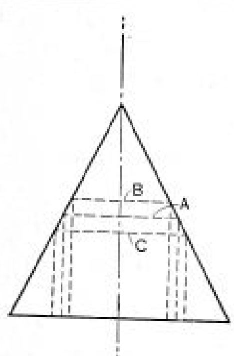


Fig. 1 One of John's Plates

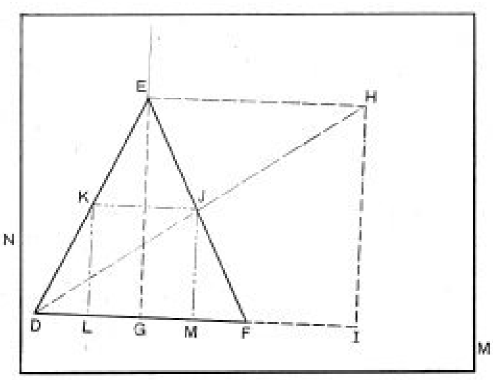


Fig. 2 Finding the Square

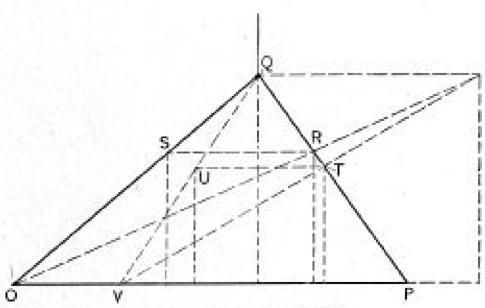


Fig. 3 Fits any Triangle

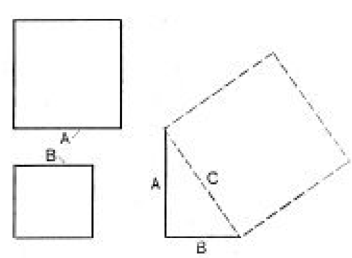


Fig. 4 Finding Side of Equivalent Square

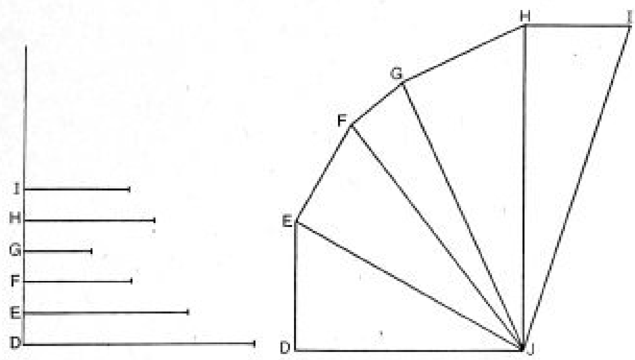


Fig. 5 Finding Equivalent of any Number of Square

Squares and Triangles

head that he will not have to be learning something new all the time?"

"Well, John, not in this world, and if you are at all progressive, I make a shrewd estimate that you will do more learning in the next world than you do here!"

"Say: that looks pretty big, too——. Well, I'll get lost in a minute in that direction. Guess I'd better wait until I get there! But, say: These three-cornered sheets are not of the same size, and there are lots of them which don't have sides *D E* and *E F* of the same length. What's to be done then?"

"Do just the same, John. That matter takes care of itself. It matters nothing whether the triangles are of the same angularity on each side of line *G E* or not."

"How does that work out?"

"Fig. 3 shows it. Here is a shape where the vertical line *Q* is not in the middle of base *O P*. But, no matter, go right ahead and lay out the square same as before, and draw the diagonal *O R* and the point *R* will be a corner of the square, same as before. Now to show how this thing works, just shorten up the base line from *O* to *V*, thus making it alike on both sides of center line *Q*. Then the square which you can cut out changes from *R S* to *T U*. You see, John, that the movement of the diagonal from *O* to *V* brings the top side of the square down just enough to make it fit the narrower and shorter section of plate. It's a mighty pretty illustration of what geometry can do for the boiler maker if the boiler maker will only give geometry a chance."

"Well, it can have all the chance at me that it wants to, only sometimes a fellow gets off the track a bit; there's so much to look after and learn."

"Never mind, John, it don't do you a bit of harm to jump the track once in awhile; only get back again before you stray far from the trail. You see, it's just this way: A fellow who jumps the trail occasionally is never very apt to 'get into a rut,' not over his head at least, and when he comes back to the trail after one of his side trips he is mighty apt to have a few new ideas which he didn't find in the old trail. So go ahead, and if you find you are out of bounds no harm will be done if you grab all the new ideas you see and hustle back again."

"I'll do that, all right, just the best I can. But, Mr. Hobart, one of the boys is worrying himself over a mighty peculiar job which they gave to him yesterday. A customer came along who had a lot of shallow evaporating pans which must total a certain area. He wanted to make new pans, larger, to take the place of the smaller ones, and keep the aggregate area the same. They gave the job to Bob and he is figuring on it now. They only marked the sizes of the pans on a stick and gave no other figures whatever. Bob is measuring them all up and then calculating the areas and sides of the larger pans which displace the smaller ones. Can he do the work any easier way?"

"Well, I rather think he could. Let's see some of the work. Oh! He must make a new pan with area equal to the aggregate area of pans whose sides are shown in the small squares in Fig. 4? And Bob is scaling these lines, then is calculating the respective areas, adding them and extracting the square root to give the length of side required for the new pan?"

"Yes, that is just what Bob is worrying himself about. Can you tell him a quicker way?"

"Yes, I can, but the way he is now working is a pretty accurate method and it does not take much time, either. He can take the squares from the tables in his 'Kent,' then he can add them, find that number and take its root right from the same tables. That will not take long."

"I didn't know but he might do it by some graphic method where no figuring would be required."

"Well, he can. But graphic methods are not always accurate except to a unit or a fraction of a unit, but where great accuracy is not required, graphic methods may often be used to advantage. In this case all that Bob needs do is to draw the sides *A* and *B* as the legs of a right angle triangle, taking care that the angle is exactly 90 degrees. Then he may measure the hypotenuse and it will be the side of a square which is equal in area to both smaller squares *A* and *B*. In Fig. 4 the dotted square *C* shows the square which equals the aggregate area of smaller squares *A* and *B*."

"Wonder what proposition in geometry that stunt belongs to?"

"Why, John, don't you recognize that? The old, familiar one that the 'sum of the squares of the legs of a right angle triangle equals the square of the hypotenuse?"

"Oh, thunder! Yes, I remember it now. It skipped me for a minute."

"Look out, John. Keep your thinker in working order all the time. When you are playing a hot game of baseball I don't see you forgetting many of the tricks of inside ball, so why can't you remember as quickly when about your work?"

"I don't know, but somehow I can't seem to think as quickly in the shop as I can in a ball game."

"Well, John, that's just because you haven't got your mind as closely upon your shop work as you have upon a ball game when you are in it. Isn't that the reason? You never think of anything else when you are playing ball, but I'll wager that in the shop you are thinking of ball games and almost everything else except what is in the shop. Isn't it so, John?"

"I'm afraid you are about four-thirds right, Mr. Hobart. Somehow everything seems to come to a fellow when he is working hard and is a bit tired on a hot, long day."

"Then, John, it is up to you to shut out the things which bother you. When on the ball field you shut out everything except inside baseball. That's what makes you such a cracker-jack ball player. Now, if you want to get to the top and be 'the Old Man' some day in some shop, possibly your own, then you must practice shutting out everything besides shop things while you are in the shop. You can do it. The more you do in that line, the more you can do, and the easier you can accomplish it. You can do the trick to perfection when there are three men on bases and only one man out, and I am sure you can do the same concentration act as regards shop work if you will only say you will do it and set out to accomplish that work."

"I wish I could do that. I don't like to find myself thinking of a ball game with all my work 'hanging in the air' now and then."

"Just stop doing it, John, and soon you won't do it or even think of such things during shop hours. If you will work for it, you can get yourself so interested in shop work that you won't know when the whistle blows, and that's some interested, you will believe. But, John, about that lot of evaporating pans which Bob has to get out? Did you say that he had to make some larger ones which took the place of two or three smaller pans?"

"Yes, that's right. Here is one case. Fig. 5 shows a lot of lines, *D, E, F, G, H, I*, where one pan is to be made to take he place of six smaller ones. Bob said he was going to save that one to figure on Sunday when he had plenty of time."

"It will not require much time to solve that problem, John. Just take from the tables the squares of those six numbers, add the squares, find the sum in the tables and take out its square root, and there you are. But if Bob wants to do it by the graphic method, let him go ahead with the first two pans, *D* and *E*, same as in Fig. 4. Then, instead of sketching a square upon the hypotenuse in dotted lines as in Fig. 4, proceed instead as in Fig. 5, to erect side *F*, from *E*, at right angles to hypotenuse *E J*. Then proceed as before and erect sides *G*, *H* and *I* in turn, always erecting each new side from the last hypotenuse drawn from *J*. The last hypotenuse obtained, *I J*, will be the length of side required by a pan, which will have an area equal to all the size whose sides are represented by lines *D*, *E*, *F*, *G*, *H* and *I*."

"Well, I snum! That is some scheme. Fig. 5 looks like a picture of a snail shell, but that don't matter if it only brings results."

"It can't help bring results, John, if you only lay off the angles and lines accurately. That is all that is required to make line *I J* check up very closely with its calculated length."

"Well, geometry is sure some stunt, all right, and the more I dig into it the more there is to it."

"That's so with almost everything, John, both good and bad. Now, there is a bit more to that matter, as shown by Fig. 5, than appears at first sight. I saw a man not long ago trying to cut a brace to reach across diagonal corners of a rectangular tank, inside. He had the three dimensions of the tank, its length, breadth and height, and was trying seven ways from Sunday to find the angular distance from the lower south right hand corner to the upper left hand north corner. He tried many ways, but if he had only taken the three dimensions as he took distances *D*, *E*, and *I*, Fig. 5, and laid them off upon the hypotenuse of the preceding quantities, then the distance *F J*, Fig. 5, would be the diagonal distance required. Or, he could add the squares of the three dimensions, extract the square root of the sum, and the result would be the diagonal distance required.

"Oh, Mr. Hobart! Will that stunt work with other shapes beside squares? Can it be used with circles?"

"To be sure, John. It will work with any shape of figure, circles, triangles, rectangles, ellipses or about any shape you can think of."

"How is it worked with circles?"

"In exactly the same manner, John. Just take the two diameters for the legs of a right angle triangle and measure the length of hypotenuse for the diameter of the large circle required. You can calculate the size of smokestacks, breechings, uptakes, etc., in this manner, and where there are only two dimensions given, a very good way is to take each length upon an ordinary steel square, mark on tongue and blade the lengths with a bit of sharpened soapstone. Then with the two-foot rule measure from one mark to the other and the result will be the side of square or diameter of circle to aggregate those of the two similar dimensions which were given."

"Say, you can't take very big numbers on the square, the figures only run up to 24 on the blade and to 16 on the tongue."

"Look out, John—a little 'Inside Boiler Making' right now! What's to prevent calling each quarter inch or each eighth or sixteenth, an inch on the square? Then you can take almost any diameter on it which you choose."

"O pshaw! Wonder if I ever will remember that there are brains in my head?"

"Tell you how I usually work that stunt, John. I take one dimension on the blade of the square, the other on the tongue; place both fair with the edge of a straight sheet of steel, mark thereon, then scale between the marks, and there you are."

The Awakening of Jimmie and Bob

Two Apprentices Attempt to Design a Boiler—Rules and Formulas and How They Are Used in Figuring Horsepower

BY W. D. FORBES

RUSH work requiring overtime and some outside repair jobs kept the two young boiler makers very busy for the next ten days after they were seized with the idea of designing a boiler, so beyond talking over the matter a little between themselves and the draftsman nothing much had been accomplished. On Saturday the boiler works shut down at 12 o'clock, and after getting their pay the young men always came home to dinner and in summer time usually took in a ball game in the afternoon and in the winter the movies, but this Saturday there was a hard snow storm, so the boys made up their minds to do some boiler designing.

"You remember," said Bob, "we were talking about night school and we agreed that we should have kept on at it. Now, I've been thinking that over, and I want to know why we didn't keep on? I have come to the conclusion——"

Here Jimmie broke in and said, "That's dead easy. We quit for the same reason that lots of other fellers quit, because the instructors were handing us out dope which may have been good enough and all right, but they didn't show us how it was going to be of any use to us.

"Just take for one thing that three-point racket in getting the diameter of a boiler. I don't believe three out of the class remember it or could see how it would be of any use. If the instructor had only shown us the way the draftsman used it, we would have all caught on, and that's the trouble with the night school. I think that they start at the wrong end. They ought to show us something like that boiler measure first and then show us how to do it. Then we would have both ends of the stick. Isn't that so?"

Bob agreed.

"Now," Jimmy contiued, "I got talking with the draftsman about formulas; those things with the letters, square root signs and brackets. I didn't get onto it at all, but the draftsman showed me what they were, this way:

"I asked him about the horsepower of an engine and how they figured it out. 'Here,' he said, 'that's dead easy. First you've got to start with your steam pressure. That does the pushing; that is, it pushes the piston in the cylinder, so the first thing you have got to know is how much push the steam gives.'

"Now, we'll say it's 100 pounds, and when you say 100 pounds it means that the steam is pressing on every square inch of the piston with a pressure of 100 pounds. But you must remember that they discovered that steam has a peculiar property of expanding. That means that if you have a cylinder which is long enough to give the travel of 5 feet to the piston, and if you let steam into it, behind the piston at one end, until the piston has traveled, say, one quarter, and then you cut the steam off, as they say, the expansion of the steam pushes the piston the other three-quarters of the distance.

"Now, of course when you cut the steam off the expansion won't continue to give 100 pounds pressure on the three-quarter travel of the piston, but will be getting weaker as the piston travels, and what does that mean? It means that you have got to take the average pressure which the steam in entering and expanding puts on the piston.

"You see it is just the same as a spring. When it is compressed up it gives 100 pounds pressure on the piston, and when the piston begins to slide forward the spring keeps on pressing, but the pressure decreases as the spring lengthens out. Therefore, the steam pressure in the cylinder has an average from 100 pounds to start with, down to, say, 10 pounds, when the piston is at the front end of the cylinder.

"For simple calculation we will assume that this average pressure is 50 pounds, and we call this average pressure the mean effective pressure, and instead of writing it all out we represent it by the three capital letters M. E. P.

"The next thing you've got to consider is how many square inches the steam is going to press against. We'll say that the cylinder is 36 inches in diameter. We just take a table of areas and run our finger down to 36, and we find the area is 1,017.88 square inches. If we have no table handy to get the area of the piston, we will square the radius, or half the diameter, which in this case would be $18 \times 18 = 324$, and this we would multiply by 3.1416, or what they call pi, which is represented by a Greek letter looking like this π.

"Now, you've got your average pressure and the area of the piston on which it pushes, but you have got to have the number of feet that the piston travels in a minute. In this case, with a 5-foot travel of the piston, which is half-stroke, one full revolution of the engine would be twice this. We would have a 10-foot travel of piston, or a 10-foot stroke. Supposing the engine turned 60 times a minute, we would then have 600 feet piston speed per minute. Then, multiplying all these together you would have $50 \times 1{,}017 \times 600$.

"Now we know that a horsepower is 33,000 pounds lifted 1 foot in a minute, so we would write it

$$\frac{50 \times 1017 \times 600}{33{,}000} = \text{horsepower.}$$

(We'll just leave off the decimal on the area.) Now, of course we can cross off some of the zeros above and below the line. We cross off the zero in 50 and the two zeros in the 600. That makes three zeros above the line; so we can cross off the zeros in 33,000, below the line. Then you would have

$$\frac{5 \times 1017 \times 6}{33}.$$

We take it this way, $5 \times 6 = 30$, and multiplying 1,017 by 30 we get 30,510. Dividing this 33 we get 924 and a little more.

"So the horsepower of the engine will be 924 and a little bit over, disregarding friction. Anything hard about that, Bob?"

"Nothng at all," was the answer. "But where do the letters come in? These are all figures."

"Oh," answered Jimmie, "that's just what I am going to show you. What I have explained is for one size of engine. Now, you want a formula that will give you the horsepower of any size engine, and the draftsman puts it down this way:

$$\frac{M.E.P. \times A \times S}{33{,}000} = \text{horsepower.}$$

Bob shook his head. "You can't get anything by multiplying S by A."

"No," answered Jimmie, "of course you can't, but you put it down this way:

$M.\ E.\ P.$ = mean effective pressure,
A = area of piston in square inches,
S = speed of piston in feet.

"So, then, for a general formula that will do for any engine you write

$$\frac{M.E.P. \times A \times S}{33{,}000} = \text{horsepower.}$$

"Now, all you've got to do is just as I have said. If you have another size engine with a different boiler pressure, what you have to do is to put down the average pressure over the M. E. P., put the area of the piston over A and the speed of the piston in feet over the S. (Of course, when you get used to it you won't have to put down the letters at all.) Thus:

$$\frac{\overset{25}{M.E.P.} \times \overset{314.16}{A} \times \overset{600}{S}}{33{,}000} = \text{horsepower.}$$

Cross off any ciphers you can, multiply all the figures above the line together and divide the result by the figure below the line and you get your horsepower every time.

"So you see in all these formulas you must know what the letters represent and then get the values of each in actual figures, just as I have shown you, and you can figure out anything that comes along."

Bob thought a little, then said: "Well, did he say anything about figuring out a boiler?"

"No," said Jimmie, "I didn't have time to ask him."

"I did," retorted Bob," and he said we were right in starting on the coal consumption per square foot of grate. Then we would have to figure out how much power we are going to get from that much coal burned on each square foot of grate, and divide the number of horsepower that we wanted to get in the boiler by this, and that would give us the number of square feet we should have in the grate.

"Next we would have to design the boiler so that the heating surface would be large enough to properly absorb the heat; then we would have to decide on how high a pressure we would have to have the steam, and we would have all the points we would need to get the horsepower. That would be on that side of it.

"On the other side we would have to start in and figure out what thickness of plate for the style of boiler we would have to have to stand the pressure and then figure on whether the seams should be single, double or triple riveted to hold up under the pressure. Then we would have to allow for what he calls a factor of safety. He said that meant that we must make the plates thick enough and the riveting strong enough not only to just hold the pressure before it let go, but a good deal more.

"Next he told me that in almost every State in the Union they had laws about boiler building, and lots of them differed from each other, so that a boiler that would pass inspection in one State might not pass in another, making a big mix-up, but lately the American Society of Mechanical Engineers had got up rules for boiler making which would be adopted by all the States sooner or later, and many have already done so. This will simplify matters a whole lot."

After a little reflection Bob seemed to think that with the books they had and what they could borrow they would be able to get started. "But," he said, "The very first thing we have got to do is to decide what style of boiler we are going to design and the size. I asked old man McCracken how his boss used to design boilers, and he laughed and answered, his boss stole them from other people's catalogues. I have noticed that the draftsman had a big stack of boiler makers' catalogues in the drafting room, and I guess there is a good deal of copying going on, anyway!"

(To be Continued)

Building Tube-Welding Fires

Preparation of Forge for Tube-Welding Fire—Building Up the Fire Pot—Shearing Corners from Plates

BY JAMES FRANCIS

"Henry, Oh, Henry! Have you built the fire on the tube-welding forge yet?"

"No, Mr. Francis, I'm just getting about that job now. You said you would show me how to build a fire which would run for two or three hours without getting out of shape—and I was born and raised in Pike County, Missouri, you know."

"All right, Henry, we'll build that fire. First, clean out the forge, way down to bed-rock. Don't leave anything loose on the forge. Get a couple of barrows and a No. 3 riddle. As you clean out the old fire, pass each shovelful over the riddle and let the fine stuff, the coal and ashes, fall into one barrel, while the coarser portions, those which won't pass through the riddle, are thrown into the other barrow."

"Say! You don't want all the dirt and ashes from the old fire, do you?"

"Yes, Henry, let it all go into the barrow of fines. There will not be too much of the stuff, if you carefully clean out the coke and the ashes therefrom before you sift out the rest of the stuff on the forge. It is only the banks of the old fire pot and their dirt and ashes which you are to save. Scrape out the pieces of large coke and throw them into the barrow for large pieces, then you can throw the coke ashes from the fire into the ash-barrow."

"What ash-barrow? We don't have any ash-barrow in our shop."

"You don't? Well, I would have one were I responsible for matters there. A large wheel-barrow with high sides is a mighty good investment in any boiler shop and should be located in some convenient place and always kept there while not in actual use. Then whenever there is a fire to be cleaned out, throw the ashes and dirt into the ash-barrow, which, when full, may be wheeled out and dumped by a laborer, who is given particular charge of that 'Irish buggy.' Then no ashes will be thrown on the shop floor and no time will be lost by one man and another having to carry out a few ashes. When there is but a shovelful of ash, see that it is carried to the barrow, but when a large forge

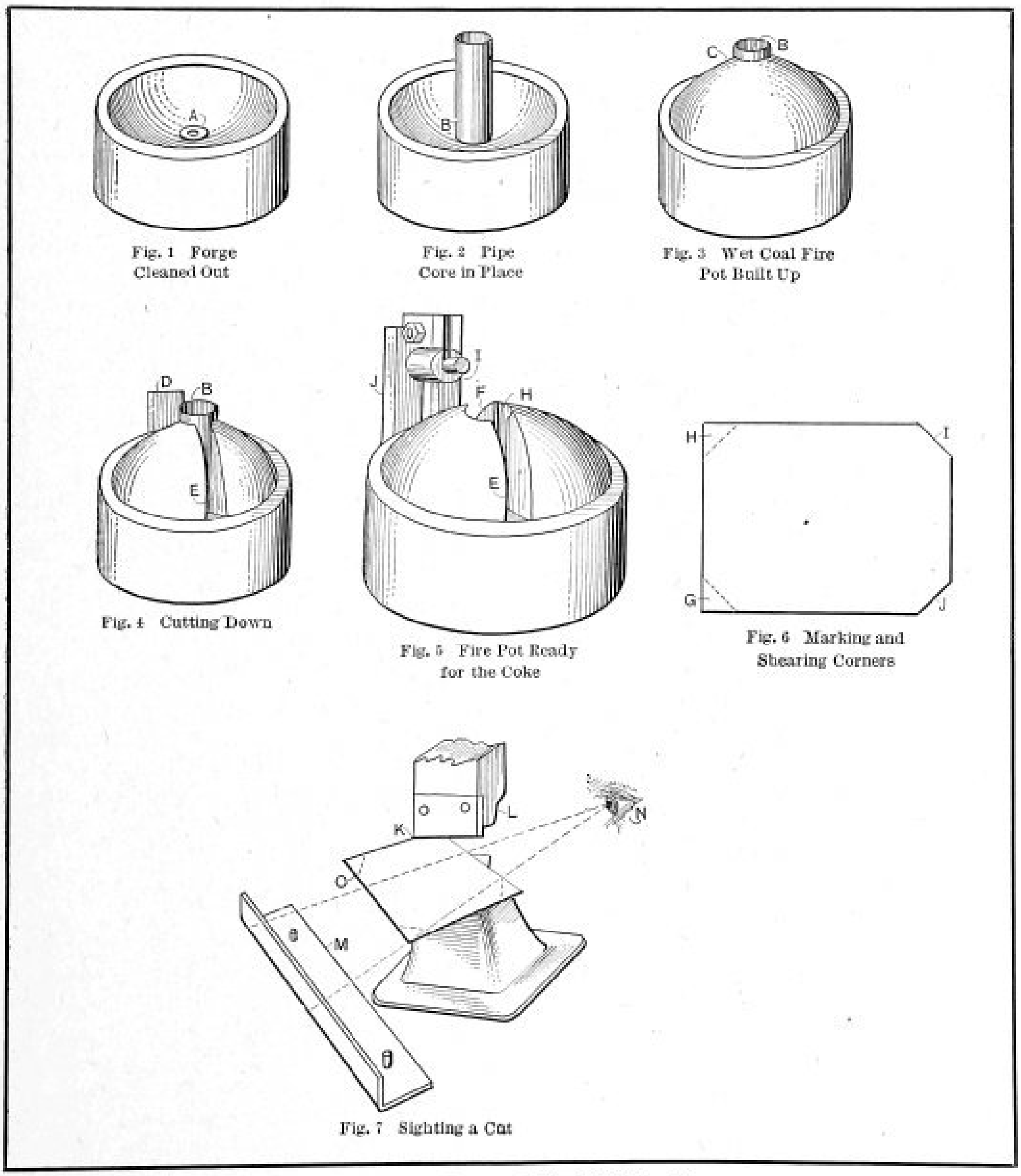


Fig. 1 Forge Cleaned Out

Fig. 2 Pipe Core in Place

Fig. 3 Wet Coal Fire Pot Built Up

Fig. 4 Cutting Down

Fig. 5 Fire Pot Ready for the Coke

Fig. 6 Marking and Shearing Corners

Fig. 7 Sighting a Cut

Building a Fire in Tube-Welding Forge

is to be cleaned out, make the men push the barrow up to that forge—and push it back to its place again after the ashes are placed in the barrow."

"Here, Mr. Francis, is the forge all cleaned out. Just look at Fig. 1 and see if that is the way it should be cleaned."

"That's good, Henry. When you clean out the tube forge, do a good job of it. Sweep the inside of the forge clean with a broom or a brush, for it is necessary that the fire pot which we will build up shall stick fast to the forge. There's nothing else to hold the fire-pot in place, but if the forge be well cleaned out and then wetted, the new fire-pot material will stick fast enough to stay in place during the tube welding.

"Look well to the air pipe opening *A* and see that it is clear and free from bits of coal or cinder. Turn on the blast by all means after you clean out a forge, and then, if needed, clean out the air-pipe, too!

"See that the forge is in good shape before you begin to build up a fire-pot. If the forge consists of a steel shell with brick lining, see that the bricks are all solid and in place. It only takes a very few minutes to mix up a little dab of Portland cement and with it plaster firmly any loose bit of brick in the forge. Sometimes a heavy blow from some piece of metal which is being handled around the shop will cause the forge bricks to become loosened, and this condition often causes the fire-pot to crumble and to burn out quickly. Touch up the forge with cement as it needs it and thus keep it in good condition always."

"Well, here is all the fine stuff from the old fire-pot, and I have put all the large bits, which would not pass through the No. 3 riddle, into the barrow with the pieces of coke which I picked out before I took away the old fire-pot."

"All right, Henry. Now push the barrow to the soft coal bin and get the No. 4 riddle and sift out enough of the fine bituminous coal to make up the quantity of material necessary for building the new fire-pot."

"Say, how much stuff do you want, anyway?"

"Why, Henry: you should know by this time just the amount of material which will be required to build the tube-welding fire-pot. If you have never noticed, take care this time to see how much the material makes when in the barrow; then on all other occasions you will be able to mix up just the right quantity. You have mixed the new, fine soft coal with the fine material from the old fire-pot? Good! Now wet the stuff in the barrow. Turn it with a shovel until it is all evenly moistened and until it is just wet enough to ball well when worked by the hands, same as if you were making a snowball. The ashes and old fine material make the new coal stick together well; therefore do not be afraid of getting too much ash in the firebox material."

"I think this will be about right. It cakes down well, and is pretty tenacious."

"Good! Wheel the barrow close to the forge. Place a piece of 7-inch pipe—8-inch for large tubes—over the air-pipe opening, as shown by Fig. 2; then begin to pack the wetted coal around the pipe. It is better to put the coal in place by handfuls, patting each handful snugly into place and making it firm and solid. There is nothing as good as the hand for this purpose."

"Shall I build the coal clear up to the top of the pipe?"

"No. Probably the pipe is 22 or 24 inches long. The forge casing is probably 6 to 8 inches deep, and you want to build the fire-pot about that distance above the edge of the forge. Therefore there will be about 16 inches of fire-pot and the rest of the pipe length will project above it and it will be handy to lay hold of when you are pulling out the pieces of pipe.

"One more thing, Henry. Don't build up the pot at first to its full height as shown by Fig. 3. If you do this, you will have to leave off the material which you cut out of the fire-pot, as shown by Figs. 4 and 5. After you have built up the fire-pot once or twice, you will know how much to allow for the material removed from the channels on either side; then you can stop the pot off at this level, as at *C*, Fig. 3, when building up the rounded mass of wet coal."

"What's the next thing, Mr. Francis? I have got the coal all patted firmly into place and am ready for the next move."

"Get a piece of thin sheet iron or steel, Henry. Perhaps a foot or 18 inches square, and use it as shown at *D*, Fig. 4, for cutting down through the coal on either side of pipe *B*. Make the cut wide enough to receive the tube which is to be welded. The channel need not be cut as wide for a 2-inch tube as for a 4-inch one; therefore, if you intend to weld several sizes of tubes with this fire, then make the cut for the smallest size tubes and weld that size first. The channel will gradually widen under the action of the fire and will become large enough to receive the larger sizes of tubes by the time the smaller ones have been welded. To be sure, if a set of 1-inch tubes are to be welded and immediately after some 6-inch tubes must be handled, it is not expected that the green coal fire pot will have burned out sufficiently to receive the larger tubes. In cases like this a bit of judgment must be used and the channel made wide enough to take the large tubes and let the small ones be heated in the channel too large for them."

"Well, what hurt is it, anyway, if the channel is too large for the tubes? They can be heated all right, can't they?"

"Sure, Henry, they can be heated all right, but we don't want to run a 7-inch fire for heating 2-inch tubes. It is for this purpose that the wet coal fire pot is built up—to confine the coke closely against the tubes, thus saving fuel and causing less discomfort to the workmen. When you heat small tubes in a big fire it requires just as much fuel and air to heat the small tubes as it would to heat as large tubes as could be placed in the channels."

"Oh, I see! You want to keep the channels *E* and *F*, Fig. 5, just as narrow as possible and let the tubes pass into them?"

"That's the idea, Henry. The heating is all done in the cavity formed by withdrawing the pipe *B* and the side channels are merely to let the tube get to the fire; therefore, make those channels as narrow as you can."

"You said not to build the cone too high, as shown in Fig. 3. What did you mean by that?"

"I meant to keep the height of the cone down sufficiently so that when the material removed from the opposite channels *E* and *F* has been placed on top of the material already placed, the cone will then be of the required height. And, Henry, when you build on this material, which you will remove by cutting down with the sheet iron, as shown at *D*; when you place this material on top of the cone, be sure to pat it down well and to round all the corners and edges. Don't leave any sharp corners, for they will crumble or burn off very quickly."

"Oh! You want me to round off all the edges and corners when I build on the material from the channels *E* and *F*? I see. That is easy. I can put the material into place and leave the edges well rounded so they will not burn off."

"That's the idea, Henry, and you must always take care to cut the back channel so the end rest *I* will project down into that channel. The stand *J*, Fig. 1, may or may not be fastened to the back of the forge. If it is, then so much the better, but however this stand may be located,

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take great care to cut the channels so the stop *L* may enter and slide freely therein, for we don't want to cut away the walls of a fire pot in order to adjust the stop against which the end of the tube bears during the heating process."

"Is the pot all right as shown by Fig. 5, Mr. Francis?"

"Yes, Henry, that will do first rate. And now you can build the fire. Get a bit of greasy waste or a dirty wipe rag from the can in which such things are kept. Always see that all greasy fabric, even in a boiler shop, is kept in a tightly closed metal can, where it, if ignited, cannot set fire to the building or its contents.

"If you have no greasy rag or waste, squirt a little black oil on a piece of paper which has been crumpled up between the hands. Place the oily paper or fabric in the hole *H*, ignite it over air-hole *A* and turn on the faintest possible blast—just enough to keep the grease rag burning. Then carefully pile small pieces of coke upon the burning grease rag. Increase the blast slightly and when the coke ignites put on more blast and continue piling on coke and increasing the blast until a full fire has been secured, which should not require more than four or five minutes from the time the grease rag was ignited."

"Say, will such a fire pot last two or three hours? I don't see why it should. The coal must burn out eventually!"

"Henry, a fire pot built up thus from fine wet coal and ashes will burn out, to be sure, but it burns very slowly indeed. If it still burns out too fast, then add more ashes to the fine coal next one you make, and you will soon find a mixture which will hold its shape well and resist the action of fire for a considerable time."

"Might mix a little cement with the coal, or a bit of calcined plaster. That would stand fire quite awhile."

"Yes, but that would mean a lot of work when cleaning out the old fire pot before starting a new one. The mixture of coal and ashes will do all that is needed if you once get the "knack" of putting up the fire pot properly."

"Much obliged, Mr. Francis, for the fire pot. Wish I could get away with my next job as easily! I have got 600 plates, about 24 inches by 30 inches, to be marked and have all four corners sheared off. And, I tell you, it is some job to mark 2,400 corners and then shear to the marks. It would be better if they put the small shear where a man could see something without holding an electric lamp to the job all the time!"

"How's that, Henry? 2,400 corners to mark and shear to a line? Say, can't you make that job a bit easier somehow?"

"Well, I don't see any easier way than to mark and shear the corners off."

"Let's see. Fig. 6 shows the work, does it? Have to mark the corners as at *G* and *H*, then shear them off as at *I* and *J*?"

"That's the stuff exactly; and it's a whole lot of monotonous work, too."

"You can do that work in an easier manner, Henry. I have seen similar work done in a manner similar to that shown by Fig. 7. In this picture the plate to be sheared is shown, all marked, at *O*, and under the cutter of the small shear, shown at *L*. The manner employed in this method is to push the plate squarely against the shear until the point where the cut was to begin comes against the cutters, as shown at *K*. But the plate may be pushed in square, not at an angle, as shown for Fig. 7. This is done after the blade *L* has been brought accurately against the beginning of mark *K*."

"Then, what's the use of marking the plates clear across the corner which is to be cut off? Why not just make a straight mark where the cut is to be started, a mark square with the edge of the plate?"

"This could be done, Henry, only it is more work to mark the plates thus than it is to mark them to a templet with the corners cut off, as was done to the plate shown by Fig. 6. Therefore, we will mark them as shown by Fig. 6 and shear according to Fig. 7."

"What do they do in this picture? Sight the cut into line?"

"That's just what, Henry. A plate is brought into position in the shear, all alined up ready to be cut, and is blocked there. Then the angle *M* is placed on the floor as shown, and sighted into alinement with the edge of the plate. The angle is so adjusted that the vertical side points exactly to the edge of the plate to be sheared, then the angle is fastened to the floor by the pins shown."

"Well, how do they work it after that?"

"Why, just sight each sheet into line with angle *M*, the eye being kept vertical with the vertical edge of the angle as shown at *N*. You can shear the plates mighty fast if you rig up like that."

Care of Marine Boilers

Boilers are the most expensive and perishable parts of the machinery of a steamship, often requiring to be replaced twice, and sometimes three times, during the life of a vessel. Deterioration and decay begin as soon as the boilers are put in use, and are only partially prevented by care on the part of designers and engineers. At the present time the demand for large and fast steamships necessitates the use of boilers of great size and cost. The attention of builders and owners is therefore directed to keeping this portion of the machinery up to the highest point of utility for the longest period at the least expense.

Twenty years ago eight years' work was considered a good average for a marine boiler, but the period of usefulness has been increased about 100 percent in recent years. This gain is due in a measure to the improved design and construction; but more probably to the more intelligent care bestowed upon them by modern engineers.

The first and simplest thing to guard against is external corrosion. This arises from various causes, drips from leaky decks, leaky screw staybolts, leaky handhole plates, joints, stuffing boxes, etc., and from a cause so apparent that it would not be noted if it did not occur so often, namely, the neglect to waterproof portions of the boilers directly under hatch openings.

There is no good reason for the existence of any of these causes of corrosion, yet they do exist and create a constant demand for the "soft patch." The most serious point of external corrosion is the front of the ash pit and the adjacent portion of the boiler head.

It may be counteracted in part by the persistent use on the ash pit fronts of the waste oil and grease from the engine room. A better method of protecting this part of the boiler, though seldom applied, is to fit soft patches or wearing plates of 5/16-inch iron over the seams connecting the furnace to front head, and extending over the lower part of the front head to take in the front seam of the shell. This should be done when the boiler is new, and, although these wearing plates will last only a few years in active service, their renewal is simple and inexpensive; therefore, to be strongly recommended. Four years' wear in hard service has been obtained from the wearing patches by keeping them smeared with the waste oils from the engine room.

With ordinary intelligence bestowed upon the care of marine boilers, there is no reason why their period of usefulness should be shortened by external decay. Internal decay is a much more serious matter.

The Boiler Maker

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NOTICE TO ADVERTISERS

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 25th of the month, to insure the carrying out of such instructions in the issue of the month following.

The annual convention of the American Boiler Manufacturers' Association will be held on June 25 and 26, 1917, at the William Penn Hotel, Pittsburg, Pa.

The annual convention of the Master Boiler Makers' Association will be held on May 22 to 25, 1917, at the Jefferson Hotel, Richmond, Va.

Readers of The Boiler Maker will be gratified to learn that the Ohio Board of Boiler Rules, at a special meeting held on December 21, 1916, unanimously adopted the American Society of Mechanical Engineers' boiler code in so far as the same relates to the construction and installation of new boilers. These rules will take effect on July 1, 1917.

This action by the Ohio Board of Boiler Rules is in accordance with the resolutions adopted by the American Uniform Boiler Code Congress, held at Washington, D. C., on December 4 to 6, and which read as follows:

"*Whereas,* It is the belief of this Congress that all States will in the near future adopt rules regulating the construction of steam boilers, and

"*Whereas,* A number of States and cities now have rules that differ slightly from one another, so that interchangeability is impossible, and

"*Whereas,* The American Society of Mechanical Engineers, after many years' experience of careful study and consultation with the best authorities, has compiled a code governing the construction of boilers and has made provision for a conference to be composed of members from States that adopt this code, thus providing for its uniform administration, and

"*Whereas,* This code has been adopted by several States while any other code now in existence is applicable only to its own State or Territory, and

"*Whereas,* Slight differences in construction militate against the economy and efficiency of the manufacturers, as well as being detrimental to users, therefore be it

"*Resolved,* That it is the sense of this Congress that this Congress recommend that all States adopt as their standard the American Society of Mechanical Engineers' boiler code, thus bringing standardization, free interchangeability of boilers and efficiency together, to the end that the manufacturers, users and inspectors may profit by the advantages of uniformity."

In the interests of uniformity and standardization, the State of Massachusetts has decided to accept the American Society of Mechanical Engineers' boiler code. This step was announced at the Uniform Boiler Code Congress in Washington last month by Mr. George A. Luck, deputy chief of the Boiler Inspection Department of Massachusetts. It will be remembered that Massachusetts was the first State to establish a boiler code and to put into effect an adequate system of boiler inspection. The fact that the leading exponent of this movement should be willing to compromise its requirements in conformity with those which are being widely established through the country gives a decided impetus to the successful progress of this important movement.

A tax on intelligence and education was proposed in Congress on December 9 in the form of a rider to the post-office appropriation bill, proposing to apply the zone system as applied to parcel post to all second class mail matter.

If this bill is enacted, the result will be that instead of the present flat rate of one cent per pound for postage for the delivery of The Boiler Maker to its readers in any part of the United States, the postal rate will be based on the distance of transportation of the magazine. In other words, those living remote from publication centers will be taxed as high as six cents per pound postage on all of their magazines, periodicals and newspapers, whereas those living within a 300-mile limit of the publication centers will still have the benefit of present second-class rates.

The proposed act permits free delivery in the county for weekly newspapers in spite of the fact that a large part of the circulation of the county weekly is by rural free delivery, which is the most expensive part of the postal service, and, therefore, robs the amendment of any claim to proportion the postage rate in accordance with the cost of delivery. Moreover, it can easily be demonstrated that the cost of delivery depends upon the number of handlings rather upon the distance of transportation.

We cannot believe that any of our readers will willingly submit to such an unfair and unjust method of taxation. To prevent this, write or telegraph immediately to your congressman expressing your disapproval of this measure.

Federal Locomotive Boiler Inspection

The fifth annual report of Mr. Frank McManamy, chief inspector of locomotive boilers, of the Interstate Commerce Commission, for the fiscal year ended June 30, 1916, just published, gives a detailed statement of all accidents resulting from failure of locomotive boilers and their appurtenances which occurred during the year, and of all accidents resulting from failure of any part of locomotives or tenders which occurred since the law became effective. A summary of the tabulated data shows that during the year 52,650 locomotives were inspected, 47 percent of which were found defective. One thousand nine hundred and forty-three were ordered out of service for repairs.

During the year there were 537 accidents resulting in the death of 38 persons and injury to 599 others. Briefly summarizing the accidents and casualties caused by failure of locomotive boilers and their appurtenances only, there were 352 such accidents with 29 killed and 407 injured thereby. This is a decrease over the preceding year in the number of accidents and in the number of casualties, but an increase in the number of killed. This increase in the number of fatalities is due almost entirely to one single class of accidents, namely: crown sheet failures, due to low water where contributory causes or defects were found, and forcibly emphasizes the importance of properly maintaining water gages and boiler feeding appurtenances. Accidents classed as boiler explosions and causing deaths and injuries numbered 41, with 20 killed and 64 injured.

BOILER EXPLOSIONS

	Accidents	Killed	Injured
Crown sheet; low water; no contributory causes found	23	7	38
Crown sheet; low water; contributory causes or defects found	16	13	21
Firebox; defective staybolts; crown stays or sheets	1	..	3
Firebox; water foaming	1	..	2

The total number of defects found in various parts of the boiler and its appurtenances were as follows: Arch tubes, 201; ash pans or mechanisms, 38; blow-off cocks, 1,005; boiler checks, 1,087; boiler shell, 2,031; crown bolts, 686; domes or dome caps, 444; firebox sheets, 2,022; flues, 798; steam gages or gage fittings, 1,700; gage cocks, 3,244; handholes, 297; mud rings, 1,419; plugs or studs, 412; safety valves, 223; staybolts, 1,133; staybolts, broken, 9,989; telltale holes, 906; washout plugs, 1,999; water bar or combustion flues, 105; water glass fittings or shield, 2,342.

The order of the Commission of June 9, 1914, fixing the minimum factor of safety for old locomotive boilers requires all such boilers to be brought up to the established standard within certain definite periods, those with the lowest factors being taken care of first. With few exceptions satisfactory progress is being made by the carriers in complying with the requirements and the indications are that all boilers will be brought up to the established standard within the limits set. The reports also disclose instances where improper repairs are made before failure occurs, and have brought about practically standard methods of repairing defects which affect the factor of safety of the boiler.

Boiler Explosion at Jackson, Tenn.

(Communicated)

Referring to the account of the boiler explosion at the plant of the Harlan-Morris Manufacturing Company, Jackson, Tenn., as given by James T. Phillips on page 357 of the December issue of THE BOILER MAKER, we wish, in justice to the magazine as well as to the Hartford Steam Boiler Insurance Company and to our firm, to correct some of the statements made therein.

It is stated that "most practical men believe the cause of the explosion to have been low water." Out of twenty-seven experts, all came to the conclusion that absolutely no sign of low water was in evidence. As far as the tubes being corroded and wasted away is concerned, all the tubes and boiler parts are intact at our plant now, as all rubbish was stored away and every boiler tube is almost perfect. There was not a sign of corrosion on any of the tubes or boilers.

It is also stated by Mr. Phillips in his article that the night watchman stated that the gage showed 110 pounds pressure at 6.30 o'clock that morning. As a matter of fact only 90 pounds of steam was carried, and the gage when tested after the explosion showed that it popped at 90 pounds. Therefore, it would have been an impossibility for the boilers to carry 110 pounds pressure.

Concerning Mr. Phillips' statement regarding the employment by this firm of cheap labor, we wish to say that we employ the best labor obtainable. All employees are old and reliable men, some having been with us twenty years.

Thus far no expert has been able to say positively what caused this explosion, but it certainly was not low water or corrosion of the boilers or tubes.

Jackson, Tenn. M. MORRIS,
Secretary and Treasurer Harlan-Morris Manufacturing Company.

A Correction

In Table 3, printed on page 321 of our November, 1916, issue, as part of the article on "Welded Joints in Tank Construction," by William Eichhoff, M. E., several errors appear in the second column under the heading "Condition of Coupon." In the sixth line of the table giving data for coupon No. 6-A, the condition of coupon should read "welded, annealed, hammered." In the eighth line, giving data for coupon No. 8-A, the condition of coupon should read "double lap weld," and in the twelfth line, giving data for coupon No. 12, the condition of coupon should read "riveted 5/8-inch rivet." The letters "E" and "A" used in designating these coupons refer respectively to "electric arc welded" and "oxy-acetylene welded" coupons.

PERSONAL

Charles B. Rearick, formerly sales manager of the Covington Machine Company, 14 Wall street, New York, has been elected vice-president and manager of the company, with headquarters in Covington, Va.

Charles H. Bird, connected with the Pangborn Corporation, Hagerstown, Md., some years ago as sales manager, for the past year with the Mott Sand-Blast Company, resigned on January 1 to become associated again with the Pangborn Corporation as vice-president and works manager in charge of engineering and production.

FACTOR OF SAFETY FOR STATIONARY BOILERS AND AIR RESERVOIRS.—The factor of safety for all new stationary boilers and air reservoirs that may be purchased or built by the Santa Fe Railway Company must be not less than 5 and all repairs made on the same must be equal to a factor of safety of 5. No stationary boiler or air reservoir is allowed in service with a factor of safety less than 3 nor is any stationary boiler or air reservoir allowed to be turned out of a shop after being repaired the factor of safety of which is less than 3½.

Questions and Answers for Boiler Makers

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

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

Address your communication to the Editor of the Question and Answer Department of The Boiler Maker, *461 Eighth avenue, New York city.*

Size of Disks for Circular Flue Sheets

Q.—I am an apperentice, working at present on the laying-out bench. Some of the work we are now doing consists in laying out the disks for circular flanged heads. I am anxious to know how to make the proper size of a disk for a head 65 inches outside diameter, having a 4½-inch flange turned to a ¾-inch radius at the inside of the head, plate thickness equals ½ inch, and the heads are to be formed on a hydraulic press. M. E. M.

A.—The drawing Fig. 1 illustrates a section as taken through the center of such a head. In this problem, where plate thickness enters into the work of forming, certain allowances must be considered. In turning a flange for circular heads of heavy plate there is a tendency, when the clearance between the internal and external dies is slight, for the depth of flange to increase in

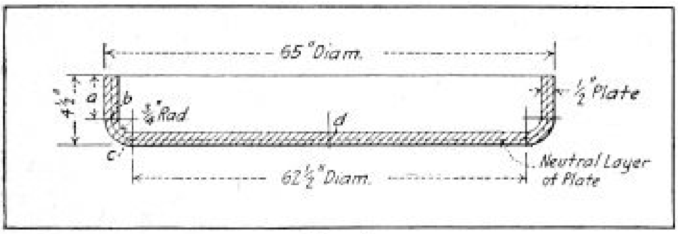


Fig. 1

length. With a slight clearance there is not room for the plate to gather and become thicker at the root or curvature of the head; therefore the metal flows, so to speak, into the depth of the flange and makes it longer than necessary. When the clearance is quite large between the dies there is a tendency of the plate to gather at the root of the flange while being formed. For heads formed in dies with a small clearance between them, subtract one-half the plate thickness from the calculated radius. For heads formed in dies with considerable clearance the best plan to pursue is to flange one head to the calculated dimensions and then note the depth of flange and make such allowance as necessary to take care of the gather. The following is given for the example in question:

It is advisable to make the calculations from the neutral layer of the plate, for at that section the plate neither gains nor shortens in length when being formed. First find the length of distance *a* shown on the sketch, which equals $4\frac{1}{2} - (\frac{3}{4} + \frac{1}{2}) = 3\frac{1}{4}$ inches. The length of the arc *b-c* equals

$$\frac{3.1416 \times 1}{4} = .7854 \text{ inch.}$$

Length of distance *c-d* equals

$$\frac{65 - 2 \times (\frac{3}{4} + \frac{1}{2})}{2} = 31\frac{1}{4} \text{ inches.}$$

Then the neutral radius of blank equals $3\frac{1}{4} + .7854 + 31\frac{1}{4} = 35.2854$ inches. From 35.2854 subtract one-half of the plate thickness (which equals ¼ inch). Then $35.2854 - \frac{1}{4} = 35\ 1/16$ inches, radius of disk.

Factor of Safety

Q.—Will you kindly let me know the simplest way to figure the factor of safety for locomotives and watertube boilers; also for return tubular boilers built before 1911 and after 1911? A. B.

A.—The ratio of the stress which will rupture a boiler to the stress allowed on a boiler under working conditions is the factor of safety. For example, the bursting stress on a given boiler was found to be 750 pounds per square inch. It was allowed a working stress of 150 pounds per square inch; what factor of safety was employed in determining the safe working pressure?

$$750 \div 150 = 5, \text{ factor of safety.}$$

The practice in many places is to use a factor of safety ranging anywhere between 4 and 6, while in some localities it is fixed by law to be a certain factor for all parts of the boiler. The A. S. M. E. code rules prescribe for all new construction a factor of safety of 5. For boilers in service one year after their rules become effective shall be operated with a factor of safety of at least 4. Five years after their rules become effective the factor of safety shall be a least 4.5. Furthermore, the code prescribes the following on existing installations: In no case shall the maximum allowable working pressure on old boilers be increased unless they are being operated at a lesser pressure than would be allowable for new boilers, in which case the changed pressure shall not exceed that allowable for new boilers of the same construction.

Layout of Irregular Pipe Connection

Q.—Will you kindly show how to develop the patterns of a cone and pipe, the pipe being round at the top and oblong where it miters on the cone. The center line of the pipe is at an angle of 60 degrees with the side of the cone, as shown in the sketch. Boiler Shop.

A.—The dimensions of the object are given in Fig. 1, and it will be seen that in order to lay off the miter between the two connecting pieces several steps in the construction are necessary; therefore, to bring out the different features, I have indicated each step separately.

The first is shown in Fig. 2. In this case we will

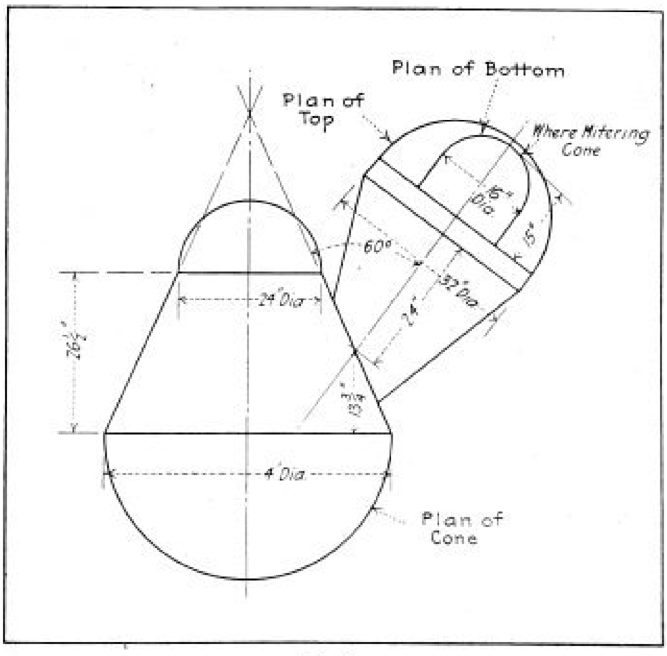


Fig. 1

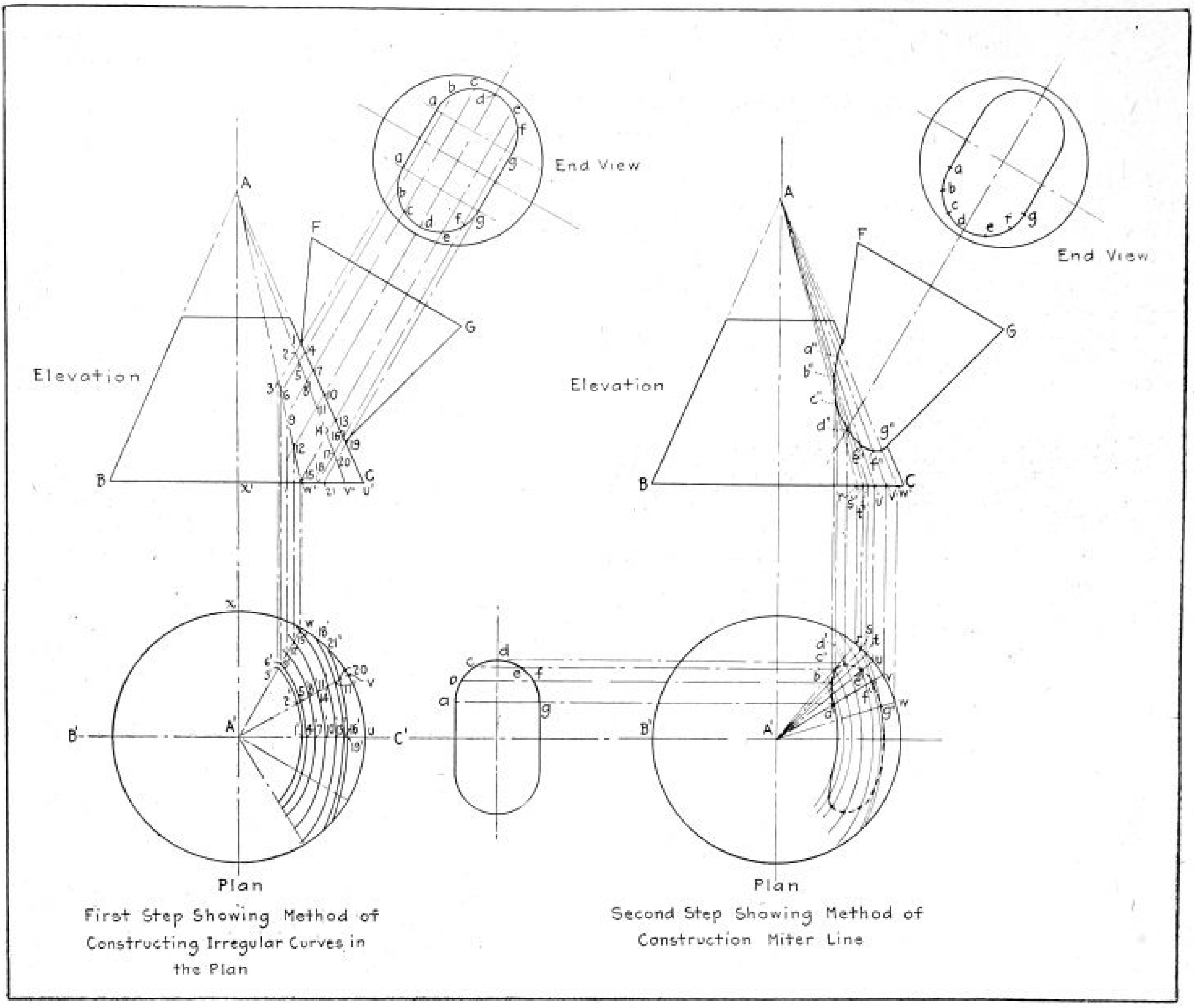


Fig. 2 Fig. 3

consider the oblong section to be straight pipe of that shape and to be passed directly through the cone at the angle shown. In passing this object through in this manner imagine the oblong pipe to be divided into sections as *a-a*, *b-b*, *c-c*, etc. These sections, we will say, are flat strips or planes. By passing these through the cone it is clear that they will cut the surface of the cone and produce sections of it which are irregular in form. These sections are shown fore-shortened in the plan. To secure their shape and position in the plan, first divide the circle, plan view, into a number of equal divisions, as shown at *u-v-w* and *x*. Connect these points with the center A'. Locate their position on the base of the cone in the elevation at v', w', etc. Connect them with center A, thus locating elements of the cone. Now find the intersections between these elements and the planes *a-a*, *b-b*, *c-c*, etc., as shown at 1, 2, 3, 4, 5, 6, 7, etc. Parallel with the axis A-A' draw verticals from these points to intersect at $1'$, $2'$, $3'$, $4'$, $5'$, $6'$, $7'$, etc., on the corresponding elements in the plan view. Draw in the curved sections.

The second step is shown in Fig. 3, which is a reproduction of Fig. 2, but in this case the object is to show the method of laying off the miter, which is as follows: First draw the profile on line $A'B'$ of the small end of the intersecting pipe. Arrange the points *a-b*, *c-d*, etc., to correspond with those of the end view in the elevation. Parallel with $A'B'$ draw horizontal lines from a, b, c, etc., of the profile to intersect the irregular curves at a', b', c', d', etc. Draw in the irregular curve as shown. Through the points a', b', c', d', etc., draw the radial lines A'-r, A'-s, A'-t, A'-u, etc. From points r, s, t, u, v and w erect perpendiculars to the horizontal line $A'B'$ to intersect the base of the cone in the elevation at r', s', t' u', etc. Connect these points with radial lines to the apex A. Then erect vertical lines from points a', b', c', d', e', f' g' to intersect the corresponding elements in the elevation, thus fixing the points a'', b'', c'', d'', e'', f'' and g'', completing sufficient data for drawing in the miter.

Development of Patterns. The third and final step in the layout is the construction of the true lengths of lines for finding the shape of the patterns for the irregular connecting piece and the opening in the pattern of the cone to receive it, as shown in Fig. 4. First divide the circle end view into the same number of parts as in the oblong profile, as at 1, 2, 3, 4, etc. Connect these points with those on the oblong profile as shown. Locate their position in the side elevation of the object. At right angles to its axis, side view, develop the triangles, the basis of which are taken from the end view and their corresponding heights from the side view, as illustrated. Before laying off the pattern, however, first develop the irregular hole in the pattern of the cone as follows: With the outside element of the cone as a radius describe an arc, making it equal in length to the circumference of its base

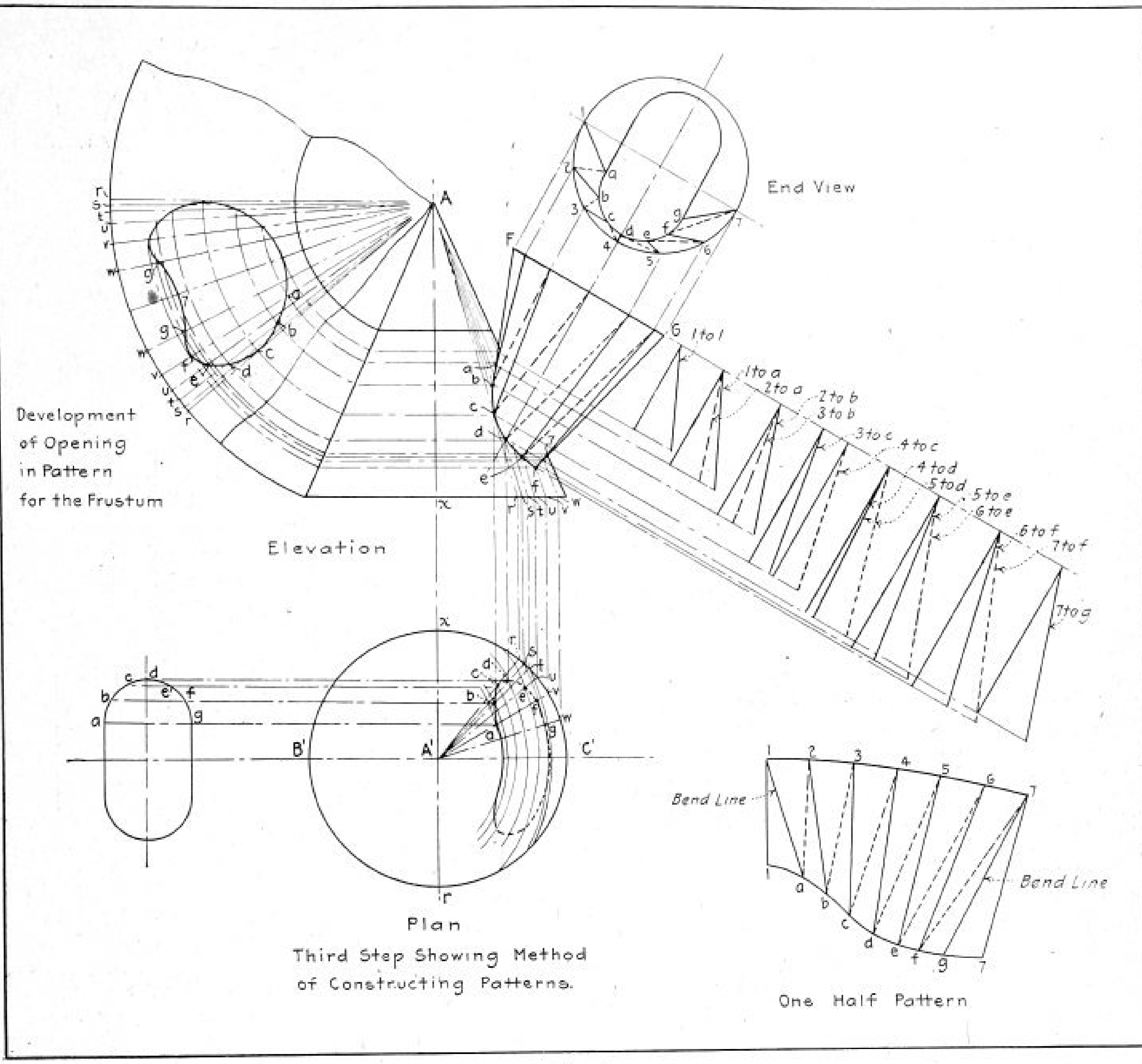


Fig. 4

plus allowances for lap. Draw in a radial line as *A*-7 and from it lay off the arc distance between the points *c*-*w*, *w*-*v*, *v*-*u*, *u*-*t*, etc., of the plan. Then draw the radial lines from these points in the pattern connecting with center *A*. Horizontal lines parallel with the base of the cone are then drawn to intersect the outer element as represented. With *A* as a center draw arcs from these points on the outer element to intersect the radial lines in the pattern as at *a*, *b*, *c*, *d*, etc. Use the arc lengths between these points in developing the pattern for the irregular connection. With the true lengths of the lines in the triangles the patterns can now be developed. As the lines are all numbered, no difficulty should be found in arranging them in their proper places. Add sufficient material for the flange connection where the object joins the cone, also for the side lap.

Layout of Elbow Section

Q.—Will you please show a method of constructing the miter and patterns for the elbow connection shown in the accompanying sketch? Drawing referred to is Fig. 5. J. T. G.

A.—This problem can be laid off conveniently by the projection method, as shown in Fig. 6. The first step is to lay off the axes *r*-*r*, *s*-*s* and *t*-*t* in their proper positions. About them construct the sections *A*, *B*, *C* and *D* of the elbow and the intersecting pipe *E* to the given dimensions

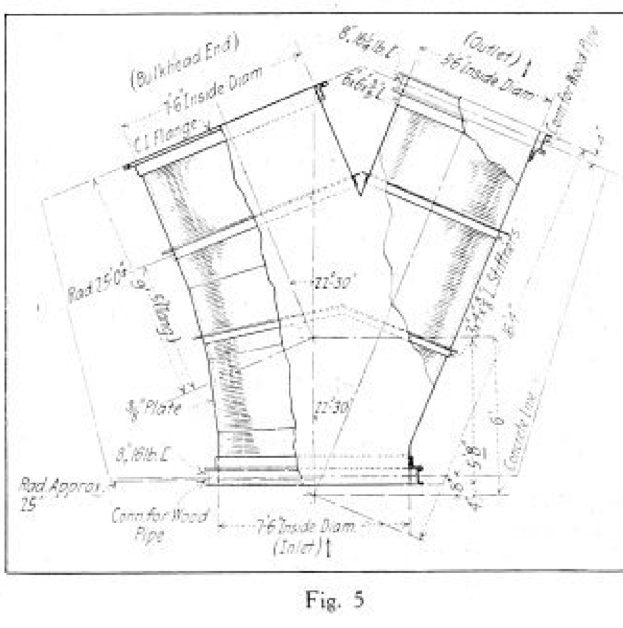
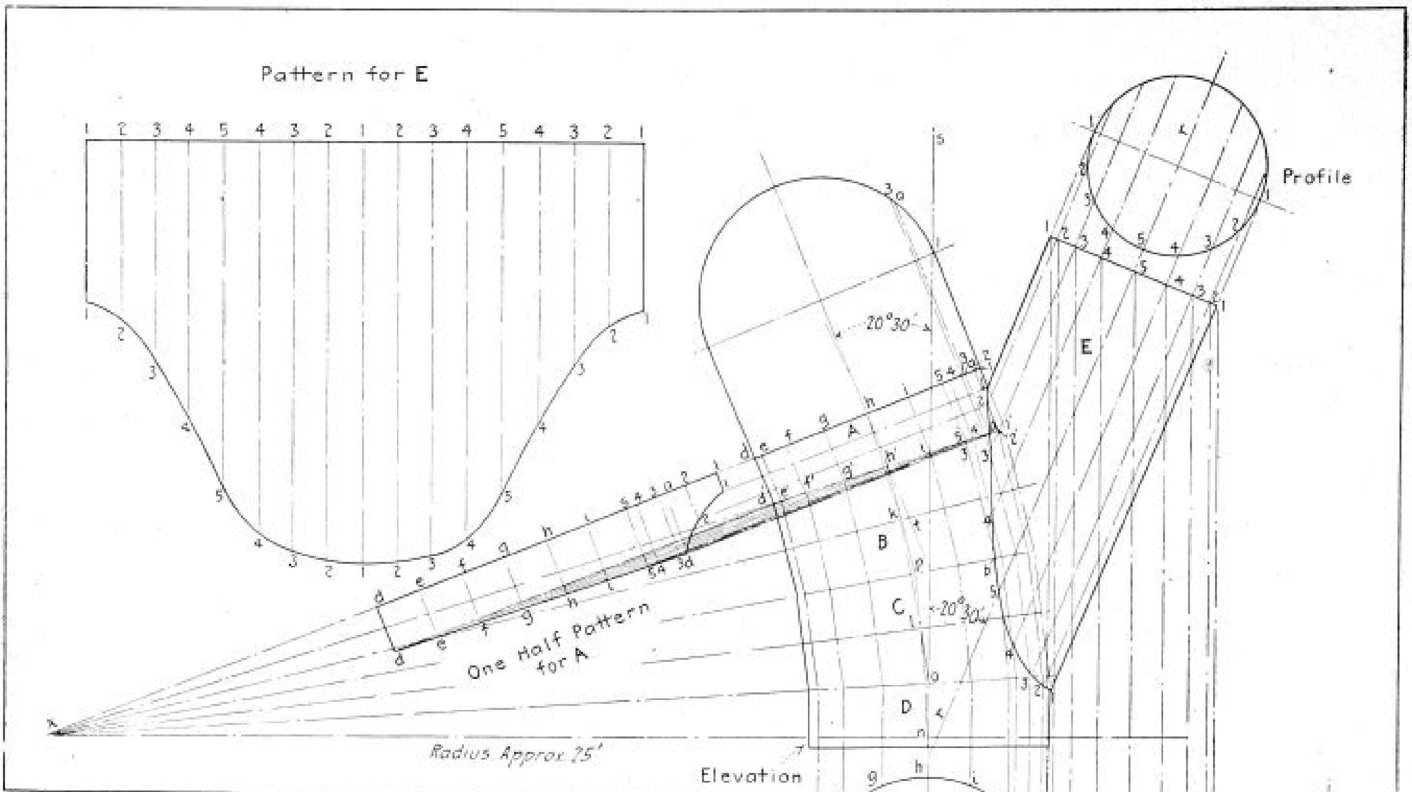


Fig. 5



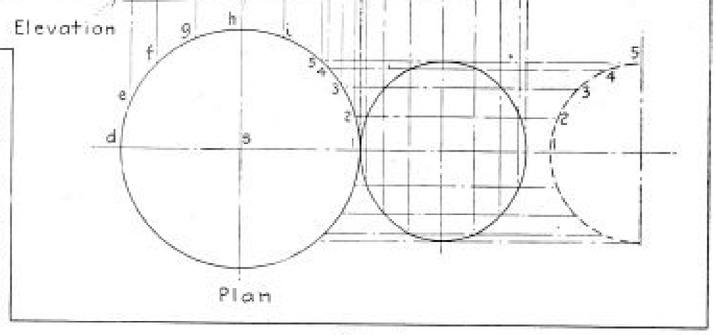


Fig. 6

in Fig. 5. Before the elbow sections can be assembled to give the proper degree of curvature, first draw an arc at the center of the elbow from points *h* to *M*. Divide this arc into one less than the number of sections required, which in this example is 3, as shown from *h* to *K*, *K* to *L* and *L* to *M*. Bisect the arc *LM* at *O*. From *O* step off with the compasses the distances *O* to *p* and *p* to *h'*. Through points *h' p* and *o* draw radial lines connecting with *x*. The miter lines are a part of the radial lines drawn through *h'p* and *O*. Set off from *h* the distance *h-d* and *h-l* equal to one-half the diameter of the elbow. From *d* parallel with the line *h-h'* draw *d-d'*. On the opposite side draw the line *l-l'* parallel with *h-h*. Perpendicular to the radial line *x-k* draw lines from points *d'h'* and *l'* to intersect the radial line *x-p*. Continue in this way until the outline of the elbow is found. Upon the axis *r-r* draw the profile of pipe *E*. Divide it into equal parts as from 1 to 5, etc. Parallel with *r-r* and from points 1, 2, 3, etc., of the profile draw the lines shown. Locate in the plan the line *d-l-l*. With *s* as a center describe an arc equal to the diameter of the elbow. Draw a one-half profile of the section *E* to locate points 1, 2, 3, 4, 5, etc., its center being located on the horizontal line *d-l*. The ellipse shows the shape of the end of pipe *E* in looking directly down upon the pipe. It is not necessary in developing the problem to show this view. Parallel to line *d-l* draw horizontal lines from the points 1, 2, 3, 4 and 5 to intersect the large circle in the plan view. Erect perpendiculars from these points on the circle to intersect the corresponding construction lines of pipe *E*, thus establishing the points for drawing in the miter, as illustrated.

The pattern for E is shown fully developed and the arrangement of the lines clearly indicate the method to pursue in its construction. Make the stretchout line *l-l* equal to the result obtained by multiplying the neutral diameter of the pipe times 3.1416; this insures a correct length for the flat plate, so that when the plate is rolled the cylinder will be of the proper diameter.

The pattern for A is a one-half section, the other half being the same; its shape will be understood from the drawing. Lay off the stretchout equal to the product obtained by multiplying the neutral diameter of the circle plan view times 3.1416. The distances between points *d-e*, *e-f* and *f-g* are equal to the arc distances between the corresponding points in the plan. The position of the lines and the projectors drawn at right angles to the axis *h-h'* show how the miter line should be laid off. The patterns for *B*, *C* and *D* are to be laid off in a similar way. The seam lines for the sections can be placed at the discretion of the layerout, but they should be so arranged as to break; that is, so as not to have a continuous seam running along the length of the elbow. Make the necessary allowances for laps to the developed patterns.

FIREBOX INSPECTION.—Any inspector examining a firebox for defects, other than broken or defective staybolts, should look carefully for bulges, corrugations and deposits of clinker or honeycomb in any part of the firebox, crown sheet, arch tubes or other parts, as these are fairly sure indications of scale forming on the water side. Leaky staybolts, crown bolts, seams, flues or cracks developing in the sheets around the staybolts are almost certain evidences of mud or scale accumulating and should receive prompt attention and the cause of the defects removed. Special attention should be given to those parts of the firebox where it is obvious that the interior of the boiler cannot be readily reached by the washout nozzle, and any indication of overheating should at once be investigated. Leaks are suggestive of overheating from some cause; either of dirt accumulating or improper drafting, and every effort must be made to ascertain the cause and to apply the proper remedy before serious defects develop.—*From Rules of the A. T. & S. F. Railway System.*

Letters from Practical Boiler Makers

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

Boiler Compounds

I have read with interest the communication on page 367 of your issue for December, 1916, on the subject of boiler compounds, contributed by Mr. A. L. Haas.

My first inclination after reading this expression of opinion was to allow it to pass as one scarcely worthy of comment, but after further thought it occurred to me that since the contributor in question is partially correct, the wrong statements should be pointed out. This is because I feel that there is nothing so dangerous in technical literature as the positive and partially correct statements of a writer. The article, which is all wrong in its statements and conclusions, will do no serious harm, because the reader who has the slightest knowledge of the subject will discover the fallacies and will not be misled.

Mr. Haas speaks deprecatingly of the "magic of the solutions, various proofs of which are offered as examples, certified copies of analyses (not of contents) showing that the material is not injurious to boiler plate * * *, etc.

What in the world does Mr. Haas mean by differentiating between "analyses" and "contents"?

My experience is that the chemical manufacturer who is willing to present a certified copy of analysis is not claiming any "magic," but is making a bid for business on a square and honest basis. Too frequently, on the contrary, the manufacturer refuses to furnish an analysis, claiming secrecy.

The above is not important in this discussion, except to show the warped view of your contributor, but Mr. Haas goes further in his remarkable contribution. He positively defines the boiler as "a vessel used to raise steam, and not a place to carry out chemical changes," and later on he speaks of it as "not a combination of a chemical factory and a steam raiser."

If Mr. Haas can design or operate a steam boiler which does not depend upon chemical reaction from the very lighting of the fire to the issuance of the last steam from the header, he is certainly a remarkable man. It should not be necessary to point out to your readers that, on the contrary, the raising of steam in steam boilers is absolutely founded and based on chemical reactions.

Mr. Haas recommends the chemical treatment of "bad" feed waters before they enter the boilers, through the use of chemical reagents with "reaction tanks, settling tanks, precipitation and filtration," and makes no exceptions, and further states, or at least implies, that all "bad" feed waters involve for their treatment the expense of treating plants, in which the results can be successfully guaranteed. He goes further and applies the above to the operation of locomotive boilers.

It was just such positive and ill-considered advice which caused the railroads, a number of years ago, to install hundreds of thousands of dollars' worth of treating plants to avoid the use of compounds in boilers, only to find that frequently the necessity for the compounds in the boilers was more marked than ever, after the water had been treated, and only to find further that numbers of these costly treating plants could not be operated at all without practically suspending locomotive boiler operation where their water product was used.

The dangerous feature of such advice as above stated is in its partial correctness. There are many treating plants on the railroads of this country which are performing the duties expected of them, and from which the benefits derived are being enjoyed, but when, on the strength of the performance of these treating plants, it was assumed that all "bad" water could be treated thereby, a very serious mistake was made, and a costly mistake it was.

Mr. Haas seems to believe, or at least the reader is led to assume from Mr. Haas' article, that these "bad" feed waters, after being run through a treating plant have all their "badness" taken out of them, and that boiler troubles accumulating from "bad" feed water will have disappeared. Certainly he must know that the chemical reagents used in the stationary treatment are not all settled out of the water before it goes into the boilers, and that upon going into the boilers they do not leave with the steam, but remain in the water to gradually concentrate as more water is introduced. If he had a "chemical factory" before, he certainly has one of double capacity now.

He speaks of corrosion and appears to assume that all corrosion is due to something in the water which can be taken out. I cannot help but wonder how he explains very serious corrosion which is so frequently found in locomotive boilers using waters so chemically pure that the most wild-eyed treatment plant fanatics could not recommend outside treatment.

The facts of the matter are that most corrosion which takes place in the boilers is due solely to certain conditions therein; and since these conditions are apparent in the boilers and not outside, it is foolish to go anywhere except to the base of the trouble, which is in the boilers themselves, to correct it.

I would not be at issue with Mr. Haas if he had made a conservative argument for treating plants, where experience and study show the conditions to be such that treating plants could take care of them, and there are such conditions undeniably.

I must differ with him in his blanket statements, and will most be pleased, indeed, to point out to Mr. Haas many treating plants which were put in on just such advice as that which Mr. Haas so graciously extends and which stand as idle monuments to the fallacies thereof.

To the man who says the steam boiler should not be expected to perform the duties of water treatment, I say that the boiler is, in one sense of the word, primarily a treatment plant, and that it will always retreat water which has been treated, and that it is so frequently so as to be almost universally true that it is far better to carefully direct the boiler which is wrongly performing these duties to perform them thereafter correctly, and that it is the part of wisdom to correct the boiler in the error of its ways rather than to attempt to take from the boiler the functions which are its own.

I would leave myself open to the same criticism as that directed at Mr. Haas were I to omit emphasizing, however, that there are many waters which can be improved as feed waters for boilers by submitting them to a reasonable process of preparation, as, for instance, the filtering or settling of the suspended mud, the skimming of organic matter and the neutralizing of acids, but when one attempts to go further than this one is apt to find himself entering the deep waters of varied troubles.

Chicago, Ill. L. F. Wilson.

How to Straighten the Crown Sheet of a Crown Bar Supported Dinky Locomotive

Straightening the crown sheet of a dinky locomotive is more difficult than at first appears to the ordinary boiler maker on account of the small firebox of such an engine.

Engines that run on the extremely narrow gage tracks have fireboxes so small that a good sized man can scarcely turn around in the firebox. Narrow gage engines used by contractors on railway and other construction work are the ones generally troubled with burnt crown sheets. The firebox of such an engine is about 35 inches long by about 30 inches wide at the crown sheet and about 22 inches wide at the mud ring. In such a small space it is quite impossible to use a maul or sledge effectively, especially when the crown sheet is hot, which it must be to get it back to its proper place. Therefore, we must find some other way of getting around the difficulty—the way the writer has overcome it in numerous cases of this kind and in places far removed from the shop and in places where it was impossible to get anything to work with only the tools and material carried along from the shop. In going away on a repair job of this kind you are told the nature of the work to be done. If you are from the works where the locomotive was built, then you are furnished with the proper material for the repairs, and you select your own kit of tools; then, being properly provided with tools and material, you proceed as follows:

Remove the engine cab off the frame. This is usually held in place by four bolts, and can be got out of the way quickly. Next remove dome casing and all steam fittings from outside of dome. Remove dome cap, throttle cover, angle lever and throttle valve, stand and dry pipe. Now cut rivets out of the dome braces, back pins out of bottom of braces and crown bars.

All braces and bars should be carefully marked so that they go back in their proper place. If the crown bolts are the ones with nuts on top of crown bars, burst or unscrew all nuts of crown bars, taking care of the diamond washers, as the bolts drop through the bar. Also take care of the ferrules that are between the bar and crown sheet.

Should the crown bolts be of the kind that are screwed into the crown sheet with heads on top of crown bars you must carefully center each bolt on firebox side and drill through bolt and sheet with a 15/16-inch drill. If some of the bolts have been drawn through the sheet when it came down, then drill or ream such holes to 15/16 inch.

Having loosened all bars, remove them out of boiler, examine carefully to see if they have been damaged in any way. If they have been straightened any, have the proper amount of crowning put back in them. Four bars is the usual number found on this kind of firebox. If the back pair of wheels are under the firebox, have them removed and block up the engine under the back bumper beam.

Now get more blocking and place it under firebox between the track. Crib it so that the top piece is lengthways with the firebox and just below the level of the mud ring.

Now get two screw jacks and a piece of hard wood 2 inches thick and the width of the base of the screw jack. Turn one jack upside down with head resting on the cribbed blocking and close to the flue sheet. Now place the 2-inch piece of hard wood on top of the base of the jack and on top of the wood place the other jack right side up (that is, the jacks are base to base, with the 2-inch piece in between).

The top jack must be unscrewed until the head is up against the crown sheet on the corrugation formed between the two middle bars. Screw up tight enough to hold in position.

Through one of the holes in the head of the top jack place a bar of iron long enough to reach through the firedoor. This bar is to prevent the top jack from turning when the bottom one is being tightened up. Then get a bar of round iron 1½ or 2 inches by about 6 feet or long enough to be about 2 feet above the top of dome when the other end is on the crown sheet. Lay this one side until ready to use.

If there is natural gas or producer gas near, pipe it close to the engine. Connect a length of hose and to the other end a piece of ½-inch pipe about 6 feet long with some small holes punched or drilled in it to form a burner. If there is no gas of any kind to be had, get a couple of gasolene torches, which you are always sure of finding in any construction job. Remove the ordinary burner and replace by one long enough to reach the flue sheet when the tank is fastened on the foot plate.

All being ready, light up and get the sheet good and hot. Remove burner and, placing the long bar of 1½-inch or 2-inch down the dome on to the crown sheet, strike the sheet on the crown *bolt holes* while an assistant is below attending to the jacks, which must be screwed up tight.

As the sheet is being knocked down along the holes, the jacks must be moved along the corrugation between the bolt holes. The jar of the blow on top with the pressure on the jacks underneath will remove all the lumps from the sheet, but will leave it a little below the old level, which is exactly what we want, for it must be remembered that when replacing the crown bars all the work must be done through the dome and all the room you can get will be none too much.

When cool enough to work, take one of the outside bars, drop it on to the crown sheet and carefully place in position with a ferrule under both ends, and put in from the firebox side one of the new bolts. Put on diamond washers and nuts. Now slip under the bar two more ferrules over the next two holes. When they are in position and the holes fair, screw up on the end bolts while your assistant is below with a flogging hammer drawing the bolt up.

When the two end bolts are up all they will go, do the same with the next bolts, always being careful to have the ferrules in position under the bar, before drawing and screwing the bolts home. When the first outside bar is on and finished repeat the same order with the other outside bar. Then take either of the two middle bars and proceed the same as before until the whole set of bars are on.

Next replace your braces. Roll a few rows of flues that may have got a little warm, and you are ready for putting back the dry pipe, throttle valve, etc.

The object of having the crown sheet a little below the former level of the sheet is that it enables the man doing the work to place the ferrules between the bars and crown sheet one at a time and at the same time he is enabled to make his crown bar fast and hold it rigidly in its proper position while each bolt is being worked up, which would be quite impossible if the sheet was left in any other way. By working the bars from the ends towards the center the sheet is gradually drawn up to conform to the crowning in the bar, and if properly done it will be almost impossible for anyone to tell that the crown sheet has been burnt, for there are no hammer marks to show, the uniform heating of the sheet has annealed it all over and the screwing up of the crown bolts so gradual that there has been no excessive strain on the sheet during the whole process.

Sometimes it will be found that natural gas nor gasolene torches can be procured; then there must be a fire built below the sheet. This can easily be done by placing two track bars (crowbars) in the flues and placing across them fish plates or any old iron, such as old broken grate bars, and on this a fire of pine chips saturated with coal oil can be started and fed and a good heat obtained. The only objection to this is that the jacks must be placed in position after the fire is removed.

In replacing crown bolts it is good practice to wrap around each bolt before it is drawn close up to the sheet a little lamp wick or asbestos packing. This will help materially in making a tight job.

Pittsburg, Pa. FLEX IBLE.

Watertube vs. Scotch Boilers for Battleships

I note that THE BOILER MAKER contains much information for railroad men; also concerning electric and gas welding and burning machines, and how to expand tubes or flues, as the railroad men call them. We used to put flues in the old marine leg boilers, and they ran from six to eighteen inches in diameter and, of course, were riveted. Some of the original locomotives were made with two or more flues, instead of tubes, but they were riveted at both ends.

Now, gentlemen, please remember that flues are riveted to the boiler, and tubes are expanded by either rolling or by a Prosser expander, or both. Candidly, I am much more interested in marine than locomotive work, for years back I did a great deal of it in my young days.

With all Europe at war or preparing for war, our own government is building everything in the line of a warship from a submarine to a 40,000-ton dreadnought. It strikes me that it behooves the boiler maker's warhorses to inquire into how new boilers are taking the place of the old ones, barring the Russo-Jap war. This war in Europe is the first real war test of the watertube boiler of any type. The Russian fleet that went out to fight the Japs had many watertube boilers, but they were at sea for over three months before they met their "Waterloo."

I note in reading Admiral Beatty's report of the first North Sea battle, in which the *Blucher* was sunk, he says a shot went through the deck of the *Lion* and landed in the port engine room, striking the feed tank and putting it out of commission, which he says caused priming, and priming put the engine out. Within thirty minutes after, the same thing (priming) put the starboard engine out; then he had to take the *Indomitable* out of the fight to take the *Lion* in tow, and the Germans got away.

As Admiral Beatty does not say what caused the priming, will some of THE BOILER MAKER'S writers kindly give us some information on the subject? My opinion is that when the men in the firerooms found they could not feed from the feed line they helped themselves to the sea water so as to save their boilers from burning, and, as the *Lion* had watertube boilers, they started to prime as soon as the salt water entered them. A Scotch boiler could steam for weeks on salt water.

Now let me ask those gentlemen, who claim to have Admiral Melville's ideal boiler, if they are aware of the fact that he insisted that his ideal boiler would have to be able to stand some salt water, and also that it would have to be able to steam for twenty or thirty minutes with the pump broken down?

I have read many statements of men boosting their watertube boilers as coming up to Admiral Melville's ideal boiler, but they never mention that he insisted that his ideal boiler must be able to stand some salt, and also to run twenty to thirty minutes with the pump broken down. The best watertube boiler made will not run more than five minutes—with safety—without the pump on.

Let us imagine a ship (in action), holding her position in a battle line, keeping a certain distance behind her leader and the same distance ahead of the ship directly behind her, and something goes wrong with the feed line. If only a lump of waste is sucked into the strainer of the feed tank it will choke the feed line sufficiently to cause trouble in the firerooms, especially so if there are several boilers in battery depending on said feed line. If she has watertube boilers she must drown her fires to save her boilers. If she has Scotch boilers she can take salt water and hold her position in the line.

In the year 1892 the British Admiralty decided to test the watertube boiler and the Scotch boiler in a run from Portsmouth or Hull to Gibraltar and return—a run of 2,000 miles. Two sister ships were selected—the *Minerva* with Scotch boilers, and the *Hyacinth* with watertube boilers. The instructions to each ship were to keep together, maintain an eighteen knot speed, clean your boilers the best you can while under way, and also at Gibraltar, but you must keep steam on your boilers from the time you leave here until you return. Take the same grade and quantity of coal.

The real facts of this trial, as reported by the officers in charge, were that when the *Hyacinth,* with watertube boilers, reached Gibraltar her coal was practically exhausted, while the *Minerva,* with Scotch boilers, had sufficient coal left to steam for ten hours longer. The time allowed at Gibraltar was limited to taking on coal and provisions for the return trip.

On the return trip, in the Bay of Biscay, the *Hyacinth's* watertube boilers began to foam and leak so much that the *Minerva* had to give a tow line and haul her into port. Mention this trial to a man boosting a watertube boiler, and out comes his paper and pencil, giving you facts and figures, treating you to a dose of horsepower mixed with heating surface and hot gases. He must have the tubes to show his heating surface, yet you know that hundreds of his tubes are heating surface only on paper.

The writer has a watertube boiler of his own design—a double-ender—which he thinks is superior to those at present in use—but heaven forbid that he would say it was the safest boiler for a battleship or large cruiser that might have to stop at sea for months at a stretch.

What show would a watertube boiler have with Japanese coal? Why did the British fleet fail to catch the Germans at Jutland? All accounts state that they got fairly between the Germans and Heligoland. Is it possible that the British fleet contained too many haphazard boilers? If so, we cannot find it out too soon.

Watertube boilers are all right for launches and torpedo boats—time will prove that they will not stand war conditions in battleships. J. S. GRANT.

Vallejo, Cal.

Ferruling Tube Ends

Recently, while making some repairs to a plant equipped with B. & W. watertube boilers, some retubing was found necessary in the lower row of 4-inch tubes. After cutting out the old tubes the holes in the headers were examined and found to be extra large in diameter from frequent rerolling of leaky tubes. It was decided to make ferrules to fit the outside of the tubes and of just sufficient thickness to take up the amount the holes were enlarged. Not having any steel tubing the correct size to make these ferrules of, I took one of the new tubes, and, heating it carefully and evenly all around at one end for about 6 inches to a red heat, I upset this end by dropping the 8-foot tube squarely a few times on a flat plate. After cooling, I cut off this upset portion and turned out the ferrules in the lathe.

These ferrules that are used to fill the enlarged holes prevented stretching the tubes too much. Tubes that have to be expanded excessively become hardened, and if examined by a strong magnifying glass will show infinite stress cracks. They become sort of crystallized, and if you have ever cut out a tube that has been excessively rolled you have noted how a piece will fly out of the end when cutting it out, or that it will crack for 3 or 4 inches.

There is some doubt as to which is the best method to use when the tube holes are enlarged and new tubes are to be installed, to use ferrules or to procure longer tubes than required by the boiler, and upset the ends; then turn to correct outside diameter. I am in favor of the upset tube ends, for I feel that they are the safest.

I have cut out tubes that were ferruled and found a coat of rust between the tube and ferrule and between the ferrule and seat in the tube sheet or header. I fully believe that the holding power of a tube is reduced when ferruled. Even though a tube may be beaded over after ferruling, if the expansion and contraction of the tube loosens the ferrule there is a chance of them pulling out from a sudden strain such as might be caused from cold feed when forcing the boiler. Safety first, at any rate, ought to be the main point, and if you use ferrules, bead the ends over as much as possible.

C. H. W.

Twist Drills

The twist drill is in almost universal application, having superseded virtually all other types.

It would, however, be a mistake to assume that it is the best form of drill for every purpose; in this as in most other matters common sense must dictate procedure. For instance, it is not the best countersink for plates nor is it the most effective type in a ratchet brace. The flat type of drill has much to recommend it, and special grinding of the twist drill edge to approximate to that of a flat drill has found able and weighty advocates.

For ratchet brace work a flat drill having lipped edges gives the best results on mild steel plate. Shipyard practice on piecework, where the mechanic is free to choose his own tools, results in the use of a flat drill. As his muscle furnishes the motive power and his reward is dependent upon his own exertions plus the efficiency of his tools, the solution is worth study. His ratchet brace is in absolutely first-class shape, well oiled and free working, and is usually his own property. He pays for this more than double the cost of the cheapest obtainable variety. In fact, this discrimination, which is evident everywhere a man finds his own tools, has kept in force the supply of a type of brace which on account of cost might have otherwise become extinct. This has the screw completely hidden with a guide to the nut the full depth of thread. The screw, in fact, is integral with the box, while the business end of the ratchet carries the internal thread. The ratchet, by means of full guidance of the sleeve, remains in use a straight line under end pressure, even with a badly worn screw.

Using a flat type drill with cutting edges lipped to produce a cutting forward rake. A mere touch on the box of ratchet produces feed; the drill is, in fact, almost self-feeding. If a twist drill were only 5 percent more efficient, its cost would not stand in the light of its application and use. Actually the driller can with less effort drill 25 percent more holes with the tool of his choice.

The chief question other than material and correct temper which has exercised twist drill makers, is in the production of a drill of uniform strength. It is obvious that if the grooves in the drill are exactly the same from point to shank the drill is weaker at the shank end. If the groove is diminished toward the shank in depth, the grooves are less in area as the drill becomes shorter, tending to choke in use due to insufficient chip clearance. This either in the case of a worn drill or drilling deep holes. There is also greater feed pressure required with a shortened drill, due to the increased area of the dead point.

Two methods of manufacture are employed to obviate the tendency to choke. The first of these is known as the increase twist. In this form the traverse of the cutters in making is increased while the rotation of the drill is kept constant. The relation of the cutters to the groove is thereby altered, the groove being wider towards the shank.

The second type of drill is known as the constant angle. In making this the angle of the cutters, while milling the groove, is altered with relation to the axis of the drill, the drill being rotated at uniform speed while the traverse of the cutters gives uniform pitch. This method of making also widens the groove towards the shank, giving freer chip clearance to a short drill.

It must be borne in mind that the grooves in the increase twist drill increase in pitch (considered as a screw thread) from point to shank; also that the grooves are less in depth, gradually diminishing in the same direction. In this type of drill the cutting angle varies and gets less efficient as the drill wears down by repeated grinding.

The constant angle drill varies the depth of groove in the same manner and direction as the increase twist. The width of groove increases in the same direction. The cutting angle presented to the work remains constant whatever the length of the drill.

Both types are superior to the uniform diminished groove drill with regard to chip clearance. The constant angle drill is superior to the others, and is the best compromise of torsional strength and chip clearance, together with a uniform cutting lip. It is obvious that both the increase twist and constant angle drills cost more to produce.

All twist drills without exception present a larger dead point and require a greater feed pressure as they become shortened. It is, therefore, permissible and desirable to thin the drill point carefully when shortened by use. Care is necessary, and a thin emery wheel of correct shape should be used and an equal amount removed both sides of the center rib.

Although for rivet holes the precaution is not necessary, holes over a certain size require a pilot hole. This need not be greater than the area of dead point of drill; too large a pilot hole leads to trouble. The question of correct feeds and speeds solves itself. If the drill corners fail, the speed is excessive. If the point fails the feed is too great.

The only test, and one worth considerable emphasis, is that a drill should make a hole of its own size. When the first hole is drilled after grinding the drill it should refuse to fall through by its own weight. It may seem stupid to mention this, but there is abounding evidence on every hand that this is worth mentioning.

The fact of a twist drill being a high-grade production, accurate to 1/10,000 inch in its own diameter, is not a guarantee that the work turned out will be dead to size. Careful grinding is essential.

The point of a twist drill is a geometrical peculiarity; it is a right cone with variations. It would be worth much in any shop to set out and make up a twist drill point of, say, 36 inches diameter in sheet metal, paint it a brilliant color, and the silent and mute evidence of that point would possibly lead to better practice.

When perfectly ground the point should have lips of equal length, the clearance should be enough but not excessive; that way lies many visits to resharpen. The angle of the cutting lips with the axis of the drill is preferably 59 degrees, or 118 to 120 degrees included angle. A few degrees either way results in trouble either with the hole made or the drill itself.

The line across dead point of drill should lead either cutting edge by 135 degrees in the one direction or 45 degrees in the other. The backing off from the edge should lie between 10 and 15 degrees. Most drills are broken by excessive feed, due to improper clearance in grinding. There is no necessity to insist that both lips must be of equal length; that fact is obvious. The proof is in the production of an equal chip. The drill making a hole of exact size will be found to effect this division of labor most efficiently. It is clear that greater feed can safely be given where both edges do their share of the work. It halves the chip thickness per revolution and consequently doubles the lip of the drill edge before grinding.

A twist drill when examined shows a distinct protruding line of some appreciable width along the leading edge of either groove. This portion of the drill body is that of size of drill, the remainder is cut away slightly to give clearance on the periphery of drill.

The preservation of this edge must be carefully watched, especially when drilling through hardened bushings. A drill with a worn leading edge will not cut freely and is a frequent cause of breakage.

There is a certain irony of fate in that the drill standing up longest to its work should be the most likely sufferer from this defect owing to wear. It is the penalty imposed upon it for good service and durability. There is only one remedy when this line is found worn, that is amputation; shorten the drill by breakage or grinding to restore the full section of leading edge.

Since the production of holes and their subsequent filling is the principal process of boiler making, while a drill is at once the most simple and most complex of tools, it is worth the while of any boiler shop to give adequate attention to the subject.

From an economic standpoint the cost per pound of metal removed, all things considered, is probably least for the drill press of any machine tool under efficient conditions; it seems worth while maintaining this reputation. Under inefficient conditions, and these resting upon apparent trifles, the cost may run up in an alarming manner.

It should be remembered that drilling is classified as semi-skilled work only. Many employers are of the opinion that any type of casual labor can drill with little or no tuition, but they also fail to remember that the lower the rate of pay the higher the cost of supervision.

The following experience of the writer on this very question may have interest. He was supplied with unskilled labor for twelve drilling machines. In the work in question were five holes to be subsequently filled by cold riveting. A trial trip resulted in perfect product. The next problem was the solution of the difficulties produced by labor of an inferior type having no experience of drilling, whatever they claimed on engagement.

The question of cold riveting makes the production of exact size holes imperative. After a troublesome period, during which some quantities proved wasters, the entire job boiled down to the single issue of drilling.

The solution was that a mechanic was placed in custody of the operation. His duties were simply to care for the drills and the machines. He ground every drill himself and drilled a trial hole with each drill, satisfying himself that exact size was maintained. He saw that maximum rates of speed and feed were kept up, and where necessary instructed the drillers. The drills were for the most part ground on wet sandstone and not on a regular twist drill grinder. The product was tested by ringing. The difference in sound was audible instantly, and if defective, went back for investigation, this independently of the mechanic. Every case of bad ringing was found due to large holes. This led to the employment of the mechanic on this work. The riveters liked to drop in the rivets and lacked the sense to see that such a method caused the trouble. The holes under the new method were of such size that a rivet by grinding needed two or three good blows to force home. The condition of the rivet under this treatment was a shedding of skin. The driving home brightened the body of rivet. When beaded the job was solid beyond question.

The question of relative cost has interest. Under the new method of supervision, production rose, the job was of excellent quality, and when all costs were taken into account the resultant saving amounted to $100 per week.

The question of good drilling would receive more attention in the average boiler shop if cold riveting were the rule. The results of the above experience seem to indicate that good and reliable pressure tight work can be done with cold riveting. Using hot rivets tends to produce a low standard of drilling; variations in the size of holes produced is thought to be compensated for in the closing of the rivet. Such is at least the general opinion. In cold riveting it is imperative that the rivet tail absolutely fills the hole; it must be an actual driving fit.

Closing rivets hot with imperfect and variable size holes produces unequal heads with the same size rivet. It accounts for scant, exact and full heads in a single seam, from the same bag of rivets, under the same conditions. The occasional rivet with the ugly base scurf found round the head, is where the hole actually has been to size, the scant heads where it has been drilled big. If the question of drilling received adequate attention, it might by utilizing the experience above related produce tight seams without such heavy calking. With rivets of the usual pitches the immense contraction exerted in cooling might be utilized, not to compensate for irregularity and inherent defects, but in actually bringing the plates into such contact that calking would be more discounted.

Good drilling might also lead to an increase in the maximum allowable pitch with a given size rivet, to the advantage of the percentage strength of the seam. Present practice is largely based upon the former practice of punched holes and inferior work. The present pitches were fixed by the former necessity for heavy calking and the resistance of a plate of given thickness to the calking tool. Calking is a poor substitute for good work and heavy calking is prima facie evidence of poor workmanship.

In the question of good drilling lies much toward the raising of the level of workmanship in the boiler shop. It may be considered a minor matter, but it is just these trifles which make reputations. A deserved reputation for good work has a tangible commercial value in the market. Boiler making is rapidly rising into line with the allied trades in the matter of accuracy and workmanship. The ancient sneer is undeserved to-day that it is a trade combining brute strength with low intelligence. It is, however, those firms who are willing to make the needed effort after good product; who give the engineer the article he requires in the way of steam raising plant a thoroughly well made and satisfactory steam generator, giving little or no subsequent trouble. A. L. H.

Arc Welding and Boiler Work

BY O. A. KENYON *

Electric arc welding has established an important place for itself in boiler repair work. In coming to the position it occupies at present it has met with a great deal of opposition; and it may be said that the only reason that it has been adopted seems to be that it has opened up a new field of boiler repairs that were formerly impossible or at least unsatisfactory.

At present electric arc welding is hampered very much in its application by the boiler code, which limits it to such an extent that it cannot be used in many places where it would be pre-eminently satisfactory.

The reason boiler codes are so drastic in their treatment of electric arc welding is that arc welding has been very uncertain in quality as far as results were concerned. The work turned out has been practically entirely dependent upon the operator; and many times with the best operators very unfavorable results have been obtained, while at other times unusually good results have been obtained. The whole thing boils down to the fact that ignorance of the science of arc welding is to blame for the prejudices that exist against it.

There are many people who have had experience with arc welding who actually believe that the electrical end of the process is of no particular importance and that any electrical circuit which is capable of furnishing sufficient power can be used for arc welding with just as good results as with the most highly developed system on the market. In fact, such an expression of opinion was recently voiced by a committee appointed to investigate and report on arc welding.

If we look at arc welding as a metal-melting proposition, regarding the arc as a miniature electric furnace, we can readily understand that with a given quality of metal the results obtained depend entirely upon the *amount* of heat that is put into the metal and the *rate* at which it is put in and taken away.

This heat input and characteristic is dependent entirely upon the electrical system. However, a skilled operator can manipulate his arc so as to get very good results from any electrical system, and this has been the cause of much misleading information. Just because certain operators are able to hold an arc that has the right voltage and carries correct current is no reason for believing that the electrical system is of no importance. First of all, who is to guarantee that a man will do as well as he is able all the time, to say nothing of the man who can't do it at all, except by accident?

The purpose of this article is to show the effect of the various factors upon heat production in the metal and to demonstrate that proper electrical control is a long step toward standard results. Once we have a standard of welding that is well up to what is obtainable, boiler codes will be revised in such a way that rivet welds and calking edges can be employed throughout and a tighter and stronger boiler built by welding than any now built with rivets.

To begin with, contrary to the idea of many people, there is no direct relation between the total amount of heat released in the arc and the temperature of the metal deposited in the weld, and the reason for this is best understood by analyzing what goes on within the arc.

In boiler work we limit ourselves to the use of a metal pencil: soft steel, with a relatively high percentage of manganese, being the preferred metal.

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The current through the arc produces heat at three points:

1. On the end of the pencil.
2. In the arc itself.
3. On the surface of the metal at the other end of the arc.

The square of current times the resistance at the end of the pencil determines the melting of the metal; that is, determines the flow of metal into the weld. The amount of heat put into that metal after it is melted depends upon the length of arc through which it must travel, and this length depends upon the voltage across the arc. The temperature in the weld itself depends upon the current through the arc and also upon the amount and temperature of the metal that is deposited. Therefore, it is not simply the *product* of current and voltage that determines the temperature of the metal in the weld—it depends upon both current and voltage, and in order to control this temperature each of these factors must be independently variable.

In a properly controlled arc the current is chosen with reference to the diameter of pencil employed, and also with reference to the rate at which it is desired to deposit metal. Other things being equal, it is desirable to use as short an arc as possible from the standpoint of making good metal. On the other hand, it is harder to hold a short arc than a long one; therefore, if the arc is made too short the effect is to slow up the work on account of the difficulty of holding the arc.

With these points in mind the writer has devised a system of control which permits the adjustment of the current to correspond to the size of pencil and character of the work, and then automatically maintains it at a constant value. The voltage across the arc is adjusted independently of the generator, and may be so adjusted as to accommodate itself to the welder, as well as to the work. Furthermore, the voltage is automatically regulated at the arc in such a way as to give the welder a time element voltage limit; that is, allow him to draw instantaneously a longer arc than the controller will permit him to hold for any appreciable length of time. In this way the evil effects of a long arc are avoided, and yet slight inequalities of the melting of the pencil will not cause the operator to lose his arc.

The practical result of this form of control is to eliminate burning of the metal, and thus to reduce the skill required in welding. Incidentally it reduces the pin-holes usually present in electric arc welding; and where it is specially desired pin-holes can be absolutely eliminated, so that a weld will be steam tight without peaning.

The system of control devised by the writer has been applied to a system which he has denoted as the constant-current, closed-circuit system. In this system the generator produces an automatically regulated current which is passed in series through the operator's arcs. In this way the distribution system is reduced to a single wire run from the generator to the nearest arc station, from there to the next, and so on back to the generator, exactly in the same way as the old series arc lighting systems were connected. The main current is adjusted to a value equal to the maximum required by any one operator; then if any one of the operators requires less current than the maximum he can shunt around his arc by means of a suitable rheostat whatever portion of current he does not want.

The only limit to the number of arcs that can be operated in series is the voltage of the machine, and up to the present time 12 arcs have been chosen as the maximum.

When this system of heat control is applied to one-arc units a different electrical machine is used. However, the results as far as welding is concerned are the same. In both systems the arc is never broken, so that craters and burnt metal and pin-holes that occur in craters are claimed to be eliminated. With a system of this kind it is possible for the man in charge of responsible work to adjust the factors that determine the quality of the weld, and then an ordinary laborer can carry out his instructions; and, what is best of all, it can be absolutely depended upon that the metal will get no more heat than the controller is set for.

Strength of Locomotive Boilers

(*Continued from page 4.*)

Stress in Stays

When figuring the area of the unsupported portion of the back head and front tube sheet to obtain the stress in the stays supporting the same, some authorities allow more to be supported by the flange of the sheet than others. An allowance of three inches appears to be the most common method used, although it has been assumed by some to be as high as six inches. Theoretically the area to be supported would begin at the tangent point where the radius makes into the straight. This is a subject which has received considerable thought and criticism, and the fact that so many differences of opinion exist makes it difficult to decide on what would be considered a logical basis to adopt. However, this matter appears to be getting into some final shape. The writer shows some of the rules now in existence in order to bring out what a great difference can be obtained in the stress in braces supporting these surfaces.

British Columbia Rules

When the head is flanged and riveted to the shell, a portion of it becomes stiff enough to carry the boiler pressure without depending upon the braces. The distance that this becomes self-supporting may be determined by the following formula:

$$\frac{1}{2}\sqrt{\frac{125 \times (T+1)^2}{B}} + \text{radius of curvature of head flange.}$$

The allowance for tubes as stay to head to equal:

$$\frac{1}{2}\sqrt{\frac{125 \times (T+1)^2}{B}}. \quad \text{From center of tubes.}$$

Where T = thickness in sixteenths of an inch,
B = working pressure.

Province of Alberta Rules

Flat heads other than dome heads should be stayed preferably by longitudinal stays having substantial upset ends and fitted with nuts and washers, the area to be stayed being determined as follows:

When the head is flanged and riveted to the shell a portion of it becomes stiff enough to carry the boiler pressure without depending upon the braces. The distance that thus becomes self-supporting may be determined by the following formula. The allowance in inches for shell as stay to head:

$$\frac{1}{2}\sqrt{\frac{112 \times t^2}{B}}, \text{ or radius of curvature of head flange, whichever is greatest.}$$

Where t = thickness of head in sixteenths of an inch,
B = working pressure.

Province of Saskatchewan and Ontario Rules

The same rules exist in these provinces as in the Province of Alberta, as shown above.

American Society of Mechanical Engineers

The rules of this society, which is one of the latest boiler codes which has been adopted, allow 3 inches to be supported by flange of head.

Interstate Commerce Commission

The following represents a ruling given to one of the large railroads on this subject of bracing of front tube sheets and back boiler heads of locomotive boilers:

Back Head to be Braced.—The total net area to be braced is the area enclosed by a line drawn two inches above the center of the top row of staybolts and a line drawn at a distance from the outside of sheet equal to the radius of the flange.

Front Tube Sheet to be Braced.—The total net area to be braced is the area enclosed by a line drawn three inches above the center of the top row of flues and a line drawn with a radius three inches less than the radius of the sheet; minus the area of the dry pipe hole.

With reference to the stress in the braces supporting the front tube sheet and the back head, it will be noted that the greater the angle of the stays or braces the greater will be the stress.

For convenience of calculations, the value of

$$\left(\frac{1.13}{D}\right)^2$$

in formula No. 16 is given for stays ranging from 1 inch to 1⅝ inches, as shown in table No. 6.

In figuring the area of the front tube sheet to be supported, the writer has found a great diversity of opinion on this point, particularly as regards the hole in the tube sheet through which the dry pipe passes. The height of 2 inches above tubes seems to be generally used for the lower line of the segment to be supported, and 3 inches in from the flange has also been considered good practice, although authorities differ on this, as will be noted from the above.

Some authorities make an allowance for the reinforcing ring around the dry pipe hole in the front tube sheet—that is, the area of a circle equivalent to the outside diameter of the reinforcing ring, while others allow only for the hole or half the hole, or an arbitrary percentage of same. The various locomotive builders differ on this question and therefore a different value is used. The writer knows of a case where it was argued that no allowance should be made, the claim being that the hole was unbalanced, due to the fact that the steam pipe was unbalanced and open to the atmosphere. To offset this it would appear from the fact that the steam pipe is securely anchored in the dome and the heavy reinforcing ring around the hole in the tube sheet, which also comes up close to the flange, the resistance offered by the steam pipes in the smoke box, etc., would about equalize this condition, and it is the belief that after summing up the different conditions, that if the hole in the sheet is disregarded, or, in other words, figure the area of the segment, minus the area of the hole that it would produce results, which would be practically realized. In actual practice there seems to be very little trouble experienced with the failure of the diagonal braces on front tube sheets, and after all this is not the most important part of the design, as the flat sheets themselves offer some support as well as the T-shaped and angle-irons, which is not taken into account in any of the calculations.

The Master Mechanic Rules recently adopted provide for rules concerning the bracing of flat surfaces which will be given in the next issue.

(*To be continued.*)

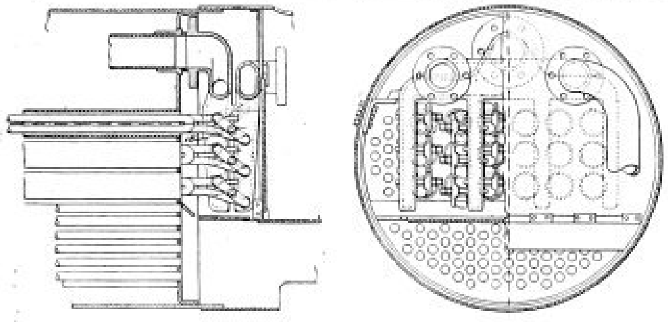
Selected Boiler Patents

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

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

1,199,405. FLUE-TUBE SUPERHEATER. GARRETT E. MILLER, OF WEST NYACK, N. Y., ASSIGNOR TO LOCOMOTIVE SUPERHEATER COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

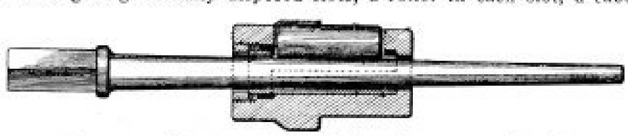
Claim.—In a flue tube boiler provided with a superheater header having pairs of superheated and saturated header branches, one in front of and spaced from the other, between alternate vertical rows of flue tubes, said branches having lateral openings, superheater elements in



some of the flue tubes, heads on the ends of each element each head having a spherical shaped side and an opening therethrough and an opposite side having a spherical tipped boss, the openings of a pair of ends being in registry with openings in a pair of header branches, a clamp bar having end recesses to receive the spherical tipped bosses, and a bolt passing between the branches and through the center of the clamp bar for holding the element ends fast.

1,199,093. ROLLER FLUE EXPANDER. GRAVES R. MAUPIN, OF MOBERLY, MO., ASSIGNOR TO J. FAESSLER, MANUFACTURING COMPANY, OF MOBERLY, MO., A CORPORATION OF MISSOURI.

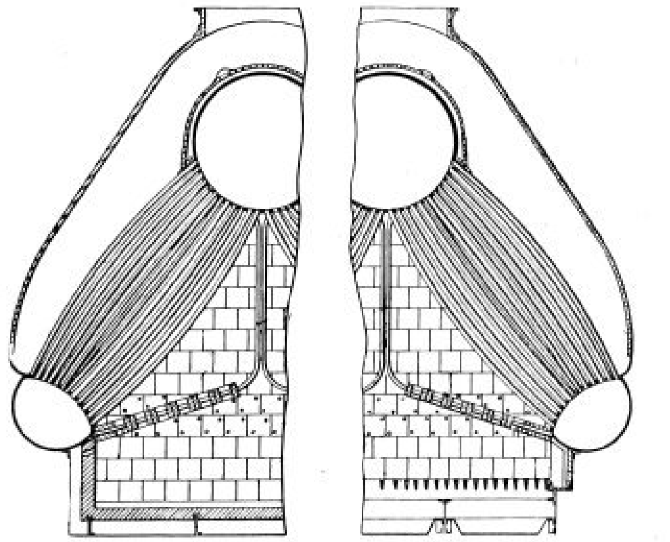
Claim 1.—A roller flue expander comprising in combination a tubular cage having longitudinally disposed slots, a roller in each slot, a tubular



roller retainer insertible lengthwise within the cage and having spaced arms for engagement with the rollers, and means within said cage at each end thereof for holding said roller retainer against axial movements relative to the cage, one of which means being removable from the cage. Two claims.

1,192,928. STEAM BOILER. CHARLES D. MOSHER, OF NEW YORK, N. Y., ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, N. J., A CORPORATION OF NEW JERSEY.

Claim.—In a watertube boiler of the inclined bank type, a combustion chamber having refractory side walls and provided with a perforated re-



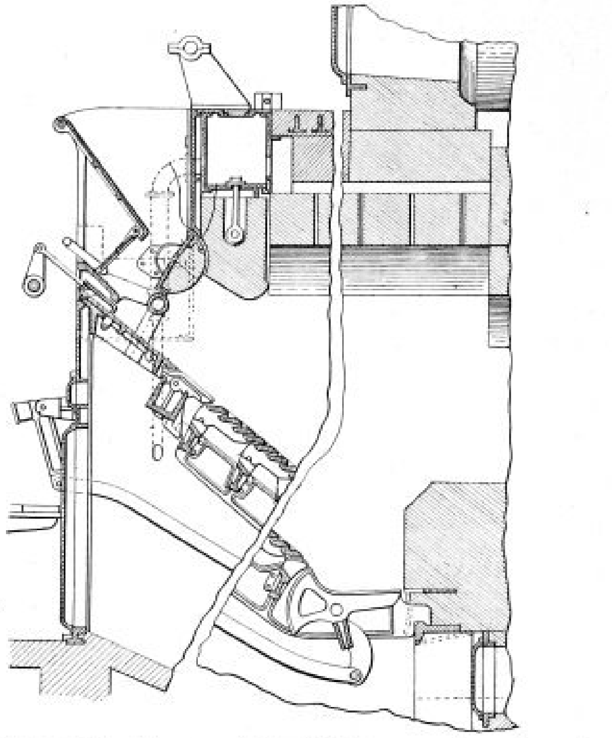
fractory screen arranged below and at an angle to the bank of tubes and through which the gases rise before reaching the tubes, said screen forming a secondary combustion chamber of general triangular form between it and the bank of tubes, and water tubes supporting said refractory screen and connected at their ends to upper and lower water spaces of the spaces of the boiler, the refractory side walls of the setting having air inlet openings in proximity to the refractory screen to aid the secondary combustion.

1,199,133. BRICK FOR LOCOMOTIVE ARCHES. ROBERT A. B. WALSH, OF ST. LOUIS, MO.

Claim 1.—A brick furnace arch having its lower side edges formed for engagement with the arch tubes, and projections extending over the entire surface of said lower side edges forming intercommunicating passages around the arch tubes. Two claims.

1,192,920. FURNACE. WILLIAM McCLAVE, OF SCRANTON, PA., ASSIGNOR TO McCLAVE-BROOKS COMPANY, OF SCRANTON, PA., A CORPORATION OF PENNSYLVANIA.

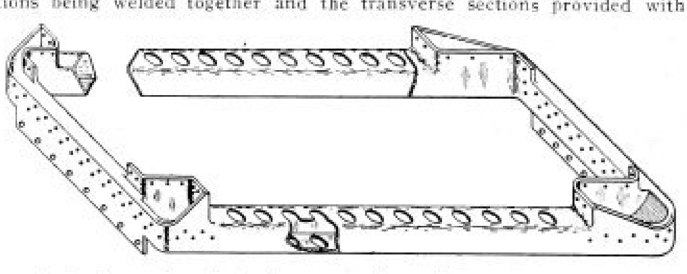
Claim 1.—In a furnace, the combination of a hopper, an inclined grate, a dead-plate lying in a substantially coincident plane, an upper dead-plate provided with fuel openings therethrough located in the path of the



fuel supply, a pusher between said dead-plates, means for reciprocating said pusher, a fuel chute between the hopper and upper dead-plate, a swinging door hinged to said hopper forming one wall of the chute and a furnace door forming the other wall of said chute, the furnace door directing the flow of fuel to the openings in the upper dead-plate. Ten claims.

1,197,806. FOUNDATION RING FOR STEAM BOILERS. PATRICK TRESTON DUNLOP, OF SPRINGFIELD, MO., AND HENRY W. JACOBS, OF TOPEKA, KAN.

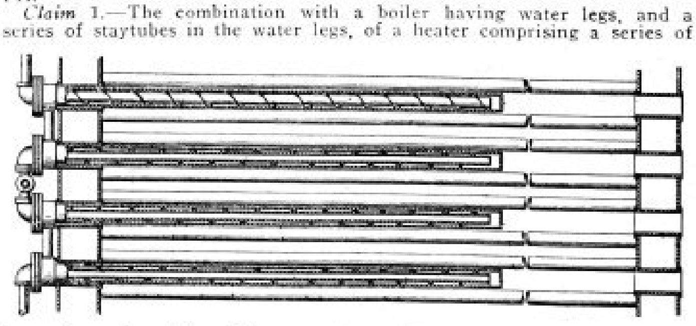
Claim 1.—A foundation ring for steam boilers, composed of solid transverse sections of cast metal and hollow longitudinal sections of sheet metal of greater density and comparative lightness, the respective sections being welded together and the transverse sections provided with



angularly disposed ends having upwardly and laterally disposed ports adapted to communicate with the chambers of the longitudinal sections and with the water legs of the firebox, while the longitudinal sections have their top, side and bottom walls rigidly secured together with the top and bottom walls provided with alined openings. Three claims.

1,193,172. BOILER. EDWARD C. MEIER, OF PHŒNIXVILLE, PA.

Claim 1.—The combination with a boiler having water legs, and a series of staytubes in the water legs, of a heater comprising a series of



boxes located outside of the water leg, said boxes having holes in their inner walls and being open at their outer ends, detachable plates secured to said boxes and covering the open end hereof, said plates having holes therein, tubes secured within the holes of said inner walls and projecting through the staytubes in the water legs, tubes smaller than the first-mentioned tubes located inside of the first-mentioned tubes and secured within the holes of said plates, end plates each having a passage communicating with the ends of said small tubes, pipes connecting said passages of certain of said boxes, and other pipes communicating with the interior of certain of the boxes.

The Boiler Maker

FEBRUARY, 1917

Marine Boiler Design

Two Furnace, Return Tubular, Water-Leg Type Boiler of 300 Horsepower

BY STEPHEN C. CAFIERO

To design a two furnace, return tubular marine boiler of the water-leg type seems at first sight a very simple affair; but if all the particular duties and requirements of an efficient boiler be carefully considered, it will be seen that there are numerous difficulties and necessities involved that must be carefully studied. Until recently this type of marine boiler was built for low pressure only, the maximum not exceeding 80 pounds gage. However, there never were any restrictions to higher pressure, providing the design and the construction is in accordance to the supervisor—requirements for the desired working pressure.

Among the data taken into account are the following:

First—Efficient evaporative qualities and fuel economy.

Second—Proper heating surfaces and grate area.

Third—Uniform circulation of the water in the boiler.

Fourth—Strength to resist pressure and comply with requirements.

Fifth—Accessibility in nearly all parts for the purposes of construction examinations and cleaning.

Sixth—Space occupied, weight and cost for a given horsepower.

The first three items are the most essential features in the production of power economically, while the last three items are those pertaining to rupture, endurance and cost. Suppose we have a compound engine of 600 indicated horsepower to be supplied with steam at a working pressure of 130 pounds per square inch, and using about 17 pounds per indicated horsepower, also that the space in a boat will accommodate a boiler shell not over 10 feet diameter and 12 feet long. By experience it is seen that two furnaces, each 4 feet 4 inches wide, with a water space, or leg, of 5 inches on each side and 5 inches in the center between the two furnaces can be fitted in this size boiler, giving two grates 4 feet 4 inches by 5 feet 6 inches long, giving a grate area of 47.3 square feet. Now with good coal having a calorific value of 13,500 British thermal units per pound, 25 pounds can be burned on every square foot of grate area, and with properly distributed and sufficient heating surfaces this boiler should absorb about 78 percent of the heat generated by this fuel, then $47.3 \times 25 \times 13{,}500 \times 0.78 = 12{,}451{,}725$ heat units. The heat above the temperature of feed water at 60 degrees F. in a pound of saturated steam, at a temperature of 355 degrees F., which corresponds to 130 pounds pressure, is $355 - 60 = 295$ heat units and the latent heat of evaporation is 862* units, therefore the total heat in a pound of steam is $295 + 862 = 1157$ units. Dividing this heat into the heat absorbed by the boiler we have

$$\frac{12{,}451{,}725}{1157} = 10{,}762$$

pounds of water evaporated into steam per hour.

The weight of water evaporated per hour, divided by the weight of coal burned per hour, equals

$$\frac{10{,}762}{1182} = 9.2$$

pounds of water per pound of coal, or, dividing the weight of the water by 34.5, the standard constant for the evaporative horsepower, we have

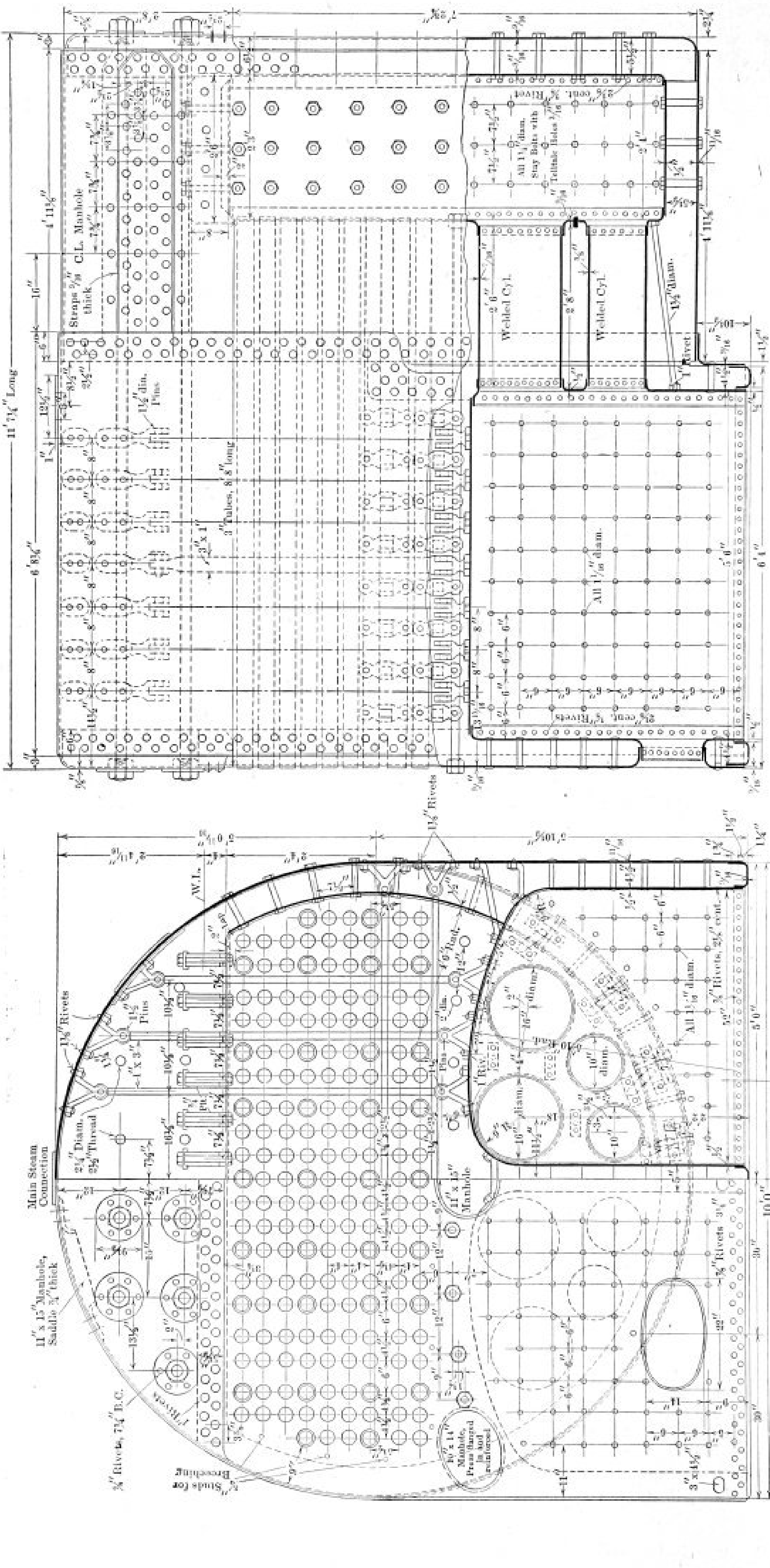
$$\frac{10{,}762}{34.5} = 310$$

boiler horsepower. This will furnish enough steam for a compound condensing engine of about 600 indicated horsepower, using 17 pounds of steam per indicated horsepower per hour for the engine and its auxiliaries collectively.

In this type of boiler a large furnace volume can be obtained, due to the square firebox, and as "soft coals" need so much flame room, which requires a high furnace crown, so that volatile parts of the hot coals will not condense as soot in the boiler tubes, without burning, but distillate with the vapors given off the green coals before complete combustion takes place. The products of combustion will leave the boiler tubes at a temperature of about 550 degrees F. and their weight will be about 13.5 pounds per pound of coal burned; the specific heat of this is 0.24. At this rate they carry off $13.5 \times 0.24 \times 550 = 1{,}780$ British thermal units, or about 12 percent of the heat in the coal fired, and allowing 10 percent for radiation losses, leaving 78 percent efficiency of boiler. The ratio of heating surface to grate surfaces in marine boilers is between 30 and 40, usually about 34 times greater than the grate surface; therefore the heating surface of this boiler should be $47.3 \times 34 = 1608$ square feet.

It now remains to distribute properly this heating surface in the boiler, which includes the furnaces, flues, tubes and combustion chamber. As this boiler is to be not over 10 feet diameter and 12 feet long over stay nuts on heads,

* See *Steam Tables*.



Marine Leg Boiler of 300 Horsepower. Diameter, 10 Feet; Length, 11 Feet 7¼ Inches Over Heads; Working Pressure, 130 Pounds per Square Inch; Total Heating Surface, 1,606 Square Feet; Grate Area, 47.3 Square Feet; Ratio Heating Surface to Grate Area, 34 to 1 then we will make it 11 feet 6 inches inside of heads. It is also important to have as large a reservoir of steam as possible above the level of the water in the boiler; this is to prevent fluctuations of pressure. Then allowing 2 square feet of water surface per square foot of grate surface will give us 94.6, and this divided by the length of the boiler, 11.5 feet, will give

$$\frac{94.6}{11.5} = 8.2$$

feet as chord of water level.

This determines the height to which the boiler tubes can be taken, and should not be less than 6 inches below the water level to top of tubes, and making the furnace volume above the grates about 4 cubic feet per square foot of grate area, as this will be enough to completely distillate all the gases given off from the fuel specified, and also have sufficient space in the furnace back to insert two 16-inch diameter and two 10-inch diameter flues, having a total sectional area of 7.95 square feet, or about one-sixth the grate surface.

Now lay out accurately on a scale drawing of the boiler in cross-section showing the arrangement of the furnaces, flues, tubes and combustion chamber (as per plan). Three-inch tubes are used, as they are considered best size, and are spaced horizontally so that they are separated by 1½ inches between them, also to clear the vertical braces that come down to the top of the furnaces. These wide spaces allow for a more *rapid circulation of the water* in the boiler, the bubbles will rise vertically, while the colder water, or feed, comes down along sides of the boiler shell. The tubes are spaced with 1 inch between vertically. Three standard manholes are provided in the front head over the furnaces and one hand-hole in each water leg. Also one manhole on the top of the shell to allow an ordinary man to get into the boiler above the tubes, for construction or cleaning purposes. Allowing 2 feet 3½ inches for the depth of the combustion chamber and 6½ inches water space to back head, then the length of the tubes will be 8 feet 8 inches, and it is seen that we can space a total of 183 tubes 3 inches diameter. The furnaces being 5 feet 6 inches long inside leaves 2 feet 6 inches for the length of all the flues, hence we can figure all the heating surfaces and see how they check with our assumed calculations, and then it only remains to calculate and design the boiler for strength of the different parts and to comply with the supervisor's requirements.

For this boiler we have the following data:

Type—Leg firebox return tubular marine boiler.

Dimensions—Shell 10 feet diameter, 11 feet 7¼ inches long.

Working Pressure—130 pounds per square inch, gage.

Grates—Two, each 4 feet 4 inches by 5 feet 6 inches, equals 47.3 square feet.

Tubes—183, each 3-inch diameter, 8 feet 8 inches long.

Flues—Eight, four 16-inch diameter and four 10-inch diameter.

	Square Feet
Heating surfaces of tubes	1,145
Heating surfaces of furnaces	190
Heating surfaces of flues	72.5
Heating surface of combustion chamber	198.5
Heating surfaces total	1,606
Cross area of tubes for draft	8.9
Cross area of flues for draft	7.89
Area of water surface	94.6
Steam room (cubic feet)	143.6

To determine the thickness of the boiler shell, when marine boiler steel of 60,000 tensile strength is used, a factor of safety 4.5 is none too low, and assuming an efficiency of 84 percent for the longitudinal joints, as the first shell wrapper sheet, though fastened at the bottom leg, with a double-riveted lap it is well braced with stay bolts to furnaces, and cross braces to opposite side of shell. Then the formula for thickness is

$$t = \frac{W.P. \times R \times F.}{T_s \times E} = \frac{130 \times 60 \times 4.5}{60{,}000 \times 0.84} = 0.690 \text{ inch,}$$

say, 11/16 inch, and check this by the following:

United States Rule:

$$W.P. = 1/6 \frac{T_s\, t}{\text{Rad.}} + 20\% = \frac{10{,}000 \times 11}{60 \times 16} + 20\% = 137 \text{ lbs.}$$

Lloyd Rule:

$$W.P. = \frac{C \times (t-2) \times B}{D} = \frac{21.55\,(11-2)\,80.75}{120} = 130.5 \text{ lbs.}$$

$$\text{where } B = \frac{n \times a}{P \times t} \times 85 = \frac{5 \times .994}{7.75 \times .6875} \times 85 = 80.75$$

least efficiency factor,

C = constant, 21.55 when longitudinal seams are fitted with double-butt straps of unequal width,

t = thickness of plate in sixteenths of an inch,

T_s = tensile strength in pounds per square inch,

D = diameter of shell in inches,

R = radius of shell in inches,

F = factor of safety, 4.5,

E = efficiency of longitudinal joints,

n = number of rivets per pitch in longitudinal joints,

a = area of rivet in square inches,

P = pitch of rivets in inches, d = diameter of rivets.

For the diameter of rivets we will use "Unwin's" formula:

$d = 1.3 \sqrt{t} = 1.3 \sqrt{0.6875} =$ 11/16 inches diameter, make holes 1⅛ inches.

In the double-riveted girth and head seams the shearing strength of the rivets is all that need be considered. This is found by taking the strength of one rivet and multiplying by the total number of rivets in the girth, and this should exceed the pressure on the total area of the heads. Therefore the area of one rivet equals 0.994 multiplied, and there are 220 rivets in each girth seam; then allowing a shearing strength of 44,000 pounds per square inch and dividing by a factor of 5 we have

$$220 \times 0.994 \times 44{,}000 = \frac{9{,}621{,}920}{5} = 1{,}924{,}384 \text{ pounds.}$$

The area of the head is $(120)^2 \times 0.7854 = 11{,}310$ square inches and has a working pressure of 130 pounds per square inch, which makes a total load of $11{,}310 \times 130 = 1{,}470{,}170$ pounds. Then it is seen that the rivets are the strongest and safe.

The longitudinal seam of the rear course is a triple-riveted double-butt strapped joint, and we have chosen an efficiency of 84 percent when figuring the thickness of the boiler shell. For this plate thickness and diameter of rivets used we will assume a very practical type of rivet spacing, in the joint, and figure on the efficiency by considering the different methods of failures.

In this joint there are three rows of rivets on each side of the butt, or plate edges. There are five rivets in each pitch; four of them are in the inner rows and are in double shear, and one is in the outer row and is in single shear; so that if this joint were to fail by the rivets shearing, nine sections of rivets in each pitch would have to be sheared. However, there are five ways in which this joint may fail. Using the following dimensions and calculating the resistance of each part separately the joint may fail: First, at the outer row of rivets, the resistance is $(7\tfrac{3}{4} - 1\tfrac{1}{8}) \times 11/16 \times 60{,}000 = 273{,}281$ pounds. Second, by tearing apart at the middle row of rivets and shearing one rivet in the outer row this resistance is $(7\frac{3}{4} - 2 \times 1\frac{1}{8}) \times 11/16 \times 60{,}000 + 0.994 \times 44{,}000 = 270{,}611$ pounds. Third, by shearing four rivets in double shear and one rivet in single shear, allowing 82,000 pounds for double shear; the resistance is $4 \times 0.994 \times 82{,}000 + 0.994 \times 44{,}000 = 369{,}768$ pounds. Fourth, by crushing in front of four rivets and shearing one rivet the resistance is $4 \times 1\frac{1}{8} \times 11/16 \times 95{,}000 + 0.994 \times 44{,}000 = 328{,}736$ pounds. Fifth, by crushing five rivets, four through both straps and one through one strap, the resistance is $4 \times 1\frac{1}{8} \times 11/16 \times 95{,}000 + 1\frac{1}{8} \times 9/16 \times 95{,}000 = 345{,}116$ pounds.

The resistance of a piece of plate equal to the width of the pitch at the outer row equals $7\frac{3}{4} \times 11/16 \times 60{,}000 = 319{,}682$. The least resistances found above, divided by this plate resistance, determine the efficiency; that is,

$$\frac{270{,}611}{319{,}682} = .847 \text{ percent.}$$

when pitch at outer row = $7\frac{3}{4}$ inches; pitch at inner rows = $3\frac{7}{8}$ inches; diameter of rivets = 1 1/16 inches; diameter of rivet holes, $1\frac{1}{8}$ inches; area of rivets = 0.994; shearing strength, 44,000 for single shear and 82,000 pounds for double shear; crushing strength, 95,000 pounds.

The flat heads in the steam space, when properly stayed by through bolts having inside and outside nuts, can be made about nine-tenths of the thickness of shell plates, then $0.6875 \times 0.9 = 0.61875$, say $\frac{5}{8}$ inch, and the through stays are $2\frac{1}{4}$-inch diameter, spaced 12×15, or 180 square inches to support with a pressure of 130 pounds per square inch equals 23,400 pounds. The area of these stays at bottom of threads is 3.96 square inches, and, allowing 7,500 pounds safe stress, each bolt will carry $3.96 \times 7{,}500 = 29{,}700$ pounds.

The fire surfaces of the boiler have a thickness of $\frac{1}{2}$ inch and all flat plates must be supported by screw staybolts, which may be considered by the following formula, allowing a safe working load of 8,000 pounds per square inch of section, for good steel stays. The diameter of these staybolts may be found, if we choose a pitch, say 6 inches each way, then

$$d_s = 0.0127 \times \text{pitch} \sqrt{\text{pressure}} = 0.0127 \times 6 \sqrt{130} = 0.868$$

inch diameter at bottom of threads. Then take the nearest standard-size bolt, or 1 1/16-inch diameter staybolt and check this by the Lloyd's rules. The area of 0.868 diameter is 0.6178, then

$$W.P. = \frac{0.6178 \times 8000}{36} = 137 \text{ pounds,}$$

and for the larger-size bolts used in the combustion chamber

$$W.P. = \frac{0.9326 \times 8000}{(7.5)^2} = 132 \text{ pounds}$$

where $W.P.$ = safe working pressure of boiler.

The pressure allowable on the area supported by each crown bolt in the combustion chamber top is found as follows:

$$\frac{135 \times (9)^2}{(7\frac{1}{2})^2} = 180 \text{ pounds,}$$

in which 135 is constant used when there are nuts on the fire side. The girders on the top of the combustion chamber will safely carry

$$\left(\frac{825 \times (6.5)^2 \times 0.75}{(27.5 - 7.5) \times 7.5 \times 2.2}\right) 2 = 139 \text{ pounds,}$$

where 825 is a constant, for two or three supporting bolts; 6.5 is the depth of girders; 7.5 is the pitch of the bolts; 0.75 is the thickness of each girder bar; 27.5 is the length of girder, or width of chamber. The welded cylindrical flues are all subject to a collapsing pressure, and we shall need a large factor of safety, say two times the boiler factor of safety, or 9, to compensate for welds. Then by "Hutton's formula,"

$$\text{Cal. press.} = \frac{C t^2}{d \sqrt{L}} = \frac{660 \times 168}{16 \sqrt{30}} = 1280, \text{ and } \frac{1280}{9} = 142$$

pounds $W.P.$

In which C = constant 660,
$W.P.$ = safe working pressure,
d = diameter in inches,
t = thickness in 32d of an inch,
L = length of flues in inches.

Thus it will be seen that the 10-inch diameter flues can be made of $\frac{3}{8}$ steel and safely carry

$$\frac{660 \times 144}{10 \sqrt{30}} = 1760,$$

and divide this by a factor of safety,

$$\frac{1760}{9} = 195 \text{ pounds,}$$

which is well within the safe limits, and these could be made 5/16 inch thick if desired.

The compressive stress on the tube plate of the combustion chamber must be within the limits, as 13,500 pounds is the greatest allowable strain. Then

$$\frac{130 \times 4.5 \times 27}{2\,(4.5 - 2.75) \times 0.562} = 11{,}200,$$

which is safe.

The sling stays, or braces, that support the crown of the furnaces are attached to forged steel "crow-feet" ends, with $1\frac{1}{2}$-inch diameter steel pins. The crow-feet have a sectional area 2.6 square inches, and allowing 6,000 pounds for welds they will safely carry 15,600 pounds. And each of the crow-feet is riveted to furnace top with two 1-inch diameter rivets and allowing 8,000 pounds per square inch for tension, two rivets will safely carry $1.57 \times 8{,}000 = 12{,}560$ pounds. The $1\frac{1}{2}$-inch diameter pins are in double shear and need not be considered, as they are sufficiently large.

The section of the sling stays or braces is made rectangular for the purpose of passing between the tubes. They are made of soft steel, upset on both ends and drilled for $1\frac{1}{2}$-inch diameter pins, which also pass through the crow-feet. The area of these braces is 3 square inches, with a safe stress of 4,500 pounds. They will safely hold a load of 13,500 pounds. The area to be supported by each of these braces, it will be seen by referring to plan, is 8×12 inches, or 96 square inches, with a pressure of 130 pounds per square inch equals $96 \times 130 = 12{,}480$ pounds, which is under the results obtained for any part of the braces.

PERSONAL.—H. D. Savage, vice-president of the American Arch Company, New York, in addition to his present duties, has been appointed manager of sales of the industrial department of the Locomotive Pulverized Fuel Company, with offices at 30 Church street, New York City. Mr. Savage was formerly connected with the Ashland Fire Brick Company, and in 1904 was appointed their manager of sales. In 1914 he was elected vice-president of the American Arch Company, which position he will still hold in addition to his new appointment.

Safety First in Boiler Construction

Assembling the Parts, Riveting, Calking and Testing—Precautions and Methods to Insure Safe Construction

BY H. W. HOOVER

BEING convinced that drawings have been approved by competent designers and engineers, as regards capacity, efficiency and strength; that all material has been tested according to the best, modern approved rules for chemical analyses and physical strength, and has passed these requirements, and also has been inspected for surface defects and dimensions; that this material bears the manufacturer's name, heat number and tensile strength indelibly stamped on it; that all parts have been accurately laid out, machined, bent to radius, and flanging done, all in accordance with the approved drawings for steam boilers, brings us to

Assembling

Drum heads and all boiler mountings that are under pressure when riveted onto the boiler shell should be made of wrought steel. They should be fitted either by heating, chipping and filing or machining to a metal-to-metal contact, rather than by springing them and the boiler shell together with the aid of bolts, sledge hammer, ram or hydraulic pressure, because forcing heads and sections of the shell into place, springing members together and drifting of rivet holes causes unequal strain on rivets, mountings and plates.

Rivet Holes

The use of punched holes should be entirely eliminated in boiler construction. Either drilled or punched and reamed holes should be used, because punching holes invariably causes minute cracks to appear in the distorted structure of metal immediately surrounding the hole, which magnify during the use of the boiler, either from the chemical action of the water used for generating steam, or from boiler compounds used for inside cleaning, or from both. This will not only shorten the life of the boiler, but is always a source of danger while in use.

The size of rivet holes should be just large enough to admit the heated rivet, because if they are one-sixteenth of an inch or more larger, not only does it waste the solid plate area between them, but it causes the use of longer rivets to fill them.

After drilling or reaming all rivet holes, the straps, plates, heads and mountings should be separated, cleaned, holes burred and then re-assembled for riveting with parallel turned bolts, fitting the rivet holes and spaced about twelve inches apart (or where the best result can be attained) for holding members in position while riveting is being done.

Riveting

To heat and drive rivets tight in steam boilers is quite simple if the proper tools and methods are used. Heating rivets is not a boy's job, and, although common practice in boiler shops, the use of inexperienced heaters finally reflects on the manufacturer, unless a competent and reliable boiler maker is driving the rivets and oversees the heating, as to the proper temperature or color, but more especially to see that rivets are not overheated or burned before driving. The proper temperature does not depend upon the method used in driving, but rather that temperature which leaves the best qualities of steel in the finished rivet.

At the same time this heat should be sufficient so that when the maximum pressure is applied it will not only fill all crevices or unevenness in the rivet holes, but will also cause the distorted structure of steel in rivet shank and new head to adhere as they are pushed together.

Hydraulic or any other riveting machines that exert their force by pressure and not by striking innumerable blows drives the most satisfactory rivets. Rivet steel toughens by applying pressure, and becomes brittle when hammered.

The only way to drive heated rivets tight in holes through cold plates ½ inch or more in thickness is to have sufficient force exerted for a length of time necessary on the end of each rivet, swelling the shank to fill the hole in plates as it expands from the heat of rivet, and so that the elasticity in the heated plates surrounding the rivets will follow up by shrinking the shrinkage of the rivets as they cool. For example, we have experimented and found that maximum temperature of heat in plates five-eighths of an inch in thickness derived from heated ⅞-inch rivets is attained from five to eight minutes after rivet is inserted into rivet hole. Consequently either of the following two methods must be used to insure that rivets fill rivet holes and will not require calking:

First—Pressure of sufficient intensity (about 60,000 pounds per square inch of rivet section) must be maintained on each rivet as driven for from five to eight minutes of time, or

Second—A number of rivets can be driven (with 60,000 pounds pressure per square inch of rivet section) for from five to eight minutes of time, after which a final squeeze of two or three seconds' duration is applied to each driven rivet, beginning with the first one of the lot. The latter method is more practical, as it is a time-saver.

Questions have been asked whether the new rivet head should be formed on the inside or outside of boilers; by forming the new head of rivets on the outside requires an extra man inside the boiler to insert the rivet in hole, and then to guide it into the die in stake. But the machine operator knows by a glance after it is driven whether to O. K. it or not. The boiler shell and rivet are stationary, being held against the die in stake, while the plunger of the riveting machine moves forward, forming the new head. Also rivets as made by manufacturers have all rivet heads concentric with the shank, consequently this means that if these rivets are inserted into holes from the inside of boilers the flange of rivet heads covers a uniform area all around, and from the edge of rivet holes on the inside of boiler. We cannot say as much for the head as formed by boiler manufacturers. Forming the new head on the inside of boilers, the machine operator cannot see it as driven; the rivet head is held in the die in plunger, while it moves forward, pushing rivet and boiler shell toward the die in stake to form the new head on rivet, the head thus formed being not always concentric with rivet shank, and, consequently, the flange of rivet head on the inside of boilers does not always cover a uniform area all around, and from the edge of rivet hole. This method requires one less man on the job. We much prefer the boiler with new rivet head on the outside.

Heated rivets driven into holes in cold plates by pneumatic hammers do not fill the holes, and consequently the rivet is tight only between the flanges of the two heads, and caused by shrinkage of the rivet lengthwise.

We will assume the plates, straps and mountings have all been cleaned, burred, assembled (without the boiler heads) and bolted up. Riveting should start any place along longitudinal seams (no matter if it be one or more courses in length) by driving one rivet each side of a bolt, then directly across, and on the other side of joint, this should be continued alternately first on one side, then on the other, until there is a rivet driven on each of every bolt in that seam or joint, then all vacant holes to be filled by driving one rivet first on one side of seam, then on the other, until all vacant holes are filled, after which the holes are filled as each bolt is removed, first on one side, then on the other. The reason for the above is that buttstraps increase in length and width from the heat of rivets and also from the pressure of riveting machines. By distributing this heat and pressure over the total length and width of the buttstraps, as rivets are driven, is much more satisfactory than starting at one end of joint, driving every rivet in succession until the other end is reached. Boiler heads to be chipped to fit over scarfing on inner buttstraps, assembled and bolted into place, with turned bolts fitting the rivet holes. Rivets should be driven one on each side of a bolt, then half way round the circumference of boiler on each side of another bolt, then quarter way around and directly opposite, after which fill every other hole all the way round; then every vacant hole, and finally each hole as bolt is removed.

Calking

Calking must be resorted to, to make boilers perfectly tight, unless welding is preferable. In case calking is used it should be allowed only on the inside of boilers until they are perfectly tight on the hydrostatic test, after which they may be lightly calked on the outside along buttstraps, around heads and mountings, to give it a workmanlike finish. The reason for this is: where outside calking is used water is always present, while the boiler is in use, between plates, straps and mountings and sometimes around the rivets to their outside heads, which not only causes deterioration, but also allows deposits of mineral substance to collect, which is not only injurious to the life and efficiency of the boiler, but is dangerous as well.

The Hydrostatic Test

There is no logical, practical reason for the customary cold hydrostatic test of one and one-half times the working pressure being used on the manufacturer's test, as regards the safety of boilers under steam.

Cold water contracts all parts of the boiler while the hydrosttic pressure is trying to expand them; thus one is trying to counteract the effects of the other, which causes unusual and unnatural strains on these parts entirely foreign to the boiler while steaming. Rivets are subjected to shearing strains, which are not again produced under normal working conditions during the life of boilers. Testing water should be heated to about 200 degrees F., and then pressure to be applied 25 percent in excess of the working pressure. Boilers thus tested would be much more satisfactory under working conditions, and perhaps would decrease the percentage of accidents and explosions.

Safety Valves

All boilers should have not less than two safety valves per boiler, each one of sufficient area so that at all times it is capable of releasing any and all internal pressure in excess of the working pressure. They should be secured to pads or nozzles having openings whose area is sufficient for the purpose intended, and these openings on the inside should be unobstructed by dry pipe or other internal fittings.

Steam boilers should not be allowed on the market unless they have been inspected by competent, conscientious, experienced boiler inspectors, and then only where the proper tools and best practical methods have been utilized in their construction.

All of the above data is essentially necessary to guarantee safety first in steam boiler construction, especially during this age of high pressure, and in view of the fact that we never fully realize the enormous energy contained in boilers carrying from two to three hundred pounds of steam, gage pressure, unless we see one suddenly leave its foundation on a sight-seeing trip, either through the wall or roof of the boiler house or through the side or deck of a vessel at sea, causing death and destruction.

The "whys" of 90 percent of boiler explosions are not positively stated simply because they are not positively known.

Intelligent Care of Boilers

The modern tendency of steam engineering is to employ increasing pressure on boilers, for the purpose of obtaining the greatest possible amount of useful work in return for every pound of fuel consumed. In all lines of steam engineering, progress appears to be in the direction of higher pressures, but locomotives still maintain the lead. There are few new locomotives now coming out that carry boiler pressure of less than 200 pounds to the square inch, and still higher pressures are not uncommon. As the most economical steam engine, all other things being equal, is that which takes steam into the cylinders at the highest possible temperature and lets it escape at the lowest, making the greatest difference in the temperature by converting the heat into work, there is a decided advantage in employing steam of high tension; but the practice is not without its drawbacks. With the defective expansion gear used on the best of locomotives, the margin of saving between an engine carrying very high and one carrying moderate pressure is very limited.

Although the locomotive boiler is higher pressed than any other form of boiler in general use, and, although the type is more numerous in America than any other form, it has an enviable reputation for causing few violent accidents. This is particularly remarkable considering the admitted fact that the locomotive boiler is subjected to harder usage from sudden changes of temperature, from bad feed water, from exposure and shocks of service than any other boiler in use.

The immunity of locomotive boilers from violent explosions reflects the highest credit on the mechanical departments of our railroads, for it is due to the enlightened care in design and construction, and to unceasing vigilance in maintenance, handling and management. The greater the margin of safety with which a boiler is constructed, the easier will it be maintained in safe working order. The tendency of intense pressure, now become the rule, is to reduce the factor of safety, which has never been high. If this tendency results in increasing violent explosions of boilers the saving resulting from high steam pressure will prove a costly way of making money.

The Railway Master Mechanics' Association has directed persistent and intelligent attention to everything relating to the proper design and maintenance of locomotive boilers. Committees have made emphatic reports recommending systematic periodical inspection of boilers, so that any dangerous weakness may be discovered in time to apply the proper remedies. They recommend a hot hydraulic test to be made on boilers every six months after they are more than two years old, and careful inspection during the test to detect any change of form that may indicate any weakness. They also recommend weekly inspection with the hammer test for broken staybolts. The adage of one man being able to take a horse to the water when ten cannot make him drink applies directly to the way many committee reports are treated. A committee can make the very wisest recommendations; but all the persuasion in the world will not make some superintendents of motive power and master mechanics act on them. We know of no committee's recommendations more important to the safe operating of railroads than those referring to the inspection of locomotive boilers, yet there are no reports more flagrantly neglected. The most serious menace to the safety of a locomotive boiler is broken staybolts, and yet it is a common thing when an engine goes into a shop for general repairs to find from ten to twenty broken staybolts on one sheet, and that on roads where regular inspection of staybolts is reported to be carried out. A mere hammer test is a very uncertain way of detecting a broken staybolt; but if it is supplemented by a carefully conducted hydraulic test, any serious defect will nearly always be identified. Some master mechanics object to hydraulic tests and say they are useless and dangerous. When this is true it is not the blame of the method, but of the men applying it. Unless tests of any kind are properly conducted they had better be omitted, for a perfunctory test that is a mere form tends to give danger the appearance of safety.—*Railway and Locomotive Engineering*.

John Buys a Steel Square

Proving a Steel Square—Kinks to Which a Steel Square Can Be Applied

BY JAMES F. HOBART, M. E.

"What have you there, John? What are you trying to do with that rusty old steel square?"

"Why, I bought this last night over to Uncle Soloman's and I'm trying to rub off enough rust with this emery cloth so that I can find the figures on the square."

"Never mind the emery cloth, John; just lay the square flat on the floor or on a bit of boiler plate. Then step right on the square and dance a little jig, which will clean the rust off the square quicker and better than any emery cloth you may choose to use. There is always a lot of grit in the bottom of your shoe soles, and if you place the square on a flat surface, hold it there with one foot and polish the tool with the other foot, you will quickly clean off the rust and dirt, leaving the tongue and blade of the square bright and clean and showing off the graduations in good shape, as they are not touched by the cleaning and remain filled with dirt and rust, and consequently darker than the metal of which the square is composed."

"Say, that does it, all right. Why, I can clean a dirty square in two minutes in that way and I had been jockeying the emery cloth for half an hour and had hardly got the job started."

"Yes, John, that's the way to clean up a square or a steel straight-edge, or any other tool which can be placed flat upon the floor or other flat surface. But, John, now that you have got the square and cleaned it up, how do you know that it is good for anything?"

"Good for anything? Why shouldn't it be good? The corners aren't worn, the blade and the tongue seem to be straight and with no kinks in either of them. Why shouldn't the square be good for something?"

"I'll tell you, John, and then you can test out the square and see if it is worth what you paid for it. To begin with, that tool is what is known as a 'carpenter's steel square.' It has a blade 24 inches long and 2 inches wide, a tongue 16 inches long and 1½ inches wide graduated on both edges of both blade and tongue. This tool differs from the bridge square, which has a blade 3 inches wide with a mortise 1 inch wide in the middle thereof. The machinist's square is a small affair, with a blade 12 inches or less in length. The carpenter's square, John, is the one which you should purchase for use in the boiler shop and that is the kind which you have. Now, as to the value of the square; that depends almost entirely upon one thing, viz., whether of not the angle of blade and tongue is exactly 90 uegrees or not."

"Of course it is 90 degrees. It wouldn't be a 'square' if it were not!"

"That's just the question, John. Whether it is 'square' or not is the problem to be solved before you dare use the square upon any piece of work."

"Well, but why shouldn't it be 'square,' and what could have made it otherwise?"

"The steel square, John, is a somewhat delicate tool and it must be handled and used with some care. A fall for even a short distance, should the square strike solidly at an angle of tongue and blade upon any hard surface, might cause the tool to be 'sprung' so that the angle was no longer 90 degrees. And once a square has got 'sprung' it is of very little use, for it is almost impossible to restore it to its previous accuracy."

"I should think that the square could be straightened. A little careful peening ought to bring the tongue and blade back to 90 degrees again."

"That is so, John, but even after that has been done carefully and accurately, the square has not been restored, because the springing and the peening have surely stretched the length of either blade or tongue; therefore, while the tool may be accurately 90 degrees, the graduation is probably 'off,' consequently, once you have 'sprung' a steel square the best thing to do with it is to trade it to Uncle Soloman for something else which you can use. And perhaps, John, this square which you have just obtained may be one which somebody has unloaded for the reasons described above."

"Thunder! then the square may not be good for anything. How am I going to test it?"

"That's easily done, John. Just hunt up a planed sheet, the edge of which proves to be straight and smooth, with no burr left upon it. Such a planed plate is shown by Fig. 1. Measure back from edge about 23½ inches and make a very light mark with a fine, sharp center punch as shown at *A*. Now, place a sharp pointed scratch in this mark, slide the tongue of the square along the edge of the plate until the blade comes against the scratch, then mark a fine line along the edge of the blade while in that position as shown at *B*."

"How would a sharp piece of soap stone do, instead of the scratch?"

"It's no good, John. Use a scratch, or the sharp leg of the dividers. A fine, true line is what you must have for this work. Next, reverse the square as shown by dotted lines at *C*, and in that position slide it again up to the scratch in hole *A*, and then make another fine scratch

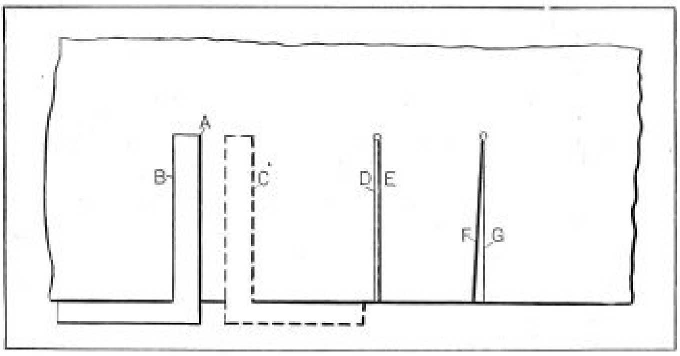


Fig. 1.—Testing John's Square

mark along the edge of the blade. Now, remove the square and inspect the two lines. If they are fully parallel, same as shown at *D* and *E*, then the square is all right and your Uncle Soloman didn't put one over on you."

"What if there isn't but one line, just a single line at *D* or *E*?"

"That's all right, too, John, and your square will be O. K. But if you find two diverging lines, as shown at *F* and *G*, Fig. 1, then your square has been 'sprung' and isn't worth a 'hurrah in Hades' and you had better take it right back to "Uncle" and swap it for what you can get, for your square is worthless. To be sure, you may be able to peen it so it will reverse all right and be of service as a square, but the graduations will be 'out,' and

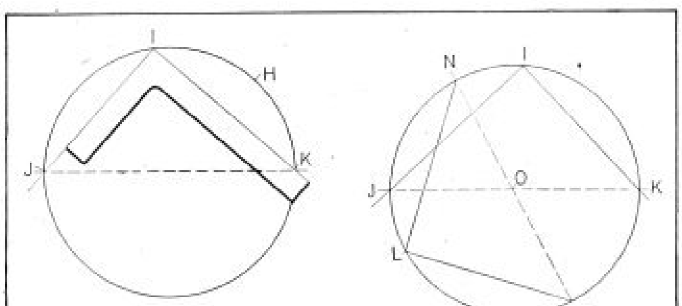


Fig. 2.—Locating a Center

sometime will lead you into error. If your square won't 'reverse,' get rid of it at once, although you can make approximate corrections by draw-filing the tongue."

"It tested out all right, Mr. Hobart. See the marks? You can't see but what they are perfectly parallel."

"Good enough, John. Now, what are you trying to do with that bit of boiler plate? It is a circle, isn't it? Cut out on a circular shear? What are you measuring across it for?"

"Why, I have got to locate the center to drill and reinforce there for a 3-inch steam pipe; therefore, I have got to locate the center of the circle pretty accurately."

"Say, John, there's an easier way than that, and you needn't do a bit of measuring, either. Do it all with the square and not make a single figure."

"Show me, will you?"

"Sure! Look at Fig. 2. There's your circular sheet at *H*. Lay the square down, no matter where, save that the corner must come fair with the circumference, as at *I*. Then scratch a line along the blade of the square, crossing the circumference at *K*. The tongue of the square don't reach to the circumference, so just place a straight edge fair with the tongue and draw another line from *I* to *J*. The points *J* and *K* will be the ends of a diameter of the circle *H*."

"Hully Gee! All I have to do now is to measure that dotted line, and find the middle of if, and that will be the center of the sheet!"

"No you don't, John. I told you there would be no measuring to do. Just slide the square part way around, a quarter of the circle, more or less, and repeat operations. Placing the corner of the square at *L*, and drawing lines to *M* and *N* along tongue and blade to the circumference of the circle same as before, and——"

"Oh! I see it now! I draw another dotted line *M N* and where this line crosses line *J K* will be the center *O*?

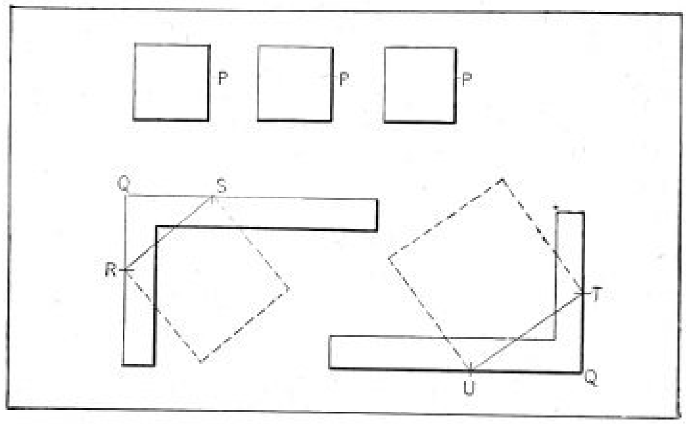


Fig. 3.—Laying Out a Breeching

Say, that is some problem—mighty handy one sometimes, I bet?"

"Yes, John, it is a handy little stunt. And can you tell me what proposition in geometry it is based on?"

"Something about right angles in semi-circles, isn't it?"

"Yes, John, you got it nearly right. It depends upon the proposition that 'an angle in a semi-circle is always a right angle.'"

"And, say, it doesn't make any difference, does it, where point *I* and *L* are laid down?"

"No, not a bit, only the closer the square the lines *J K* and *M N* pass each other, the more accurate will be the work."

"That's a pretty good stunt. What other things can be done with the square?"

"It would require a pretty large book, John, to tell all the things you can do with a steel square, but I will try and find room here for two or three more. When you are building, or designing, smoke up-takes or boiler breechings, the square is handy for determining the size of conduit required after each boiler has been connected thereto. For instance, if each boiler requires a smoke area of 22 inches square, how large must be the breeching between the second and third boilers and between the third boiler and the stack?"

"Well, you can figure that easily enough, can't you?"

"Yes, if you care to bother with figures, but you can also solve the problem with the steel square. Here are the three openings, in Fig. 3; *P, P* and *P,* each 22 inches square. To find the side of a square *R S,* which shall be equal in area to two of the *P* squares, simply take 22 on both blade and tongue of the square, from *Q*. Then draw the diagonal *R S,* and it will be the side of the square breeching required between the second and third boilers. Place a rule from *R* to *S,* and it measures 31.11 inches."

"And what do you do next? How is the next size of breeching found with the square?"

"In just the same manner, John. Take 22, the size of the other *P* square, on the tongue of the square, as before (or on the blade, it makes no difference which), say from *Q* to *T*. Then, on the other side of the square, take the dimension 31.11 already found at *R S*. Lay this off from *Q* to *U,* draw the diagonal *T U,* which will be found to be the length of the side of a square having an area equal to three squares *P, P* and *P*. The length of side *T U,* if accurately measured, will be found to be about 38.1 inches. Therefore, a breeching 38.1 inches square will handle the gases from three boilers, each requiring an opening 22 inches square for smoke passage to the chimney or stack."

"Well, that surely works out fine. But the steel square is not large enough to handle so large sizes. Guess I'll have to make up a wooden square of large size?"

"No need of that, John. Just work on a smaller scale. Call each quarter-inch an inch, then you can make the same allowance when measuring from *R* to *S* and from *T* to *U*."

"Say, that's so. I never thought of that! I can call eighths or sixteenths equal to inches, if I need to do so, and work pretty large sizes on the little old steel square, eh? But, wait a minute! If I want to work backwards and divide up a big area among several smaller ones, what do I do?"

"Just work backwards, John. Take the distance *T U* and place it across any angle at which it brings the points *T* or *U* to one or more sizes of opening or area required. Then work back from the distance found to correspond with *Q U,* and take this distance to be *R S,* placing one end of it to any chosen distance, say *R* or *S,* and thus determine the size of the remaining branches which equals the distance from *Q* to *R* or to *S*. And, John, you may, in like manner, divide either or both these quantities into still smaller areas, should conditions require it."

"Well, that's some stunt, for sure. But how can I work circles, triangles or rectangles?"

"Work them in exactly the same manner, John. Use like dimensions of side in each case. Then, if you use circle diameters, you will obtain results in terms of circle diameters. If you use triangles or rectangles, using like sides of said figures, then you will obtain results which are like sides of the same shaped figures."

"Oh, I see! Just stick to the same relative shape of figure all the way through, eh?"

"That is the way, John, then you will come through all right. But there is a neat little way of halving an area which will be useful many times in the boiler shop. Say you have a square sheet, *V Z,* and you wish to cut another square having exactly one-half the area of *V W*. To do this, lay the square along the diagonal *V W,* determine its center *Y,* then place the heel of the square at that point and draw the square *W Y Z,* shown by the dotted lines in Fig. 4. This smaller square will have one-half the area of the larger square."

"Phew! That's getting things down fine. Guess I'll have to study that a bit to see how and why."

"Just another geometry proposition, John. This time it

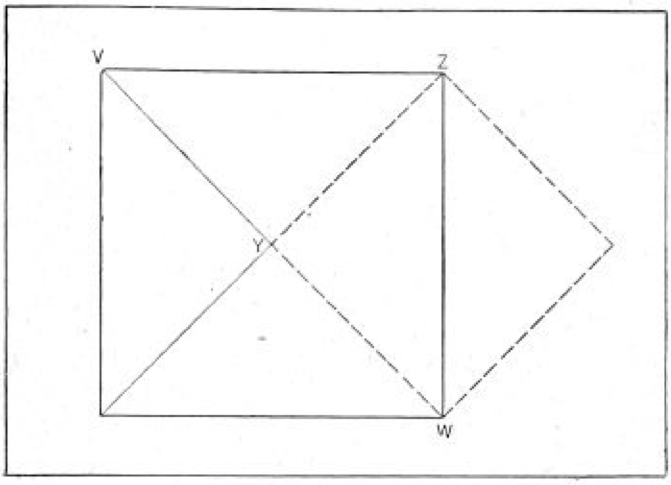


Fig. 4.—A Square of One-Half Area

is that old one that the "sum of the squares of the base and perpendicular of a right angle triangle is equal to the square of the hypotheneuse. See?"

"Thunder! So 'tis!"

"There are a couple more 'square kinks,' John, which I will show you to-day. They relate to laying out cones or gusset sheets. Suppose, for instance, you wanted to lay out a stack roof cone, something as shown by Fig. 5, in which *A* represents the plan and *B* the elevation of the roof-cone. To find the layout of this cone, draw the line *C D,* Fig. 6, place the steel square at *C,* fair with line *C D,* and lay off half the diameter of the large end of the cone at *E,* marking along the square for the line *C E*.

"Then lay off the height of the cone *C F,* and move the square down to *F,* keeping the tongue fair with line *C D*. With the heel of the square at *F,* lay off the lesser diameter of the cone from *F* to *G*. Then, through points *E* to *G,* draw a line *E G,* cutting line *C D* at *H*."

"Say, isn't line *E H* the true diameter of the cone development?"

"You are right, John. *E H* is the diameter, or, rather, the radius of the cone development, and we will proceed to draw a portion of a circle with this radius, as shown by Fig. 7, where *H G* is the radius in question. Next draw another portion of a circle with *H G* as radius and the portion between *E* and *G* is the development of the roof cone."

"But, say! How do you find the length of sheet *I J K*?"

"There are several ways, John. You can make the radius of circle *A,* Fig. 5, the numerator and radius *H E,*

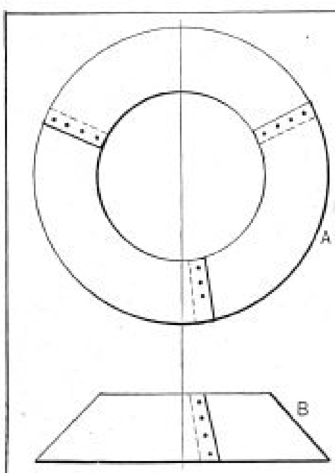


Fig. 5.—Stack Roof Cone

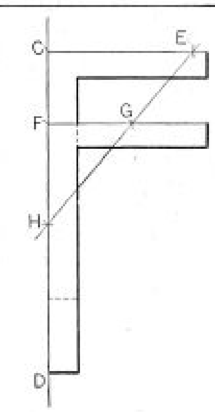


Fig. 6.—Laying Out a Cone

Fig. 6, the denominator of a fraction. Multiply this fraction by 360 and it will give the number of degrees in circle-section *I J K*, Fig. 7. But we will do it quicker than that. Just space half way around circle *A*, Fig. 5, with the dividers. Say it is 19 steps. Then, just start at vertical line *J*, Fig. 7, and space off 19 steps, which brings

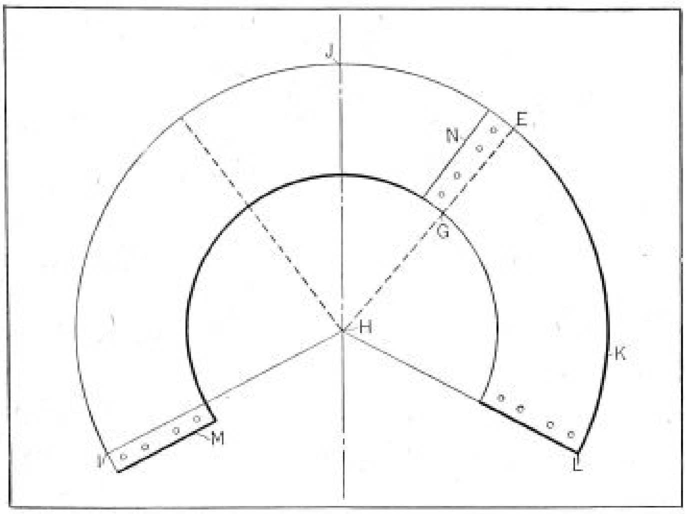


Fig. 7.—Cone Developed

us to *L*. Do the same on the other side of the line, and locate *I*, to which must be added the lap allowance *M*."

"If I draw the two radial lines to center *H*, I have got the whole layout for a one-piece cone, haven't I?"

"Yes, John, and if you make it in three pieces, as shown by the plan, you have only to space off one-third the circumference from *L*, and you have it. There are 19 steps each way, 38 in all, and one-third of 38 equals 12 2/3. Therefore, step off 12 2/3 spaces from *L* and you locate

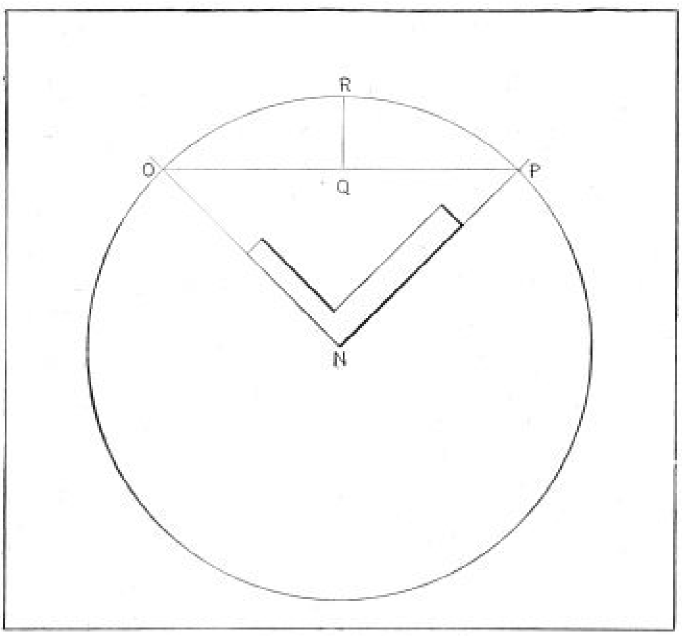


Fig. 8.—To Find the Circumference

E G, to which you add the lap allowance *N*, and there you are. And, John, one way to find the circumference of cone *A*, Fig. 5, is to place the square on the center, as shown by Fig. 8. Use a straight edge or two for extending the lines *N* to *O* and to *P*, then draw the line *O P*, find its middle, and measure the length of the line *Q R*. Add this length to three times the diameter of the cone, and the sum is its circumference."

"Well, by the big crane! Of all the juggling geometry I ever heard of that trick surely takes the cake! Say, some day you will only have to push an electric button marked "Geometry" and out will come any question that might be asked, all answered and explained! Say, I am going back to the shop. That's too rich for my blood. Why, it's uncanny! But I'm going to hold on to it, all the same!"

Boiler Inspection, as Viewed by Hon. T. J. Duffy of the Industrial Commission of Ohio*

The object of this convention is to bring about the adoption of a uniform boiler code to be observed and enforced in the various States. It may not be presumptuous on my part to say that perhaps the best way to accomplish this object would be to follow the lead of the American Society of Mechanical Engineers.

This society is best able to lead the way in such a matter, not only because of the high technical and mechanical skill within its membership, but because it would be better able to overcome that State pride which might cause some of the States to hesitate about adopting a code that happened to be the product of any one particular State.

The Industrial Commission of Ohio, through its boiler rules, has expressed its willingness to adopt the code of the American Society of Mechanical Engineers, and I might say that Ohio has for some time been inspecting boilers constructed according to the provisions of the code of this society. I know it will not be giving offense to any of you if I say that the American Uniform Boiler Law Society is entitled to special mention on this occasion, because of the splendid and effective work it has done to bring about the adoption of a uniform boiler code. Perhaps each and every delegate here has been enlightened and encouraged by the splendid reports made by its chairman, Mr. Durban.

Those who are interested in this boiler question are aiming to make the construction of boilers more reliable, the inspection more perfect, and the hazards less in number and in frequency. The purpose of all this is to protect human life and valuable property against the dangers of boiler explosions.

In the State of Ohio during the past year there have been three deaths resulting from explosions in that class of boilers that are subject to inspection under the law. During the same time fifteen deaths have resulted from explosions of boilers or other steam power vessels that are not subject to inspection. The contrast is the more striking when we bear in mind that this class of boilers has been exempted because they were thought to have been non-hazardous. This should demonstrate to us most forcibly the importance of the safety movement of which boiler inspection is a part. We want to show the boiler operators and the boiler owners that boiler inspection means not only the protection of life and limb, but the protection of valuable property, and is therefore economy in the end. We want to show the employer that money he spends to equip his factory with safety appliances, and to make his factory a safe place of employment, is not only spent in a humanitarian purpose, but that it means economy to him, for the saving of human life and limb means that less money will have to be paid out as compensation to the victims of industrial accidents.

Likewise, we want to impress upon the workingman himself the vital importance of taking no unnecessary chances. Men become so familiar with the hazards of the factory that they are unconscious of the dangers that

* From opening address delivered at meeting of the American Uniform Boiler Code Congress, Washington, D. C., December 4 ,1916.

surround them. They will operate an unguarded machine or perform a dangerous operation 9,999 times and escape injury, but they forget that it takes only one accident to put out an eye, amputate a human limb, or crush out a human life; and the object of all safety measures is to protect the worker in that one time when fatigue, indifference or carelessness will cause him to make a move that might be followed by serious or perhaps fatal consequences. And so we can see the importance of this safety movement and its relation to the boiler question.

The Awakening of Jimmie and Bob

In Working Out the Design of a Boiler Jimmie and Bob First Calculate the General Proportions

BY W. D. FORBES

"Jimmie, these textbooks get me wuzzy. I don't seem to know enough to find out what we want in the index, and I get thumbing over the pages and then perhaps I stumble on just what I was looking for—that is, I think I have, but it's awful work to dope it out even then.

"Most everything we are looking for is right in these textbooks. The trick seems to be to find it and then to understand it. Take this matter of how much coal to burn—you get a table of all kinds of coal which, when burned, seem to give different amounts of heat for each pound of coal, so of course we will have to strike some kind of an average."

Jimmy agreed with all this most emphatically and added: "Of course, most of the trouble lies in not knowing enough, or perhaps we haven't got hold of the right book, but it seems to me there is a whole lot of trouble that is due to the way the books are indexed. But let's stop kicking and get down to brass tacks. Howland, the draftsman, told me to get a couple of blank books like these and keep all our notes about this boiler work in them. Then we can refer to them without trouble, and when we've learned a thing from one of the textbooks we can put down the page and book's name so we can look up the subject any time.

Textbooks Prove Baffling

"We've agreed to build a vertical type boiler of 30 horsepower. Now we start this way, 'Notes and calculations on a vertical type 30 horsepower boiler; then we put down the date. I can't find anything in these textbooks yet that tells me just how much air is required to burn one pound of coal, yet it must be in the book somewhere. Have you doped out anything?"

Bob admitted that he had met the same trouble exactly and asked: "Why the deuce don't they put it down in the index like this, 'Air required for burning one pound of coal'? Then a fellow could do something. But I have found this, and we can start that way, anyhow, that it takes more heating surface than grate surface in a boiler and the heating surface must be effective (as the high brows call it). That means that the heating surface must be so placed that the heat will reach it. Now, with a vertical boiler the tubes go straight up from the firebox and the heat goes directly through them, so all the surface I thought ought to be effective.

Jimmie here broke in, saying: "Yes, but the tubes over the middle of the fire where it is hottest will have more effective surfaces than the tubes around the edge of the fire, that's sure. Now I should think that a boiler with straight vertical tubes would not be economical, as the heat would go scooting through them before it would do much good in boiling the water. What do you think?"

Bob pondered a little before he answered: "Yep, but you can put those retarders in the tubes and they must do a lot of good."

Jimmie did not know what a retarder was, so Bob explained. "They take a strip of sheet metal about one-sixteenth inch thick, or perhaps a little more, and with a machine twist it up like an auger. They are about as long as the tube, but not quite, and these spirals are pushed down into the tubes so when the heat comes up it has to follow the spirals, so more heat is absorbed by the water."

Retarders

"H'm," said Jimmie, "Howland told me that if a tube didn't have water around it, it would burn out pretty quick, and I should think this twisted up sheet metal would not last any time. How about that?"

"Well," said Bob, "you see they will burn out after a while, but there is no pressure on them, so there is no danger, but I should think they would stop the draft a whole lot. We'll have to ask about that or read up on it. There's another thing I have been thinking of, the upper ends of the tubes can't have water around them, 'cause you must have some steam space. I wonder how it is they don't burn out. I guess they do, but when you come to think of it they are a good way from the fire, so they won't burn out very quick."

"Here," said Jimmie, "is another thing we have got to look after. How far must we have the fire from the lower end of the tubes? I should think the nearer the fire was to the tubes the better off they would be."

"No," answered Bob, "there is something about that here somewheres. You have got to have a certain height of firebox, as it is called, to get good results, so that more air can get to the 'products of combustion' (how's that for high brow talk?) and it will be more perfect. Now, I've put down about the size of boiler and style. The next thing is, the boiler pressure we are going to have. Let's call it 100 pounds, as that is dead easy to figure with. Next, we are going to use anthracite; that's hard coal, you know; those things are all fixed and we know what they are. Then we want to put down the things we want to find out, as follows:

Data Required

"Square feet of grate surface, square feet of heating surface, diameter of tubes, length of tubes, number of tubes, gage of tubes, diameters of tube sheets, thickness of tube sheets, diameter of shell, thickness of shell, length of shell, diameter of smokestack, size of safety valve.

"Those are a whole lot of things we've got to find out. The first we want to know is what they call the horsepower of a boiler. Here is one fellow and he says, 'In actual practice the result of a great many tests has shown that an evaporation of 30 pounds of water per hour from a feed water temperature of 100 degrees F. into steam at 70 pounds gage pressure is the equivalent of one horsepower,' and here we get it again for heating surface. It seems to come down to having some say 10 square feet, but we'll call it 12 square feet, of heating surface for each horsepower, so if we are going to have a 30 horsepower boiler we must multiply $12 \times 30 = 360$ square feet of heating surface. Next this same book says that 'one-third of a square foot of grate surface is needed for each horsepower, so we must have $30 \times 1/3 = \frac{30}{3}$, or 10 square feet of grate."

"I was in the drafting room the other day," said Bob, "when they were figuring something like that, and when they got it figured out the old man said, 'Let's see what Hinck's & Co.'s catalogue says about size of boiler'; so I guess they don't always trust their own figures, anyhow."

Jimmie then struck in: "Now we've got to find out about the size of the tubes. We have to figure, I suppose, the inside of the tube as heating surface, and over here in this book it says that one-sixteenth inch of a deposit of soot on a tube has the effect of retarding the transmission of heat equal to a thickness of 4 inches of metal. Gee! if I was paying for the coal in a boiler, I'd make them keep it clean. But what size of tube will we have? Of course we can take anything you like?"

Size of Tubes

"No," answered Bob, "you can't get them too small or they will choke up, and if we get them too big, they will not be economical and it will make the boiler too big, anyhow. Suppose we call it 2½-inch diameter and see how that figures out."

"Well," said Jimmie, "how thick are we going to make them? According to that soot proposition the thinner they are the better they will make steam, but you must not get them too thin or they will bust up. But we can leave that for a moment and see about the heating surface. Now, none of the books tells us whether to figure out the outside of the tube or the inside for heating surface. Of course the outside of the tube would be the heating surface for the water, but the inside would be the heating surface of the heat. I'd like to lambast some of these fellows who write these handbooks. I don't believe that any of them ever drove or calked a seam. Take the table of circumferences, Jimmie, and tell me what the circumference of 2½-inch diameter is."

Jimmie looked it up and said, "It's 7.85 inches."

"Now," went on Bob, "we will have to multiply this by 12 inches to get the surface on each foot. That comes to how much?"

Jimmie figured it, saying in a minute or two, "That makes 94.2, call it 94."

"No, you don't," said Bob. "You put down the decimal. It's all right to skip a decimal if you have only one unit, but they count up when you have a lot. Now remember that 94.2 is square inches, not inches. Every foot of our 2½-inch tube has an area of 94.2 square inches. Now you see we've got to have 360 square feet of heating surface, and of course to get the number of square inches we've got to multiply it by the inches in a square foot, which is, of course, 12×12, or 144. 360 multiplied by 144, Jim, is what we want. A draftsman would take and do that on a slide rule in about half a minute, but we will both figure it out and see where we land. 51,840 is what I make it."

"The same," said Bob. "Now we divide this by 94.2. That means that we put a decimal first to the right and add a zero; thus $51{,}840.0 \div 94.2 = 550.3$. Now we can drop the decimal and call it 550 square feet of heating surface, which we will have to have in the tubes."

"Hold on," cried Jimmie, "don't they count the lower tube sheet heating surface? I should think it would be the best of the lot."

The young men searched the handbooks for several minutes, then gave it up, as neither could find whether or not the tube sheet counted as effective heating surface. It would, of course, be such, they saw clearly. Finally Bob exclaimed, "Here's something I've just come across. I just happened to pick it out: 'Boiler tubes are measured on their outside diameter. Standard pipe is measured on the inside diameter.'"

Jimmie, looking up from his book, replied: "Here we have it all right. This man says, 'The area of all surfaces exposed to the fire and hot gases, which on their sides come in contact with the water in the boiler, should be taken into account.' So the lower tube sheet does count, but the upper sheet won't count, nor will the surface of the tubes which pass through the steam space count as heating surface. But let's take a pipe and talk it over."

(To be continued.)

James Watt—"Boiler Maker"(?)

In the December issue in the course of an article by N. G. Near there is the statement that James Watt was a boiler maker. This bald utterance is liable to mislead, unless qualified. To claim James Watt as a skilled mechanic is, however, justified up to the hilt.

The fact is that Watt was first a scientific instrument maker, second a mechanical engineer, third a philosophic, inventive thinker—all the time a genius of an order only too rare, and the simple label of boiler maker is a perversion of fact.

Like N. G. Near, I bow the knee to Watt, as I do to Leonardo da Vinci—or, for that matter, to Shakespeare and other super-men. Da Vinci, for example, was an engineer of great attainment as well as a painter of masterpieces, a combination so astounding that it is almost impossible to reconcile the two activities. Now the point is that to claim Da Vinci as an oil and color merchant because he painted is to belittle the man. Da Vinci experimented in color, as in all else that he touched. To claim James Watt as a boiler maker is in exactly the same manner a perversion of fact. Shakespeare was an actor, but who to-day consciously realizes him in this sense?

James Watt needed boilers to make steam under pressure; as a consequence he designed and had boilers made. I take it that a boiler maker is a man interested in boilers for a living, not as a means to an end. The end sought by Watt was the generation of power for which he required boilers to generate steam as one link in the process. He was the first man to attempt to obtain a rational vessel to hold pressure and exchange the heat of fuel into potential energy. In this sense Watt was the patron saint of boiler makers, since he it was who first instituted the trade, but to describe him as a boiler maker is contrary to fact.

Watt set out to pump water, to do this he needed steam, to obtain steam he required a boiler; hence the necessity which leads to invention founded an important trade.

Upon the roll of illustrious mechanics the name of Watt assuredly tops the list; his research, patient endeavor and inventive genius are settled beyond dispute. Like all great men he was humble minded. In essentials the work of Watt has had a greater direct result than that of any single individual since the beginning of things. He can

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rightly be said to have started the industrial revolution. He overcame the initial difficulties, he discovered the starting point of a new era, whose close is not yet in sight. Like the small opening in a dyke the flood has come pouring in—thousands upon thousands have taken out patents, made improvements, secured fortunes by reason of the initial and pioneer work of James Watt. All modern industry, wealth, transport, refrigeration, all the multitudinous conveniences of civilization, date back to Watt. As a pioneer he discovered the greatest contentment, enlarged the possbilities of mankind, as no other individual has ever done.

It is in all respects fortunate that Watt, like Faraday had a mechanical bent; they were both pioneers whose discoveries have worked miracles. We are all heavily in debt to the men who started the beginning, whose bent by accident was mechanical.

There is one reflection worth making about the discoveries of new eras; it is that the discovery was waiting to be made, and providentially at the moment came along the precise individual who could puzzle out the key to the mystery. This does not lessen; it enhances achievement, it takes genius to the first step; the sequence of events then lies to more ordinary people.

The most extraordinary part of epoch-making discoveries is that they are so obvious looking backward. No doubt we are puzzled as to how certain things of which we have no experience are produced; when opportunity is afforded the means are simple and effective and it looks as though anyone would naturally "do it that way." Beneath the seeming simplicity there lies years of experiment and a chain of experience decades old, each generation being heavily in the debt of that preceding. Anyhow, the starting point was the real trouble, not the subsequent improvement. It looks to some as though if the discovery were still to be made anyone could make it, but without training (non-existent) and standard of comparison (totally absent) the seemingly obvious would then baffle understanding.

This is why in any assessment of men the pioneer discoverer receives the credit.

To-day every boiler maker of any intelligence is probably a better practical maker of boilers than Watt, for the modern exponent is the custodian of a century of practice since Watt's day.

The description of Watt as a boiler maker is like terming Kelvin a plumber because the latter invented a faucet (and a very good article it is, too), or claiming Faraday as a shift engineer or electrician. To localize genius by claiming men of the calibre indicated as practioners of any single sectional trade is to belittle achievement.

James Watt was a skilled mechanic, for he wrought with his hands as an instrument maker, and without a shadow of doubt considered the title an honorable distinction. What the world owes to the skilled mechanic it is impossible to assess or realize. It is perfectly true to say that the two most vital matters of discovery (assessed by results) ever made were inaugurated by simple mechanics, and in neither case was there any pretension to academic honors.

This was the industrial resolution started by James Watt and aviation solved by the Wright brothers. In both cases it was mechanical practical training, fostered and developed by scientific spirit animated by an acute intelligence commonly termed genius.

To term James Watt a boiler maker because he designed boilers is untenable. There are thousands of mechanical engineers who design, supervise and are responsible for inspection, selection, installation and operation of boilers. Like an architect who cannot be rightfully termed a builder, they are not boiler makers; it is doubtful if they could even, if given every facility, make a boiler. In any event their respect for the practical boiler maker is considerable and his trade skill is given due credit. The writer personally knows one successful engineer running his own business who was apprenticed as a boiler maker. He could justly so describe himself.

However, to enter into a controversy as to the merits of or make comparisons between trade and trade is invidious and not the purpose of this article. Exactly what is the purpose is less the defense of James Watt from an honorable aspersion as that Mr. Near's statement is inaccurate in fact, although correct enough in intention. First rate trade skill in any business is an acquisition of which any man may be proud; he is a member of a goodly company among whose number many illustrious names have occurred. It is to be feared that mechanical men neglect the biography of their greatest men. To read "Smiles' Lives of the Engineers" is to be amazed at the difficulties overcome by a single individual. All mechanical craft has been founded upon the work of men mostly in humble circumstances who had grit, determination, vision, and who by reason of the fact they could do things made for themselves an imperishable name.

No romance ever penned is as vitally interesting to those in the business of metalworking as the plain, unvarnished record of fact in the lives of Watt, Nasmyth and others. Doubtless there are discoveries yet to come, other fields to conquer, fresh applications to be made. There is literally in deed and fact no other business so vital to the community as that of metal working; practically all else depends upon it. Failure, anyhow, often involves catastrophe, and for this reason alone its importance cannot be too emphasized. It is, moreover, certain that here and there throughout the world are individuals patiently disentangling process method, inventing, originating, a proportion of whom will serve mankind in an essential way.

No engineer can be considered competent until he has one or more patents, successful or not, among his papers. The scientific spirit should animate us in our daily work; few trades make more demands upon conscientious scruples than boiler making, few cause so much disaster through failure.

James Watt was associated with the trade, since he was the first individual who tackled some of its problems; but he was not a boiler maker in any understood sense, and to claim him as such is to understate the glory of his achievement and belittle his great name.

There really should be some special title to distinguish such men. The appellation engineer is too universal, that of boiler maker or machinist too particular, scientist covers nearly everything in heaven or earth.

London, England. A. L. HAAS.

RATE OF WELDING.—Welding is usually accomplished more quickly by the electric arc than by any other process, as shown by the following figures from the *Railway Mechanical Engineer:*

A full set of locomotive flues, 36 superheater and 256 2¼-inch flues have been welded in 12 hours and 30 minutes by one operator. The 36 superheater flues were completed in three hours, or at the rate of 12 an hour. The 256 boiler flues were welded in 9 hours and 8 minutes, or at the rate of 27 per hour. Twelve leaks developed and required 20 minutes to reweld. On the superheater flues 175 amperes were used with 20 volts at the arc, using 5/32-inch electrodes. On the smaller flues a ⅛-inch electrode and 125 amperes were used with 20 volts at the arc.

The Boiler Maker

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NOTICE TO ADVERTISERS

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 25th of the month, to insure the carrying out of such instructions in the issue of the month following.

How serious to the public in general the question of adequate inspection of steam boilers really is can be realized from the losses due to boiler accidents enumerated by Dr. F. R. Hutton, M. E., Emeritus Professor Columbia University, New York, and vice-president of the Museum of Safety, in his recent address at the American Uniform Boiler Code Congress in Washington. As summed up by Dr. Hutton, a boiler accident entails a loss in at least five directions, namely:

First, the property loss in making repairs otherwise unnecessary.

Second, the cost of compensation properly payable directly to the persons injured, or spent in insurance premiums.

Third, the loss of wages, borne both by the victims and by dependents upon them, and appearing as lost opportunities for schooling and in lowered standards of living.

Fourth, and most consequential of all, the loss in arrested production. Every tool and every employee should be making product every working hour, to pay the costs of interest and overhead expense. This earning should be as nearly as possible a continuous process; the cost accounts are such. So that, to arrest the earning of either tool or man is to increase the high cost of living.

Fifth, the costs borne indirectly but none the less really by the community in the operation of hospitals for the injured, dispensaries, ambulances, and premature pensions.

These are all ponderable and capable of being expressed in dollars. Then there is a sixth loss in the pain and sorrow which must be borne, in the bereavement of fatalities, and in the suffering, which are inseparable from the material aspects of the disaster. These are losses and costs which no Christian employer or legislator can view unmoved, or without stirrings of soul and spirit.

At the last annual meeting of the apprentice instructors of the Santa Fe Railroad many useful directions were given as to the best methods of teaching the subject of laying out. Some of these are given below:

In teaching laying out the first steps should be taken in the school room, where drawings of the objects are made to scale, developed, cut out, and assembled. The first laying out jobs in the shop should be closely supervised by the instructor. The apprentice should follow the laying out job to completion. Blue prints should be carefully studied and thoroughly understood before beginning the work upon the table.

The importance of properly squaring up a sheet was brought out. Apprentices should have experience on all of the laying out jobs done in the boiler shop. The apprentice should start with the light sheet metal work and later work on the heavier grades.

After the boy shows his ability he should be left to his own resources, but the work checked by the instructor and any errors pointed out and corrected. Work of this nature should be given to third and fourth year boys only.

Whenever possible apprentices should fit up the work they lay out. If this latter direction is followed out, much better progress will be made by the apprentices. Not only will they more readily appreciate the whys and wherefores of the work which they have done but they will learn to be more careful and avoid needless mistakes and, what is of equal importance, they will gain confidence in their ability to carry out the work on their own responsibility from start to finish.

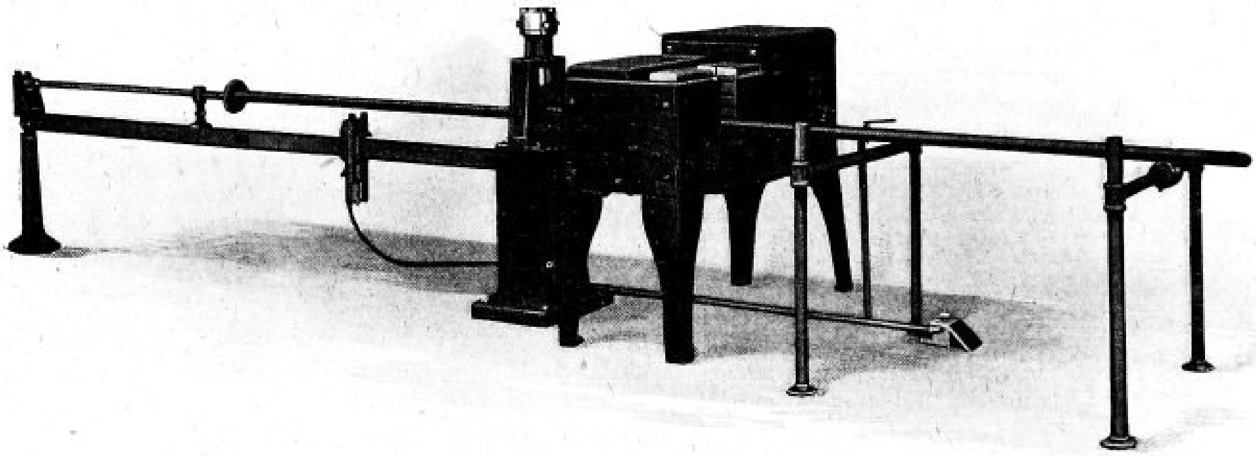
The present age of high steam pressures in power plant design serves to keep the boiler maker alert for new developments in boiler materials and fittings and for improved tools and methods for safe boiler construction. Boiler pressures of five and six hundred pounds per square inch are now being talked of and, coupled with a superheat of one hundred or more degrees Fahrenheit, give promise of limited adoption in the near future. Pressures of from two hundred to three hundred pounds per square inch, which now prevail to a large extent in new construction in the marine, railway and stationary fields, call for the best that can be produced in materials and shop practice in order to guarantee safety in boiler construction. It should be remembered, also, that the general trend towards higher pressures and larger units calls for better workmanship and better trained boiler makers to do the work. Good boiler makers, thoroughly trained and fully capable of meeting the exacting requirements of modern safe boiler construction, are none too plentiful and young men should be encouraged to take up this trade as a profession.

Engineering Specialties for Boiler Making

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

Ryerson Boiler Tube Reclaiming Machines

Reclaiming old boiler tubes has in the past been given very little consideration, due in general to the fact that the reclamation of old materials has only been taken up seriously by the railroad companies within the last few years. During that period little was done toward reclaiming tubes, owing to the fact that no satisfactory machine had been devised or offered for welding lengths greater than those ordinarily used in the common safe ending process.



Ryerson Tube Reclaiming Machine

The safe ending process has, furthermore, been carried on to such an extent that not infrequently five or six, or even more pieces, are welded on to the tubes used in high pressure locomotive boilers. Where safe ending is carried on to such an extent the balance of the tube is, as a rule, not worth reclaiming after the last removal from the boiler. The more stringent regulations of the Interstate Commerce Commission, coupled with the generally adopted safety first movement, have done much to better the class of tube welding done, and the number of safe ends that are pieced on to the tubes is generally less than was the rule some few years ago; the result being that the railroad companies have great numbers of short tubes which are in good condition and can be used, provided they can be welded together to make up the proper lengths required with not more than one or two welds.

The equipment described herein has been developed for the reclamation or welding together of these short tubes; the object in this development being not only to provide a satisfactory flue reclaiming unit, but also to offer standard machines which may be utilized for the regular safe ending operations.

The equipment consists of a special pneumatic flue welding machine of the hammer type, an oil heating furnace, proper racks and the special mandrel on which the tube is placed. In operating, the tube is heated and belled out in the usual way and the safe end or shorter tube inserted. The tube with the safe end inserted is then passed through the furnace and over the mandrel until the point of weld is in the proper place for heating in the furnace. When the proper temperature is reached the tube is shoved forward through the furnace to the proper point under the welding dies, the welding machine being in direct line with the furnace opening. A stop or guide is arranged on the mandrel and this acts as a gage to locate the welding point under the dies as well as an automatic starting device for the welding machine. When the farther end of the tube strikes this stop or guide it operates a lever which in turn operates the air valve of the welding machine. This permits the entrance of air into the cylinder of the welder and thus automatically begins the welding operation. As soon as the pressure of the tube is taken off the gage stop, the air supply is cut off and the welder comes to a standstill. The tube is then pulled back through the furnace and the operation is completed.

By the installation of this tube reclaiming equipment a great number of tubes that are at the present time scrapped may be reclaimed, and a correspondingly large saving accomplished. The equipment is designed for railroad shops particularly and permits the utilization of short boiler tubes which would otherwise be scrapped, the operation being merely that of welding the shorter tubes together into pieces of proper length for locomotive service. The outfit is so arranged that practically any length of safe end can be handled. The machine is manufactured by Jos. T. Ryerson & Son, Chicago, Ill.

Labor Saving Specialties for the Boiler Shop, Manufactured by the MacLeod Company

In these columns our readers have undoubtedly learned a great deal of the art of autogenous welding and cutting, but it is a well-known fact that this method of welding and cutting of metals is not as yet fully developed, and a large number of manufacturers have not as yet realized the great saving one of these outfits will prove to them, probably due to the fact that a complete investigation of the merits as applied to their particular requirements have not been made.

Fig. 1 shows a portable Buckeye oxy-acetylene welding and cutting apparatus manufactured by the MacLeod Company, of Cincinnati, Ohio. This outfit has proven its value particularly in the railway repair shops in the boiler department, though its uses in other departments are almost innumerable. For the repair of flue sheets, cracked and broken crown sheets, water legs, arches, etc., it has proved eminently useful, resulting in economy of both time and money.

A short time ago one of the largest roads in the East had a cracked crown sheet repaired as a test, and the locomotive on which the work was done has been in constant use since the day the repair was made until the present time without the slightest sign of deterioration showing in the weld. Since the first repair was made by this process a number of other boilers have been repaired for the same road, in the same manner, and with complete success.

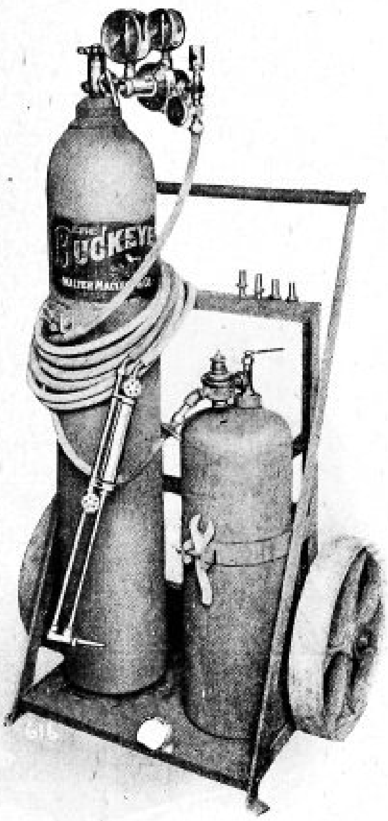


Fig. 1.—Portable Buckeye Oxy-Acetylene Welding and Cutting Apparatus

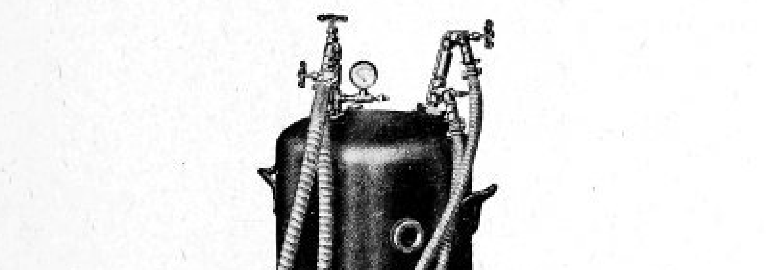


Fig. 2.—Buckeye Heater

In this connection we also call attention to the Buckeye heater, as shown in Fig. 2, also manufactured by the MacLeod Company. This machine has been found one of the handiest labor savers that could be installed for boiler repairs, and also for new work in laying up corners, joints, also for flanging. With the addition of reducing valves this outfit will give a softer heat at a low pressure, but in a large number of boiler shops this outfit is being operated at pressures ranging as high as 100 pounds. This type of oil burner will stay ignited without the help of the front nozzle casing on the burner, which proves that it has perfect atomization.

Fig. 3.—Rivet Forge

Fig. 3 shows a type of rivet forge manufactured by the MacLeod Company that has practically been adopted as the standard by most of the United States navy yards. These forges are built in a number of different designs, some with three or four openings for different sizes of rivets, and can be supplied for the use of either oil or gas fuel, as the customer desires.

Perolin—A Boiler Metal Treatment

Perolin, a boiler metal treatment recently introduced into the railway field by the Perolin Railway Service Company, St. Louis, Mo., is not a "boiler compound" or a "chemical water treatment." It is a metal treatment and consists of a viscous, non-volatile, mineral liquid which, when injected into the boiler through a short pipe or siphon attached to the suction of the injector, diffuses through the water, and is immediately attracted to the hot boiler metal, and as a result of this attraction or affinity, is drawn through the pores, cracks and crevices that exist in the scale, into direct contact with the metal, where it works its way along the steel, breaking the bond of adhesion between the scale and the metal. Perolin has a high coefficient of expansion; starting at 180 degrees F., it reaches a maximum expansion at 500 degrees. This expansive force, exerted between the scale and the metal, removes the existing scale *mechanically*, and, it is claimed, will break loose from the metal the densest and most tenacious scale. During and after the removal of scale from the boiler metal, a thin coating of Perolin establishes itself on all the water-covered surface. This skin, or film, is a better conductor of heat than water, and prevents any sediment from baking on to the metal in the form of scale, and at the same time thoroughly protects the metal against pitting and corrosion. Instead of permitting the incrusting salts to precipitate on to the boiler metal and bake on in the form of scale, Perolin causes the solids to remain in suspension in the water, precipitated in their natural state—that is, without the addition of chemicals. This so-called "colloidal action" eliminates surface tension and stops boiler foaming.

Perolin is fed at the roundhouse by the hostler when preparing the engine for service, and requires only a few seconds' time to feed the small dose required for the entire trip of engine or the day's work of the switch engines. None is required to be fed by engineer or fireman while on the run. Where this treatment has been used in locomotive service, it has been found that engine failures due to poor water have been reduced, that the mileage between boiler washings has been increased three to four times, that less tube and tube sheet work are required, with a consequent saving in firebox repairs, and that the life of the tubes and tube sheets and staybolts has been increased by its use. With cleaner boilers the fuel consumption will be decreased, and this is one of the results that has been realized by its use. Where Perolin has been used it has been found unnecessary to erect and operate water-treating plants which require attention with every change in the analysis of the water throughout the year. The company provides special representatives for the service of the railroads using Perolin to see that it is being properly applied to the locomotives and that the roads are obtaining the fullest possible benefit from its use.

The Quickwork Company Incorporated to Take Over and Operate the Machinery Business of H. Collier Smith of Detroit

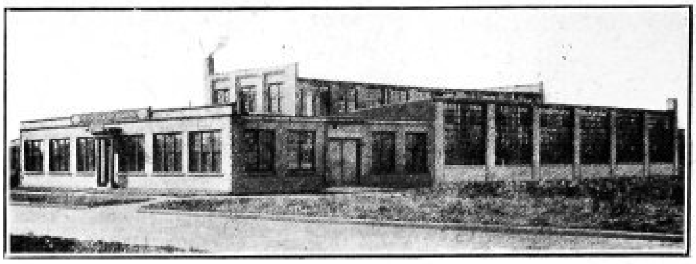
Announcement is made of the incorporation of the Quickwork Company of Ohio, organized for the purpose of taking over and operating the machinery business of H. Collier Smith, of Detroit. Mr. Smith retains the controlling interest and will have active charge of the operations of the company.

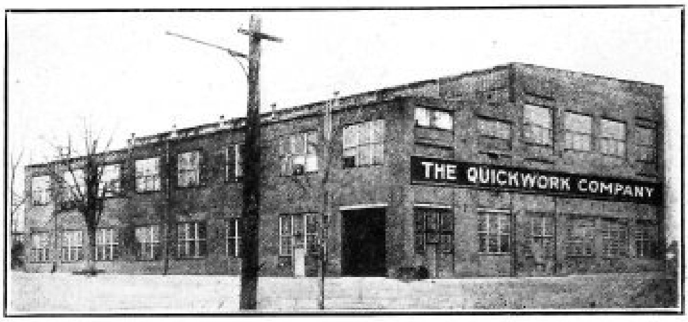
The company is capitalized at $400,000, there being no bonded or mortgage indebtedness. The personnel of the management of the business will remain unchanged, H. Collier Smith being president and general manager; H. E. Groves, vice-president; A. F. Smith, secretary and treasurer; K. J. O'Leary, production manager; R. H. Sims, sales manager, and Harry G. Smith, head of the engineering department.

Quickwork machines will be manufactured at St. Mary's, Ohio, where the company has purchased a modern, well-equipped plant, occupying 21 acres within the city limits. The general offices, sales rooms and show rooms will be in Detroit as heretofore.

Mr. Smith began manufacturing Quickwork machines in 1911. They were revolutionary in character and embodied new principles for working plate and sheet metal. Automobile manufacturers eagerly grasped the opportunity to install machines which would permit them to meet the demand for abnormal production on economical lines, and within two years Quickwork machines were making 90 percent of the automobile fenders in this country.

Engineers and production managers in other and heavier classes of work were close behind the motor car manufacturers in recognizing the economic value of these machines. Heavier machines were made and sold to shipyards, boiler shops, bridge builders, car shops, steel mills, navy yards and various concerns handling plate or sheet



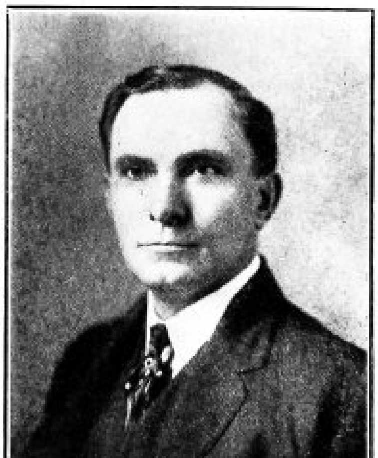


Detroit Office and Salesroom and St. Mary's Plant of Quickwork Company

metal. The largest and heaviest machine is a rotary shear weighing 17½ tons for cutting ¾-inch steel plate.

The rapidly developing business all over the United States, and the fact that orders have been received and shipments made to practically all foreign countries, indicates the immense market for Quickwork machines. Very largely increased facilities for manufacture and expansion have become necessary, therefore the incorporation of the business.

The story of the career of H. Collier Smith, the originator of the business and the head of the new company,



H. Collier Smith

is extremely interesting. Beginning his life work as a plate and sheet metal worker in his father's shop when but ten years of age, he spent forty years in the business as helper, workman, foreman, superintendent and manager.

Mr. Smith is an internationally recognized authority in plate and sheet metal work and enjoys a wide acquaintance among consulting engineers, production managers, workmen and metal men in all parts of the country, who will congratulate him on his success in the past and wish him well for the future.

Questions and Answers for Boiler Makers

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

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

Address your communication to the Editor of the Question and Answer Department of The Boiler Maker, 461 *Eighth avenue, New York city.*

Examination Questions

Q.—(1) Why are the tubes in a watertube boiler set at an angle or inclination?

(2) Which parts of a horizontal tubular boiler are first endangered by low water?

(3) What is a combustion chamber in a boiler?

(4) In what boiler plants are more than one feed appliance required?

(5) Give formula for determining the maximum approved pressure on heads. The following is a formula please work out. The thickness required is an unstayed dished head with pressure on the concave side when it is a segment of a sphere shall be calculated by the following formula:

$$T = \frac{5.5 \times P \times L}{2 \times TS} + \frac{1}{8}$$

where

T = thickness of plate, inches.
P = maximum allowable working pressure, pounds per square inch.
TS = tensile strength, pounds per square inch.
L = radius to which the head is dished, inches. Where the radius is less than 80 percent of the diameter of the shell or drum to which the head is attached the thickness shall be at least that found by the formula by making L equal to 80 percent of the diameter of the shell or drum. *Example*—Assuming that this is 60 inches diameter and 85 pounds working pressure, find the thickness of plate required.

(6) The diameter of the drum is 42 inches; the depth of the bumped head is 5.625 inches, what is the radius to which the head is bumped?

(7) What is meant by back pitch of rivets?

(8) What defects occur most frequently on horizontal tubular boilers?

(9) Describe how you would make a shop inspection and test of a new boiler.

D. H.

A.—(1) To induce a rapid and uniform circulation of steam and water it is necessary in watertube boilers to have the tubes inclined at as great an angle as possible with the horizontal. The nearer the tubes are to a vertical position, the easier the flow, and the liability of solid matter collecting on the walls of the tubes is lessened.

(2) The upper row of tubes.

(3) A combustion chamber is that part of a boiler in which the gases from the fire are mixed with air and burned. Some types of boilers have their combustion chamber back of the bridge wall, while others have none but the firebox or furnace, as for example the locomotive and vertical types of boilers. Combustion chambers set back of the bridge wall are found in boiler settings for externally fired cylindrical boilers. In marine boilers the combustion chamber is a boxlike connection placed between the flues and tubes at the back for a single-ended boiler and at the middle for a double-ended connection.

(4) Two independent means of feeding water to boilers should be installed. Many stationary boilers have but one feed-water supply. All marine boilers subject to inspection are required by law to have two feed supplies.

(5) Substituting the values given in the example in the formula, proceed as follows:

80 percent of 60 inches equals $60 \times .80 = 48$ inches radius head is dished to.

$$T = \frac{5.5 \times 85 \times 48}{2 \times 55{,}000} + \frac{1}{8} = .329, \text{ say } \frac{3}{8} \text{ inch.}$$

By transposing the values to find the given working pressure in the example we have $.329 - \frac{1}{8} = .204$.

$$\frac{2 \times 55{,}000 \times .204}{5.5 \times 48} = 85 \text{ pounds per square inch.}$$

The allowable pressure on unstayed convex heads when single or double riveted to shell according to the rules prescribed by the U. S. Board of Supervising Inspectors of Steam Vessels is found as follows for single riveted bumped heads when the pressure is on the concave side.

$$\text{Allowable pressure} = \frac{\text{thickness of head in inches} \times 1/6 \text{ tensile strength of plate}}{\text{radius to which head is dished}}$$

For heads that are double riveted to shell,

$$\text{Allowable pressure} = \frac{1.2 \times \text{thickness of head in inches} \times 1/6 \text{ tensile strength of plate}}{\text{radius to which head is dished}}$$

(6) The radius that a head is bumped to may be determined by the following rule:

(Rule) Multiply the square of one-half the diameter and divide by the depth of dish; to the quotient add the depth of dish and divide the sum by 2. Substituting the values in the example, we nave

$$\frac{\dfrac{(\frac{1}{2} \times 42)^2}{5.625} + 5.625}{2} = 42.0125 \text{ inches, radius.}$$

(7) The term "back pitch" evidently means the pitch in the back row of rivets.

(8) The defects arising in horizontal tubular boilers under operation vary under different conditions of care and management.

The deterioration may be due to the chemical action of water, which corrodes or eats away the plate. Corrosion attacks both the inner and outer surfaces of the plate. Grooving in the lap seams due to the action of the water and pressure often occurs. The bending action in lap joint boilers is liable to cause small cracks in the seam, which allow the metal to be easily attacked by the corroding elements in the water. Careless workmen may, in calking seams, produce cracks or distort the metal; in which condition it is affected by grooving. The bottom of the shell overheats when there is low water or heavy scale; in such a condition the shape of the bottom may become distorted or fire cracks, burned rivet heads, plate, etc., may result. Braces in such boilers are liable to break and flues leak, etc.

(9) In making a shop inspection of a new boiler under construction, first determine that the material is in accordance with specifications; second, that the construction operations of forming the plate, as punching, rolling, flanging, etc., are properly done; third, that the boiler parts are properly assembled and that the riveted joints, bracing, etc., meet with the requirements.

The test of a new boiler is made so as to locate defects, if any, in the construction or material. It is done by hydraulic pressure (that is, water pressure).

The usual method in making the test is to apply the pressure gradually until it is 1½ times the allowable working pressure the boiler is to carry. This test will show leaky rivets or joints, which should be marked and afterwards calked; flues that are not tight will also show leaks. After the pressure is released and the boiler emptied, note the condition of the stays and look for cracks or broken stays.

Stack Problem

Q.—I would like a simple method of laying out a smokestack from the stock plate up. The stock plate has round ends and straight sides.
E. B. G.

A.—The general shape of the breeching connecting the stack to the stock plate is shown in Fig. 7. It tapers from a round section where it joins the stack to a wash-boiler section at the stock plate connection. In Fig. 8 the required views for developing its pattern are given. Lay off a plan and elevation to the required dimensions. Their complete views are shown, but only a quarter outline of the plan view is sufficient. Divide the profiles representing the bases of the object into a number of triangles. This is done by first spacing off the quarter circles into the same number of equal parts; then draw in the solid lines as from 1 to 1, 2 to 2, 3 to 3, etc. Then the dotted lines from 1 to 2, 2 to 3, 3 to 4 and 4 to 5. All of these lines are shown fore-shortened in both views, hence their true lengths must be found; this is done by constructing right-angled triangles, as shown to the right of the elevation. Lay off a base line *ab* in this diagram and draw a perpendicular *c-d* to it from any convenient point. Transfer the solid lines, 1-1, 2-2, 3-3, etc., from the plan and locate them on the base line *a-b*, as shown. In the same manner transfer the dotted lines. As the upper and lower bases of the object are parallel, the height for all the triangles will be the same and equal to the distance *X*. The hypothenuses of the triangles as 1 to 1, 2 to 2, etc., are required lengths of lines to be used in developing the pattern.

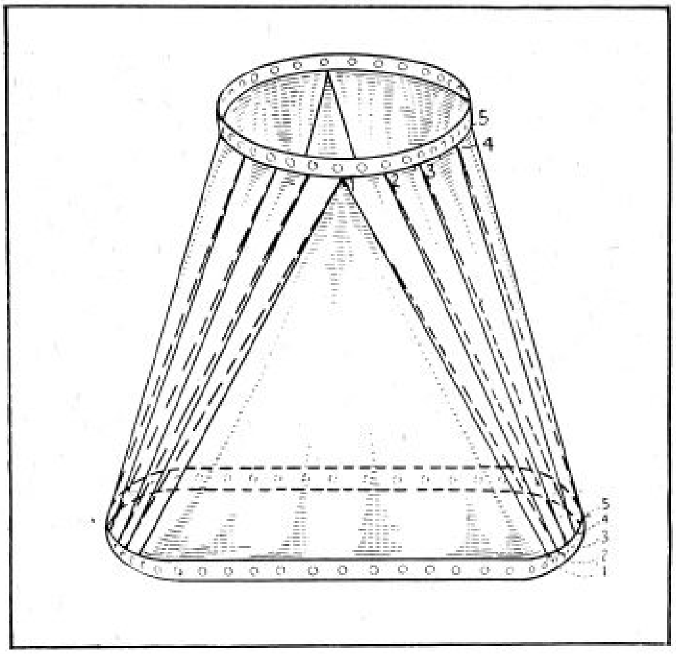


Fig. 7.—General Shape of Breeching

Layout of Pattern. The development may be started from any desired point. In case the object is large it is advisable to make it of at least two pieces, bringing the seam lines through lines 5-5. Consider that this is required in this example; then, to bring the seam lines as stated, lay off a vertical line equal to 1-*a* of the triangles. From point *a* in this pattern draw the line 1'-1' at right angles to the vertical line *a*-1. The length of line 1-1 at the base of the pattern equals the width of the base of the straight triangular side. The arc lengths at the top of the pattern are equal to those on the circle, plan view, and those for the bottom of the pattern are transferred from the profile of the wash-boiler shaped section. Assemble the true lengths of the diagram of triangles in their proper position, as illustrated in the pattern. As they are all numbered to correspond in the different views, no trouble should be had in laying off the pattern.

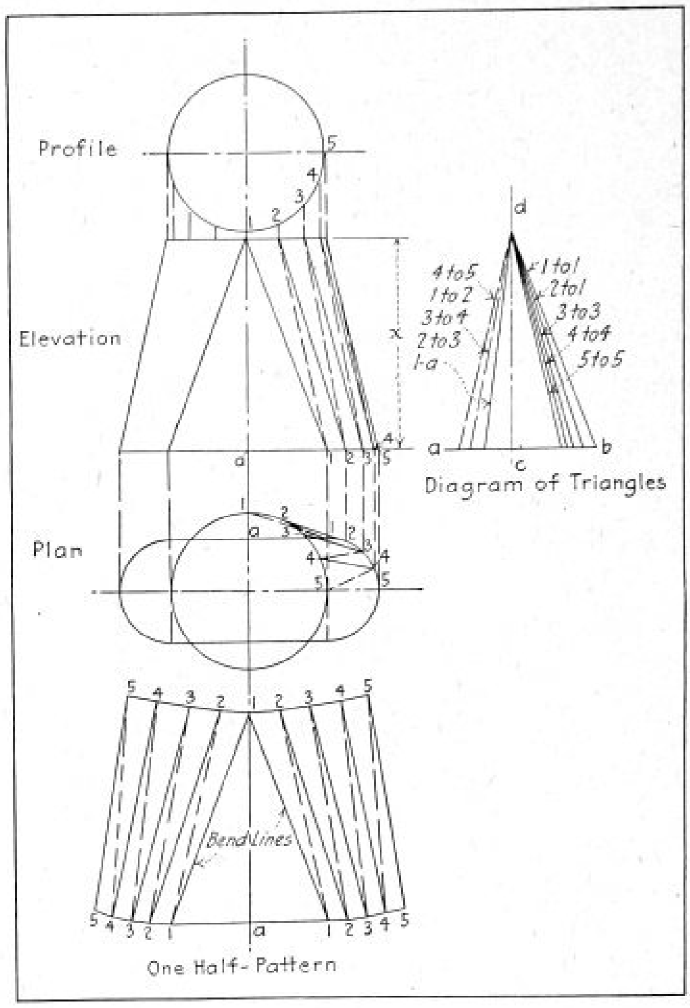
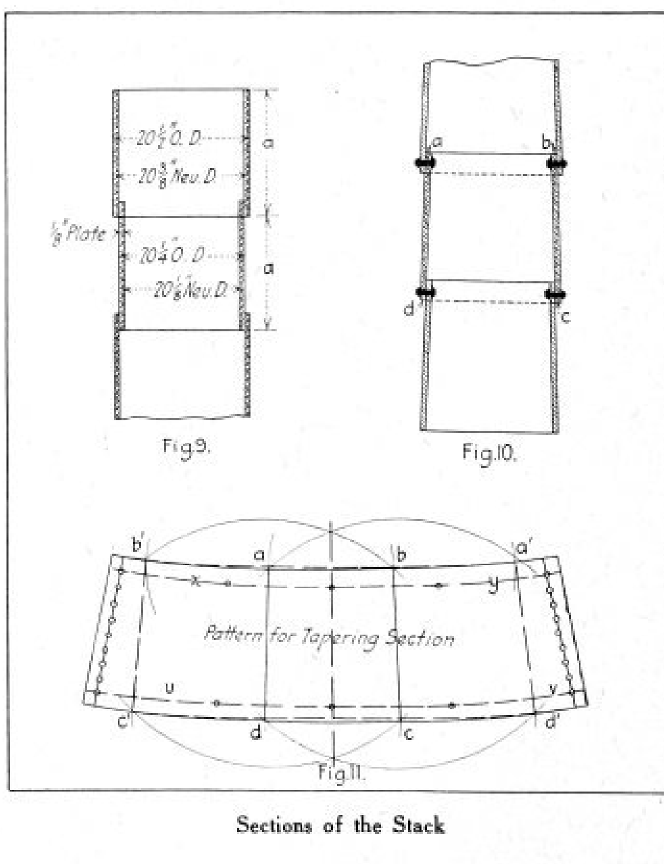


Fig. 8.—Development of Pattern

Stack Construction. There are two ways of building the sections of the stack. One method is shown in Fig.



Sections of the Stack

9, in which large and small sections are riveted together. In Fig. 10 the sections are made tapering from a large diameter to a smaller diameter. This arrangement permits of a more even flow of gases through the pipe, since there are no lap projectors, as in Fig. 9, to retard the flow. The sections Fig. 10 are frustums of a cone. The dimensions of the end diameters, being indicated, show that the difference between them is only two times the plate thickness.

The pattern for one of the tapering sections may be laid off as shown by the construction in Fig. 11. Transfer the frustum of the cone *abcd*, Fig. 9, to the position shown in Fig. 10. With the compasses set to *a-b* describe arcs from points *a* and *b*. With *c-d* as a radius describe arcs from points *c* and *d*. Then with the compasses set to the diagonal distance *a-c* or *b-d* describe arcs from points *a, b, c* and *d*, intersecting the arcs previously drawn in points *a′, b′, c′* and *d′*. Bend a thin piece of bar iron or strip of wood to form curves passing through points *b′, a, b, a′* and *d′, c, d, c′*, as shown at the top and bottom of the pattern. Extend these curves beyond the lines *b′c* and *a′d′*. With a circular measuring wheel lay off the stretchouts on the curved or camber lines of the pattern. The spacing of rivet holes may then be done by first laying off line *b′a′* and above *c′d′* the curved lines *x-y* and *u-v*, upon which may be laid off the rivet centers.

The patterns for the smaller and larger rings, Fig. 9, are simply rectangular sheets having a width equal to the height *a* of the sections, and a length equal to the product of the neutral diameters times 3.1416.

Neutral diameter of small section equals 20¼ — ⅛ = 20⅛ inches; 20⅛ × 3.1416 = 63¼ inches, required stretchout.

Neutral diameter of large section equals 20½ — ⅛ = 20⅜ inches; 20⅜ × 3.1416 = 64 inches, required stretchout.

NOTE.—In calculating lengths of stretchouts for heavy plate work always employ the diameters taken to the neutral layer of the plate as shown for Fig. 11.

Calculations for Working Pressure of Experimental Boiler

Q.—Enclosed is sketch of boiler built for a motor car (experimental purposes) 24 x 20 inches; the head and shell, and also flue sheet are ¼-inch boiler steel; the rest of the box is 3/16 steel. We built this boiler with ¾-inch plugs, a tight fit and riveted plugs on both sides. The drop flues are for quick heat. What I want to know is this: How do you determine the working pressure by hydrostatic test, by calculation, the bursting pressure and safe working pressure? Something else I experienced, I can't acount for. Three washout plugs were put in and tightened good with a wrench. After the hydrostatic test I could turn the plugs out with my fingers. What size engine would this boiler be capable of feeding to? SANFORD JOHNSON.

A.—In basing the working pressure allowable on a boiler, the thickness of plate, diameter of boiler, factor of safety, strength of riveted joints, etc., must be considered. The allowable pressure is not found by hydrostatic test (test by water pressure), as such a test is made for locating defects in boiler material and construction. Authorities differ as to the extent of the hydraulic pressure best suitable for such test; usually 1½ times the allowable working pressure is sufficient.

The bursting pressure per square inch tending to burst a seamless cylindrical vessel apart on a plane taken through the diameter of the vessel may be found according to the following formula:

$$P = \frac{T\,t}{D}$$

in which P = bursting pressure in pounds per square inch of section,
t = two thicknesses of boiler plate in inches,
T = tensile strength of plate in pounds per square inch,
D = diameter of boiler.

Using the values given in the example to find the bursting pressure that will break the large cylinder when T = 55,000 pounds per square inch we find that

$$\frac{55{,}000 \times 2 \times \frac{1}{4}}{20} = 1{,}375 \text{ pounds per square inch.}$$

The strength of the riveted joint in this example as compared with the solid plate commonly called efficiency

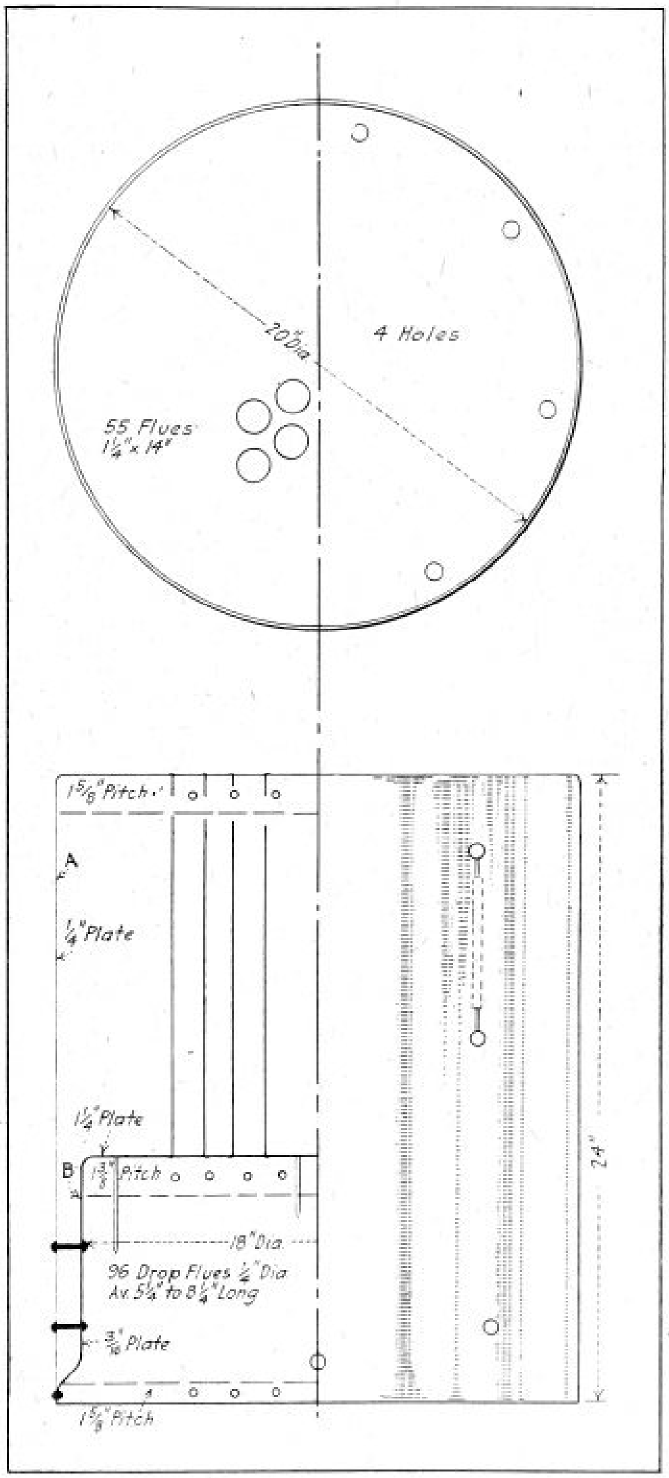


Diagram of Experimental Boiler

of joint equals, for example, 60 percent. Hence the boiler shell is weakened by the seam and upon the weakest part of the boiler is based the allowable or safe working pressure.

Then 1,375 × .60 = 825 pounds per square inch.

To insure safety in the operation of a boiler it should not be worked to the bursting pressure. The margin of safety, known as the factor of safety, is the ratio between the calculated bursting pressure and the safe working pressure. Some authorities use 5, others 6, as factors of safety, while other designers base the factor upon the nature of the boiler material, design and workmanship. Using a factor of safety of 6 to find the allowable safe pressure on the shell *A* we find that $825 \div 6 = 137\frac{1}{2}$ pounds per square inch. A further examination must be made into the action of the pressure within this type of boiler. The pressure tending to burst the outer cylindrical shell *A* also exerts an equal pressure upon the firebox or furnace. The action of the pressure tends to collapse the furnace.

The strength of stayed cylindrical furnaces may be determined by the rule applied to stayed flat surfaces. The A. S. M. E. code gives the following:

The maximum allowable working pressures for various thicknesses of braced and stayed flat plates with braces or staybolts of uniform diameter symmetrically spaced shall be calculated by the formula:

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

in which P = maximum allowable pressure,
C = constant, varying for different kinds of stays and their attachment,
t = thickness of plate in sixteenths of an inch,
p = maximum pitch between centers of stays.

For the values of C refer to the A. S. M. E. code.

The furnace in this example is made of 3/16-inch plate; its height measures approximately 9 inches from center of rivets at the ogee base to the rivet centers at the flue sheet connection. The maximum pitch between stays equals, for example, 3 inches. C equals 112 for stays screwed into plates not over 7/16 inch thick with ends riveted over. Substituting the values in the formula we find that

$$P = 112 \times \frac{3^2}{3^2} = 112 \text{ pounds per square inch,}$$

which is the maximum pressure allowed on the boiler, providing the stays are of the proper diameter. The size and pitch of stays for any given pressure are based on the rules given in the design of boiler details.

We cannot understand why the washout plugs became loose in the boiler unless you subjected it to too great a hydrostatic pressure, which stretched the plate and loosened the plugs.

The size of engine the boiler will supply depends upon the quantity of steam required per engine horsepower per hour, and upon the valve gear with which the engine is equipped.

To ascertain approximately the horsepower of the boiler first determine the heating surface and divide the product by 10. The assumed horsepower of the engine may then be found by multiplying the horsepower of the boiler by $34\frac{1}{2}$ and divide the product by 20 for a Corliss type of engine or by 40 for a slide valve engine.

The rating of a boiler is variable, depending on the evaporation of water. To rate all boilers approximately, the relationship of heating surface of each type per horsepower is becoming general practice. The factor 10 is given for the vertical type of boiler and 15 for tubular boilers. These factors are the ratio of the square feet of heating surface of the boiler to the rated horsepower. The unit horsepower developed by a boiler is taken at $34\frac{1}{2}$ units of evaporation per hour; that is, $34\frac{1}{2}$ pounds of water evaporated into steam per hour at and from 212 degrees F.

The tube and plate surface in contact with the water and transmitting heat to it is the heating surface. The heating surfaces of this boiler are the shell of the firebox, the flue sheet and tubes.

Consider the height of the furnace above the grates at 9 inches. Then the heating surface of the shell *B* equals $3.1416 \times 9 \times 18 = 509$ square inches. Heating surface of the tubes equals $3.1416 \times 1\frac{1}{4} \times 14 \times 55 = 3{,}025$ square inches. The heating surface of the drop tubes equals $3.1416 \times \frac{1}{4} \times 6\frac{3}{4} \times 96 = 509$ square inches. The average length of the tubes was found as follows:

$$\frac{5\frac{1}{4} + 8\frac{1}{4}}{2} = 6\frac{3}{4} \text{ inches.}$$

Heating surface of tube sheet equals $.7854 \times 18^2$ — the area taken up by the opening of 55 — $1\frac{1}{4}$-inch tubes, and the openings of 96 — $\frac{1}{4}$-inch tubes.

$$.7854 \times 18^2 - (1\tfrac{1}{4}^2 \times .7854 \times 55) - (\tfrac{1}{4}^2 \times .7854 \times 96) = 254.47 - 67.496 - 75.398 = 111.58 \text{ square inches.}$$

Total heating surface in square feet

$$= \frac{509 + 3025 + 509 + 112}{144} = 29 \text{ square feet.}$$

144 equals number of square inches in 1 square foot.

The horsepower of the boiler equals $29/10 = 2.9$.

The boiler will supply a slide valve engine having horsepower equal to

$$\frac{2.94 \times 34.5}{40} = 2.5 \text{ horsepower, or a Corliss engine having a}$$

horsepower equal to $\frac{2.9 \times 34.5}{20} = 5$ horsepower.

The values 20 and 40 are assumed and may be taken as averages.

A first class multiple condensing engine may use only 10 pounds per horsepower per hour, whereas an old slide valve engine may be in such a condition that it will use 50 pounds of steam per hour.

Cracks in Flange of Flue Sheets

Q.—We are having trouble with the knuckle of flue sheets, cracking all the way across the sheet at the top. All flues are welded in by electricity in our boilers, but before they were welded we did not have this trouble. I have my idea about the matter, but would like to hear what others think about it. LOCOMOTIVE.

A.—By welding the flues in, a rigid flue sheet is produced, devoid of all flexibility at the flue ends. This rigid condition of the flues does not allow the metal between them (commonly called bridges) to expand and contract as freely as when the flues are expanded and beaded in position. It is a known fact that firebox flue sheets grow in length, so to speak, from the action of the intense heat. When flues are rolled and beaded it is difficult to keep them tight owing to the slight elongation in the flue holes due to the expansion of the sheet in the direction of its length. It is, therefore, evident that when a rigid connection is made between the flue sheet and the flues by welding, some trouble is likely to be had with the metal between the flue holes. Small cracks may appear at first, gradually increasing in size until the metal breaks. This may be remedied temporarily by welding up the cracks when they first appear. This rigid construction also affects other parts of the flue sheet, especially in the curvature at the flange of the head. The inside wrapper sheet in expanding and contracting also places additional bending stresses on the flange. The continual action of the bending forces on the knuckle of the flange are liable to break it, especially when a rigid head is formed, as mentioned, without having any degree of flexibility.

The Wangler Boiler and Sheet Iron Works, Litchfield, Ill., has purchased property on which it will erect a new factory.

The Camden Boiler Works, Camden, N. J., has been incorporated, with a capital of $10,000, to operate a local plant, by J. E. Boyle, W. Dusine and H. Ladage.

Letters from Practical Boiler Makers

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

Experience

One of the peculiar beauties of any mechanical craft is the demand it makes upon the intelligence and foresight of its humblest member. From top to bottom all carry responsibility. Conscience is reputed to make cowards of us all; the mechanic without a conscience is a traitor to his craft and, worse, may be a public danger.

There is no single member of the staff of any firm equipped at all points and knowing everything. We are mutually dependent one upon another, our work properly done equally meritorious.

The cultivation of reasonable humility is a necessity forced home at times upon the most independent and least teachable.

It cannot be too strongly insisted upon that while opinions may differ as to the best method of doing any job, two men may operate differently and may by differing means achieve the same result. There is rarely only the choice of right and wrong, my way being certainly right and your method is certainly wrong, yet in how many instances will one man admit the possibility of any alternative means. Even the fact that a method is hoary with tradition is not prima facie evidence it is wrong; it depends upon the precise conditions. Failure to consider the whole of the phases of any job may lead to incorrect reference and even a positively wrong result.

The endeavor to look at all things from a critical viewpoint is a habit of mind to be fostered. Reservation of judgment for confirmation is worth while if time permits. It is by the exercise of such habits that experience is built; in the same manner that muscles are strengthened, the mental faculties may be increased.

Experience is valueless unless its lessons are duly digested; unless thought is induced by an occurrence, and reflection opens up application of the matter, the experience is vain.

Never let a difficulty go by unless its solution is understood and analyzed. Every debatable point is worth elucidation and reference to whatever books and memoranda are available. The habit of resting unsatisfied until the point at issue is made daylight clear is worth cultivation. We are all apt to rest satisfied if we muddle through somehow.

Scientific research is simply commonsense applied in sequence. Repeated failure is certain, success problematical, but all the ground up to a point is definite and can be proved. Borrowing other men's previous experience is one way to view tutition. It is little use to fail in just those things other men have failed in where the lessons are available.

There is no royal road to success. Hard work involves fatigue, and true success is to be found in a widened mental horizon and the upbuilding of character, rather than in any form of cash consideration. We have each a limited field, but within its range our kingdom should be supreme. The narrower and more restricted, the more specialized, our vocation, the greater, in one sense, the opportunity open.

Nothing ever seen, heard or felt is ever out of consciousness; it is merely overlaid or inaccesible until a chain of fresh happenings calls up the forgotten experience. "That reminds me" is the commonest of remarks. From such accumulations, skill and mechanical aptitude are formed. In usual work it is not the startling and vivid occurrence which is always the most valuable, experience is gained from the most commonplace work—it is the viewpoint that matters, not simply the actual job.

It is by no means necessary to become a bird of passage, working short intervals in a multitude of shops, to become experienced. In actual fact men of this type are usually reminiscent. There will never be a shop to work in like the last shop and the present job is always inferior, in their estimation. Sticking to the old stand may have drawbacks, but it is proof of character and confidence likely to tide one over a slack spell.

London, England. A. L. Haas.

Renewing a Crossbox

A navy boiler maker's manner of installing a new crossbox in an old watertube B. & W., 27-header type boiler might be of interest to some of the readers. The old box had to be removed on account of a defective weld that had opened up for several inches.

There are twelve 4-inch nipples connecting the headers and two 4-inch nipples connecting the uprights or legs.

The usual blocking was placed under the lower row of 4-inch tubes, care being taken to see that each element was supported, using wedges as needed for this purpose.

The packing between the headers for about half the distance up was driven out, this to permit springing the headers.

Getting in the furnace and removing the fireclay from the outside of the nipples, I drive a diamond point chisel through each nipple; using this hole as a starting place for the corner of my ripper, I cut each one in half and then remove the box. Cutting the nipples in half does not take much longer than the method of cutting down through the inside with a diamond point, and there is absolutely no chance of injuring the seat if the nipples are cut in half from the outside.

After removing the box, the halves of the nipples remaining in the headers are easily knocked out and the holes are then examined for defects. The new box being cleaned and nipple-holes examined, it is placed in position on blocks and a few nipples dropped into the holes that are found to line up. I flare or bell one end of all nipples before putting them in place. This flare end of the nipple is the end that is expanded in the box. To get them in place after flaring, slip them in the handhole and fish them along; then hook them up into place.

Expand the end nipples that lead to the uprights; expand only the part in the box and let the part in the upright go until half the header nipples are rolled in place. Next expand all nipples that come fair; let the headers that are out of line come last.

Some headers have to be drawn forward or back or sprung to the right or left in order to get the hole in the header to line with the hole in the box. An easy way to draw them in either direction is to use long rods with plenty of thread on each end of about 1¼ inch diameter. These rods pass through the 2-inch tubes of the next headers to the one that is required to be moved, and with straps suitably drilled and blocks placed under the strap on the header to be moved, the springing comes easy. Use steel wedges for moving them sideways. It is not always possible to correctly line up the holes, and the nipple might have to be forced in and rolled in an offset position; I have had to do this several times and as much as ⅛ inch. These nipples have, in my experience, given satisfactory results and last nearly as long as a perfect set nipple.

After expanding of the nipples is completed, wash off all the oil left from the rolls with a strong caustic soda.

NAVY.

Boiler Inspection

It is not a real pleasant bit of work, and perhaps all boilers do not get a real good inspection on that account. In many instances the only examination that some ships' boilers receive is that given them by the U. S. Steamboat Inspection Service, or mayhap the insurance company. While this inspection may be sufficient to satisfy the owners as to the safe condition of the boilers, it does not tell the engineer that they are in the proper shape for efficient steaming. This condition interests only the owners and operators of the boilers, and not the regular inspectors.

Therefore, to obtain a proper inspection giving you true knowledge of conditions, some one competent in the knowledge of boilers and connected with the engineer department of the ship should be detailed to accompany the regular inspector in the work of examination. To aid in accuracy in making reports of the inspection, printed or typed forms should be used. The usual note book is nice to have along, but a definite report is best made out at the time of the inspection. The external parts should be tabulated in the manner that they are inspected, giving a line under each subject to comment on; the same for the internal parts. When the part inspected is found to be in good condition it is simply marked O. K. on the report to show that it has been inspected.

Making the Inspection

When the time for inspection is decided on, have the boilers thoroughly cleaned on the fire and water sides. No inspection can be efficient where dirt bothers your progress. Make sure that all cocks and valves leading to the boiler are shut tight and wired; do not trust a tag on the wheel.

A one-piece suit of overalls, a pair of eye goggles, a scraper, a cross peen hammer, an electric flash light, or long extension cord portable, and someone to take your notes; then you are ready. The proper place to start is inside the boiler. Doing this first enables you to have the boiler closed and filled with water while you are making the external inspection, at the finish of which the boiler will be ready, or nearly so, for the pressure test.

Grooving, pitting and corrosion, in general, are important features of the inetrnal inspection. Rivet heads, tube ends, braces, stays, baffles, dry pipe, internal feed, scum pipe, water column, try cocks and steam gage openings must all be given careful attention. The writer has frequently found internal feed pipes badly plugged with sediment. Along the water level at tube ends in mud legs or near blow-offs is the place that most pitting is apt to be found. Any place that sediment is apt to collect needs careful watching. All such places should be carefully noted externally for signs of blisters and bagging, if they are exposed to the fire. The location of any severe or deep pitting of the inside of steam drum should be made on a sketch on the back of the printed form; its depth measured and recorded in order that at the next inspection comparisons can be made.

Perhaps the most disagreeable part of the work is the examination of the fireside, yet for economy it is the most important. It includes grates; they must be properly spaced and suitable to the fuel used, and all the best at the back, where they will last the longest; older ones at the front where they can be easily renewed. The front ends of the back grates should be lower than the back ends of the front ones. This saves many from being broken by the slice bar.

Exterior of tubes must be examined for blisters, lamination bulges, distortion or deflection. Any tubes found deflected from their natural plane ¾ inch or more ought to be renewed; the same applies to badly blistered or bulged tubes. The cause of these defects should be investigated to prevent future repetitions.

If a watertube boiler, and baffle bricks rest on the tubes, raise a few and examine the tube for deterioration and heavy scale. These bricks absorb moisture when the boiler lies idle and cause the rusting of the tubes. The side tubes, where near the casing, are one side covered with the casing fire tiles. Often these tubes are found to be wasted away very thin, due to the moisture collected in the fire tile and asbestos packing of the casing.

Baffles and Flame Plates of Watertube Boilers

These are of vital importance in regard to the boiler efficiency. The alinement and tightness of them should be carefully noted. Broken or leaky gas or flame baffles allow the heat of the fuel to pass to the stack without doing any work in the combustion chamber. No amount of turbining and cleaning of tubes will be of much use if you have leaky baffles or flame sheets.

Exterior Shell and Rivets

That part of the shell, rivet heads, seams and joints which are accessible should be examined for scale and defects. Once each year a portion of the shell casing and lagging should be removed to ascertain its condition. The writer had the experience of finding a drum shell very severely deteriorated and rivet heads wasted away. It was caused by the pad of the boiler stop valve leaking; the condition found was dangerous. In many cases there are drippings from safeties or other valves running down under the casing lagging.

Boiler Casing and Brick Work

These are carefully noted for air leaks into the combustion chamber and for heat insulation. Test for leaks by opening damper and going over the exterior with a candle or a pine stick dipped in alcohol and lighted; the flame will be drawn inward. Mark all such spots for repairs with asbestos and fire clay. Inspect the operation of the damper, making sure it opens full and closes tight.

This about completes the boiler, but a thorough inspection would include a knowledge of the condition of the boiler fittings, the safeties, steam stop valves, blow-off, feed checks and stops, try cocks, water column and steam gage. The steam gage and safeties are to be tested and regulated after such an inspection as outlined, and a complete record of it made, and you are armed with a complete knowledge of conditions.

Your repair notes are easily taken from the report, and as they are accomplished, suitable entry is made in the report. All reports, when made up in smooth form, can be done in duplicate, one copy for the chief's file and the other for the ship's report to the owners. Many more points are thus brought out in an inspection of this sort, accomplished by one of the ship's engineers, than will be found in a report of a safety inspector.

Concord, N. H. C. H. W.

The Safest Boiler for a Warship

I note that Mr. N. Roberts has answered my article, of the March Boiler Maker, dealing with "The Safest Boiler for a Warship." I agree with Mr. Roberts in all the statements he makes, which conform to Admiral Melville's ideal boiler, and admire the gentlemanly manner in which he handles the subject from beginning to end. I will answer him in like manner, barring that circumstances force me to correct the mistakes that either he or the printer made in the statement.

On the first page (353) he says, "Various types of watertube boilers have been used successfully; namely, the Belville, the Babcock & Wilcox and the Niclausse." Can we call them a success after all the men they have scalded to death during the short time they have been in our Navy? Is Mr. Roberts aware of the fact that they have killed and maimed more men in their brief history than the Auld Scot did in sixty years?

Next, on page 354, he says that the steam drum should be placed at the front of the boiler and not less than 54 inches in diameter, no tube to be less than 3¼ inches in diameter." Assuming this drum on top of twenty-seven headers, and being half full of water, where is your light-weight boiler?

Near the bottom of page 354 Mr. Roberts says, "For Naval service the boiler must stand forcing and severe abuse." I have yet to see the first one of them that was forced or abused without letting you know of it.

On the same page, column 2, top paragraph, he says, "Sufficient water should be carried so that the boiler can steam thirty minutes before the water leaves the top drum." Why, Mr. Roberts, that is one of the provisos that Admiral Melville insisted on for his ideal boiler, but, great Scott! what would happen to the tubes of a watertube boiler while the water was lowering from the middle to the bottom of the steam drum? I dare say that was a misprint.

On the same page and column, second paragraph from bottom, he says, "High pressure produced from a little deck space, with as little weight as possible, is what we want to-day." This is another mistake, as the boilers are not placed on the deck of a ship; they are put down as low as possible; in fact, fastened to the bottom frames of the ship, and a Scotch boiler does not have to be 16 feet in diameter; you can place six furnaces in a double-end Scotch boiler, 14 feet in diameter.

On page 355, column 1, he says, "There is also less danger of accident to a watertube boiler or injury to employees in case of explosion to either boiler or steam lines." That statement puts a bad taste in my mouth and, therefore, I cannot roast it as brown as it deserves; so I will put the blame on the printer once more, as any fool boiler maker knows that when a steam line explodes it means "Good-bye, John," for every man in that compartment.

On the same page, column 2, paragraph 4, where it says, "There is one advantage the firetube has over the watertube boiler for marine purposes; that is, a tube cannot be cut out or plugged without cutting out the boiler," That statement is also a mistake, as the tube of a Scotch boiler can be plugged with steam on the boiler, but a watertube boiler cannot be plugged until the boiler is cooled and opened. "Sandy, ye maunt take anither fether tae yer bonnet."

In the next paragraph is said, "Experience with Scotch and watertube boilers at sea undoubtedly indicates that the watertube boiler is not as economical as the best type of Scotch boiler"; four lines below it says, "Actual test shows that the water tube is a more efficient and economical boiler than the Scotch." Look that statement over. He says the Scotch is undoubtedly the best, and the watertube is actually the best. This logic reminds me of a correspondence school book I read some time ago which said, in building a boiler always have two furnaces instead of one, so that when gives out you can run the other one.

On page 356, column 1, it says, "It is claimed by some engineers that the life of a boiler lies in the life of the tubes." Mr. Roberts says that is not so, as any boiler can be retubed. Sure, but what the engineers mean is that if the tubes give out the boiler is dead for the time. Imagine, Mr. Roberts, that you were chased by a ship that was more than a match to fight and your tubes gave out; would your boiler not be dead for a time?

At the last paragraph it says, "A watertube boiler steaming with salt water would require more attention than a Scotch boiler." Does that imply that he could use salt water in a pipe boiler? I can assure him that one feed of salt water will knock out the best watertube boiler made, while you can steam a Scotch boiler for months on it, if you have to. "Ye can ha a finnan haddie the noo, Sandy."

"Say what you will, and think what you may,
The watertube boiler is here to stay."

This may be all true, but I will have to wait until this cruel war is over and poor old John Bull tells us how the haphazards served him out in the North Sea. We know what they did to the Russians.

My whole aim and object in this controversy is to guard against placing unreliable boilers in our high sea fighting ships.

Vallejo, Cal. J. S. Grant.

Is the Tidy Man Best?

In the November, 1916, issue of The Boiler Maker N. G. Near draws attention to four different types of boiler makers:

First—The man who jumps right into a job, using no particular method, but still doing a quick job.

Second—the man who starts out on a job and after a while discovers that he has made a mistake and must start all over again.

Third—The man who looks his job over before starting, seeing, if possible, the best way to accomplish the job, and then carrying it through in good time.

Fourth—The man who starts thinking and never gets anywhere.

It so happens that the writer has met the four types mentioned and, like N. G. Near, finds that either type may handle a certain job correctly; taken off that job they are helpless and, like a fish out of water, soon die. To illustrate the point, two men are given a certain job which calls for the patching of a locomotive firebox. The engine was located at a coal mine, the man in charge of the job was of the first type, but never followed any particular method but one of his own, which the writer will show was no method at all, but very bad practice. This particular man was one of the hot-air kind, always blowing about what they used to do in certain shops, and what they have not done was not worth doing. But to come back to the patches. They were put on and looked a very creditable job, but the engine was in service but a short time before trouble developed and the same men were sent to attend to it. Some little calking and a few patch bolts were put in and the job called O. K. Within another week there was more trouble with the patches, and complaints of loss of time at the mines, so the firm sent another man (one of the third type) to investigate and find out the cause of all the trouble: and what do you suppose he discovered? Nothing more nor less than the patches had been applied without first removing the defective sheet. Yet this man would argue that he had seen it done on many occasions and no trouble resulted. Evidently this man was out of place when working on a locomotive boiler, but put him on a stack or a pipe line and he would be in his element. To rectify this mistake the tidy man was very much in evidence.

Again, Jack Mc—— was sent to do a little job on a threshing machine boiler. He found that he was to put a patch on the smoke-box. Having taken the measure of the patch required, Jack returned to the shop, got out the patch and tools ready for making an early start next morning, when Jack and his helper set out to finish up in good time. But when the patch was put in place it was found to be too short. To return to the shop and get out another one was out of the question, and to tell the farmer that a mistake had been made would never do; so, making some excuse that he wanted a piece of flat iron, Mc—— was given the piece of iron used by the farmer's wife to close up the mouth of her brick bake-oven.

Here again was a case of thoughtless plunging. Had this man used some system or method of setting about his work it would be impossible to have made such a blunder on such a small job; yet it is a fact that Jack was paid five cents per hour more than the maximum rate of the shop. Had one of the tidy sort of men been sent on the job he could have made a note of what was wanted for the job, and when he would be ready to apply his patch everything would be in its place.

Another case: Extensive alterations were being made at a blast furnace, when the dinky engine hauling material got her crown sheet slightly scorched, which put her out of service and tied up some of the improvements. Close at hand was a gang of men erecting a hot-blast stove. The foreman of this gang was consulted about making repairs on the engine. He said that a new crown sheet, coming well down to top row of staybolts, must be put in; but the furnace superintendent could not see it that way, so another boiler shop was called up, and they sent their man out to look the job over.

This man said a new firebox must be put in. Now, the cost of such repairs and the delay it would cause were out of the question, so another shop was called up and requested to send a good, reliable man over to make an examination of the firebox and to see what would be needed to make the boiler safe.

This man, one of the tidy type, made a very careful examination and found that the crown sheet was still good, and that by removing about twelve crown bolts the boiler could be made safe again, and such was the report made to his manager.

The writer was present when the furnace superintendent was called up and told the result of the examination. Almost the first question he asked was as to the judgment of the man making the examination, and when assured that his word was always taken in cases of this kind, they were told to go ahead with the job, which was done according to the report made.

Now, had the advice of the first man been taken and the crown sheet cut off just about the top row of staybolts it would be almost impossible to have made a job of it, for the engine was of about 36-inch gage and very narrow at the mud ring and very wide at crown sheet. Now, the crown sheet was supported with radial stays, the dome being well ahead of the firebox, so that in removing or replacing a crown sheet of this kind the man undertaking it would be up against a very difficult piece of work, and it shows poor judgment, and less method, on the part of the man suggesting such repairs. The man that wanted a new firebox was one of the puttering, thinking kind, and he was looking for some easy way out of a bad situation. The third man, by his good judgment, saved the furnace company a lot of unnecessary expense, for, as the superintendent explained, the engine would be of no further use to them when the alterations were completed. Some months later the writer saw this engine in the service of a contractor, doing good work.

Still another case was that of men sent to do repairs on a steam-shovel boiler. The firebox was badly cracked around the furnace door and required patching; so the defective plate was removed and the sheet prepared for the patch, the measurement of which was taken, and the men went away to get it out. Returning with the patch, they found that they were wrong, that a blunder had been made, and, like N. G. Near's second type, must make a fresh start. Almost any man is liable to make a mistake, and profit by it; but, very strange to say, the second patch was a misfit also. Eventually a patch was got on and the job finished; but whether it was done by the same men or not the writer has his doubts and is rather inclined to believe that another and better man, one of the tidy type, was called in to complete the job. But the evidence of the blunders was left on the dump, where the writer was shown them by the contractor some time afterwards. Here again a lack of knowledge of the trade or method was shown, and the job undertaken was away out of their reach, which makes the writer think that they had missed their vocation.

The above are a few of many such cases that have come to the notice of the writer in which men have been put to work on jobs they knew very little about, but having a superabundance of hot air managed to pass muster by the skin of their teeth. A little hot air is good sometimes, especially when backed by a good knowledge of the trade, for the good man blows his own horn sometimes or gets badly left. If the shop foremen, master mechanics or others directly in charge of boiler makers would look around their shops, compare the work done by the different types of men, I am sure they would find that the tidy man, going about his work in a regular, methodical way, delivers the goods; not once in a while, but nine times out of ten. My experience with the first type is that he, on any job, scores more misses than hits; that both the first and second types should be given jobs helping the third type until they learn a little more method and how a good man sets about his work.

The ideal boiler maker can be found in almost any shop in the country, be it railway, marine, contract or small country shop, and mighty good men; many of them are capable of filling any position in the shop, from layer out down, and carry a job through to a finish with credit to themselves and satisfaction to their employers, while others are unable to lay out, but can fill all other positions, but transplant them and give them work that they have never seen done and for a time they would find it strange, but would in a short time be quite at home. The man who has once learned method can grasp a situation almost at a glance and make every move and every blow count and go far toward the completed job.

The tidy man has his chosen profession at heart, and, at the same time, his finger ends. Like N. G. Near, I like the tidy man, and think that if there were more of his kind in our shops the trade would be lifted to a higher plane than the one it now occupies.

Many firms getting work done make the task of the repair man (tidy man) a difficult one by harassing him with a lot of fool questions as to how long he will be on the job, that they stand in need of their engine or boiler, that they are paying high-priced men, from the time they leave home until they return, etc., are not at all choice in their language or the way they express themselves, forgetting that the work is being done under vastly different conditions to those found in the modern boiler shop; that such work is done under the old Armstrong system, and that such jobs, to be done right, take as much time to-day as they ever did; that the boiler maker is human, with feelings, sensitive alike to pain or pleasure; that a pleasant word, helps the work along, a harsh one retards it, and when given the ghost of a show will deliver the goods in jig time.

FLEX IBLE.

Pittsburg, Pa.

Strength of Locomotive Boilers—II

Simple Formulas, Based on Well-Established Rules Generally Accepted by Engineering Authorities, for Figuring Strength of Boilers

BY WILLIAM N. ALLMAN

The Master Mechanic Rules recently adopted provide for the following rules concerning the bracing of flat surfaces:

LONGITUDINAL GUSSET BRACES AND FLAT SURFACES

(a) In figuring stress in diagonal braces, allowance for the angularity of the brace shall be made.

(b) The sectional area of the brace and the strength of the attachment of the brace to the shell both to be investigated and the lowest net strength to be used.

(c) In determining the strength of the gusset braces for supporting the back head and tube sheets, use 100 percent of rivet bearing area, 80 percent of the rivet shear and 90 percent of the gusset plate area measured at right angles to the longest edge of the gusset sheet, and of the three, select the minimum value.

(d) The calculation of stress in gusset braces shall cover both the section of the plate and strength of fasteners, and the lowest net strength shall be used.

(e) In figuring flat stayed surfaces, such as back heads, the boundary of the unsupported surface shall be located at a distance equal to the outside radius of flange measured from inside of shell.

(f) No supporting value shall be assigned to the stiffness of flat plates on flat surfaces, as it is too small to be of material value.

(g) Reinforcing plates, such as back head liners, shall not be figured as having any staying or supporting value, but shall be merely considered as mechanical reinforcements for various attachments, such as longitudinal stays, staybolts, etc.

(h) The distance beyond the outer row of flues on tube sheets, assumed to be self-supporting, shall be 2 inches.

(i) In calculating the area to be stayed on front tube sheets, the area of the dry pipe hole shall be deducted.

(k) Tee irons or other members, when used subject to bending, shall be calculated without addition for strength of plate, and the stress in such beam and its abutments must not exceed 12,500 pounds per square inch. The spacing of the rivets over the supported surface shall be in conformity with that specified for staybolts. No allowance for value of such beams shall be made in calculating the total area of longitudinal braces that may be attached thereto.

(l) Where there are a number of diagonal stays supporting a flat surface, such as back-head and front tube sheet, the proportion of the allotted area to each brace shall be as follows:

Divide the entire net area of the braces. If it is felt that any individual brace is so segregated as to receive more than its fair proportion of the load, it shall be investigated separately as to the area it supports.

STRESS IN DIAGONAL STAYS

T = stress in stay,
A = area, supported by stay,
P = boiler pressure, pounds per square inch,
D = diameter of stay in inches.

In calculating the stress of the stays supporting the segment on back-head and front tube sheet, in the following analysis it is considered that each stay supports an equal area. When the area of the segment is determined

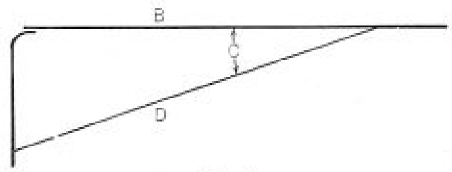


Fig. 1

by a planimeter, taken from a drawing known to be accurate and to scale of the drawing, viz:

Scale of drawing equals ¾ inch to 1 foot or one-sixteenth size.

Planimeter reading equals 3.2.

Actual area of segment would then be equal to 3.2 multiplied by sixteen squared, or 3.2 × 256, which equals 819.2 square inches.

$$(16) \quad T = \frac{A \times P}{\text{Cos.}\, C} \times \left(\frac{1.13}{D}\right)^2$$

$$(17) \quad \text{Cosine } C = \frac{B}{D}$$

Constants for value of $\left(\frac{1.13}{D}\right)^2$

TABLE No. 6

1 inch Diameter Stay	1.28
1⅛ inch " "	1.008
1¼ inch " "	.817
1⅜ inch " "	.676
1½ inch " "	.567
1⅝ inch " "	.482

Area to be braced in front tube sheet is equal to the area of the segment minue diameter of hole "A" for the steam pipe, as shown in Fig. 2.

Three inches is allowed as the distance in from inside of shell for the portion supported by the flange.

Two inches is allowed as the distance above the top row of tubes for the area supported by same.

The same condition exists on the back-head when figuring the area of the segments; that is, the lower line of the segment is taken as 2 inches above the top row of firebox stays.

NOTE.—It will be noted that there is a difference as regards the area to be supported, when figured on some of the rules that are in effect, but in the opinion of the writer, if the above is generally followed it will give results that would be acceptable under all conditions.

(To be continued.)

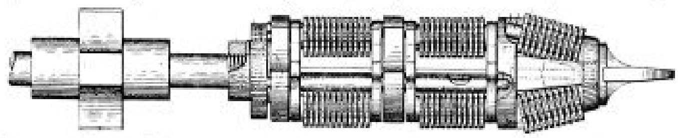
Selected Boiler Patents

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

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

1,205,230. BOILER-TUBE CLEANER. GEORGE A. LUFKIN, OF REVERE, MASS.

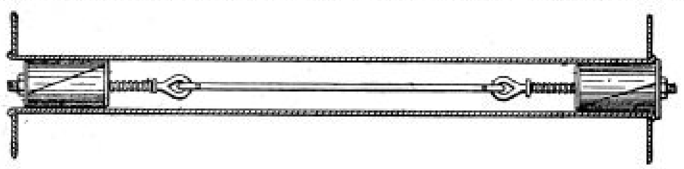
Claim.—In a boiler-tube cleaner, the combination with a body having separated flanges connected by webs, of pins sustained by said flanges,



frames situated between the flanges and pivotally mounted on said pins, and cutting disks sustained by the frames, each frame having projections at its front and rear ends to engage the web and limit its swinging movement.

1,205,891. PLUG FOR BOILER TUBES. PERCY HARRISON, OF BALTIMORE, MD., ASSIGNOR TO HARRISON SPECIALTY COMPANY, A CORPORATION OF MARYLAND.

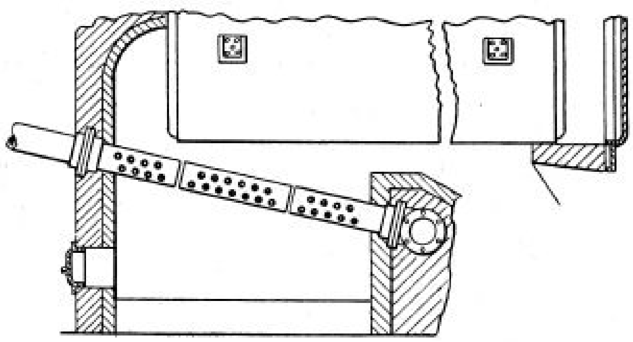
Claim 4.—A plug for boiler tubes comprising a plurality of tapered sections, a tapered core fitted within said sections, a rod extending



through said core and having an eye on one end and a collar adjacent said eye, a washer mounted on said rod and impinging against one end of said core, a spring between said washer and said collar, and a washer at the opposite end of said plug. Four claims.

1,196,102. STEAM SUPERHEATER. EDWARD ARTHUR GEOGHEGAN, OF NEW YORK, N. Y.

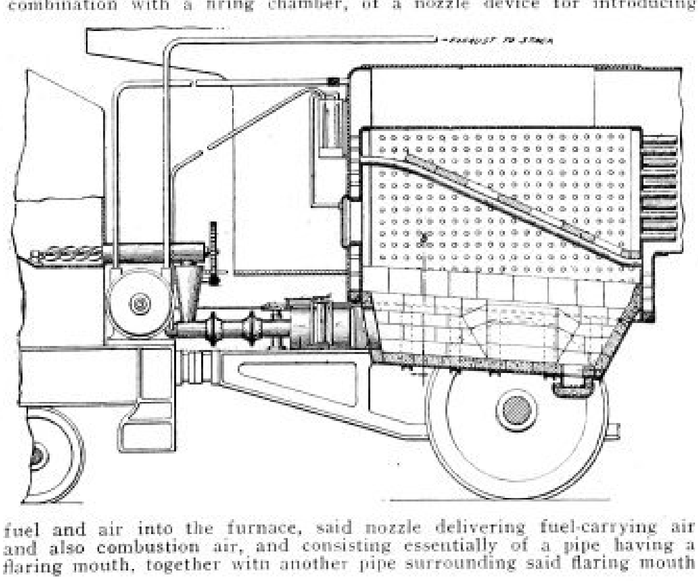
Claim 1.—In a steam superheating apparatus, a steam boiler, a fire wall, a rear wall, side walls, tube headers located in inclined positions in said side walls, with the ends thereof adjacent to said fire-wall being



lower than the ends adjacent to said rear wall, and steam conveying tubes parallel with said fire-wall and connected with said inclined headers. Two claims.

1,204,631. FEEDING AND BURNING FINE FUEL. WALTER D. WOOD, OF NEW YORK, N. Y., ASSIGNOR TO FUEL SAVING COMPANY, OF ALLENTOWN, PA., A CORPORATION OF PENNSYLVANIA.

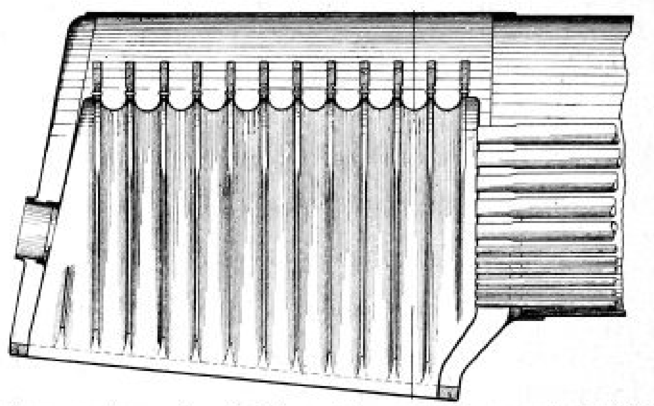
Claim 1.—In an apparatus for feeding and burning powdered fuel, the combination with a nring chamber, of a nozzle device for introducing



fuel and air into the furnace, said nozzle delivering fuel-carrying air and also combustion air, and consisting essentially of a pipe having a flaring mouth, together witn another pipe surrounding said flaring mouth and of greater diameter and into which the flaring mouth discharges, said second pipe communicating with the furnace, means for creating and supplying the dust-laden current to said nozzle, and automatically controlled valve means for separately supplying combustion air thereto and controlling the amount of said combustion air. Twenty-four claims.

1,191,201. STEAM BOILER FIREBOX. DAVID M. LIGHT AND WILLIAM H. V. ROSING, OF SPRINGFIELD, MO.

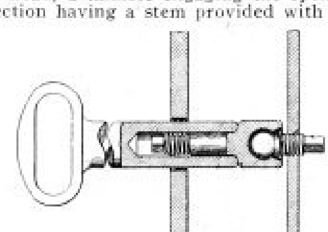
Claim 1.—The combination, in a steam boiler firebox, of side water walls; a plurality of channel section crown sheet members extending between and connected to the side water walls; and a plurality of support-



ing beam members, of arched form, interposed between and connected to the crown sheet members, said supporting beam members terminating at the tops of the side water walls, and being unconnected to the roof sheet of the firebox. Three claims.

1,197,434. FLEXIBLE STAYBOLT. CHARLES F. BEARICKS, OF YOAKUM, TEXAS.

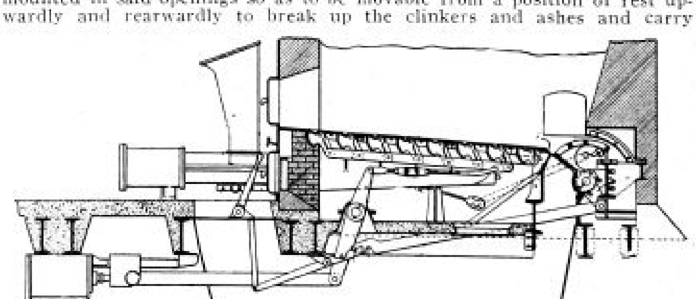
Claim.—In a flexible staybolt, the combination of spaced inner and outer sheets provided with threaded openings, the threaded opening in the outer sheet being of greater diameter than the threaded opening in the inner sheet, a bolt section having a threaded portion engaging the threaded opening in the inner sheet and riveted, said bolt section being provided with a spherical head, a thimble engaging the opening in the outer sheet, a second bolt section having a stem provided with an outer threaded end



disposed within the thimble, and formed at its inner end with a socket open at its outer end and pivotally receiving said spherical head and presenting an abutment shoulder at the juncture of its inner end with said stem, a nut engaging the threaded end of the second-named bolt section and having pivotal connection with the thimble, and a closure for the outer end of the thimble.

1,196,869. UNDERFEED STOKER. WILLIAM J. KENNEY, OF WILMETTE, ILL., ASSIGNOR TO UNDERFEED STOKER COMPANY OF AMERICA, OF CHICAGO, ILL., A CORPORATION OF NEW JERSEY.

Claim 1.—In combination, a furnace, a retort in the furnace, dead plates at the sides of the retort for receiving clinkers and ashes therefrom, said dead plates being provided with openings therethrough, dogs mounted in said openings so as to be movable from a position of rest upwardly and rearwardly to break up the clinkers and ashes and carry



them toward the rear, operating mechanism for said dogs, means for adjusting said mechanism to adjust the position of rest of said dogs, the dogs and the openings in which they lie being so constructed and arranged as to vary the clearance between the dogs and the edges of the openings upon a variation in the position of rest of the dogs, and means for introducing air under pressure beneath the dead plates. Five claims.

1,201,912. COMBINED FEED-WATER HEATER AND WATER-COOLED SPARK ARRESTER FOR LOCOMOTIVES AND THE LIKE. ANDERS ANDERBERG, OF MALMO, SWEDEN.

Claim 1.—In combination, a boiler having a smokebox at one end, a smokestack in the smokebox, a water-heating chamber having a central opening, said opening registering with the smokestack, the lower end of the smokestack being attached to the water-heating chamber and snugly fitting around the opening therein to cause all the escaping products of combustion to pass through the opening to said stack, a second water-heating chamber spaced from and in alinement with the first-mentioned chamber, a plurality of spaced pipes connecting the two chambers, inlet and outlet feed-water pipes communicating with the two chambers, and an exhaust nozzle in the smokebox and extending through the second-mentioned chamber and terminating intermediate the two chambers. Two claims.

THE BOILER MAKER

MARCH, 1917

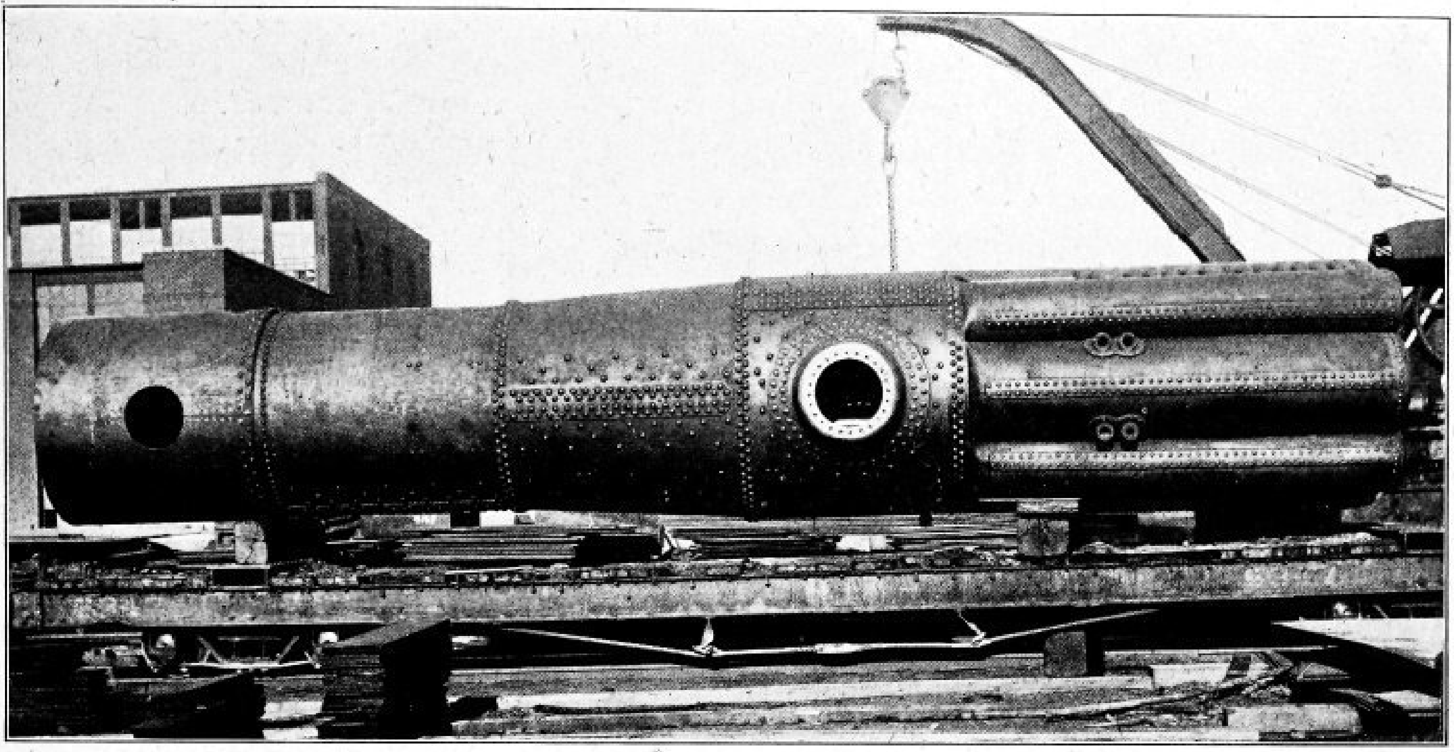


Fig. 1.—Top View of Boiler, Showing Steam Chambers Forming Top of Firebox

The McClellon Type of Locomotive Firebox*

Boilers Built by American Locomotive Company for New Haven Freight Locomotives Fitted With Watertube Fireboxes

BY W. E. JOYNES

HAVING the opportunity within the past year of working on the design of a locomotive boiler with a peculiar type of firebox, known as the McClellon water-tube firebox, the writer is presenting below a few photographs and information regarding the same:

Commencing from the bottom of the firebox, the mud or firebox ring is 107⅞ inches by 71¼ inches inside, and is made of 1½-inch steel plate flanged into a trough or channel shape 6 inches by 71¼ inches inside, and bent to a 2⅜-inch radius at the back end corners, thus forming two sides and the back of the ring. The inside is planed to 1⅛ inch thick. The front end of the ring is made of solid steel casting about the same design and size as the regular type of firebox ring, with lugs for bolting the expansion sheets. This front end ring is studded to the plate ring with four 1¼-inch studs at each end; and riveted over after applied. The outside of the rings is covered with a 1⅛-inch plate, screw riveted on the edges and ends and 1-inch hollow staybolts through the center. The inside edges of these cover plates are slightly beveled off and electric welded to insure a steam-tight joint. It may be said here, and you will note further along, that welding plays one of the principal parts, or rather, makes the construction of this firebox possible. The outside back corners are reduced in thickness to ⅝ inch on account of the large radius.

An angle iron is riveted to the under side of the back end for securing the expansion plate.

The sides of the firebox are formed by a series of 6-inch O. D. tubes by ¼ inch thick, spaced vertically 6 1/15 inch center to center. The one-fifteenth of an inch is to allow for expansion of the tubes. The backhead is also made of tubes sloped to a taper of 1 inch in 4 inches. The sloping of the backhead made the back corners somewhat of a different problem to deal with and was accomplished by the welding of two sloping tubes to the back side tube. The backhead tubes are 5⅜ inches and 5 inches in diameter, but could be of the same diameter as the side tubes if the width of the backhead was such that they could be properly worked in. The firehole opening was made by flattening four sides of two large tubes, and also a third tube was flattened as a filler to bring the hole in the right

* From *Loco*.

location. There are four pipe thimbles, for circulation, between the bottom horizontal and the filler, and also the same number between the filler and the firebox ring. These square chambers are welded to the vertical tubes and, of course, with holes in the tubes at the connection for circulation. The ends of the filler piece were covered with a plate, acetylene welded in, and then welded in solid to the surrounding tubes and ring. The tubes were flattened on a hollow cast iron mandrel. The mandrel was tallowed and graphited for easy removal. The side and backhead tubes are swaged to 4 inches diameter, top and bottom, for entering the firebox ring at the bottom and the drums at the top, after which they are rolled and belled into same. Hand holes with taper screw plugs in the bottom of the ring under each tube permitted the use of the roller and belling tools. Placed on top of the side and backhead tubes are three drums, or steam chambers, which have just been mentioned above, forming the top of the firebox. The middle drum is 32 inches outside diameter by 148¾ inches long, made of ½-inch firebox steel plate with ⅝-inch pressed steel end in back, shaped as shown in photograph. The head is also reinforced with ½-inch liner to replace the metal removed for the two large holes which receive the cab turret and injector check.

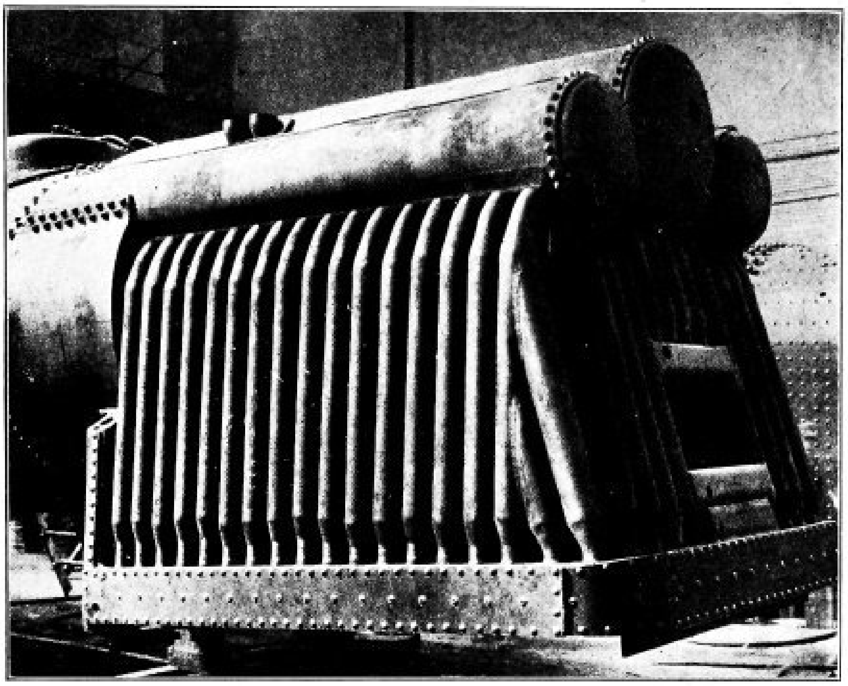


Fig. 2.—General View of Firebox

The side drums were made of 1¾-inch firebox steel plate, planed to ½ inch thickness, except in way of side tubes, where a boss was formed the full thickness of the plate, to receive the tubes.

It is the writer's understanding that Mr. McClellon, the inventor of the firebox, has since improved upon the method of securing the tubes to the side drums; i. e., not making it necessary to use the heavy plate to form the boss. The new method will not be explained here, as the writer does not possess full information regarding the same.

The middle drum is flattened on either side, and the side drums on the inner side for placing and fastening the drums together. This will be more clearly understood by referring to the perspective back end view in the picture.

After the drums were set in position they were riveted together with two rows, one top and one bottom, in the flat space, by 1⅛-inch boiler threaded rivets. The seams for riveting the drums together, after rolling into shape, are placed on the top center line of all three drums. They are single riveted, butt jointed with the welt strips inside and outside, extending to where the drums commence to shape into the ring course, as explained below. From this point to the end the drums are welded. The front ends of the drums are open, and shaped down on the top to enter the third ring course of the boiler and on the bottom to rest on the flue sheet. This makes the ends of an odd, irregular shape, and the shaping was done with a specially devised collapsible die.

It seems to be the proper place here to say to those who are not familiar with the design of a locomotive, that the front end of the boiler, or all of that part in front of the firebox, is the same design as the regular type of locomotive boiler. This will be clear to those familiar with the locomotive boiler by a glance at either the top or bottom views shown in the accompanying photographs.

The two castings seen on the middle drums are to receive the safety valves and the whistle.

In the beginning of this article, the firebox was referred to as the McClellon watertube firebox. This is perfectly true regarding that end of the boiler, but should not be misconstrued and referred to as a watertube boiler. Having already mentioned that the front part of the boiler is of the regular locomotive type, it is not believed the title will be misused. Following this explanation, I wish to add that these boilers are equipped with the regular firetubes and a superheater. In fact, the two boilers equipped with these fireboxes were the last two boilers in an order of twenty-five Mikado locomotives for the New York, New Haven & Hartford Railroad Company freight service built by the American Locomotive Company.

It is also interesting to note that these boilers have a combustion chamber. The chamber is made by extending the third ring course 45 inches beyond the back tube sheet at the bottom and sides, and placing a very simple design of a circulation chamber made of ⅝-inch thick flanged plate along the bottom center. The back end of this chamber is closed up by welding in a plate of the same thickness. The front end if left open to feed the tubes running out of the same. The tubes are bent to the shell of the boiler and enter the side drums. These tubes are 2½ inches, 4 inches and 5 inches diameter, respectively. The construction of the combustion chamber will probably, also, be better understood by referring to the interior view shown by the photograph. The bottom end of the two back combustion chamber tubes is welded into place. This was made necessary on account of the throat. They were not accessible for rolling into place. The remaining tubes are made accessible for rolling and belling by the means of a flanged plate on the outside of the shell, the same in design as the inside chamber. Both ends have a plate end welded in and taper plug holes opposite each tube for using the roller and bell tools. There will also be noticed in the bottom view picture a large tube and elbow connecting the bottom of the boiler with the throat. This tube is to feed the throat and firebox, rising from the ring through the tubes to the drums.

There is still another circulation tube of 3 inches extra

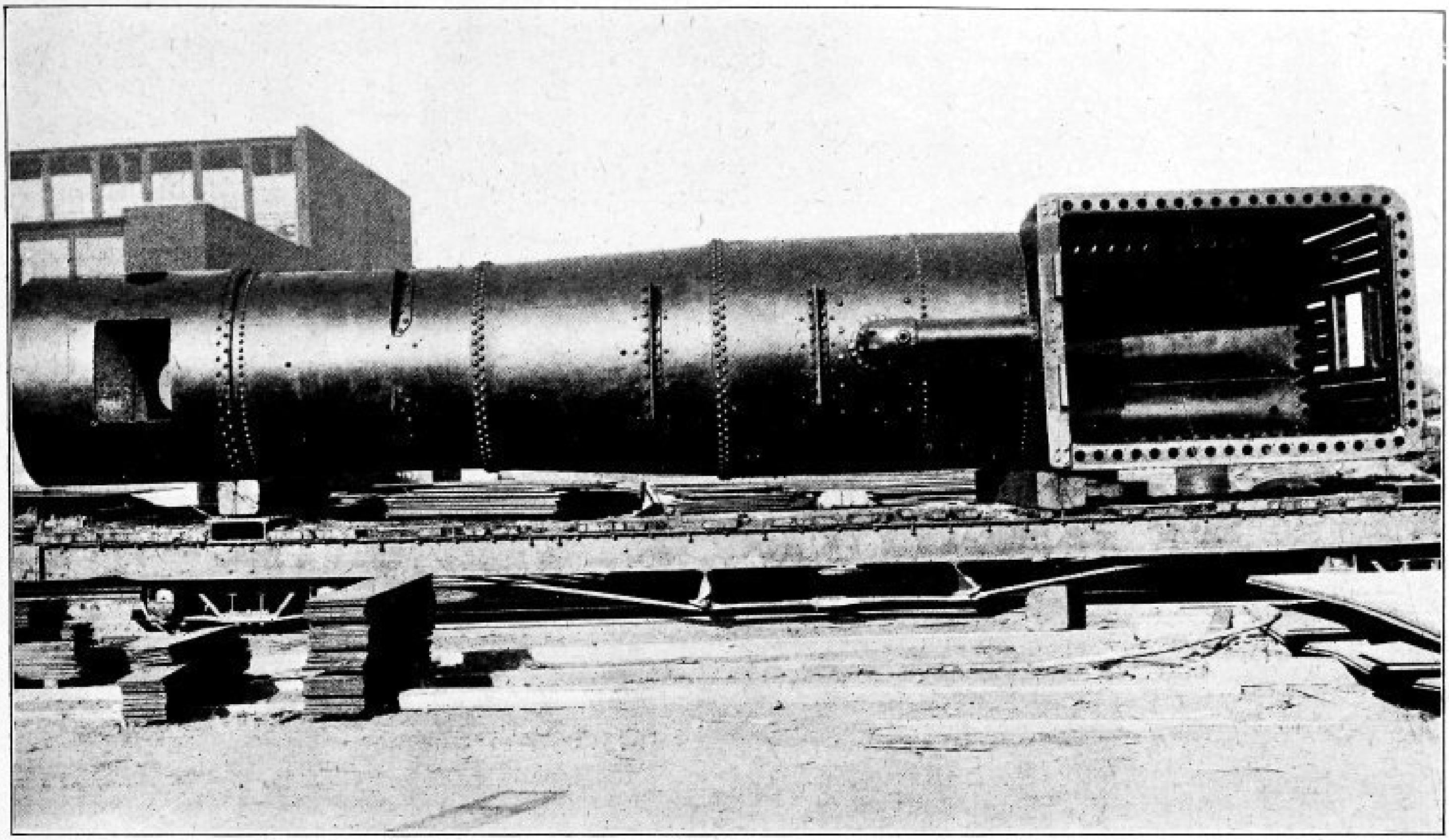


Fig. 3.—Bottom View of Boiler

heavy pipe and cast steel elbows connecting the top of the throat to the boiler shell. The connection to both the throat and shell is of the ball-joint design. The front end of the firebox, commonly known as the throat, and already referred to as such, is composed of an inside and outside throat sheet. Both sheets are ½ inch thick with a 6-inch water space between them. These sheets are flanged and riveted to the boiler shell at the top and riveted to the cast steel front end ring at the bottom. The inside sheet is screw riveted to the inside of the side ring and welded at the top of the same. The sides of the throat sheets are made by flanging the sheets to form the sides and a lap seam single riveting them together above the firebox ring and to the cover plate of the ring.

The throat sheets are, of course, staybolted together, this being the regular method of firebox construction. It should be noted here that the staybolts in the throat are the only ones required in the construction of this firebox. The omission of the major part of staybolts is one of the principal advantages of this boiler over the regular type.

The sloping construction of the top of the throat sheets as seen in the photograph is a good example of the strength and advantage of welding. The cover plate closing this slope is 6 inches by 7½ inches, and is set flush with the throat sheets and held in position entirely by acetylene welding.

The firebox has firebrick supported on four 3-inch tubes in the usual way. The back end of the tubes are turned up and supported by beading over in the bottom of the drums. The small holes in the drums, backhead tubes and the outside of the firebox ring as seen in the picture are for washing out purposes.

With the exception of making a few remarks about the covering or lagging for this unusual design of firebox, it is felt that the design of the same has been fully covered.

It might occur to some of the critics of this firebox that the vibration of the engine when running, or an ordinary shock, would easily start a leak with the tubes; on the contrary, this has not been found so, and it is the opinion of the writer that very little trouble will be experienced in this respect.

It will not be surprising if some one is wondering how this strange looking firebox is to be made fire-tight, as it can be imagined that there are large open spaces where the tubes are swaged, and, in fact, all over the whole firebox, as the tubes are not set close together.

Taking a section through the side and backhead tubes: first will be found a layer of hot blast or a high temperature cement. This fills in around each tube almost to the center and ½ inch outside of the same. The cement is also reinforced with ½-inch mesh No. 18 B. W. G. steel crete expanded metal. Outside of this comes 1½-inch thermofelt lagging, and then the jacket. On the top of the drums there is a 1½ inch thick layer of sectional magnesia and the jacket. The valley formed on top by the placing together of the large and small drums is filled in with a 4-inch diameter wrought iron pipe set in asbestos cement.

After the firebox is lagged and jacketed, it is perfectly tight and looks similar in appearance to the ordinary locomotive boiler. The 12-inch feed pipe under the boiler is lagged with asbestos cement and jacketed, where it was found necessary, small lugs were welded on to the tubes to fasten the supports for holding the lagging in place.

A comparison of the heating surface of this boiler with one of the same size, of the ordinary type, is as follows:

Ordinary Boiler	Square Feet	McClellon Boiler Square Feet
Fire tubes..........	1,778	1,810
Superheater flues...	795	795
Firebox	229	308
Arch tubes.........	25	24
Total	2,827	2,937

Total weight of the New Haven Mikado engine with ordinary boiler is 252,000 pounds, and the total weight of engine with McClellon boiler is 258,000 pounds.

The former is a 92 percent boiler, and the McClellon is 103 percent boiler.

These boilers are now in service and are proving themselves good steamers and are giving very satisfactory results, and the writer's wish is that they will continue to prove efficient, as well as something new in boiler design, and not a "pipe dream" or a "nightmare," as they have been frequently referred to during their design and construction at Schenectady.

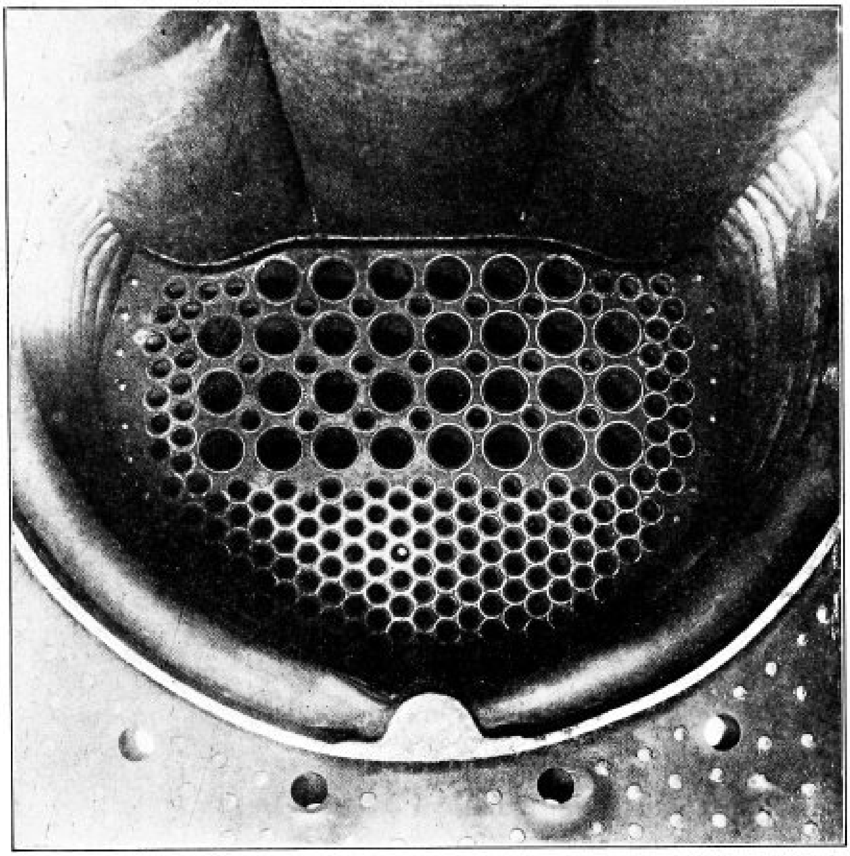


Fig. 4.—View of Combustion Chamber

Locomotive Firebox and Tube Plate Troubles

In looking very carefully over your February issue I read, on page 52, questions in regard to cracks in flange of flue sheets, which the writer alleges they are having trouble with, by the flue sheets cracking all the way across the sheet at the top.

He states "flues are welded in by electricity, and before they were welded in they did not have this trouble." He also states "he has an idea about the matter, and would like to hear what others think about it." I notice there is an answer to the question, with which I agree, but I wish to state, from a constructing engineer and boiler maker's experience, that the trouble he speaks of will never be eradicated until flexibility is given to the firebox and tube plates themselves.

I possibly have spent more good hard cash than any other constructor in the United States to find out as to the verification of my statements in regard to the trouble in locomotive boilers during the past eight years, only to verify my diagnosis in 1908, which is as follows:

First. The heating surface is increased by plates being made flexible, which means less coal burned.

Second. The firebox made flexible by flanging is over 600 percent stronger than the flat plate.

Third. On account of the strength given to a firebox flanged and made flexible in the firebox there will will be from 350 to 700 less stays required in each firebox, according to the size.

Fourth. The expansion and contraction of the firebox is divided equally between each staybolt.

Fifth. The flanging of fireboxes can be so arranged as to suit the space in the leg of the boiler, which will undoubtedly increase, which has been proved, the circulation around the firebox.

Sixth. Corrugated surface giving flexibility to the firebox sheets break up a body of water and increase the rapidity of the currents, consequently the amount of deposit on such surfaces is very much less than on flat surfaces.

I think that your readers will be interested in this diagnosis made by me and, as previously stated, I have found out by the information, as to the working of locomotive boilers, practically, that it would be contrary to the elements of common sense to expect anything otherwise to relieve the troubles in locomotive fireboxes and tube plates, or afford relief only that which can be had by flexibility in the plates themselves.

In conclusion, it would be well to note the ingenuity displayed by some railway officials to try and invent a locomotive firebox to do what I have set forth in my diagnosis, which will be verified by looking over the recent lists of United States patents, and it would appear somewhat strange, especially when there are locomotives at work accomplishing all the claims set forth in my diagnosis. WILLIAM H. WOOD,
Mechanical and Constructing Engineer.
Media, Pa.

What Additional School Work is Needed for Boiler Maker Apprentices

BY G. T. PETERSON

The school work should harmonize with the shop work. Special problems pertaining to boiler work are now being prepared. In drawing, the boy should complete the regular lessons for all trades through the geometrical construction problems, then the school room work should be designed to apply more directly to boiler work.

Make all of the regular laying out drawings and extra drawings from blue prints such as used in the shop. The laying out work done in the school room should conform to the work the boy is on in the shop. In school the parts are laid out to scale, cut out, and pasted together. This gives each boy an opportunity of seeing for the first time how the work will appear when rolled and assembled.

While on general boiler work the boy should systematically study the locomotive folio, learning what it contains pertaining to boilers and subjects closely related to boiler work. In general his work in school should conform to what he is doing in the shop and in addition he should be required to study the folio, boiler rules, learn to calculate strength of joints, seams, patches, etc.

Among Indiana Boiler Shops–I

Building of Rivet Fires—Good and Bad Riveting—Annealing of a Batch of Boiler Tubes

BY JAMES FRANCIS

"Henry, it's no good staying home all the time. Let's take a day off and visit a few shops besides our own. We may pick up some points well worth the time spent!"

"That suits me from base plate to top of the smoke stack! Where'll we go? Over to that brand new shop or down Blank street to some of the old shops where the sun never shines?"

"We'll go to both places, Henry. In the old shops we will find some mighty interesting kinks and dodges. We will see how they do many kinds of work with very few tools and we shall find some things which we can use to advantage. I say, let's go to the old shops first, then to the new one, where we will see everything up-to-date, with machines and tools for everything. Why, they say that all the foreman has to do in that shop is to press a lot of push-buttons and the machines just do the work themselves without waiting for men to operate the various tools and appliances. Tim Strong told me about it!

"There, Henry, let down the dolly-bar. That rivet is home and don't need any more driving. They have got things pretty well systematized nowadays, but I haven't seen any boiler shops yet which were quite automatic. They still have to swing a sledge once in a while, and if Tim Strong is as good a boiler maker as he is a "kidder," then the new shop surely has one good man, anyway."

"Say, Mr. Francis, here's Blank's little shop. Let's go in there. I heard they had just taken some mighty big contracts for tanks. And, say, isn't it a shame how the boiler makers are cutting each other's throats in the tank business? Why, if somebody wants bids on a little heating tank, most of the shops seem to fall all over themselves trying to get in the lowest bid so as to get that little tank order. Some of them even figure down so the work must be actually done at a loss. I don't believe in that business, do you? Some shop owners say they will take work below cost sometimes just to keep the shop running so the men can have work. Do you believe in that, Mr. Francis? It don't look good to me."

"No, Henry, I don't believe in that sort of thing at all. I believe that if a shop cannot keep at work and make a fair profit, it is time that they either reorganize or go out of business. Even in dull times, some shops run all the time and make money. All shops should do the same, were it not for two things."

"What are those things, Mr. Francis?"

"I'll tell you, Henry. Either the shop is not properly organized and cannot do work at a reasonable cost figure or it is not properly managed, and does not get the right kind of contracts or at the right figures."

"Say, isn't that putting it on pretty steep? How can any shop be anything else than what it is? How can it do work cheaper than it can?"

"That's not the way to put the matter, Henry. If the shop be properly organized, it can do work at bottom figures and still pay their workmen good wages and discount their bills payable. In other words, a live man has set the shop things running properly so there is a minimum of waste, either of time, material or energy. See? And furthermore, the same good management enables the shop to get work at fair prices and it never has to take work at a loss in order to 'keep the shop running.' See that, too?"

"Yes, I see that, or hear you say it; but there are some shops I know of which could never meet requirements in either directions. What, then, will those shops do?"

"That's just the point I wish to make, Henry. Boiler shops which cannot meet the requirements of the two points in question have no business to be in existence. It is a case of the 'survival of the fittest,' in boiler shops as in everything else on this earth, and why should a weak, half efficient boiler shop be permitted to do a half-way business? Such a shop only makes it harder for all the other shops. Such a shop tends to lower the prices of work and to lower the standard of boiler making for the

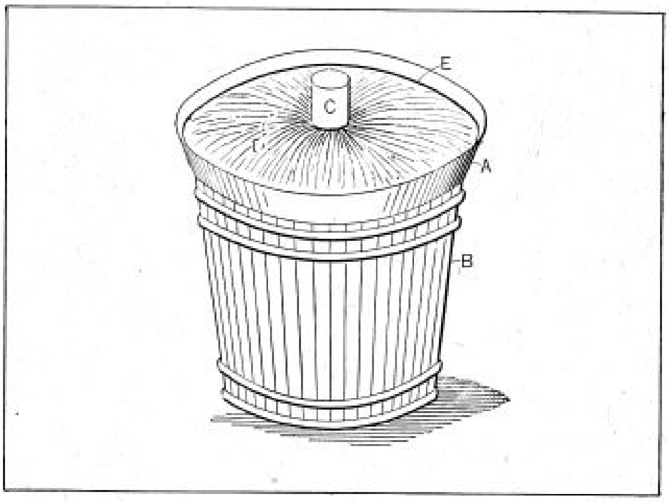


Fig. 1.—Building a Rivet-Forge Fire

town or city in which the weak shop is located. Therefore, why shouldn't such weak shops be put out of business 'for the good of the order'? Rub out a poor boiler shop and give its owner a chance to become a good concrete sidewalk contractor, duck worker or chicken farmer. The fact that there is a weak boiler shop is good proof that somebody has thrust a 'round peg into a square hole.' The poor or weak boiler shop is only a superfluous branch of the tree. It is either growing out of place or has passed its prime and begun to decay. In either case, apply the pruning knife and cut off the weak branch, or the weak boiler shop, and thereby raise the tone of the whole and give the healthy ones a better show."

"Well, say, that's pretty hard on the weak shop, but it seems the truth, all right, and if it could be done, how it would knock the bottom out of price-cutting and taking work for nothing, wouldn't it? But here we are at Blank's—and just look at that, will you? See that helper with the top of a rivet heater piled up on a butter firkin. There, right in Fig. 1. What's he doing, anyway?"

"Watch him a bit, Henry. Don't you see that he is building a base for a rivet-forge fire? The flare *A* has just been lifted from the frame which carries it. That forge uses compressed air, so all there is to it is the flare *A*, a tuyere iron and a frame to hold the flare in place.

Pretty simple they are, too, those little rivet forges, and they do the business, too. The shop has one of the modern oil furnaces with a muffle to heat the rivets in, but you see it standing there all covered with dust, while this little coal waster is in constant use. What's the reason for that? Well, that's one of the things you will have to find a reason for when you reorganize the shop to prevent price cutting! There's a reason for it, Henry, and it is yet to be shown that the reason is a good one. Still it may be that they use the oil rivet heater on large jobs and the little coal heater on small work."

"But what's the man trying to do with that forge flare? Seems as though the man thought he was working in a foundry. See! He is setting a gate print—there at *C*. What is it all about? And just look at the butter tub, *B*!"

"Hold on a bit, Henry. That chap knows what he is about. The tub, *B*, is a mighty handy thing to have around a boiler shop, and four or five of them would be a paying investment, even for a small shop like this. Why, that butter tub is the handiest thing ever. When a man is driving rivets with an 'air gun' on a shell which is lying on friction wheels upon the shop floor, then a tub like *B* is just the thing to place the air gun upon while removing a bolt or working the drift pin. There is a certain height from the floor where the gunman can best work while sitting down, and the tub is just the thing for that. Don't laugh at the butter tub in the boiler shop, Henry. Put in more of them, but cut a small hole in the top, so you can get the fingers in. Then you can pick up the tub with one hand, where it takes two hands to move it now. And if the wooden tubs go to pieces too quickly, just make up a few sheet iron ones. They pay well in the shop."

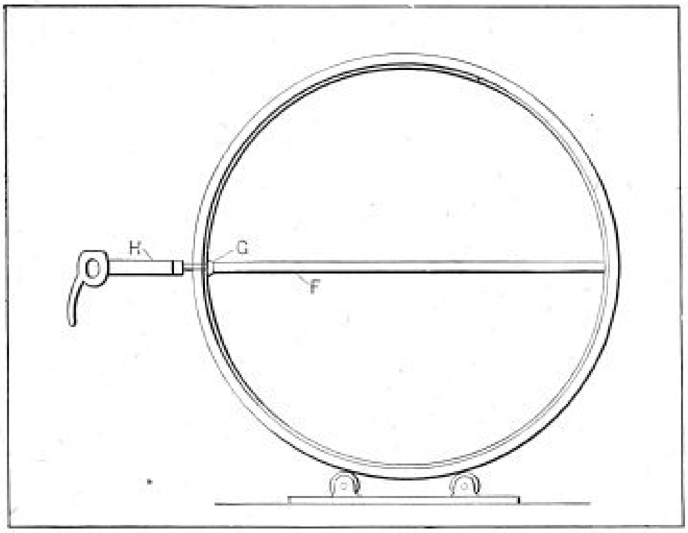


Fig. 2.—Good Work with Air-Gun and Dolly Strut

"But what is that man doing all that foundry work for?"

"Why, he is making up a bed for a rivet fire. That plug, *C*, fits into the air pipe of the forge. The man has sifted out a lot of fine coal through a No. 3 or No. 4 riddle. He has wet the coal with water and is now tamping the mixture at *D*, around plug *C*, which he will pull out after the flare has been filled almost full. Just notice that he does not let the coal come even with the top of the flare, but keeps it about an inch lower around the edge, as shown at *E*. The coal surface is a little higher around plug *C*, and the space around the edge at *E* is left so a row of rivets may be laid around the edge of the forge, where they cannot roll off and from whence they may be readily and quickly picked up and thrust into the fire when needed."

"What's the good of all that trouble? Why not just fill the flare with coal, then build a fire on top of it? Wouldn't that heat the rivets just as well?"

"Yes, Henry, it would heat the rivets, but the way this fire is built gives about four or five inches of solid coal below the level where the rivets are placed. The finely packed coal burns away very slowly and enables the heater man to keep the fire in good shape far longer than is possible with a flare full of coal loosely thrown in.

"Watch the man, Henry. See! He has got too much water in the coal and the mixture is rather slushy and does not compact under the rammer nearly as well as if he had used a bit less water. And there's another thing he might have done, Henry. Had he pulverized a little fire clay and sifted it through a No. 8 riddle and mixed the clay with the fine coal he would have secured a foundation for his fire which would have lasted all day and possibly part of the second day. The fire clay would harden under influence of the fire and would bind together the particles of coal in a manner which would hold them fast until they had been entirely burned away. But it will not do to get too much fire clay into the mixture, or there will be a fine, porous bit of brick left in the fire after the coal has burned away. Just fire clay enough to hold the coal in place until it is burned, also to make the coal burn slower—that is what the portion of fire clay does.

"And now, Henry, just watch that man start the fire. He surely knows his business. There he goes to a flange forge fire and brings back some burning coals on a shovel. These are dumped into the hole where *C* was pulled out, just a little blast turned on and a few pieces of nut coal thrown in on top of the live coals. As the green coal ignites, more coal is placed on top, but the pile is no greater in diameter than the hole *C*. The blast is strengthened, and a pile of coal 3 or 4 inches high is built up and ignited, then the pile is spread out a little, more green coal is added and more blast is put on. In five minutes he has a fine fire 8 inches in diameter, 2 or 3 inches above the level of the coal at *D*. Then some rivets are placed point down in the top of the fire, the blast is cut down to give a 'soaking flame,' and in three minutes more the rivet heater is throwing rivets 20 feet as fast as four 'gunmen' can drive them home."

"He surely does work that mighty well, Mr. Francis, and his fire seems to hold its size pretty well—only about 8 or 9 inches in diameter, and seems to stay that way. Well, there is one good 'kink' for me to-day!"

"Look at that dolly-bar, Henry. How do you like that? There it is, in Fig. 2. The bar, *F*, goes right across the inside of the shell, is cupped upon the rivet at *G*, and all the hold-on man has to do is to remove the bar after the gun, *H*, has driven the rivet home."

"Some stunt that, Mr. Francis. Pretty soft for the holder-on, isn't it?"

"Seems so, Henry; but let's watch the work a while. Seems to me there will be trouble bye and bye. Just watch a bit."

"What is the matter, Mr. Francis? I don't see anything wrong with that arrangement. What is it?"

"Just keep watching that work, Henry. You will see it pretty soon. There! Now you can see something to keep away from. Fig. 3 shows it. The gunman is now driving a girth seam and is working on a rivet pretty well down toward the ground. The line of the rivet should be on line *P*, but a drift has been used—all specifications to the contrary notwithstanding—and the rivet now points along line *O* instead of along line *P*. The dolly-strut has evidently found an oval place in the shell, and slips down until it lies on line *Q*, instead of being diametrical on line *P*, or with the rivet on line *Q*. To make bad matters worse, the rivet is being well driven toward the ground, therefore the gunman unconsciously holds the far end of the gun too high, so it lies on line *S*, which is a long ways from the rivet line, *Q*. The dolly-strut is off about as much in the other direction, therefore the action of the gun and of the dolly is to drive the heads of the rivet in opposite directions instead of axially toward each other. Although the angles shown in Fig. 3 are exaggerated to show the matter more plainly, it goes without saying that

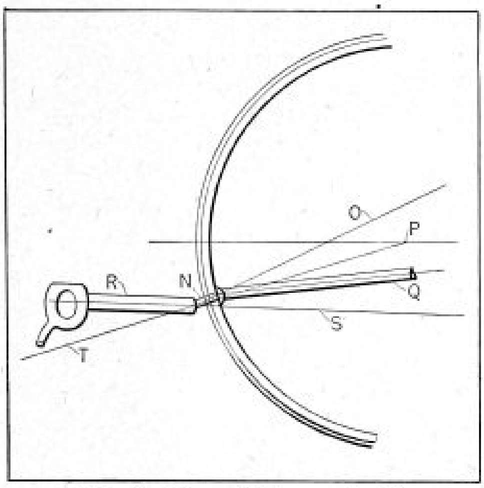


Fig. 3.—Some Things to Avoid

driving rivets in that manner can never give good results. You must watch these things, Henry, whenever you have a similar bit of work to do."

"Yes, Mr. Francis, I see how it must work when the rivet, the dolly and the air gun do not point along the same axial line, and the result will be a rivet which can never be as strong as one driven with both gun and dolly in the exact line of the rivet."

"Say, Henry, here's another thing to look after. Watch that big fellow at the far end of the shell. He is driving a rivet pretty high up from the ground and, quite naturally, he holds the outboard end of the 'gun' somewhat too low. Fig. 4 shows just what he is doing. The gun, *L*, is held upon line, *M*, while the rivet lies in line *I*, and the head being driven will naturally be offset, but in a direction opposite to the business shown by Fig. 3. There is another matter shown also by Fig. 4. The dolly-strut, *J*, instead of being placed in line with the rivet, *I*, and falling to a working position at *J*, is found to be a bit too short, possibly on account of the shell being a trifle oval, and the dolly-strut fails to come to a bearing until it

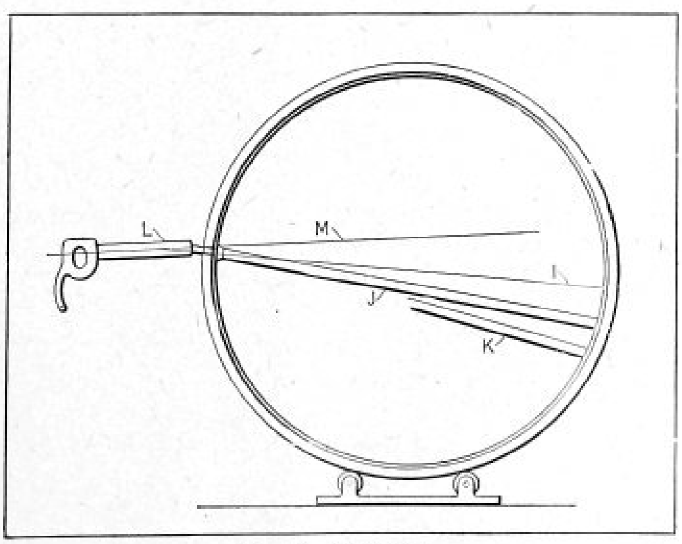


Fig. 4.—Bad Work

reaches position *K*, thus making far too much angle between lines *M* and *K*, of gun and of dolly respectively. This is the same trouble as was shown by Fig. 3, but in a reverse order, both heads being pushed to one side, instead of in opposite directions, as in Fig. 3."

"I don't see how it can be helped, Mr. Francis. The dolly-strut must be short enough so that it can be put in position over the hot rivet head, and as the rivet is driven the dolly will take up a bit, therefore it must sink down a bit as it slides over the shell opposite to the rivet being driven. What can be done about it?"

"It can easily be entirely prevented, Henry. Instead of having the holder-on a plain dolly-strut, same as shown at *J*, Fig. 4, have one made with a small air cylinder at the end which rests against the shell. This cylinder may be plain, and made to slip on over the end of any length of bar. It need have no valve at all, save a plain stop valve for admitting or shutting off air. With the dolly-strut in place, axially with the rivet, air pressure is admitted to the little cylinder and its piston is forced against the boiler shell, holding the dolly exactly in place, even as the inside head takes up under the stress of driving the outer end of the rivet. Then, when air is cut off from the

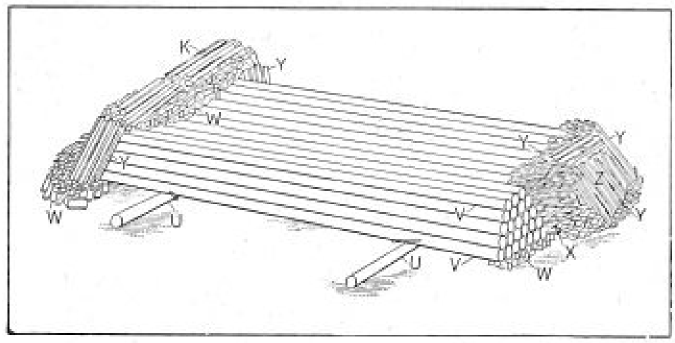


Fig. 5.—Annealing Both Ends of Seventy 4-Inch Tubes

little cylinder, the bar will come away easily and will not have to be driven out with a hammer."

"Say, that would be great, wouldn't it? And it would save a lot of time, too, besides keeping the bar at all times in line with the rivet. That's good—but, Mr. Francis, what is going on out in the shop yard? See that big bonfire! Let's see what they are doing."

"Just annealing a batch of boiler tubes, Henry. These tubes were cut off by a revolving wheel business pretty much like an ordinary pipe cutter, with the result that each and every tube end thus cut has been hardened somewhat during the cutting operation. Annealing makes the tubes roll up much better and prevents trouble from cracked tube ends, hence the annealing, which is just heating them redhot and then allowing them to cool slowly—the slower the better."

"Why don't they have a furnace to heat them in; then they could control the heat as they pleased?"

"A tube-annealing furnace is a very fine thing to have, Henry. We will probably find one when we get to the up-to-date shop, but this little shop hasn't any, and they do a mighty handy annealing job right under foot in the yard. There's a neat bit of work, Henry. See how they piled the tubes? Count 'em—yes, there's just 70—they are all placed on two old tubes, *U U*, then 17 tubes are laid down close together, side by side, as shown by Fig. 5. The outer tubes are chocked upon bearers, *U U*, in order that the upper courses may not cause the lower course to spread out and roll away, 16 tubes in the second course, then 15 in the next, then 14, and the balance of the 70 piled above the four full courses. Some dry wood was procured from a nearby furniture manufactory. Much of the wood was 3 inches and 3½ inches wide, and of all lengths, from 3 inches to 8 inches. Another lot of the wood was strips evidently jointed from the edges of stuff about 30 inches long. A lot of the very short stuff was shoveled against, under and upon the pile of tubes, as shown at *W, W, W.* Then the longer pieces, say 6 inches to 8 inches, were placed inside of each tube, as shown at *Z.* The long strips were set on end, as shown at *Y, Y, Y,* and more of the short pieces were shoveled in wherever there was a chance."

"That sure is a very neat job, isn't it, Mr. Francis?"

"Yes, Henry, it is a good bit of work. Now watch the neat way in which they set all that wood on fire at the same time. There! See that? You must have noticed a man who has been starting a fire on the flange forge and who chased the rivet boy when he took some lighted coals to start his fire with?"

"Yes, I saw that. What about it?"

"Well, haven't you noticed that man has been piling up and igniting a big pile of coal—at least a bushel of it—on the flange forge? And now, there goes that same man with a shovelful of that ignited coal. See him spread it along the pile of wood? Four or five shovelfuls of hot coals and the wood is all on fire. What's that? 'When will the tubes be ready?' Well, they will just leave them there over night and ship 'em away first thing in the morning. What! Whistle blowing six o'clock already? Well, we will have to let that new shop wait for our visit until we get another day off. 'So 'long,' Henry."

Layout of Threeway Connection

Two Approved Methods of Laying Out Complicated Connection with Three Outlets

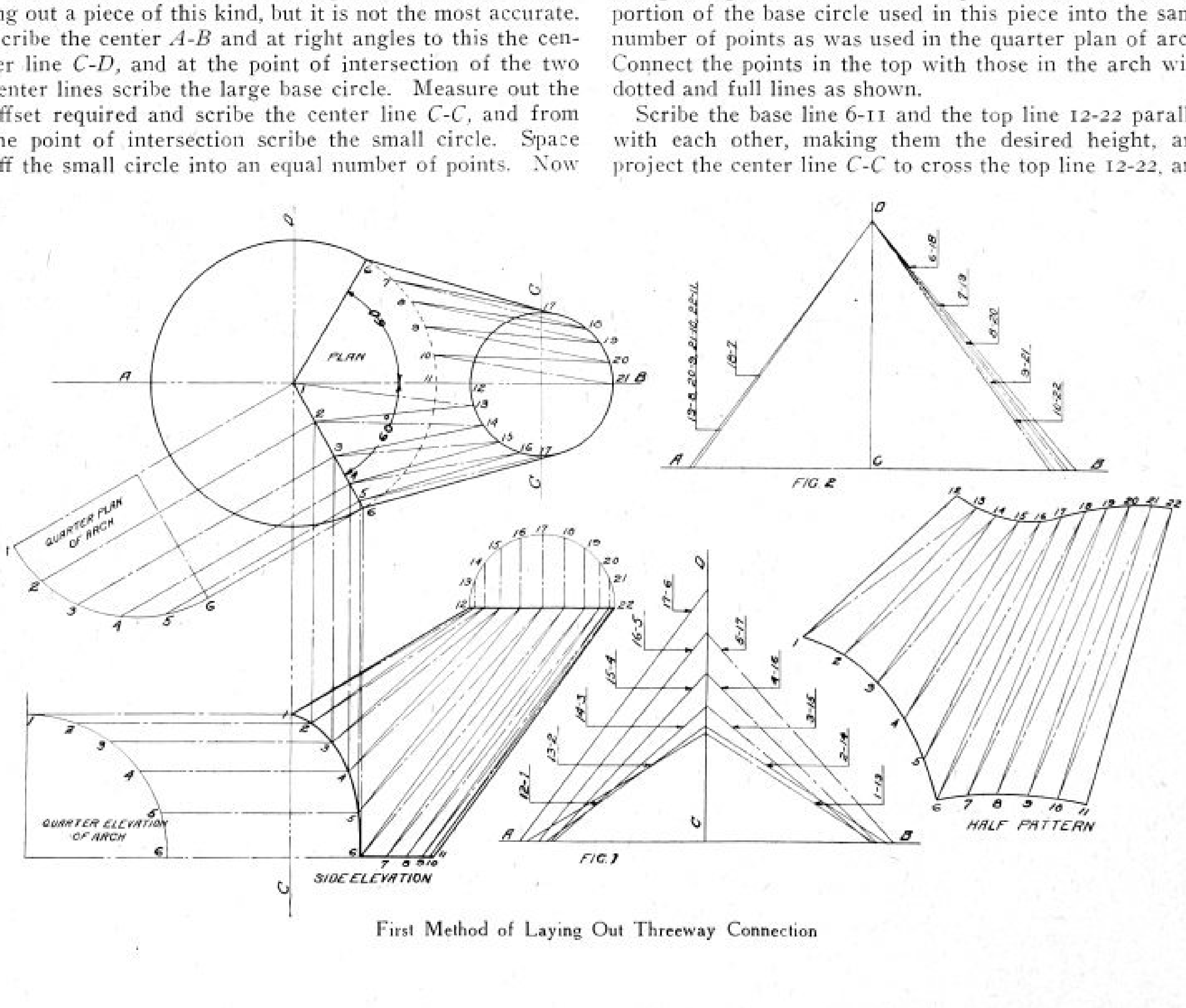
BY R. J. HETTENBAUGH

It is customary in laying out a piece of this kind to make the area of the top one-third the area of the bottom.

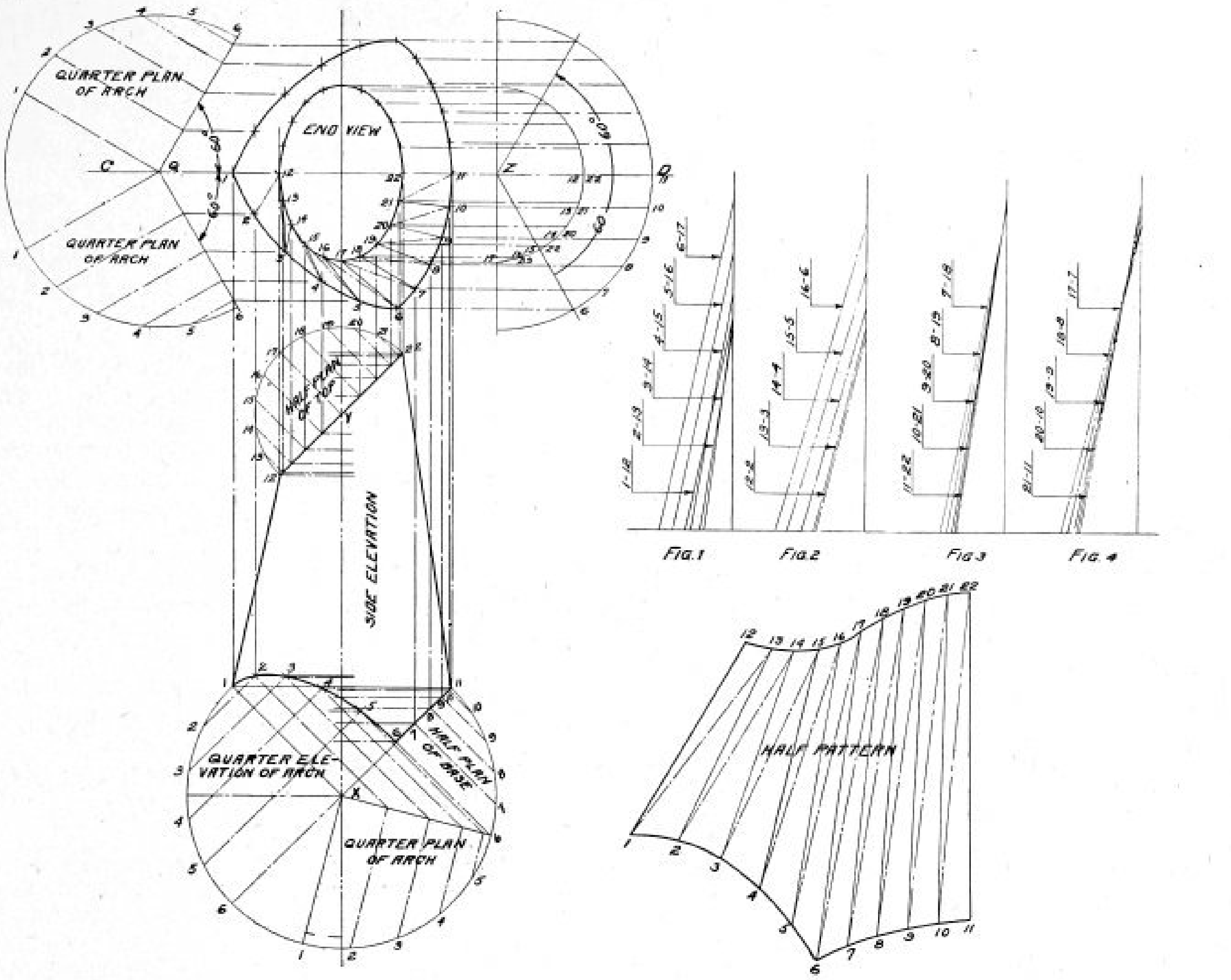
First Method

This is the most common and practical method of laying out a piece of this kind, but it is not the most accurate. Scribe the center *A-B* and at right angles to this the center line *C-D,* and at the point of intersection of the two center lines scribe the large base circle. Measure out the offset required and scribe the center line *C-C,* and from the point of intersection scribe the small circle. Space off the small circle into an equal number of points. Now scribe the two lines 1-6 each 60 degrees from the center line *A-B.* Lay out the quarter plan of arch as shown and space off into the same number of points as was used in one-quarter of the small circle. Project these points at right angles to the line 1-6. Space off one-half of the portion of the base circle used in this piece into the same number of points as was used in the quarter plan of arch. Connect the points in the top with those in the arch with dotted and full lines as shown.

Scribe the base line 6-11 and the top line 12-22 parallel with each other, making them the desired height, and project the center line *C-C* to cross the top line 12-22, and



First Method of Laying Out Threeway Connection



Second Method of Laying Out Threeway Connection

from the point of intersection scribe the half circle. Space this off equally into the same number of points as was used in one-half the small circle in plan and project all points at right angles to the line 12-22. Next lay out the quarter elevation of arch, as shown, and project all points to the side elevation. Project points 1 to 6 from the plan to the side elevation to cross the lines taken from the quarter elevation of arch. The points of intersection will form the side elevation of arch.

The construction triangles must now be formed. Lay out the horizontal lines *A-C-B* and the perpendicular lines *C-D* as in Figs. 1 and 2. Take the length of line 12-1 in the plan and place it on the base line of Fig. 1. Next take the length of the line 12-1 from the side elevation and place it on the perpendicular line of Fig. 1. Scribe a line across these two points, which will give the true length of line 12-1 and the first construction triangle. In like manner take the length of the line 1-13 from the plan and side elevation and place them on the opposite side of the perpendicular line in Fig. 1. Continue in this manner until all the construction triangles in Figs. 1 and 2 are found.

The next step will be to piece the construction triangles together and form the half pattern. Scribe a line on the sheet and on this line lay off the true length of the line 12-1 in Fig. 1, and with point 12 as a center scribe an arc equal to the distance between one of the spaces in the small circle. With point 1 as a center scribe an arc equal to the length of line 1-13 in Fig. 1. The point of intersection with the arc taken from point 12 will form point 13. With point 13 as a center scribe an arc equal to the length of line 13-2 in Fig. 1. With point 1 as a center scribe an arc equal to one of the spaces in the quarter plan of arch. The point of intersection of the two arcs forms point 2. Continue in this manner until point 6 is reached, and from here on the arcs must be taken from the spaces in the base circle.

Double the pattern on the line 22-11 and cut out the full pattern for one section of the threeway. Use this piece as a pattern for the other two sections.

SECOND METHOD

This is not the shortest method of laying out a threeway, but it is the most accurate and involves a nice problem in projection work, which requires careful work.

Scribe the center line *A-B* and 45 degrees from this line scribe the top and base lines 22-12 and 11-6, projecting the line 11-6 to the center *X*. With point *X* as a center scribe the large circle, which is subdivided into the quarter elevation, quarter plan and half plan of base and arch. From point *X* scribe the line *X*-1′ and 90 degrees from this line *X*-6′. Divide this portion of the circle into six equal points and project points to the line *X*-6′ parallel to the line *X*-1. Project the line 11-*X* to point 6 and 90 degrees from this line scribe the line *X*-1. Divide this portion of the circle into six points as before and project these points to the true side elevation parallel to the line 11-*X*-6. Project all points from the quarter plan of arch to the side elevation parallel to the line *X*-1 so that they cross the points taken from the quarter elevation. The points of intersection will form the side elevation of arch. Divide the half plan of base into six equal points and project to the line 11-*X*.

With point *Y* as a center scribe the circle representing half plan of top. Space this circle in eleven equal points and project them at right angles to the line 22-12. This completes the side elevation.

Scribe the line *C-D* at right angles to the line *A-B* and on this line scribe the two large circles. With point *Q* as a center scribe two lines to points 6, 6 sixty degrees from the line *C-D*, and on these lines erect the quarter plans of the two arches, as shown. Space these off into six equal parts and project the points at right angles to the lines *Q*, 6 ,6, and thence to the end view parallel to the line *C-D*. Project all points from the side elevation of arch to the plan so that they cross the points just taken from the quarter plans of arch. The points of intersection will form the plan of the two arches.

Repeat the same thing on the other side, scribing the two lines 60 degrees from the line *C-D*, and space the portion of the circle between these two lines into eleven equal parts and project all points parallel to the line *C-D* to the plan. Project the corresponding points from the side elevation to plan parallel to the line *A-B*. The points of intersection will form the base.

Next scribe the small half circle from point *Z* and space this into eleven equal parts and project all points parallel to the line *C-D* to the end view, project corresponding points from the side elevation to cross these, the points of intersection forming the end view of top.

Project all points from the arch, base and top in the side elevation to the center line *A-B*. From these points the heights of the construction triangles are to be found. Scribe the horizontal and perpendicular lines in Fig. 1. With a pair of dividers take the distance between points 1-12 in the end view and place this on the base line of Fig. 1. Next take the distance between points 1-12 on the center line of the side elevation and place this on the perpendicular line of Fig. 1. The distance across these two points will give the true length of line 1-12 and forms the first construction triangle. In like manner take the length of line 12-2 and place it on the base line of Fig. 2. Take the height of line 12-2 from the center line of the side elevation and place it on the perpendiclar line of Fig. 2. Scribe a line across the two points forming the second construction triangle. Continue in like manner with lines 2-13, 13-3, 3-14, 14-4, etc., until all the construction triangles in the half pattern are found.

THE PATTERN

The next step will be to piece the triangles together and form the half pattern. Lay out the true length of line 1-12 on the sheet, and with point 1 as a center scribe an arc equal to one of the spaces in quarter plan of arch, with point 12 as a center scribe an arc equal to the true length of line 12-2, in Fig. 2, to cross the arc taken from point 1, the intersection will form point 2. Now with point 12 as a center scribe an arc equal to one of the spaces in quarter plan of arch. With point 2 as a center scribe an arc equal to the length of line 2-13, in Fig. 1, to cross the arc taken from point 12, the point of intersection forms point 13. Continue in this manner until the half pattern is formed.

Double the pattern on the line 11-22 and cut out full pattern for one section of the threeway. If this work is done accurately you will find that it is the most accurate method of laying out this pattern.

BOILER SHOP DAMAGED BY FIRE.—The O'Leary Brothers Boiler Works, South Pearl Street, Green Bay, Wis., was damaged $5,000 by fire Feb. 1. It has been decided to build a modern boiler and structural shop as soon as possible. Existing orders will be completed in the undamaged part of the plant.

Recommended Standards for Dampers, Breeching and Stacks for High Pressure Steam Power Plant

BY O. MONNETT

DAMPERS

Horizontal Return Tubular Boilers.—Dampers shall occupy the full width of available opening and have a free area 25 percent in excess of the combined area of tubes. No type of damper plate that restricts the opening to be used.

Watertube Boilers.—A free opening of one-quarter the grate surface shall be provided, and dampers shall hang in such a manner as not to obstruct the movement of gases when wide open. It is recommended that no damper be placed in the main breeching.

BREECHINGS

Breechings shall be as short and direct as possible, preferably having a direct run without turns into the stack. No right angle turns to be used. If necessary to install a breeching with turns the latter shall be in long sweep bends with a radius on center of turn of not less than the diameter or width of breeching.

Breeching shall not dip below the horizontal, but preferably should have an easy slope upward to the stack.

Connection from breeching to stack to be at an angle of 45 degrees.

MATERIALS

Breechings should not be constructed of brick or other porous material subject to leakage. Breechings made of steel plate should have angle irons on outside and have no projections on inside to make resistance for gases.

Lagging should be on the outside, where its condition can be readily inspected and where repairs can be made without interrupting the operation of the plant and where loose pieces will not obstruct the flow of gases.

Clean-out doors to be provided at convenient points for removal of accumulation of soot.

AREA

Watertube Boilers.—Area of breeching shall not be less than 22 percent of total area of grate surface served, or a ratio of breeching area to grace surface of 1 : 4½.

Horizontal Return Tubular Boilers.—Area of breeching shall be 25 percent in excess of total area of tubes.

SECTION

Breechings shall preferably have a round or square section. In case of rectangular shape one side shall not be more than one-third greater than the other.

STACKS

Location.—Stacks to be located to get the most favorable run of breeching possible. Steel stacks to be lined for a height equal to ten times their diameter.

AREA

Watertube Boilers.—The free area of the stack at the smallest point to be not less than one-fifth the area of the total connected grate surface where the stack is less than 150 feet high. Where the stack is over 150 feet high, the area shall be not less than one-sixth the grate surface.

Horizontal Return Tubular Boilers.—Stacks shall have an area in free opening at smallest point 25 percent in excess of combined area of tubes served.

HEIGHT

The formula for calculating necessary height of stacks shall be:

$$D = 0.52\, H\, P \left(\frac{1}{T} - \frac{1}{T_1} \right)$$

In which

D = draft in inches of water,
H = height of stack above grate in feet,
P = atmospheric pressure in pounds per square inch,
T = atmospheric temperature absolute,
T_1 = absolute temperature of stack gases.

For convenience the values of the product

$$0.52 \times P \left(\frac{1}{T} - \frac{1}{T_1} \right) = K$$

have been calculated for a number of different flue gas temperatures at sea level and 60 degrees F. atmospheric temperature and the formula becomes $D = K H$, the values of K being as follows:

Temp. Stack Gas	K
750	.0084
700	.0081
650	.0078
600	.0075
550	.0071
500	.0067
450	.0063
400	.0058
350	.0053

To provide for frictional resistance .001 to be subtracted from constant K

$$K - .001 = U,$$

giving the ultimate constant U.

Therefore, to find the available draft in a stack of given height, multiply height of stack by constant corresponding flue gas temperature:

$$D = H\, U.$$

To find height of stack above grate necessary to make available a given draft at a given flue temperature, divide draft required by constant corresponding to temperature:

$$H = \frac{D}{U}.$$

Strength of Locomotive Boilers—III

BY WILLIAM N. ALLMAN

FORMULA FOR FIGURING AREA OF SEGMENT

A = area of segment,
H = height of segment,
R = radius of segment.

$$A = \frac{4 H^2}{3} \sqrt{\frac{2R}{H} - .608} \qquad (18)$$

Table No. 11 gives net area of various segments and covers a various range of heights and diameters, and is convenient for determining the area of segments.

NOTE.—Any definite ruling on the part of the Interstate Commerce Commission or other State Boiler Commissions which may be more rigid than the above, such rulings would necessarily have to be used and adhered to in order to bring the stress within the required limits.

DATA ON CROWN BAR BOLTS

Diam. of bolt	Diam. at root of thread	Area at root of Thread
¾"	.620"	.3020 Sq. In.
⅞"	.731"	.4197 " "
1"	.837"	.5502" " "
1⅛"	.940"	.6940 " "

(Bolts based on U. S. Standard Thread)

STAYBOLTS

The next subject to take into consideration is the stress on the staybolts.

TABLE NO. 8—AREAS SUPPORTED BY STAYBOLTS—SQUARE INCHES

	3½	3 9/16	3⅝	3 11/16	3¾	3 13/16	3⅞	3 15/16	4	4 1/16
3½	12.25	12.47	12.69	12.91	13.13	13.34	13.56	13.78	14.00	14.22
3 9/16	12.47	12.69	12.91	13.14	13.36	13.58	13.80	14.03	14.25	14.47
3⅝	12.69	12.91	13.14	13.37	13.59	13.82	14.05	14.27	14.50	14.73
3 11/16	12.91	13.14	13.37	13.60	13.83	14.06	14.29	14.52	14.75	14.98
3¾	13.13	13.36	13.59	13.83	14.06	14.30	14.53	14.77	15.00	15.23
3 13/16	13.34	13.58	13.82	14.06	14.30	14.54	14.77	15.01	15.25	15.49
3⅞	13.56	13.80	14.05	14.29	14.53	14.77	15.02	15.26	15.50	15.74
3 15/16	13.78	14.03	14.27	14.52	14.77	15.01	15.26	15.50	15.75	16.00
4	14.00	14.25	14.50	14.75	15.00	15.25	15.50	15.75	16.00	16.25
4 1/16	14.22	14.47	14.73	14.98	15.23	15.49	15.74	16.00	16.25	16.50
4⅛	14.44	14.69	14.95	15.21	15.47	15.73	15.98	16.24	16.50	16.76
4 3/16	14.66	14.92	15.18	15.44	15.70	15.96	16.23	16.49	16.75	17.01
4¼	14.88	15.14	15.41	15.67	15.94	16.20	16.47	16.73	17.00	17.27
4 5/16	15.09	15.36	15.63	15.90	16.17	16.44	16.71	16.98	17.25	17.52
4⅜	15.31	15.59	15.86	16.13	16.41	16.68	16.95	17.23	17.50	17.77
4 7/16	15.53	15.81	16.09	16.36	16.64	16.92	17.20	17.47	17.75	18.03
4½	15.75	16.03	16.31	16.59	16.88	17.16	17.44	17.72	18.00	18.28
4 9/16	15.97	16.25	16.54	16.82	17.11	17.39	17.68	17.96	18.25	18.54
4⅝	16.19	16.48	16.77	17.05	17.34	17.63	17.92	18.21	18.50	18.79
4 11/16	16.40	16.70	17.00	17.29	17.58	17.87	18.16	18.46	18.75	19.04
4¾	16.63	16.92	17.22	17.52	17.81	18.11	18.41	18.70	19.00	19.30
4 13/16	16.84	17.14	17.45	17.75	18.05	18.35	18.65	18.95	19.25	19.55
4⅞	17.06	17.37	17.67	17.98	18.28	18.59	18.89	19.20	19.50	19.80
4 15/16	17.28	17.59	17.90	18.21	18.52	18.82	19.13	19.44	19.75	20.06
5	17.50	17.81	18.13	18.44	18.75	19.06	19.38	19.69	20.00	20.31

	4⅛	4 3/16	4¼	4 5/16	4⅜	4 7/16	4½	4 9/16	4⅝	4 11/16	4¾
3½	14.44	14.66	14.88	15.09	15.31	15.53	15.75	15.97	16.19	16.40	16.63
3 9/16	14.70	14.92	15.14	15.36	15.59	15.81	16.03	16.25	16.48	16.70	16.92
3⅝	14.95	15.18	15.41	15.63	15.86	16.09	16.31	16.54	16.77	17.00	17.22
3 11/16	15.21	15.44	15.67	15.90	16.13	16.36	16.59	16.82	17.05	17.29	17.52
3¾	15.47	15.70	15.94	16.17	16.41	16.64	16.88	17.11	17.34	17.58	17.81
3 13/16	15.73	15.96	16.20	16.44	16.68	16.92	17.16	17.39	17.63	17.87	18.11
3⅞	15.98	16.23	16.47	16.71	16.95	17.20	17.44	17.68	17.92	18.16	18.41
3 15/16	16.24	16.49	16.73	16.98	17.23	17.47	17.72	17.96	18.21	18.46	18.70
4	16.50	16.75	17.00	17.25	17.50	17.75	18.00	18.25	18.50	18.75	19.00
4 1/16	16.76	17.01	17.27	17.52	17.77	18.03	18.28	18.54	18.79	19.04	19.30
4⅛	17.02	17.27	17.53	17.79	18.05	18.30	18.56	18.82	19.08	19.34	19.59
4 3/16	17.27	17.54	17.80	18.06	18.32	18.58	18.84	19.11	19.37	19.63	19.89
4¼	17.53	17.80	18.06	18.33	18.59	18.86	19.13	19.39	19.66	19.92	20.19
4 5/16	17.79	18.06	18.33	18.60	18.87	19.14	19.41	19.68	19.95	20.21	20.48
4⅜	18.05	18.32	18.59	18.87	19.14	19.41	19.69	19.96	20.23	20.51	20.78
4 7/16	18.30	18.58	18.86	19.14	19.41	19.69	19.97	20.25	20.52	20.80	21.08
4½	18.56	18.84	19.13	19.41	19.69	19.97	20.25	20.53	20.81	21.09	21.38
4 9/16	18.82	19.11	19.39	19.68	19.96	20.25	20.53	20.82	21.10	21.39	21.67
4⅝	19.08	19.37	19.66	19.95	20.23	20.52	20.81	21.10	21.39	21.68	21.97
4 11/16	19.34	19.63	19.92	20.21	20.51	20.80	21.09	21.39	21.68	21.97	22.27
4¾	19.58	19.89	20.19	20.48	20.78	21.08	21.38	21.67	21.97	22.27	22.56
4 13/16	19.85	20.15	20.45	20.75	21.05	21.36	21.66	21.96	22.26	22.56	22.86
4⅞	20.11	20.41	20.72	21.02	21.33	21.63	21.94	22.24	22.55	22.85	23.16
4 15/16	20.37	20.68	20.98	21.29	21.60	21.91	22.22	22.53	22.84	23.14	23.45
5	20.63	20.94	21.25	21.56	21.88	22.19	22.50	22.81	23.13	23.44	23.75

	4 13/16	4⅞	4 15/16	5	5 1/16	5⅛	5 3/16	5¼	5 5/16	5⅜	5 7/16	5½
3½	16.84	17.06	17.28	17.50	17.72	17.94	18.16	18.38	18.59	18.81	19.03	19.25
3 9/16	17.14	17.37	17.59	17.81	18.04	18.26	18.48	18.70	18.93	19.15	19.37	19.59
3⅝	17.45	17.67	17.90	18.13	18.35	18.58	18.80	19.03	19.26	19.48	19.71	19.94
3 11/16	17.75	17.98	18.21	18.44	18.67	18.90	19.13	19.36	19.59	19.82	20.05	20.28
3¾	18.05	18.28	18.52	18.75	18.98	19.22	19.45	19.69	19.92	20.16	20.39	20.63
3 13/16	18.35	18.59	18.82	19.06	19.30	19.54	19.78	20.02	20.25	20.49	20.73	20.97
3⅞	18.65	18.89	19.13	19.38	19.62	19.86	20.10	20.34	20.59	20.83	21.07	21.31
3 15/16	18.95	19.20	19.44	19.69	19.93	20.18	20.43	20.67	20.92	21.16	21.41	21.66
4	19.25	19.50	19.75	20.00	20.25	20.50	20.75	21.00	21.25	21.50	21.75	22.00
4 1/16	19.55	19.80	20.06	20.31	20.57	20.82	21.07	21.33	21.58	21.84	22.09	22.34
4⅛	19.85	20.11	20.37	20.63	20.88	21.14	21.40	21.66	21.91	22.17	22.43	22.69
4 3/16	20.15	20.41	20.68	20.94	21.20	21.46	21.72	21.98	22.25	22.51	22.77	22.93
4¼	20.45	20.72	20.98	21.25	21.52	21.78	22.05	22.31	22.58	22.84	23.11	23.38
4 5/16	20.75	21.02	21.29	21.56	21.83	22.10	22.37	22.64	22.91	23.18	23.45	23.72
4⅜	21.05	21.33	21.60	21.88	22.15	22.42	22.70	22.97	23.24	23.52	23.79	24.06
4 7/16	21.36	21.63	21.91	22.19	22.46	22.74	23.02	23.30	23.57	23.85	24.13	24.41
4½	21.66	21.94	22.22	22.50	22.78	23.06	23.34	23.63	23.91	24.19	24.47	24.75
4 9/16	21.96	22.24	22.53	22.81	23.10	23.38	23.67	23.95	24.24	24.52	24.81	25.09
4⅝	22.26	22.55	22.84	23.13	23.41	23.70	23.99	24.28	24.57	24.86	25.15	25.44
4 11/16	22.56	22.85	23.14	23.44	23.73	24.02	24.32	24.61	24.90	25.20	25.49	25.78
4¾	22.86	23.16	23.45	23.75	24.05	24.34	24.64	24.94	25.23	25.53	25.83	26.13
4 13/16	23.16	23.46	23.76	24.06	24.36	24.66	24.96	25.27	25.57	25.87	26.17	26.47
4⅞	23.46	23.77	24.07	24.38	24.69	24.98	25.29	25.59	25.90	26.20	26.51	26.81
4 15/16	23.76	24.07	24.38	24.69	25.00	25.30	25.61	25.92	26.23	26.54	26.85	27.16
5	24.06	24.38	24.69	25.00	25.31	25.63	25.94	26.25	26.56	26.88	27.19	27.50

	5 9/16	5⅝	5 11/16	5¾	5 13/16	5⅞	5 15/16	6
3½	19.47	19.69	19.91	20.13	20.34	20.56	20.78	21.00
3 9/16	19.82	20.04	20.26	20.48	20.71	20.93	21.15	21.38
3⅝	20.16	20.39	20.62	20.84	21.07	21.30	21.52	21.75
3 11/16	20.51	20.74	20.97	21.20	21.43	21.66	21.89	22.13
3¾	20.87	21.09	21.33	21.56	21.80	22.03	22.27	23.50
3 13/16	21.21	21.45	21.68	21.92	22.16	22.40	22.64	22.88
3⅞	21.55	21.80	22.04	22.28	22.52	22.77	23.01	23.25
3 15/16	21.90	22.15	22.39	22.64	22.89	23.13	23.39	23.63
4	22.25	22.50	22.75	23.00	23.25	23.50	23.75	24.00
4 1/16	22.60	22.85	23.11	23.36	23.61	23.88	24.12	24.38
4⅛	22.95	23.20	23.46	23.72	23.98	24.23	24.49	24.75
4 3/16	23.19	23.45	23.72	23.98	24.24	24.50	24.76	25.13
4¼	23.64	23.91	24.17	24.44	24.70	24.97	25.23	25.50
4 5/16	23.99	24.26	24.53	24.80	25.07	25.34	25.61	25.88
4⅜	24.34	24.61	24.88	25.16	25.43	25.70	25.98	26.25
4 7/16	24.68	24.96	25.24	25.52	25.79	26.07	26.35	26.63
4½	25.03	25.31	25.59	25.88	26.16	26.44	26.72	27.00
4 9/16	25.38	25.66	25.95	26.23	26.52	26.80	27.09	27.38
4⅝	25.73	26.02	26.30	26.59	26.88	27.17	27.46	27.75
4 11/16	26.07	26.37	26.66	26.95	27.25	27.54	27.83	28.13
4¾	26.42	26.72	27.02	27.31	27.61	27.91	28.20	28.50
4 13/16	26.77	27.07	27.37	27.67	27.97	28.27	28.57	28.88
4⅞	27.12	27.42	27.73	28.03	28.34	28.64	28.95	29.25
4 15/16	27.46	27.77	28.08	28.39	28.70	29.01	29.32	29.63
5	27.81	28.13	28.44	28.75	29.06	29.38	29.69	30.00

TABLE No. 9—SAFE LOADS ON STAYBOLTS

Diameter in Inches Frac. Dec.	Threads: No. per inch U. S.	Threads: No. per inch Sharp V	Threads: Depth	Threads: Diam. at Root	Area: at Body	Area: Root of Thread	Safe Load at Stress of 4000 lbs.	4500 lbs.	5000 lbs.	5500 lbs	6000 lbs.	6500 lbs.	7000 lbs.	7500 lbs.	8000 lbs.	8500 lbs.	9000 lbs.
	13	..	.0500	.4001	0.196	0.126	504	567	630	693	756	819	882	945	1008	1071	1134
½" 0.50	..	10	.0866	.3268	0.196	0.084	336	378	420	462	504	546	588	630	672	714	756
	..	12	.07217	.3557	0.196	0.099	396	445	495	544	594	643	693	742	792	841	891
	11	..	.0590	.5069	0.307	0.202	808	909	1010	1111	1212	1313	1414	1515	1616	1717	1818
⅝" 0.625	..	10	.0866	.4518	0.307	0.160	640	720	800	880	960	1040	1120	1200	1280	1360	1440
	..	12	.07217	.4807	0.307	0.181	724	814	905	995	1086	1176	1267	1357	1448	1538	1629
	10	..	.0649	.6201	0.442	0.302	1208	1359	1510	1661	1812	1963	2114	2265	2416	2567	2718
¾" 0.75	..	10	.0866	.5767	0.442	0.261	1044	1174	1305	1435	1566	1696	1827	1957	2088	2218	2349
	..	12	.07217	.6057	0.442	0.288	1152	1296	1440	1584	1728	1872	2016	2160	2304	2448	2592
	9	..	.0722	.7307	0.601	0.420	1680	1890	2100	2310	2520	2730	2940	3150	3360	3570	3780
⅞" 0.875	..	10	.0866	.7018	0.601	0.387	1548	1741	1935	2128	2322	2515	2709	2902	3096	3289	3483
	..	12	.07217	.7307	0.601	0.419	1676	1885	2095	2304	2514	2723	2933	3142	3352	3561	3771
	8	..	.0812	.8376	0.785	0.550	2200	2475	2750	3025	3300	3575	3850	4125	4400	4675	4950
1" 1.00	..	10	.0866	.8268	0.785	0.537	2148	2416	2685	2953	3222	3490	3759	4027	4296	4564	4833
	..	12	.07217	.8557	0.785	0.575	2300	2575	2875	3162	3450	3737	4025	4312	4600	4887	5175
	7	..	.0928	.9394	0.994	0.694	2776	3123	3470	3817	4164	4511	4858	5205	5552	5899	6246
1⅛" 1.125	..	10	.0866	.9518	0.994	0.711	2844	3199	3555	3910	4266	4621	4977	5332	5688	6043	6399
	..	12	.07217	.9807	0.994	0.755	3020	3397	3775	4152	4530	4907	5285	5662	6040	6417	6795
	7	..	.0928	1.0644	1.227	0.893	3572	4018	4465	4911	5358	5804	6251	6697	7144	7590	8037
¼" 1.25	..	10	.0866	1.0768	1.227	0.911	3644	4099	4555	5010	5466	5921	6377	6832	7288	7743	8199
	..	12	.07217	1.1057	1.227	0.960	3840	4320	4800	5280	5760	6240	6720	7200	7680	8160	8640
	6	..	.1082	1.1585	1.485	1.057	4228	4756	5285	5813	6342	6870	7399	7927	8456	8984	9513
⅜ "1.375	..	10	.0866	1.2018	1.485	1.134	4536	5103	5670	6237	6804	7371	7938	8505	9072	9639	10206
	..	12	.07217	1.2307	1.485	1.189	4756	5350	5945	6539	7134	7728	8323	8917	9512	10106	10701
	6	..	.1082	1.2835	1.767	1.295	5180	5827	6475	7122	7770	8417	9065	9712	10360	11007	11655
½" 1.50	..	10	.0866	1.3268	1.767	1.383	5532	6223	6915	7606	8298	8989	9681	10372	11064	11755	12447
	..	12	.07217	1.3557	1.767	1.443	5772	6493	7215	7936	8658	9379	10101	10822	11544	12265	12987
	5½	..	.1180	1.3888	2.074	1.515	6060	6817	7575	8332	9090	9847	10605	11362	12120	12877	13635
⅝" 1.625	..	10	.0866	1.4518	2.074	1.655	6620	7447	8275	9102	9930	10757	11585	12412	13240	14067	14895
	..	12	.07217	1.4807	2.074	1.722	6888	7749	8610	9471	10332	11193	12054	12915	13776	14637	15498
	5	..	.1299	1.4902	2.405	1.746	6984	7857	8730	9603	10476	11349	12222	13095	13968	14841	15714
1¾" 1.75	..	10	.0866	1.5768	2.405	1.953	7812	8788	9765	10741	11718	12694	13671	14647	15624	16600	17577
	..	12	.07217	1.6057	2.405	2.025	8100	9112	10125	11137	12150	13162	14175	15187	16200	17212	18225
	5	..	.1299	1.6152	2.761	2.051	8204	9229	10255	11280	12306	13331	14257	15382	16408	17433	18459
1⅞" 1.875	..	10	.0866	1.7018	2.761	2.275	9100	10237	11375	12512	13650	14787	15925	17062	18200	19337	20475
	..	12	.07217	1.7307	2.761	2.352	9408	10584	11760	12936	14112	15288	16464	17640	18816	19992	21168
	4½	..	.1443	1.7113	3.142	2.302	9208	10359	11510	12661	13812	14963	16114	17265	18416	19567	20718
2" 2.00	..	10	.0866	1.8268	3.142	2.621	10484	11794	13105	14415	15726	17036	18347	19657	20968	22278	23589
	..	12	.07217	1.8557	3.142	2.704	10816	12168	13520	14872	16224	17576	18928	20280	21632	22984	24336

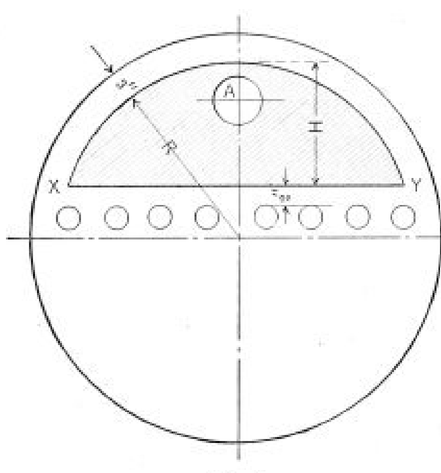


Fig. 2

Fig. 3 represents the actual conditions that exist in the firebox; that is, the actual area supported by one stay is $(a)^2$ minus the area of stay. The general method is, however, to consider the area as represented by Fig. 4, or equivalent to $(b)^2$, disregarding the area of the stay.

Table No. 8 covers the area of surfaces supported by staybolts for a range of pitches from 3½ inches by 3½ inches to 5 inches by 6 inches, and is a convenient table for calculating the stress in staybolts. The telltale hole in the outer end of the staybolt, while actually decreasing the net sectional area of the stay, has been generally disregarded; however, it will be noted from the following that the rules recently adopted by the Master Mechanics'

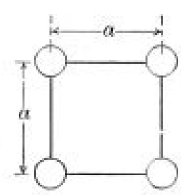


Fig. 3

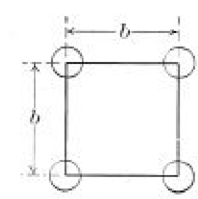


Fig. 4

TABLE No. 10—DATA ON BOILER STAYS—12 THREADS PER INCH.

Diameter Over Thread	Diam. at Root of Thread in Inches: "V" Thread	U. S. Thread	Whitworth Thread	Area in Sq. In. at Root of Thread: "V" Thread.	U. S. Thread	Whitworth Thread	Depth of Thread in Inches: "V" Thread	U. S. Thread	Whitworth Thread	Area Reduced Section in sq. In.: ⅛" Less in Diam.	3/16" Less in Diam.	Area at Body of American Staybolt
⅞	.7306	.7668	.7683	.4193	.4618	.4637	.07217	.05412	.05336	.4418	.3712	
15/16	.7932	.8293	.8308	.4941	.5401	.5421	.07217	.05412	.05336	.5185	.4418	.4418
1"	.8557	.8918	.8933	.5750	.6246	.6267	.07217	.05412	.05336	.6013	.5185	.5185
1 1/16"	.9182	.9543	.9558	.6622	.7152	.7175	.07217	.05412	.05336	.6903	.6013	.6013
1⅛"	.9807	1.0168	1.0183	.7558	.8120	.8144	.07217	.05412	.05336	.7854	.6903	.6903
1 3/16"	1.0432	1.0793	1.0808	.8547	.9148	.9173	.07217	.05412	.05336	.8866	.7854	.7854

Diameter at Root of Thread

"V" $= D - (P \times 1.732) = D - .1443$

U. S. $= D - (P \times 1.299) = D - .1082$

Whitworth $= D - (P \times 1.2807) = D - .1067$

$D =$ outside diameter,

$$P = \text{pitch} = \frac{1}{\text{No. threads per inch}}$$

Depth of Thread

"V" $= P \times .8660$

U. S. $= P \times .6495$

Whitworth $= P \times .6403$

Are Fire Box Sheets Welded With The Oxwelding Process Efficient?

Answer:

The tensile strength of a single lap riveted seam is approximately 52% to 60% of the strength of the metal itself.

By tests, it has been proven that the tensile strength of a seam welded by the Oxwelding Process is from 80% to 85% of the metal itself.

Why not submit your boiler repair problems to our staff of experts, who are constantly in touch with the application of the Oxwelding Process to the special needs of the steam railroad field?

OXWELD RAILROAD SERVICE COMPANY

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TABLE NO. 11—AREA OF SEGMENT TO BE STAYED IN BOILERS OF DIFFERENT DIAMETERS

Height from Tubes to Shell.	Area to be stayed, in Sq. In.												
	24″	30″	36″	42″	48″	54″	60″	66″	72″	78″	84″	90″	96″
8″..........	28	33	37	40	43	47	51	53	55	58	60	63	65
8½″........	35	41	46	51	55	59	63	66	72	74	76	80	82
9″..........	42	49	56	62	67	72	76	82	86	90	92	95	98
9½″........	50	58	66	70	80	86	91	96	101	105	111	116	119
10″..........	57	68	77	85	93	99	106	112	117	123	129	132	137
10½″........	66	78	89	98	107	114	123	131	135	142	147	155	160
11″..........	74	88	100	111	121	130	138	147	155	161	169	174	183
11½″........	83	99	112	124	137	146	156	165	173	181	189	196	204
12″..........	91	109	125	139	151	163	174	184	194	203	213	219	230
12½″........		120	138	153	167	180	193	204	216	224	234	243	252
13″..........		132	151	168	183	197	211	224	235	247	256	267	279
13½″........		143	164	183	200	216	230	246	258	270	282	293	302
14″..........		155	178	199	217	234	250	266	280	294	305	319	331
14½″........		167	192	215	235	254	271	287	303	318	333	345	360
15″..........		178	206	231	252	273	291	309	326	343	357	372	386
15½″........			220	247	271	291	312	332	350	368	382	400	417
16″..........			235	263	289	312	334	355	374	394	411	423	443
16½″........			249	281	308	332	357	380	399	420	436	457	475
17″..........			264	297	326	353	378	402	425	447	467	487	502
17½″........				314	345	374	400	426	449	471	494	516	536
18″..........				331	365	396	424	450	476	500	520	543	564
18½″........				349	384	417	448	476	501	526	552	577	598
19″..........				366	404	439	470	500	529	555	580	604	631
19½″........				384	424	461	496	528	558	584	613	641	663
20″..........				401	444	483	519	552	583	613	642	667	699
20½″........					464	505	543	578	613	643	675	706	729
21″..........					485	528	568	604	640	673	705	733	766
21½″........					505	551	594	632	669	703	739	766	797
22″..........					526	574	618	658	697	734	769	800	835
22½″........						597	643	687	726	765	800	835	867
23″..........						620	668	713	754	796	830	869	906
23½″........						642	695	740	784	827	866	904	945
24″..........						667	719	768	814	859	897	939	978
24½″........						689	745	797	843	892	934	975	1,018
25″..........						714	771	825	875	922	966	1,010	1,051
25½″........						737	798	855	907	956	1,003	1,047	1,092
26″..........						761	824	882	936	987	1,035	1 083	1,126
26½″........							850	909	968	1,024	1,073	1,120	1,167
27″..........							877	939	998	1,053	1,106	1,157	1,202
27½″........							904	968	1,030	1,089	1,145	1,195	1,243
28″..........							930	997	1,060	1,120	1,177	1,232	1,279
28½″........								1,028	1,092	1,157	1,211	1,270	1,321
29″..........								1,056	1,123	1,187	1,248	1,305	1,360
29½″........								1,084	1,155	1,221	1,284	1,347	1,400
30″..........								1,115	1,187	1,255	1,321	1,382	1,442
30½″........									1,218	1,290	1,358	1,424	1,480
31″..........									1,252	1,324	1,394	1,459	1,523
31½″........									1,286	1,359	1,433	1,496	1,561
32″..........									1,317	1,394	1,467	1,538	1,605
32½″........										1,430	1,508	1,575	1,650
33″..........										1,465	1,542	1,617	1,687
33½″........										1,500	1,578	1,655	1,733
34″..........										1,536	1,617	1,695	1,770
34½″........											1,654	1,735	1,816
35″..........											1,692	1,775	1,856
35½″........												1,810	1,900
36″..........												1,857	1.941
36½″........													1,984
37″..........													2,026

Association provide for the area of the telltale hole and the area of one staybolt in four is considered. This will, of course, affect the stress in the staybolts and will give a slight increase in the stress.

(a) In figuring the net area of staybolts to obtain the stress, the area of the telltale hole shall be deducted.

(b) When figuring area at root of thread, the area must depend upon the type of thread used; namely, United States, "V" or Whitworth threads, as the case may be.

(c) In determining the area for figuring stress on staybolts, the area of one staybolt shall be deducted from the rectangular area included between any four staybolts.

The Whitworth (or English) screw thread is now being used quite extensively on firebox staybolts. The difference between the Whitworth and the "V" thread is well known, the Whitworth thread having a radius at the top and at the root of the thread, while the "V" thread is sharp at the top and root. The angle of the Whitworth thread is 55 degrees, while that of the "V" is 60 degrees. The relative strength and life of staybolts, provided with either of the two threads mentioned, has been determined through tests, and the following table represents the results obtained. In a vibration test, each bolt was screwed and riveted in a ½-inch steel plate in the same manner as staybolts are secured to the boiler. Each bolt was given a vibration of ⅜ inch; the average number of vibrations withstood by the "V" thread bolt was 1,485, while the average for the Whitworth thread staybolt was 3,437. In a second series of tests, each bolt was given 10,500 vibrations through an arc of 3/16 inch, and then vibrated to destruction through an arc of ⅜ inch. In this case the "V" thread staybolt averaged 791 additional vibrations, while the Whitworth thread staybolt failed at 1,932 vibrations. One very noticeable feature of the test was that the Whitworth thread staybolts held on to the sheets much tighter than the "V" thread bolt, and also showed no tendency to cut into the sheet.

BOILER STAYBOLT TEST

Thread	Diam. of bolt.	Area in inches.	Breaking Strain in lbs.	Strain per sq. in.	Original length inches.	Percent of elongation in length of section.
Sharp "V".....	0.880	0.608	32,100	52,870	8	20.5
	0.881	0.610	32,910	53,960	8	15.7
	0.879	0.607	31,140	51,310	8	19.0
Average.......			32,063	52,713	8	18.4
Whitworth....	0.882	0.611	33,060	54,120	8	27.5
	0.889	0.621	33,040	53,210	8	27.75
	0.887	0.618	33,080	53,540	8	27.25
Average.			32,060	52,623	8	27.50

Bending tests were also made, and in these the "V" thread failed when bent over a 3-inch circle, while the Whitworth thread bolt withstood a bending over a 2-inch circle, but failed when bent over a 1⅞-inch diameter.

(*Concluded on page 84.*)

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NOTICE TO ADVERTISERS

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 25th of the month, to insure the carrying out of such instructions in the issue of the month following.

The locomotive boiler with a watertube firebox, described elsewhere in this issue, is of interest not only on account of the novel form of its construction, giving a boiler with an increased amount of heating surface in the firebox, but also because it will give an opportunity to determine from actual practice whether this type of construction will tend to reduce the troubles and large amount of repair work commonly necessary in the fireboxes of locomotive boilers.

From the description of the boiler, it will be seen that the firebox is composed of a large mud ring from which, on the sides and back, 6-inch tubes spaced close together lead to three steam drums which form the top of the firebox. The large tubes which form the sides and back of the firebox are separated by approximately 1/15 inch to allow for expansion of the tubes. The back head tubes slope to a considerable degree and the back corners are formed by welding two of the sloping tubes to the back side tube. It was found that without the process of welding this form of construction would have been practically impossible.

This boiler is not only equipped with a watertube firebox, but also with a deep combustion chamber and a superheater. Except for the firebox, the boiler is of the regular locomotive type, and the two boilers built from this design by the American Locomotive Company were the last two boilers in an order of twenty-five Mikado locomotives for the New York, New Haven & Hartford Company's freight service. There will therefore be a splendid opportunity to determine the actual advantages of this type of construction as compared with the regular form of locomotive boiler from service records.

Boiler manufacturers who intend to export steam boilers to China should take the advantage of the experience of one American boiler manufacturing firm in filling an order cabled from Changsha for two boilers.

These boilers were desired for use in an interior plant some distance from Changsha, but no information was given to the manufacturer as to difficulties which might be experienced in transporting the boilers to the interior of China. The American firm promptly filled the order and in due time the boilers reached Changsha, where they were loaded on junks and started for their destination, a point some distance from any river, in the hills. When the junks reached the place of unloading, it was discovered that it would be impossible to transport the two heavy boilers over land to their destination, as in this locality the only available roads were narrow footpaths; consequently, the boilers were taken back to Changsha and were sold to other purchasers. At the same time, it was necessary to send another order to the American firm for duplicate boilers, but this time they were ordered to ship the boilers knocked down.

This incident illustrated the advantages of an intimate knowledge of the country in which the manufacturer intends to develop a market for export. There is little doubt that a splendid opportunity for exporting machinery is awaiting American manufacturers in the Far East, if proper methods are taken to develop this trade.

The American Institute of Steam Boiler Inspectors of New York City held its seventh annual banquet on Saturday evening, February 24, at the Marlborough Hotel, New York. It was attended by more than one hundred members and guests, and for the number in attendance and excellence of the entertainment, under the skillful guidance of M. Fogarty as toastmaster, the occasion surpassed all previous social sessions of the organization. Addresses were made by T. T. Parker, president, and L. A. Turnbull, the retiring president, who was presented with a gold enameled badge bearing the emblem of the Institute. Short addresses were made also by Dr. D. S. Jacobus, of the Babcock & Wilcox Company, Col. F. W. Bigelow, of the Bigelow Company, Franklin Van Winkle of *Power*, W. S. Wilding, of the International Filter Company, Messrs. T. G. Ranton and A. Oldfield, of the Boston Institute of Steam Boiler Inspectors, G. E. Lanagan, Examiner of the Police Department Boiler Squad, and other speakers. President Parker extended a cordial invitation to all those present to attend the next regular monthly meeting of the Institute, which will be held at the Engineering Societies' Building, 29 West Thirty-ninth street, New York, Friday evening, March 30.

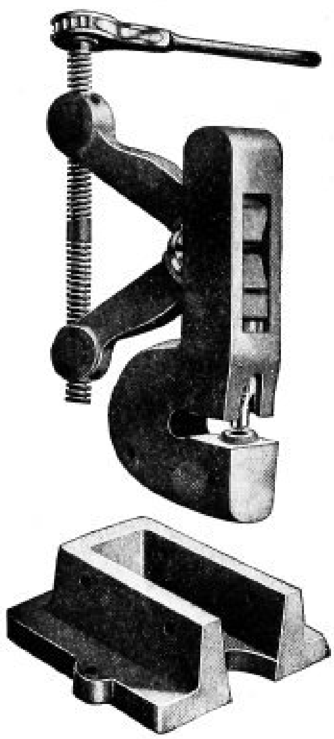
Engineering Specialties for Boiler Making

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

Gunnell Screw Punch

The Gunnell screw punch, shown in the illustration, which is manufactured by the Manitowoc Engineering Works, Manitowoc, Wis., is of the toggle joint type, made of all forge steel and weighs but 60 pounds.

The punch can be made stationary by placing it in a base, and it can be made a power punch by using a re-

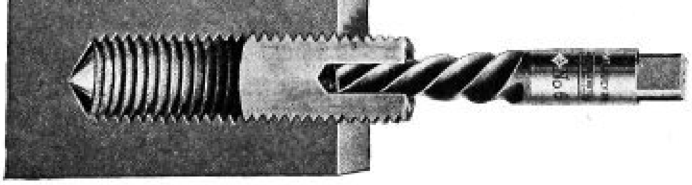


Gunnell Screw Punch

versible air drill in place of the ratchet handle. It can be used on work high in the air or in the shop, and due to its compactness is easily carried about from place to place. It has a capacity up to three-eighths inch thick.

Broken-Screw Extractor

One of the most ingenious and useful, but simple, tools made in recent years is the "Ezy-out" extractor for broken stud bolts, set screws, etc., just announced by the Cleveland Twist Drill Company, Cleveland, Ohio. As shown in the accompanying sketch, a hole is bored in the shank of the broken screw and the tool is stuck in and twisted left hand. The left-hand, coarse, helical threads of the tool grip the sides of the bored hole and back out the

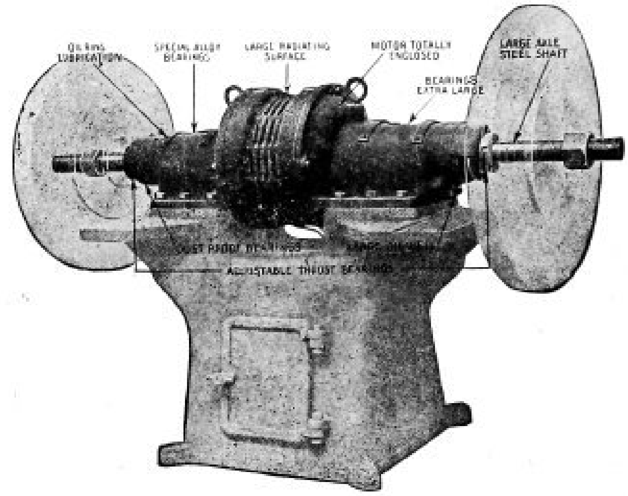


Sectional View, Showing Application of "Ezy-Out" Screw Extractor

old screw. A set of "Ezy-outs" consists of three tools of different sizes, which it has been found will meet the requirements of an ordinary shop or contractor.

Westinghouse Alternating Current Grinder Motor

The grinder motor illustrated, recently placed on the market by the Westinghouse Electric and Manufacturing Company, of East Pittsburg, Pa., is designed for use on two- and three-cycle, alternating-current circuits and is constructed especially to meet the severe conditions to which such motors are subjected in grinding and polishing work. This grinder motor is obtainable in three sizes,



Westinghouse Grinder Motor

having capacities of 5 horsepower, 7½ horsepower and 10 horsepower, respectively. The 7½ and 10 horsepower, two-phase motors are supplied with auto starters. For the 5 horsepower, two- and three-phase motors an ordinary knife switch is employed, and a special starting switch for the 7½ two- and three-phase motors pedestal bases, grinding wheels, and tool rests are furnished by the tool manufacturer.

To protect all parts against wear and injury from grit and metallic dust, the bearings are made dustproof, and the motor is wholly enclosed. Large radiating surface is provided, however. The end brackets are solid and are cast integral with the feet, which are extra heavy and arranged so that they can be bolted rigidly to the pedestal.

The heavy grinding wheels with which these motors are designed to be used put a great strain on the shaft and bearings. These parts are therefore made extremely strong and rugged. The shaft, which is made of axle steel, is of extra large diameter, and is extended at both ends to receive the grinding wheels. The bearings, which are the only wearing parts on the whole motor, have very large bearing surfaces, insuring long life. Each is thoroughly lubricated by two oil rings. The end thrust is taken up by adjustable collars.

The rotor of the motor, which is of the squirrel cage form, cannot be damaged. There are no moving contacts. The rotor bars are firmly fastened in the iron core and are short circuited by end rings. No bolts or screws are used, and there is nothing about the rotor that can work loose, even under the most severe service, or that will deteriorate under heat. The stator winding is thoroughly treated with moisture-resisting varnish. In motors larger than 5 horsepower the winding consists of coils wound on forms and completely insulated, then laid in the open stator slots and securely held in place by means of wedges.

Improved Industrial Type Oil Switch

This improved type of oil switch is used extensively in industrial establishments to control and protect induction motors up to 2,500 volts and 300 amperes. It can be mounted on a wall, post or other vertical flat surface, or by means of suitable supports on the machine operated by the motor. The switch is made by the General Electric Company, Schenectady, N. Y., in both non-automatic and automatic forms; the first simply to start and stop the motor, and the second to cut off current from the motor automatically on the occurrence of an overload greater than that for which the overload trip is set.

Through a recent improvement in the design of the mechanism, a low-voltage trip can be added to the automatic switch as an attachment at any time. To the non-automatic switch, either a low-voltage trip or a series-overload trip, or both, can be added whenever desired. Both means of tripping are mounted inside the switch cover.

Up to 550 volts (except on 110 volt, 60-cycle circuits, where the trip coil only is sufficient), an auto-transformer is used in place of the resistance previously required in series with the low voltage tripping coil. This transformer has taps to which proper connections can be made for the operating voltage. For 2,200 volt circuits, a new type voltage transformer replaces the transformer and series resistance used heretofore. The use of the new auto-transformer, or voltage transformer, makes the watt loss in the low-voltage device practically negligible.

On the switch with the time limit overload trip, the calibrating tubes and dash pots are protected from injury by a cast iron guard which has been added to the equipment.

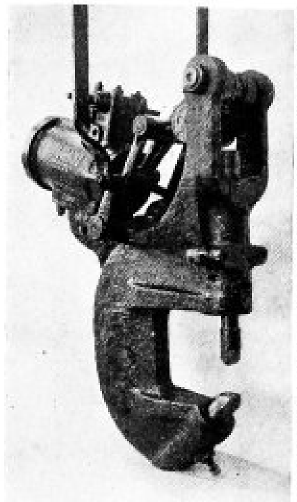
Switches can also be furnished with covers arranged to mount a round pattern ammeter and provide, in addition to control and protection, a means of knowing at all times the amount of current being taken by the motor. This gives a continual indication of the motor load and the opportunity to detect trouble in the motor or its circuit.

New Hanna Riveting Machine

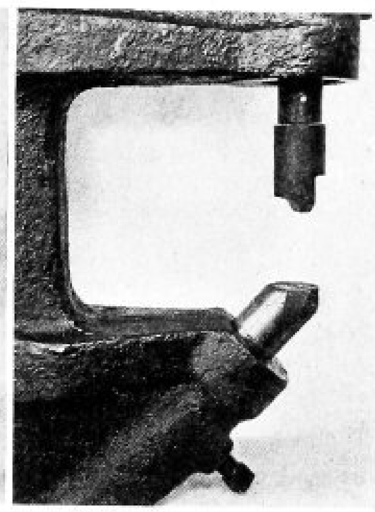
The Vulcan Engineering Sales Company, Chicago, Ill., has placed on the market a new riveting machine, manufactured by the Hanna Engineering Works, for operating in sections where the space is limited, as shown in the illustrations. The lower stake or nose of the machine is removable and can be shaped to any form of base adapted to the work that is being handled.

A combination of toggles, levers and guide links is employed to give a large opening of the toggle joint movement with a gradual increase in the amount of pressure applied, until the desired amount is secured, followed by a simple lever movement through a considerable space under approximately the maximum pressure of the machine. This toggle action takes place while the piston is traveling through the first half of its stroke and the die covers the greater portion of its travel in that time. The die completes its stroke in the time required for the piston to travel the rest of the way, this amount being relatively quite small, but enough, it is claimed, to eliminate any uncertainty regarding the pressure applied to the rivets.

The change in the mechanism from that of a toggle to that of a lever is accomplished automatically without a critical point. As the rate of maximum pressure is exerted through a relatively large space, the necessity for adjustment to take care of ordinary variations in rivet



New Hanna Riveting Machine



The Punch and Stake

length, diameter or hole or thickness of plate is done away with after the machine has once been set. This whole movement, the manufacturers claim, also gives the metal in the rivet time to flow and fill the hole, in addition to giving an opportunity for the rivet to set, prior to releasing of the pressure on the return stroke of the die.

McGraw and Hill Publishing Companies Consolidate

The McGraw Publishing Company, Inc., and the Hill Publishing Company, New York, have been consolidated as the McGraw-Hill Publishing Company, Inc. The new company acquires all the properties and interests of the two constituents, including the following technical journals: *Electrical World, Electrical Railway Journal, Electrical Merchandising, Engineering Record, Metallurgical and Chemical Engineering, The Contractor, American Machinist, Power, Engineering News, Engineering and Mining Journal,* and *Coal Age.*

Two of these papers, *Engineering News* and *Engineering Record,* will be consolidated under the name *Engineering News-Record,* with Mr. Charles Whiting Baker, now editor of *Engineering News,* as editor-in-chief.

Mr. James H. McGraw will be president of the new company; Mr. Arthur J. Baldwin (now president of the Hill Publishing Company), vice-president and treasurer, and Mr. E. J. Mehren (formerly editor of *Engineering Record*), vice-president and general manager.

PERSONAL

S. E. Westover, formerly foreman boiler maker of the Oregon-Washington Railroad & Navigation Company, has accepted a position as superintendent of boiler construction for the Willamette Iron & Steel Company, Portland, Ore.

Charles B. Rearick, manager of sales for the Covington Machine Company, Covington, Va., has been made vice president and manager of the company.

Questions and Answers for Boiler Makers

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

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

Address your communication to the Editor of the Question and Answer Department of The Boiler Maker, 461 *Eighth avenue, New York city.*

Safety Valves

Q.—From equations 2 and 3 given on page 107 of the A. S. M. E. Code, please work out examples accordingly? J. H.

A.—To answer this question it is advisable to give herewith Paragraph 421 of the Code that refers to the method of computing Table 8. This table is in the A. S. M. E. code book.

(421) *Method of Computing Table* 8. The discharge capacity of a safety valve is expressed in equations 2 and 3 as the product of C and H. The discharge capacities are given in Table 8 for each valve size at the pressures shown and are calculated for various valve sizes, pressures and for three different lifts. The discharge capacities are proportional to the lifts, so that intermediate values may be obtained from the table by interpolation:

C = total weight or volume of fuel of any kind burned per hour at time of maximum forcing, pound or cubic feet,
H = the heat of combustion, B. T. U. per pound or cubic feet of fuel used,
D = diameter of valve seat, inches,
L = vertical lift of valve disk, inches, measured immediately after the sudden lift due to the pop.
P = absolute boiler pressure or gage pressure plus 14.7 pounds per square inch,
1100 = the number of B. T. U. required to change a pound of feed water at 100 degrees F. into a pound of steam.

The boiler efficiency is assumed as 75 percent.

The coefficient of discharge, in Napier's formula, is taken as 96 percent.

$$\frac{C \times H \times 0.75}{1100 \times 3600} = \frac{3.1416 \times D \times L \times 0.707 \times P \times 0.96}{70}$$ for valve with 45-degree seat. (1)

$$CH = 160{,}856 \times P \times D \times L$$ for valve with bevel seat at 45 degrees. (2)

$$CH = 227{,}487 \times P \times D \times L$$ for valve with flat seat at 90 degrees. (3)

To illustrate the application or use of equation 2, certain values will be assumed.

Example.—A tubular boiler operated at a pressure of 175 pounds uses at the maximum rate 2,000 pounds of bituminous coal, having a heat value of 12,500 B. T. U. per pound. Find, accordingly, the required lift and number of 3-inch bevel-seated safety valves that would discharge the steam generated. In equation 2, $CH = 160{,}856 \times P \times D \times L$. Substituting values in the equation and transposing the value 160,856, it is evident that

$$\frac{2000 \times 12{,}500}{160{,}856} = 175 \times 3 \times L.$$

To find the value of L, transpose the value 174×3 in the preceding equation and we have

$$L = \frac{2000 \times 12{,}500}{160{,}856 \times 175 \times 3} = .30 \text{ inch nearly.}$$

The A. S. M. E. Code states specifically that the maximum lift of a pop safety valve shall not exceed .15 inch, and that no valve shall be less than 1 inch or more than 4½ inches nominal diameter measured in at the inner edge of the valve seat.

As L for one 3-inch bevel-seated valve is found in this example to be too great, it is necessary in order to meet the requirements of the Code to provide a sufficient number of valves of the proper size and lifts that will discharge the steam generated. The discharge capacities of safety valves being proportional to the lifts, it is evident that the two 3-inch valves, each with a .15-inch lift, or three 3-inch valves each with a .10-inch lift, would discharge the steam generated.

To find any unknown value in equations 2 or 3 when the other values are known, simply transpose values similar to the method just explained.

Table 8 in the Code was compiled according to equations 2 and 3, to give immediate data on the safety valve problems.

Replacing Worn Tires

Q.—Will you kindly inform me of the best way to change worn out tires on locomotive drive wheels? Please give full details as to how much to allow for shrinkage and how hot the tire should be heated and handled away from the shop? O. P.

A.—In making such repairs, suitable rigging must be employed in order to jack and block up the engine. The driving rods, boxes, etc., are removed in order to take the

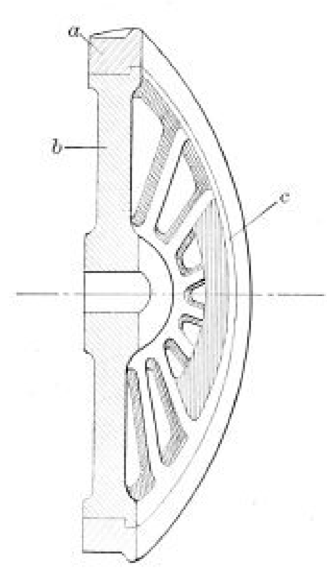


Fig. 1

wheel off and place it in a convenient position for heating the worn tire. Gas flames arranged in the form of a circle are usually employed to heat the tire uniformly. After it has expanded sufficiently, it is removed from the cast iron core. The new tire is then heated until it is expanded enough to slip over the core of the wheel. It is then allowed to cool, thus causing it to contract and bind firmly to the core.

In Fig. 1 is shown one of the many types of cast iron cores, and tires used for locomotive drive wheels. The tire a being bored a trifle smaller in diameter than the core b, must be expanded as already explained in order to be shrunk on. Proper allowances must be made for shrinkage. The following table gives the allowances adopted by the American Railway Master Mechanics for shrinkage of tires.

Inside Diameter of Tire—Inches	Allowance in Inches
38	.04
44	.047
50	.053
56	.06
62	.066
66	.07

The above is based upon an allowance of about .0125 inch per foot diameter.

Tires need not be heated any hotter than a blue heat, which is sufficient to expand them. It is not customary practice to remove worn or broken tires on the road. If the trouble arises on the road, the engine is blocked up to remove the pressure on the wheel, and then towed into the shop, where suitable rigging and equipment is at hand for handling such work.

Method of Testing Oil Tanks and Renewing Rivets

Q.—1. Which is the proper way to test an oil tank having ½-inch or ⅝-inch rivets driven with a riveting hammer; calking all seams and rivets dry before the water test or calking up the seams, applying the water test and then calking the rivets?

(2) Which is the best way to drive ½-inch or ⅝-inch rivets in oil tanks where there are only a few rivets renewed?

(3) Is it all right to back them in on tanks haing ¼-inch shell?

TEST.

A. (1) Calk the seams before applying the water test, then fill the tank with water and calk leaky rivets and seams. In tank work the rivets should be larger in diameter and placed closer together than for corresponding plate thicknesses in boiler work. Well-driven rivets with all seams properly laid up and calked should be the aim in order to insure tight seams.

(2) Back them in, forming a flat head on the inside.

(3) Yes.

Acetylene Welding

Q.—The Inspection Department of Steam Boilers for the Province of Ontario has refused to accept the welding of tubes for firetube boilers by the acetylene process. Is there any reason that boiler tubes welded by the acetylene or similar process would not be as strong as when welded by machinery? This method is used in the welding of fireboxes of boilers, and we do not quite see if it is suitable for this work why it would not be suitable for the welding of boiler tubes. P.

A.—By the acetylene process it is practically impossible to produce welds that have the same chemical properties as the original metal. Even if the greatest care is taken in making such welds, oxidation of the metal cannot be entirely prevented. Practical tests under the most favorable conditions have been made to determine the reliability of such welds. These tests showed changes in the quality of the metal from the original, and that these changes not only take place in the joint, but also in the zone of metal directly adjoining the weld. Good welded joints by this process should show tensile strength of about 80 per cent of that of the original plate. Such welds can be made with a high tensile strength, but when subjected to ordinary working conditions the material at the weld is liable to fail from the repeated shocks and vibrations that the boiler is subjected to. It, therefore, seems advisable to exercise extreme caution in the use of the autogenous process in all cases where boiler parts are to be placed under heavy stress, also because there are no means presentable in such joints, except by destructive tests, of determining definitely whether the weld is good or poor. It is owing to the uncertainty of the good quality of the welds that some countries prohibit its use in welding boilers or boiler parts. This process of welding, however, is of considerable value in boiler construction, especially for parts that are not placed under severe and sudden shocks.

In welding a joint by either the electric or acetylene methods, expansion and contraction stresses are set up in the weld, due to the heating and cooling of the plate. These stresses cause strains that may injure the weld. To relieve such strains it is necessary to anneal the work, which is practically impossible in most cases in boiler work.

The factors entering into the production of good welded joints, being the *proper grade of material* and *first-class workmanship*, it follows that if either of these prove not up to proper standard that welds accordingly made are not desirable in high pressure boiler work.

Lining Up a New Boiler

Q.—Will you please give a full description of the best way of lining up a new boiler? F. S.

A.—As the correspondent does not state what type of boiler, we will assume in this case that a tubular boiler is to be lined up, so as to have the courses parallel, and

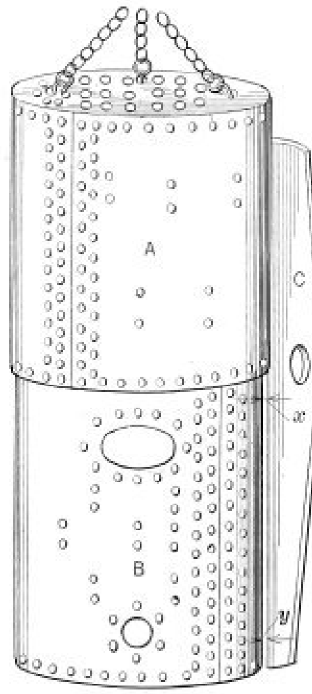


Fig. 2

also to place in position a steam nozzle for marking it off. Referring to Fig. 2, is shown two courses *A* and *B*, with the head riveted to course *A*. Preparatory to suspending the boiler by an overhead crane, the two shell courses are first fitted and then bolted together in several places. The shells are then suspended by a crane so

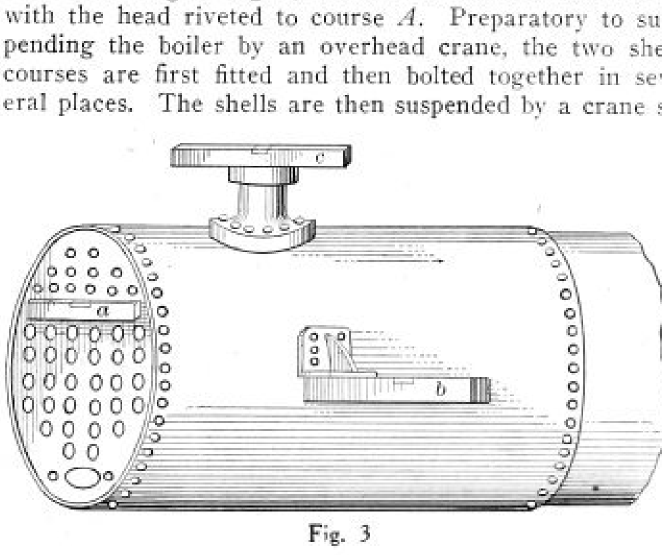


Fig. 3

that they are perpendicular to the floor. By means of the straight edge *C*, each quarter of the shells is tested, and if the distances *x* and *y* between the two courses are the same at each quarter, the courses *A* and *B* are in line or straight.

In Fig. 3 is shown the method of testing whether the flues, brackets and fittings are in proper alignment. If the boiler is properly laid out and fitted together, these details will be level, and as would be indicated by the readings of the spirit level when placed in the positions *a*, *b* and *c*, which would be alike at these points.

Planing and Rolling Plates for Butt Joints

Q.—Should the edges of plates forming a butt joint be beveled? How should the butt straps be formed? BUTT.

A.—The edges of plates for butt joints should be planed straight, so that they will butt fair as shown in Fig. 4 along the line *x-x*. If the stretch-out for the shell

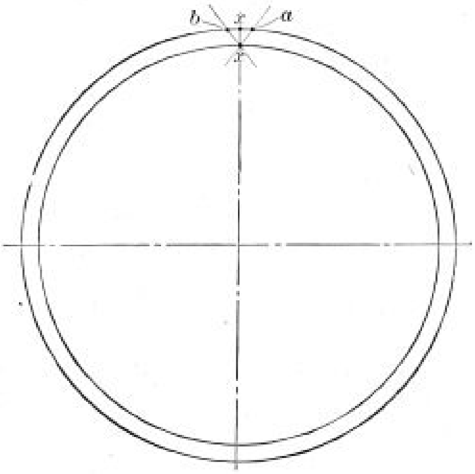


Fig. 4

course is correctly made and the operations in rolling properly done, the ends of the plate will butt together. The gap between the edges of the plate *a-x* and *x-b*, which you claim arises if no allowance is made for bevel, is no doubt due to a short plate length or stretch-out. A plate rolled to a cylindrical form is affected by the rolling process, the outside of the plate stretches while the inside gathers. If the stretch-out of a shell is figured from its inside diameter and no allowance made for the gather,

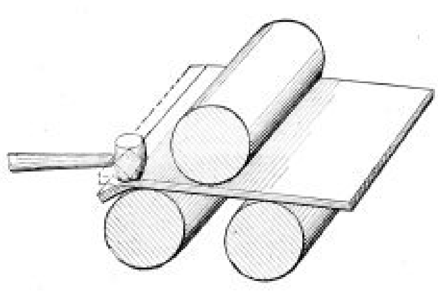


Fig. 5

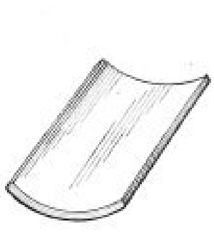


Fig. 6

the edges of the plate will not meet at all, providing it is rolled to the proper sweep, but if the shell is forced together, the bottom edges of plate will butt, leaving a gap between the upper edges, as in Fig. 4. By figuring the plate lengths for heavy boiler work from the neutral layer of the plate, sufficient allowance is made to take care of the change in plate length or "take up."

3.1416 × the neutral diameter = required stretch-out.

Example.—A boiler shell made with butt joints and of ½-inch plate is to be rolled to a 48-inch inside diameter; find the required stretch-out.

Neutral diameter equals $48 + \frac{1}{2} = 48\frac{1}{2}$ inches. $3.1416 \times 48\frac{1}{2} = 152\frac{3}{8}$ inches.

Before rolling the plate the sheet should be bent at both ends as shown in Fig. 5. This may be quickly done by running the plate into the rolls and hammering down a short length to the required curvature with the use of sledges. Then when the plate is passed through the rolls two or three times to the required sweep, it should be practically a cylindrical form. However, it may require a little *rounding up* after it is taken out of the rolls. Another way of producing curved ends in heavy plate work is to employ a heavy sheet, Fig. 6, that is bent to the required curvature. After the plate for the shell has been rolled to the required sweep, it is taken from the rolls and the plate as shown in Fig. 6 is placed on the two bottom rolls with the curved side up. The shell is afterwards placed in position again for rolling. By passing the ends through the rolls back and forth several times a distance from 20 to 30 inches, they will take the same curvature as the other part of the shell. Unless the ends of shell plates are bent to the same radius as the shell, the joints cannot be properly made.

Volatile Matter in Fuel

Q.—(1) I would like to have you explain what is meant by total amount of volatile matter (25 percent); also the heat of volatile matter? (2) Explain this statement, "Air temperature 70 degrees, humidity of the air entering boiler room 60 percent." Is the remaining percent of water vapor? Does the humidity of air increase or decrease as the temperature rises?
(3) In what way does radiation differ from conduction? Take the tubular bricked-in boiler and the internally fired boiler. B. E. D.

A.—(1) Volatile matter arising in the combustion of coal may be divided into two classes: namely, *combustible* and *non-combustible* substances.

The substances in the first class are driven off from heated coal in the form of gases and some as vapors, as coal tar, naphtha, etc. The amount of volatile matter in coal depends upon its composition. The nature of the combustible gases, so important in the generation of steam, and that of the non-combustible elements, vary with elements of the coal and the conditions under which the coal is burned. The term 25 percent volatile matter expresses the amount of vapor and gases taken off from coal that is heated in a closed vessel free from the action of the atmosphere. The remaining 75 percent of the coal are ash, moisture and fixed carbon.

A very high furnace temperature is needed to burn successfully the combustible volatile substances. Owing to the rapid absorption of heat by the plates in contact with the water, the temperature of the furnace rarely reaches over 2,500 degrees F. It is estimated that firebox temperatures should range between 1,800 to 2,500 degrees F.

(2) Degrees of heat and cold are measures of temperature. The temperature of a body, of the air, etc., indicates how hot or cold they are. The measures of heat and cold temperatures are made by means of a thermometer. The thermometer graduated according to the Fahrenheit scale is employed in this country, while the Centigrade thermometer is generally used by scientists.

The statement, "Air temperature, 70 degrees, humidity of the air entering the boiler, 60 percent," means that the condition of the air coming into the boiler room measures as to its temperature 70 degrees, and that the quantity of water vapor in the air commonly called *humidity* is 60 percent. When expressed in percentage, as the ratio of the quantity of moisture in the air to the quantity of moisture that it could contain under the same atmosphere conditions as to pressure and temperature, is termed relative humidity. Hence 60 percent humidity at a temperature of 70 degrees means 60 percent of the complete saturation of the air with moisture at a temperature of 70 degrees. The percentage of moisture or humidity increases per unit of volume with the temperature. One cubic foot of air at 70 degrees temperature will hold 8 grains of moisture, while at 32 degrees it holds 2 grains, and at zero but 0.5 grain.

(3) Heat that is transmitted through space is said to be *radiated,* while heat that passes through solids is conducted. Heat transmitted directly from a hot body to a colder one, as for example a person standing a short distance from a heated forge, feels the warmth from the fire, but which is not due to the temperature of the air, the air being penetrated by the heat without raising its temperature to any great extent.

To illustrate the conveying of heat by *conduction,* consider a crowfoot brace, the end with the palm or foot is placed in a forge, the other end being held in the hand. At first the metal feels cool, but as the other end becomes heated, the end in the hand becomes so hot that it cannot be held. The heated end absorbed the heat, which in turn was conducted through the entire length of the brace.

The heat from the fire in a firebox or furnace is transmitted principally by radiation. The plates directly in contact with the fire are heated by radiation, which in turn heats the plate not in contact with the heat by conduction.

Laying Out Problems

Q.—I would like to know of some quick way of laying out an elliptical base for a light sheet iron stack; also I would like to get a formula for figuring the length of an arc of a circle when the chord length subtending the extremities of the arc are known? A. G.

A.—The development of a stack base was treated upon in one of the preceding issues of The Boiler Maker. Refer to the solution given, and if further information is required let us know.

To find the length of an arc of a circle when the chord length is known, proceed as follows: In Fig. 7 is represented an arc *a-b-c; a-c* is the chord joining the extremities *a* and *c* of the arc. Draw the radial lines *a-d* and *c-d* and determine the angle between them. By this formula the arc length may then be found.

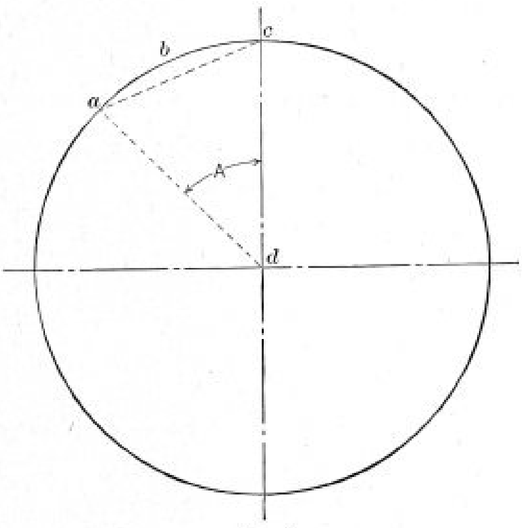


Fig. 7

Arc length = .0175 × angle A × radius of circle. For example: Let A = 45 degrees; radius of circle = 10 inches; then, .0175 × 45 × 10 = 7.875 inches, length of arc *a-b-c.*

Another way to find the arc length when the angle A is known is to first determine the circumference of the circle of which the arc is a part. Then divide the circumference by 360, the number of degrees in a circle, and multiply the quotient by the number of degrees in the angle A. Thus the circumference for the preceding example equals 3.1416 × 20 = 62.832 inches. 62,832 ÷ 360 = .1744 inch, length of arc for one degree. .1744 × 45 = 7.85, length of arc in 45 degrees when the radius is 10 inches.

Gas Forge for Heating Rivets

Q.—Will you please give me a sketch showing the design and method of constructing a gas forge or furnace for heating rivets? O. B.

A.—A gas or oil burning rivet furnace or forge should be properly designed so that it can do its work well within the shortest possible time, and with practically no attention. It should be economical in the use of fuel and produce all the heat there is in it. So many conditions arise in a design of this kind that it is cheaper to buy one of the standard makes and save time, work and worry. The proper heating of rivets is an important factor in boiler construction. They should be heated economically by a soaking, non-scaling heat. Some home-made furnaces, no doubt, are giving good results in this respect, but the writer advises that such a question of shop equipment be left with a company that fully understands the conditions and is competent and prepared to meet the needs of such heating problems.

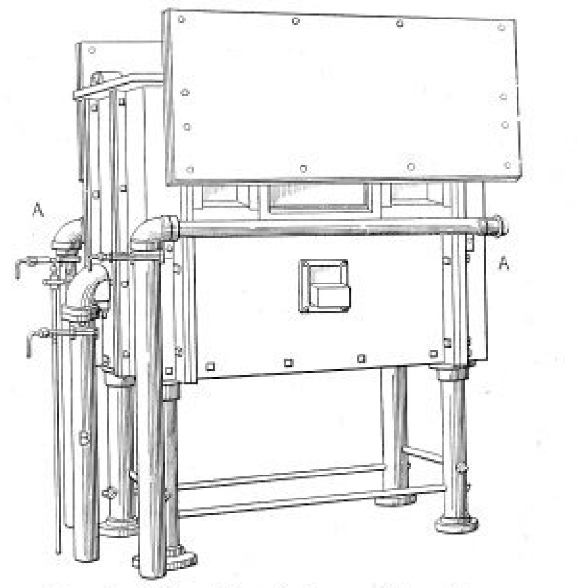


Fig. 8.—Oil or Gas Stationary Rivet Forge

Fig. 8 shows one of the designs made for *bull machine* or *snap* work where large quantities of heated rivets of different sizes are required. There are four furnace openings in this type so that four gangs of riveters can be supplied from the one furnace. Pipes A are blast pipes, and used for the protection of the operator from the heat and gases. Pipe B is the supply pipe to the combustion chamber, which is below the bottom or floor of the rivet chambers. The heat is carried around the walls of each furnace, thus heating the rivets from all directions, which method insures a soaking uniform heating of the rivets. The walls of the combustion chamber and furnace are lined with brick.

Nagle Steel Company Buys Potts Bros. Plant.—The historic plant of Potts Brothers, Ltd., Pottstown, Pa., which had been in that family for over seventy years, was purchased February 1 by the Nagle Steel Company, Pottstown. Work will be started at once on remodeling of the plant, which has been idle for five years.

Letters from Practical Boiler Makers

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

Something About the Use of Factors of Evaporation

The A. S. M. E. has decreed that the standard boiler horsepower shall be the evaporation of 34.5 pounds of water from a feed water temperature of 212 degrees F. into steam of the same temperature and at atmospheric pressure. This is based upon an earlier standard—that of the centennial—of the evaporation of 30 pounds of water at a temperature of 100 degrees F. into steam of 70 pounds gage pressure.

The 34.5 pound value is known as the "equivalent evaporation," or evaporation "from and at 212 degrees F." That is, 34.5 pounds of water, from and at 212 degrees F. is relatively the same as, and equivalent to, the 30 pounds value mentioned. The 30 pounds value also is known as "actual evaporation." Equivalent evaporation is used as a basis of comparison, as between different boilers, operating under varying conditions, as to pressure, feed temperature, etc.

Therefore, to convert actual evaporation into equivalent evaporation, a "factor" of evaporation is employed. The factor is found from this formula:

$$\frac{H - t + 32}{966.1} = \text{factor of evaporation.}$$

in which H = the total heat of the steam at the observed pressure. (Found in steam tables.)
t = degrees F. temperature of the feed water.
32 = a constant.
966.1 = the latent heat of steam at atmospheric pressure. (Found in steam tables.)

The factor so found is used as a multiplier for the actual evaporation, and so converts the actual number of pounds of water evaporated, in any given case, in the quantity that *would have been* evaporated had the evaporation taken place from a feed temperature of 212 degrees F. into steam of atmospheric pressure.

While the factors of evaporation may be found from the formula given, yet it is more convenient to use a table of factors, contained in most engineers' handbooks. Factors of evaporation are, in short, nothing but *multipliers*, as before explained.

Now, if it is desired to learn what is the corresponding value to the standard value of 34.5 pounds—in short, just what a boiler must evaporate per horsepower in any given case and under any given conditions—then the multiplying process with the factor of evaporation is reversed, and we *divide* by the factor for the given case, the dividend being always 34.5. Suppose, for example, it is desired to know how many pounds of water a boiler must evaporate per horsepower per hour, to correspond with the standard 34.5 pounds. Assume that the feed temperature in the case is 100 degrees F. and the steam pressure (gage) is at 180 pounds per square inch. By using the formula, or by referring to a table, we find the factor of evaporation to be 1.169, and $34.5 \div 1.169 = 29.51$ pounds of water, corresponding to 34.5 pounds.

Again, assume a case where the feed temperature is 200 degrees F. and steam 180 pounds gage pressure. The factor of evaporation is for this combination 1.065, and $34.5 \div 1.065 = 32.3 +$ pounds, corresponding to 34.5 pounds, the standard. For any other temperature of feed water, and pressure of steam, the same method may be employed and a value found for the case in particular. After the value is found, it is used as a divisor into the total pounds of water evaporated in one hour, in the boiler, and under the same conditions that the factor was found, and the quotient will be the horsepower of the boiler on the A. S. M. E. rating.

In order to still further verify the foregoing and check its accuracy, the standard 34.5 pounds evaporation means the absorption of 33,330 British thermal units by the water in the boiler. This latter value is found like this: As the latent heat of steam at atmospheric pressure is 966.1 British thermal units, and as the standard is 34.5 pounds of water, then, $966.1 \times 34.5 = 33{,}330$ British thermal units per hour for each 34.5 pounds of water evaporated. Having this value 33,330, we may employ it as follows, using the two illustrative cases before given.

In the first case, the water at first, 100 degrees F., is to be raised to the boiling point of 379.61 degrees F., due to a pressure of 180 pounds gage or 195 pounds absolute, in round numbers.

This means, the water is to be raised through $379.61 - 100 = 279.61$. The latent heat of steam at 180 pounds gage pressure is 845.3 British thermal units. Then $845.3 + 279.61 = 1{,}124.91$ British thermal units, and $33{,}330 \div 1{,}124.91 = 29.6 +$ pounds, which is within one-half of one percent of the result found by the first method given.

In the second case the water is at 200 degrees F. and the pressure the same, 180 pounds gage. To raise the water from 200 degrees F. to the boiling point at 180 pounds pressure, requires $379.61 - 200 = 179.61$ British thermal units, and $179.61 + 845.3 = 1{,}024.91$ and $33{,}330 \div 1{,}024.91 = 32.5 +$ pounds, and again within one-half of one percent of the previous result. The differences are due to the dropping of decimal places during the operation and explain themselves.

The foregoing enables one to decide beforehand just how many pounds of water per hour per horsepower any given boiler must evaporate under given conditions to conform to the standard, and it will be found very useful at boiler tests.

Charles J. Mason.

Scranton, Pa.

Shop Talk

One of my hobbies is talking shop, and I get a great deal of entertainment and benefit by it at odd times with fellows who work in the same shop with me, and also with those from other shops. The other night I dropped into a barber shop to get a shave, and as usual there were five or six ahead of me. One of them was a fellow from a shop near to my own, and so I started talking shop with him. I always sort of try out those whom I talk to in this way, to see if this kind of conversation agrees with them. This fellow liked it, and we were soon deep in the discussion of various methods in use at our shops. Soon one of my own shop mates dropped in, sat down near us, listened awhile, and then said to me: "Say, Joe, don't you ever talk anything but shop? I'll bet you don't know there's a war going on in Europe. If you do, I never hear you talk about it. Why don't you cut out this shop talk and get a new line of stuff to talk on? You're not the only one doing it, but, on the level, I don't see why you guys are so fond of thinking and talking shop nearly every time I meet you. Whenever I hear the whistle blow, that's quits for me and any shop stuff till I have to think of it again."

Well, we started to elaborate to him the benefits we derived from discussing shop subjects and the articles we read in the trade journals, but he could not see through it. His argument was that when a fellow has worked nine hours a day driving rivets, or punching and shearing plate, he ought to be tired enough of shop to forget it when it is quitting time. Maybe he is right, in a way, but I have always sized his kind up in this manner: He works hard because he has to, in order to get a living, but never had, or will have, any real interest in work of any kind.

I once had to take a vacation of six months on account of a plate crushing my foot, and I received full pay, also benefits from my lodge and accident insurance. I was getting twice as much money as I would have received had I been working. I had nothing to do but lie around and take things easy while I improved. Not a thing should have worried me, but there was, for I missed the shop and the activity that I had been used to. I certainly was happy when one of the boys would drop in to see me and talk about the shop. I used to coax the apprentices to visit me, delighting in teaching them laying out stunts and other shop kinks. I got out all the copies of THE BOILER MAKER and would go over some of the interesting things with them.

During my layup I perhaps formed the habit of talking shop, and if so I am glad I did, for I acquired a great deal of information out of it. One of these days I will be able to use the experience and benefits to my advantage, and when that time comes I don't think I will be at all sorry that I spent some of my spare time in studying, thinking and talking shop, instead of refighting the battle in Europe leaning on the bar of some prominent booze emporium. C. H. W.

Boilers for Warships

The writer has become interested in the controversy on the subject of which is the best type of boiler for naval use. As the proof of the pudding is in the eating, perhaps I (having eaten some of the pudding for the past ten years in the naval service) am in a position to make a few remarks. I might begin by saying that the watertube boiler for fighting craft has undoubtedly won its place on such merits that it will ever remain, and I quite agree with Mr. Roberts, in the December, 1916, issue of THE BOILER MAKER. The boiler he describes approaches near to the ideal and would be best for our navy.

While I am not in a position to attack the statements of J. S. Grant, made in the January issue, in regard to the watertube boiler in the European war, I will say that the shooting away of a feed tank should not be sufficient cause to resort to use of sea water, as all ships of the English Navy carry fresh water in the double compartments and these are connected to the auxiliary feed pumps.

In reference to the article in the February issue, one would be led to think that Mr. Grant judges the success of a boiler on the comparative amount of victims that each type kills; perhaps the reason that the watertube casualty list is so much greater in its brief history is that it has a wider field than the Scotch.

Mr. Grant does not knock very gently and leaves himself open to a great deal of criticism. If he wasted a little less effort in making so many references as to the particular paragraph, its location on the page, etc., and put a little more effort in trying to interpret what Mr. Roberts meant, he would have perhaps had less to knock about. For instance, he picks up such an item as *"deck space,"* when he really knew that space was the real item that Mr. Roberts meant to impress; even landlubbers know the ship's boilers are down in the hold next the keel.

Now in regard to the bad taste that Mr. Grant has in his mouth over the statement that Mr. Roberts made, there is less danger of accident to a watertube boiler, or of injury to employees in case of accident. I want to say that I am a survivor of a recent disaster that occurred to one of our naval vessels, a cruiser, fitted with sixteen watertube boilers. To take that bad taste out of his mouth, I will say that when the 14-inch main line burst in the port engine room, there was but one man killed; others were scalded, but survived; and when two boilers were torn apart, due to the shock of the ship striking the rocks, there were some fifteen men in the firerooms and I was one of them. While we were terribly scalded, there were but six died.

There are many cases of watertube boilers failing, due to low water and other causes, where no one has been killed and the property loss considerably less than it would be with any shell tubular boiler. It is common knowledge that a sectional watertube type of boiler is far safer than the Scotch, when results of an explosion are reckoned. The total horsepower can be made into effective small units, and this distributed in such a way that if one or more is disabled it will not affect a ship's steaming as seriously as would the Scotch type, built in units of large horsepower capacity.

As for steaming with salt water, while not as well adapted to it as the old Scotch, they nevertheless will steam several days with salt feed when they are brined at the blow-offs frequently. Of course, the efficiency is reduced considerably, but this applies to all types when salt feed is resorted to. As for priming, it depends a whole lot on the judgment and care used when steaming with salt feed. Recently the writer had the experience of steaming several days with very high saturation, due to badly leaking condensers; all the feed was salted up to a point of 1,900 grains per gallon, and we were up against a pretty rough spell of weather, which would not permit stopping for repairs.

We continued to steam with this high saturation for four days. Each day it became worse, but it proved that with care, salt feed can be used. The boiler stops were choked to about two-thirds open, and all separators were carefully watched and drained; the water level and feeding were kept uniform and steady, and the boilers were not forced.

While this would have been a handicap in war times, were we caught in this condition by an enemy foe, I think that we would have been as safe as if we had the big old Scotch, for it has been my experience that they cannot be forced without foaming and priming, when using salt feed. High rate of evaporation of salt feed water will cause priming or foaming in any make or type of steam generator. I do not know of any Scotch boilers that for months steam on salt feed, and feel that it is rather a broad statement by Mr. Grant. If he has ever seen an evaporator coil being scaled after distilling fresh water for one week, he ought to be able to form some sort of an idea as to the quantity of salt scale deposited on the heating surfaces of the tubes, about 3/16 inch to ¼ inch thick.

As nearly all of our latest fighting craft are fitted to burn fuel oil, giving them more efficient steaming power and radius, and the fact that many prominent engineers have proven by comparative tests that the watertube boiler and its particularly large combustion chamber are far more suited to the use of fuel oil than the corrugated Scotch boiler furnace, and its combustion chamber, and the additional fact that all boilers for our *fighting* craft for the past ten years that have been installed are watertube, ought to be sufficient proof that they have been proven the best. Why does Mr. Grant admit that they are all right for torpedo boats and not for battleships? Surely the operating conditions are much better on board larger craft—and we have torpedo boats to-day that reach past the 1,000-ton class. This is as large as some of our former battleships.

When proper precautions have been taken to provide flexibility in arrangement of piping and pumps for feeding fresh water in different emergencies, the watertube boiler is so far ahead of the Scotch that there can be no reasonable comparison.

From the personal observation that the writer has made in ten years of naval service on gunboats, torpedo boats, cruisers and battleships, operating boilers, and under all sorts of conditions, it is my opinion that the watertube boiler is undoubtedly the safest type for use on fighting craft where speed is dependent on quick and high rates of evaporation. The watertube boiler certainly answers to the call of the forced draft blower and, being a sectional type, freely expands to the forcing without any serious effect. C. H. W.

Concord, N. H.

Riveting

Referring to the article, "Safety First in Boiler Construction," by H. W. Hoover, in the February BOILER MAKER, I note in the second column of the article, paragraph four, Mr. Hoover says that a pressure of sufficient intensity must be maintained on *each* rivet as driven of from five to eight *minutes* of time. At this rate it would take a man a couple of months to build a high-pressure boiler with, for instance, a butt-joint triple-riveted seam.

It would appear that Mr. Hoover has not come in contact with actual boiler practice, and that he is under the impression that there are only five or six rivets to each boiler. A. L. LECHNER.

Erie, Pa.

James Watt—Boiler Maker

I note that I am criticised rather energetically by A. L. Haas because I call James Watt a boiler maker. Mr. Haas seems to think that I detract from Watt's fame by thus writing about him.

My argument still is, however, that Watt was a boiler maker because he actually designed boilers, and supervised their construction. If necessary, I believe Watt could have put on overalls like the men under him and he could have actually fashioned the metal into shape. Perhaps the boilers would have been better if he had done the work himself from the ground up. However, he didn't have time to do it all. He had too many other things to do and he had no difficulty in finding men who understood what he wanted.

Perhaps some readers of THE BOILER MAKER didn't know that Watt also designed and improved boilers. If so, I should say that I have added to Watt's fame rather than belittled it.

Abraham Lincoln was a log splitter. I believe that most people in the United States are acquainted with that fact and are the prouder of Lincoln because of his log-splitting strength. He was also a lawyer. He was our greatest President, according to the views of many of our citizens, and I am one of them. As a lawyer I understand Lincoln wasn't much of a success, but as a log splitter he was a success. I believe Lincoln never hesitated to admit that he at one time split logs.

When it comes to defining the actual meaning of the name boiler maker, I believe it has a very broad meaning. I am sure there are men to-day who call themselves boiler makers yet wield nothing but a pen. Presidents and officials of companies that manufacture boilers surely have a right to call themselves boiler makers, and since Watt himself was a boiler maker—the greatest man that ever lived—these manufacturers should be proud of their profession, and they doubtless are.

I have investigated this publication, THE BOILER MAKER, to the extent of learning just where it goes—whether to the owning, managing, operating, or working class—and I find that the largest percentage of the circulation goes to the owning, business managing, and operating managing class. These men, I am sure, call themselves boiler makers, yet I have my doubts as to their actually swinging hammers, laying out, cutting, drilling, rolling flues, etc. But I believe that most of them could do it, if necessary, in the same way that Watt could have done what the men under him did.

Besides, I doubt if there is a single living man who has made a complete boiler. Riveters usually do riveting only. Flue rollers do nothing but roll flues. Each man has his own special task to perform. Yet each man is called a boiler maker. I see no reason why he shouldn't be called a boiler maker. And if a man worked in a boiler factory at making stays, for instance, for one year, and then went into the law business, and finally became our President, I think it would be perfectly right to say, "President Jones was once a boiler maker."

Personally, I have worked on farms as a farmhand; I have worked as a section laborer on a railroad; I have heaved coal; I have helped make boilers, etc. I therefore do not hesitate to say that I was once a farmer, a section laborer, a coal heaver, a boiler maker, etc.

James Watt's name is so well known, his life's story has been told so often, that my contention that he was a boiler maker also is not going to cancel everything that has been previously told and make of him a boiler maker only. I therefore hold that my "bald utterance" does not need qualification. I may say, for further example, that Henry Ford was a stationary engineer. He is already known to the world as an automobile manufacturer. I surely wouldn't have to qualify my statement, because I know that the principal part of the story is already understood by all readers or listeners.

Watt's name is so well known that he needs no special title. Engineer, boiler maker, machinist, scientist, or even inventor, are inadequate. His name—James Watt—is sufficient. Thomas Edison is often called a "wizard" as well as an inventor, but such terms do not suffice. His name—Thomas Edison—is the best title.

In most respects I agree with all that Mr. Haas says. I believe the story of Watt's life is a beautiful and wonderful one. I believe that no attempt should be made to besmirch Watt's name, and even if such an attempt were made it would merely tend to bring out the truth. I called Watt a boiler maker. Mr. Haas says that I do Watt an injustice. Whether I am wrong or not can now be left to the reader, and to history, for THE BOILER MAKER will doubtless be found in library files hundreds of years hence.

I am glad that this discussion has arisen, because it can do nothing to harm Watt. If anything, we are brightening his name. N. G. NEAR.

New York.

Modern Tools—Their Use and Abuse

While passing through the boiler department of a railway shop, I noticed between three and four dozen tube roller expanders of various sizes and makes, and in various conditions, some of the cages without rolls, others with one or two rolls and some with broken mandrels. Upon examination the cages were found to be of solid steel and very little the worse for wear. They were made by one of the best manufacturers of boiler makers' tools in the United States, and should give many more years' service if properly looked after; in fact, the cost of again putting them in good working condition would have been very small. There is no reason why a tool of this description should be thrown away simply because a roll or so gets lost or a mandrel broken, for mandrels and rolls can be purchased from the manufacturers at very little cost, where it is impossible that the parts can be duplicated in the shops.

If a shop is provided with but one lathe, it is quite possible to keep up the repairs on the boiler makers' tools in a small shop; in fact, round steel of the best quality, called drill rods, can be purchased in any size and is quite suitable for roller expanders by simply sawing them off to the required length for the different kinds of rolls and then having them tempered. There are many ways of taking care of tools if one is so minded. Now, if we stop to inquire the cost of, say, a 2-inch expander of any of the best makes, we will find that they are an expensive tool. What, then, must be the cost of three or four dozens of them? The writer was at a loss to understand why those tools were discarded when to his certain knowledge rolls of the same make have been in actual daily use for over nine years. Sometimes the holes in the cages wear and the tools become a self-feeding roll and make the work a little harder to perform, otherwise no difficulty in the use of the tool is met with.

Further along in the same department were several long-stroke air hammers. Looking them over, some of them were found to be without plungers or springs to hold the dies in place and were in very poor condition, as if thrown to one side as of no further use. Again, there is no good reason for throwing tools of this kind away, for, like the flue expander, all parts can be duplicated. Should a valve be worn out, it is a very easy matter to put a new one in place. Almost any mechanic ought to be able to do a job of that kind. The writer knew a boiler maker who always made the repairs on his air hammer and had the same hammer for many years.

A long-stroke hammer also is an expensive tool, and one that should be well looked after, and when a riveting job is done it should be well cleaned and put away either in a tank of carbon oil or washed out with carbon oil to remove any grit that may have got in the valve and prevent the lubricating oil from gumming. A tool of this kind should render good service for many years.

Air motors were the next modern tool that attracted the writer's attention. There were several of the most powerful type in this group, some with broken feed handles, some minus handle, and all with dull centers, all jumbled together in a corner of the shop, covered with dirt and grease and carelessly put there in the corner of the shop by the last man that used them without any care, and would remain there until wanted again. Now, of all the modern shop tools the air motor is one of the most useful, and at the same time one of the most delicate in construction, and should receive the greatest of care.

Let us consider the parts of one of those useful tools. Take the crankshaft, connecting rod, valve, and the various ball bearings. Examine them carefully, and you will arrive at the conclusion that it is a perfect little machine and one that requires careful handling. How often have we seen men using these machines in fireboxes, drilling out staybolts, who, instead of being provided with proper sockets to reach across the box from one side to the other, have some flimsy arrangement of blocks to back up their machine, and when the feed pressure is applied the whole thing gives way and the motor lands on the grate bar badly damaged, if not put out of service entirely? Or perhaps someone is working on a scaffold some feet above the ground and wants to lower his motor down to put it away. He carelessly swings the motor over the side, hanging on to the air hose, while the weight of the machine is liable to pull the nipple out of the hose. Should this happen, the tool usually drops on the handle and flops over onto the floor or ground in no gentle manner, running the risk of displacing some of the parts.

Another cause of trouble with air motors is the way many men have of removing the drill or socket. Nearly all machines are provided with a steel pin which, when the feed screw is worked down, presses against the top of the drill or socket and pushes it out. Sometimes the steel rod gets bent and fails to work properly or not quick enough to suit the operator, who takes his hammer and chisel, digs into the socket or drill, and out it comes so easy; but he does not realize the amount of damage he has wrought to the mechanism inside. What does he care? He has finished his job, the machine is put away, and unless examined in the tool room nothing is known of its condition until it is called into service again, when it is discovered the machine will not work.

In the same shop the writer saw in the scrap heap enough air hammer chisels, beading and calking tools to equip a tidy-sized shop, and to all appearances nothing wrong with them, other than a little care from the blacksmith or machinist.

Where there are tool rooms to look after the welfare of all shop tools it would be impossible for anything like the above condition to exist, for there they are closely watched. At the first sign of a defect repairs are made and everything kept in good working order, but in shops not equipped for repairing their own tools and where no one is held responsible conditions like the above can and do exist. Still there is no reason that it should be so, for where a tool of any kind gets out of order and repairs cannot be made such tool can be sent back to the maker and defective parts renewed and the tool put in condition almost as good as new.

It is the writer's experience that air hammers and air motors can be repaired quicker and at less cost at the factory than they can be in any shop not specially provided for such work. FLEX IBLE.

Pittsburgh, Pa.

WEIL BOILER COMPANY SOLD.—The Weil Boiler Company, Indianapolis, has been sold to the Kewanee Boiler Company, Kewanee, Ill., for $70,000. There will be no change in name, business administration or policy. The officers of the Weil Company are Isidor Weil, Chicago, president; Benjamin Weil, Indianapolis, vice-president, and C. T. Kingston, Indianapolis, secretary and treasurer. The officers of the Kewanee Company are Emerit E. Baker, president; B. F. Baker, vice-president and treasurer, and M. S. Moore, manager. R. M. Powers is superintendent of the Indianapolis branch.

Strength of Locomotive Boilers—III

(Concluded from page 72.)

These tests indicate, without question, the theoretical superiority of the Whitworth thread for staybolts, while the practical superiority has been demonstrated by the great decrease in broken staybolts on several roads which have adopted the Whitworth thread as standard. However, the United States form thread is now growing in favor.

DATA ON STAYBOLTS

		"V" Thread	Whitworth Thread
7/8" Diam. 1 "	Diameter at root of thread	.7307"	.76828"
	Area in sq. in. at root of thread	.4193"	.46374"
	Depth of thread	.07217"	.05336"
1" "	Diameter at root of thread	.8557"	.89328"
	Area in sq. in. at root of thread	.5750"	.62671"
	Depth of thread	.07217"	.05336"
1 1/8" Diam.	Diameter at root of thread	.9807"	1.01828"
	Area in sq. in. at root of thread	.7558"	.814376"
	Depth of thread	.07217"	.05336"
(Above figures are based on 12 threads per inch)			

Table No. 9 gives the safe loads on staybolts for various stresses and diameters, and covers figures for both the

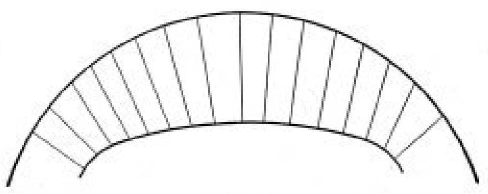


Fig. 5

sharp "V" thread and the United States standard thread, with both 10 and 12 threads per inch.

Table No. 10 gives various data, such as diameter at root of thread, area in square inches at root of thread, depth of thread and area of reduced section for stays having "V" thread, United States thread and Whitworth thread, as well as data on the American Staybolt.

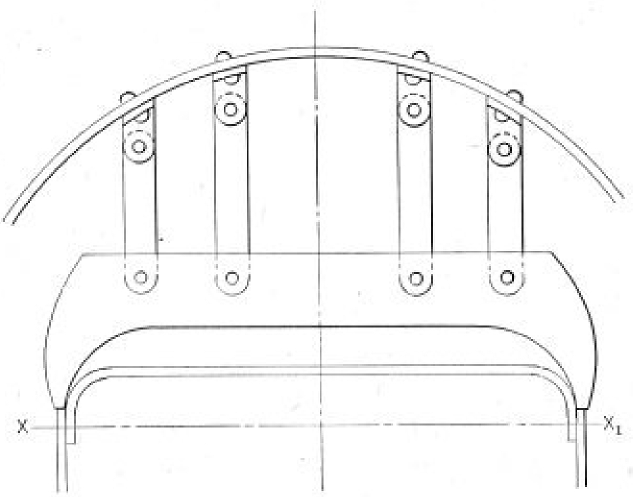


Fig. 6

The next subject to receive attention is that of crown stays. In figuring the stress on the crown stays, the same general conditions apply as in the case of the ordinary staybolt. It will be noted from Fig. 5 that the area of the portion supported on the outer end of the crown stays is greater than the area supported on the lower end of the stay, but in calculating the stress in the bolt the area in the crown sheet end, or the lower end of the stays, should be used.

GIRDER STAYS

In figuring the stress in sling stays in boilers with crown bars supported on firebox side sheets no doubt differences of opinion have existed concerning the method of calculation.

It has been the practice in some cases to consider the crown bar as a beam supported at both ends, as at X and X_1 in Fig. 6, and allow the crown bar to carry a certain portion of the load, and the remaining portion to be supported by the slings. However, this matter has been definitely settled in the recent report of the committee on boiler construction of the Master Mechanics' Association, and in these rules the following quotation is self-explanatory:

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

This method will, of course, give a greater stress in the sling stays, but after giving the matter serious thought it is questionable, after all, whether a perfect bearing on the top of the side sheets is always obtained, and in this event it is no doubt on the side of safety to design the sling stays to carry the full load, thereby making the cross sectional area sufficient to meet the requirements as to the fiber stress.

How May Apprentices Be Taught Work Usually Given Special Men*

BY CHARLES SCHMIDT

The object is to give the apprentice some experience in all kinds of work. The apprentice should not be worked with handymen, but with journeymen, and not be used as helpers merely to carry tools. Some of the boiler makers do not explain work to an apprentice, consequently the shop instructor should explain the work. It is as much the duty of the shop instructor to see that the apprentice is given the various classes of work as it is to assist him after the work is assigned. The management intends that the instructors shall be held personally responsible for this.

The best method of giving a boy work done by a special man is, so far as possible, to have the boy placed with the man doing the work. It seems that at some points, especially the smaller places, the boys have not been getting much of this class of work. This may be due to the fact that there is only about enough of this work to keep one man engaged, and if an apprentice is placed with the man it will lower the man's efficiency, as two men's time will be charged when it is only one man's job. In this connection, Mr. Purcell said that he wished all of these boiler maker apprentices to be given some of this special work. It will be necessary for the apprentice instructor to watch for an opportunity and then use the boy. This is particularly true with staybolt testing, hydrostatic tests, etc.

Mr. Purcell's idea for training apprentices for inspecting staybolts was to have the apprentice go over the staybolts of a firebox while the engine is on the hospital track and mark on standard form each one thought to be fractured or broken; this in addition to the regular report made out by the staybolt inspector. After firebox is cut out or marked bolts removed, have the apprentice go over his report and notice if staybolts he has marked are the ones fractured or broken. In this way he can learn to distinguish fractured and broken staybolts by sound.

* From proceedings of annual meeting of Apprentice Instructors, Santa Fe System, Topeka, Kan., May 25-27, 1916.

Selected Boiler Patents

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

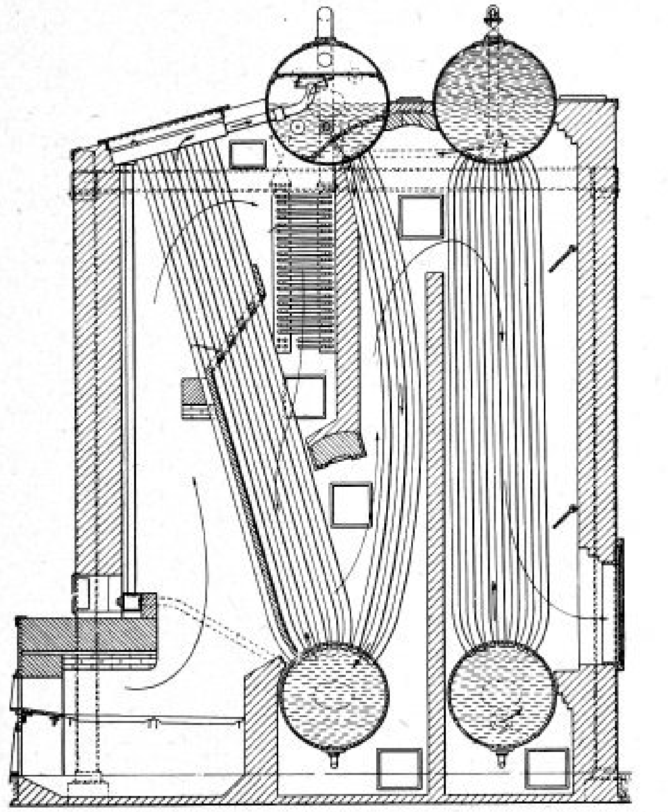
Readers wishing copies of patent papers, or any further information regarding any patent described, should correspond with Mr. Decker.

1,192,984. CLEANING DEVICE FOR MARINE BOILER FURNACES. JOHN K. BRUFF, OF BALTIMORE, MD.

Claim 1.—A device comprising a pair of metal bars adapted to be arranged in embracing relation upon a boiler furnace and detachably connected together at their extremities, equidistantly spaced scraping blades of a length greater than the width of said bars adapted to extend longitudinally of the furnace wall, means for detachably securing the blades upon the inner faces of said bars, and operating means fixed to each of said bars. Two claims.

1,192,848. STEAM GENERATOR. KARL W. BRANCZIK, OF LONDON, ENGLAND, ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, N. J., A CORPORATION OF NEW JERSEY.

Claim 1.—A watertube boiler comprising a bank of tubes inclined upwardly toward the front of the setting, a mud drum into which the lower ends of said tubes are expanded, headers into which the upper ends of said tubes are expanded, a steam and water drum connected to said headers, a baffle extending upwardly from the mud drum in



front of some of said tubes, a bank of downcomer tubes connecting said drums, and a baffle extending downwardly from the steam and water drum between the first-mentioned tubes and the downcomer tubes. Two claims.

1,200,357. STEAM SUPERHEATER. HEBER C. INSLEE, OF ROSELLE, N. J., ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, N. J., A CORPORATION OF NEW JERSEY.

Claim 1.—In combination, a superheater tube, a core therein having its lower end tapered, and a wedge device for supporting the core con-

sisting of a base having fingers projecting therefrom, said fingers being adapted to be forced into the space between the core and the lower open end of the tube. Four claims.

1,188,676. MEANS FOR TREATING BOILER FEED-WATER. FREDERICK O. PAIGE, OF NEW YORK, N. Y., ASSIGNOR TO PAIGE & JONES CHEMICAL COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

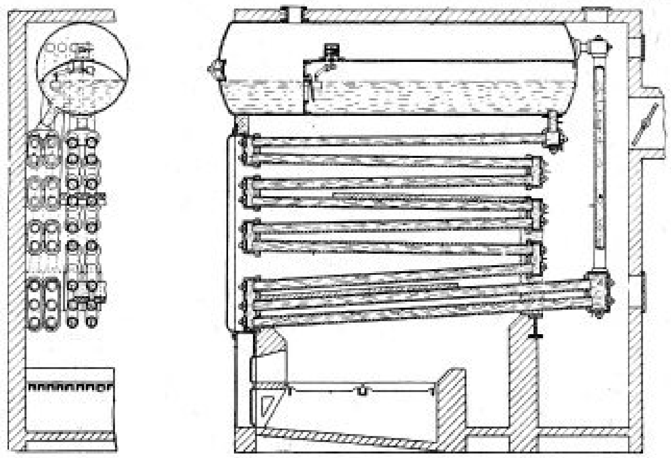
Claim.—The method of uniformly impregnating boiler feed water with a boiler compound consisting in combining the compound with a binder gradually disintegrable in water at ordinary temperture, forming thereof a universally rollable solid body, and introducing said body into the feed-water tank of a locomotive boiler where it will be subject to the oscillation of the moving vehicle and thereby caused to roll about to facilitate uniform and gradual disintegration.

1,205,616. DUMPING GRATE. EARL V. GILBERT AND GEORGE H. KRAMER, OF DAYTON, OHIO, ASSIGNORS TO THE KRAMER BROTHERS FOUNDRY COMPANY, OF DAYTON, OHIO, A CORPORATION OF OHIO.

Claim 1.—The combination with an oscillatory grate unit of an operating lever therefor, a detent carried by the lever, fixed stops spaced one from the other and alternately engaged by the detent permitting a limited movement of the lever in either direction of less extent than the full stroke of which said lever is capable, said detent being movable independent of the lever out of position to engage the stops, thereby permitting the lever an additional degree of movement. Seven claims.

1,205,656. STEAM GENERATOR. JOHN C. PARKER, OF BALA, PA.

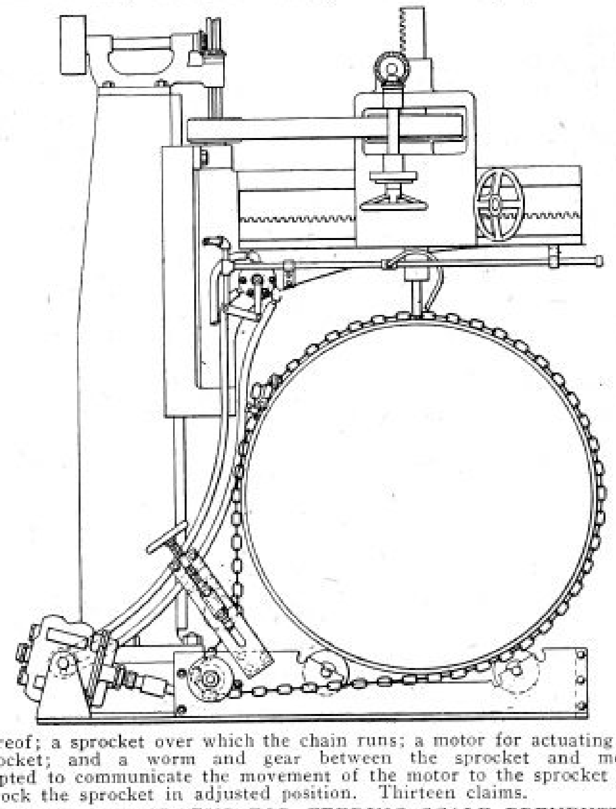
Claim 1.—In a steam generator, steam and water containing means, an upcast connected with the steam space of said means, a down-flow coil having an upper section connected with the water space of said means, a bottom section inclined upwardly in the direction of flow therethrough



and having its upper end connected with said upcast, the lower end of the upper section discharging into the lower end of said bottom section, a baffle between said bottom and upper sections, and means for applying primary heating action to said bottom section immediately beneath said baffle. Two claims.

1,204,451. TURNING DEVICE FOR BOILER SHELLS AND THE LIKE. JAMES C. KAVENEY, OF ERIE, PA., ASSIGNOR TO ERIE CITY IRON WORKS, OF ERIE, PA., A CORPORATION OF PENNSYLVANIA.

Claim 5.—In a turning device for boiler shells and the like, the combination of a base having points adapted to contact the periphery of a shell at each side of the axis thereof; a chain adapted to be wrapped around the shell, said chain having means for varying the length



thereof; a sprocket over which the chain runs; a motor for actuating the sprocket; and a worm and gear between the sprocket and motor adapted to communicate the movement of the motor to the sprocket and to lock the sprocket in adjusted position. Thirteen claims.

1,197,337. APPARATUS FOR FEEDING SCALE PREVENTIVE INTO BOILERS. WILLIAM W. BONFIELD, OF CLEVELAND, OHIO, ASSIGNOR TO THE CONTRACTORS' MACHNERY COMPANY, OF CLEVELAND, OHIO, A CORPORATION OF OHIO.

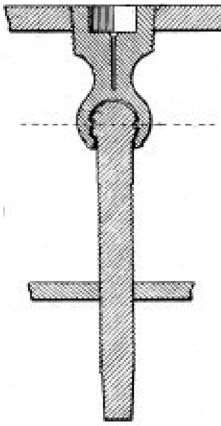
Claim 1.—In an apparatus, the combination of a reservoir adapted to contain powdered scale preventive and having an opening at the top, an intake tube depending through said opening and extending to a point adjacent the bottom of the reservoir, a tube depending from said opening around the intake tube forming the outlet passage and terminating intermediate the top and bottom of the reservoir, and a connection between the outlet passage and the boiler. Five claims.

1,200,666. METHOD OF CONSTRUCTING A BOILER. FRANCIS E. STANLEY AND CARLTON F. STANLEY, OF NEWTON, MASS.

Claim 1.—The method of constructing a wrought metal boiler which consists in forming the shell with one of its heads integral therewith, making flue openings in said integral head, forming a second head with flue openings formed therein and closing the open end of said shell with said second head, shrinking a band on the outside of the shell of said second head, fusing said second head, the end of the shell and said band together by autogenous welding, preparing flues for said boiler by plating their ends with a suitable brazing metal, securing the flues in said openings by expanding the ends thereof and further securing the flues by subjecting the head o. heads of the boiler and the flue ends therein to a degree of heat of approximately 1,740 degrees Fahrenheit to melt a brazing compound so it will flow around and adhere to the flues and walls of the openings to unite the flues to the flue openings in the boiler head. Two claims.

1,191,676. STAYBOLT. PHILIP DI MAGGIO, OF ALBANY, N. Y.

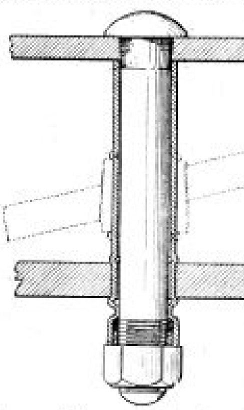
Claim.—A flexible staybolt comprising a bolt section having a spherical head, and a threaded plug having a spherical socket engaging the spherical head of the bolt, said spherical head of the bolt having diame-



trically opposite hemispherical recesses on the curved surface, and hemispherical projections in the periphery of the spherical socket engaging said recesses of the head.

1,191,729. BOILER STAYBOLT. CHARLIE L. POOL, OF BIRMINGHAM, ALA.

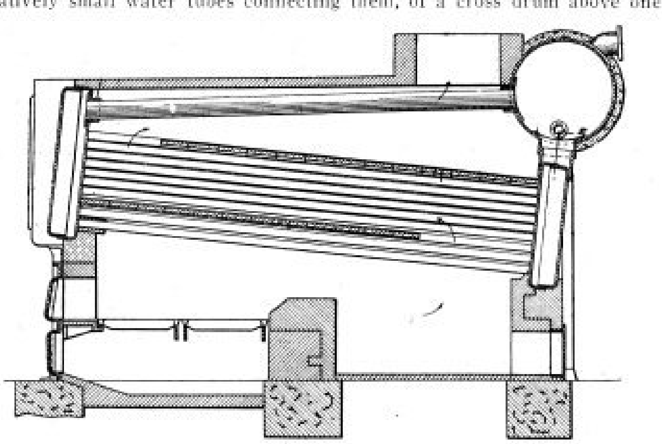
Claim 1.—The combination with inner and outer boiler sheets, of a staybolt therefor, a tube surrounding the bolt and adapted to engage the inside of the inner sheet and have its inner end closed thereby and to



project through and beyond the outer sheet, said tube being free of perforations and having its inner end adapted to be expanded into the outer sheet wherever the latter happens to come on the tube, a nut on the threaded end of the bolt which projects from the outer open end of the tube, and means to pack the joint between the tube and bolt. Eight claims.

1,196,878. CROSS-DRUM BOILER. EDWARD C. MEIER, OF PHŒNIXVILLE, PA.

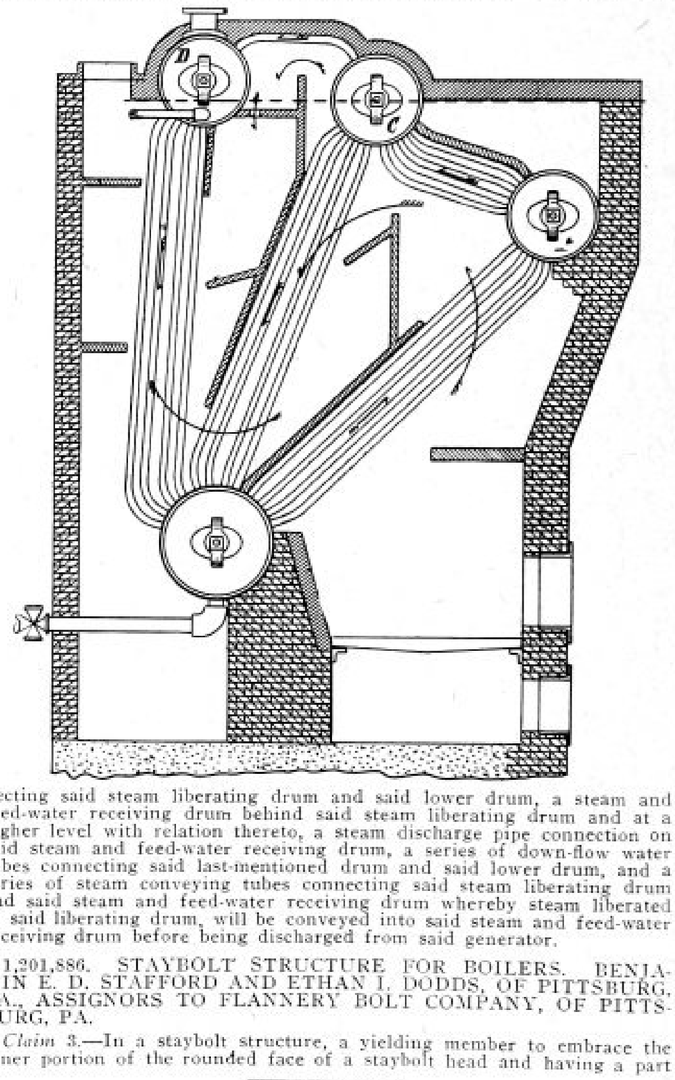
Claim 1.—In a boiler, the combination with a pair of box headers and relatively small water tubes connecting them, of a cross drum above one



of the box headers, pipes connecting the side of the drum with the box header farthest removed therefrom, a neck depending from and projecting through a hole in the bottom of the drum, said neck connecting with an outlet in the header below the drum, said neck having a flange positioned within the drum and of larger diameter than said hole and forming a passage from the drum to the box header below, necks forming fitting supports for said second-mentioned pipes, each of said latter necks extending through holes in the drum and said farthest removed header and having flanges within the drum and said latter header. Two claims.

1,201,442. WATERTUBE STEAM GENERATOR. LAWRENCE E. CONNELLY, OF CLEVELAND, OHIO.

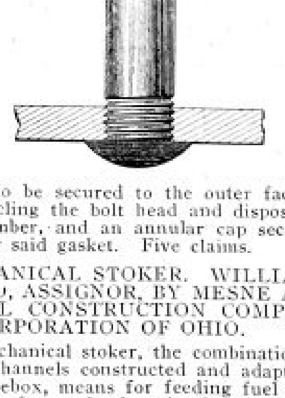
Claim.—In a watertube steam generator, a fire-wall, a furnace grate, a lower water drum behind said fire-wall, a water drum above the front end of said furnace grate and below the water level, so as to be at all times filled with water, up-flow watertubes connecting said drums, a steam liberating drum vertically above the rear end of said furnace grate and partially above the water level, up-flow watertubes connecting the same with the second-mentioned drum, down-flow watertubes con-



necting said steam liberating drum and said lower drum, a steam and feed-water receiving drum behind said steam liberating drum and at a higher level with relation thereto, a steam discharge pipe connection on said steam and feed-water receiving drum, a series of down-flow water tubes connecting said last-mentioned drum and said lower drum, and a series of steam conveying tubes connecting said steam liberating drum and said steam and feed-water receiving drum whereby steam liberated in said liberating drum, will be conveyed into said steam and feed-water receiving drum before being discharged from said generator.

1,201,886. STAYBOLT STRUCTURE FOR BOILERS. BENJAMIN E. D. STAFFORD AND ETHAN I. DODDS, OF PITTSBURG, PA., ASSIGNORS TO FLANNERY BOLT COMPANY, OF PITTSBURG, PA.

Claim 3.—In a staybolt structure, a yielding member to embrace the inner portion of the rounded face of a staybolt head and having a part



to rest against and to be secured to the outer face of an outer boiler sheet, a gasket encircling the bolt head and disposed between the same and the yielding member, and an annular cap secured to said yielding member and engaging said gasket. Five claims.

1,200,436. MECHANICAL STOKER. WILLIAM T. HANNA, OF CINCINNATI, OHIO, ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE MECHANICAL CONSTRUCTION COMPANY, OF CINCINNATI, OHIO, A CORPORATION OF OHIO.

Claim 1.—In a mechanical stoker, the combination with a distributing plate provided with channels constructed and adapted to direct the fuel to the side of the firebox, means for feeding fuel to and over said distributing plate, means for projecting the fuel therefrom and means for adjusting the position of the distributing plate with respect to said fuel projecting means whereby the feed of fuel over the plate and through said side channels may be varied by changing the relative position of said fuel projecting means and said channels. Two claims.

THE BOILER MAKER

APRIL, 1917

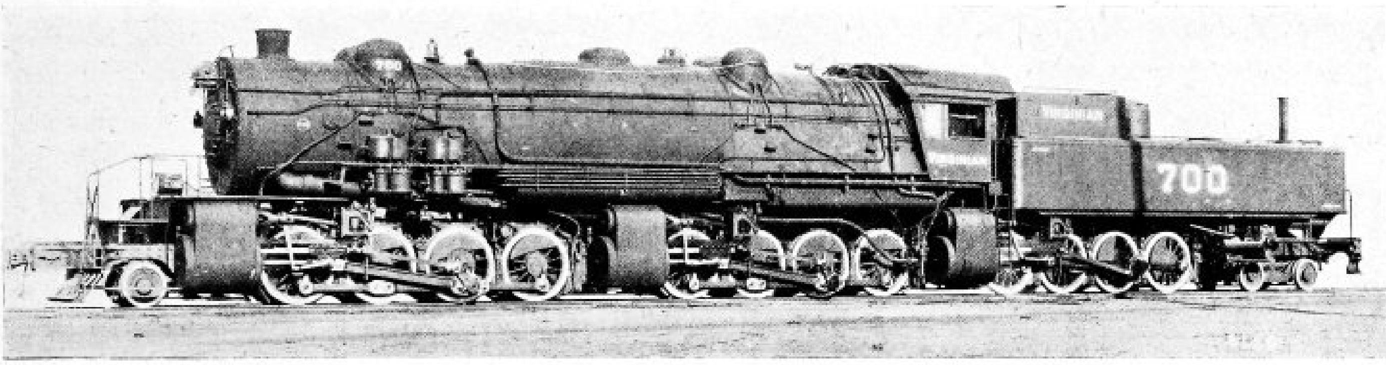


Fig. 1.—The Largest Locomotive in the World

Triple Articulated Compound Locomotive for the Virginian Railway

Maximum Tractive Force of Locomotive 166,300 Pounds, Total Weight 844,000 Pounds—Boiler of Wagon-Top Type with Radial Stayed Firebox

A triple articulated compound locomotive, with 2-8-8-8-4 wheel arrangement, has recently been built by the Baldwin Locomotive Works for the Virginian Railway. As far as the general principles of its design are concerned, this locomotive is similar to the Erie triples, which have now been in service a sufficient length of time to demonstrate the value of the type in heavy grade work. The Virginian locomotive exerts a maximum tractive force of 166,300 pounds, and was designed with a height limit of 16 feet 10 inches and a width limit of 12 feet, at a height of 2 feet 3 inches above the rail. The center line of the boiler is placed 10 feet 9 inches above the rail. Flanged tires are used throughout, the lateral play between rails and flanges being 7/8 inch on the front and back drivers of each group and 5/8 inch on the main and intermediate pairs. The locomotive is turned on Ys, on which the curvature is 18 degrees.

The boiler is of the wagon-top type with an outside diameter of 110 inches at the third ring. Both the main and auxiliary domes are mounted on this ring, the latter being placed over a 15-inch opening in the shell. The longitudinal seams are all placed on the top center line. That on the dome ring is welded throughout its entire length, while the seams on the first and second rings are welded at the ends. The circumferential seam uniting the second and third rings, and the seam uniting the third ring with the throat and outside firebox sheets, are triple riveted. The back tube sheet is straight, and the tubes have a length of 25 feet.

The furnace is of the Gaines type and the arch is supported on five tubes. As the firebox is placed above the middle group of driving-wheels, the space available for the throat is exceedingly restricted. Sufficient depth of throat has been obtained by depressing the front bar of the mud ring between the wheels. Flexible bolts stay the throat and back of the firebox and are used in the breakage zones in the sides, and four rows of Baldwin expansion stays support the forward end of the crown.

The mud ring is supported on vertical plates at the front and back and at one intermediate point. Here the load is transferred to the plate through a transverse, cast steel brace, which is strongly ribbed and supports the longitudinal grate bearers.

Attention may be called to the ash pan, which in spite of the limited space available, has two large hoppers with cast-steel bottoms and drop-doors. The back receiver pipe and reach rod are run through the pan, which has a longitudinal duct running through it for this purpose. Provision is made for admitting air at the front of each hopper and near the top of the duct at each side, as well as under the mud ring.

The locomotive is fired by a Street mechanical stoker, and a Franklin pneumatically operated fire door is applied.

The throttle is of the Rushton type, specially designed to suit restricted clearance limits. The dome is 10 inches high and 36 inches in diameter, and the dome opening in the shell measures 20 inches longitudinally by 28 inches transversely. The throttle valve is seated immediately over this opening, and the throttle pipe has cast on it a supporting bracket which is bolted to the boiler shell. The valve is lifted by a transverse rotating rod, which passes through a stuffing box in the side of the boiler below the dome, and has an outside connection with the

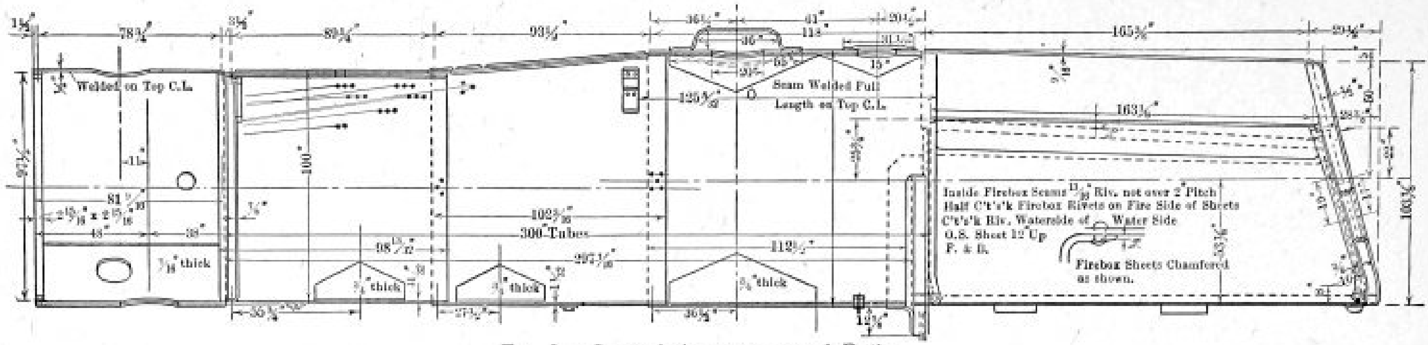


Fig. 2.—General Arrangement of Boiler

throttle lever. The latter is placed in a vertical position and is designed to give maximum leverage and slowest valve movement when the valve is starting to lift.

The superheater header is of cast iron, in one piece, and is designed for a 65-element superheater having 2,059 square feet of surface. The superheated steam pipes leading back to the high pressure cylinders are fitted with slip joints, and the right-hand pipe has a connection through a suitable cast steel elbow with the Simplex starting valve. This valve is located in the high pressure cylinder saddle.

When working compound the two high pressure cylinders exhaust into a common chamber, which communicates with the front and back receiver pipes. In starting, the intercepting valve is in such a position that live steam enters both the front and back receiver pipes, as well as the high pressure cylinders, and the high pressure exhaust is conveyed to the smoke-box through a separate pipe, which terminates in an annular nozzle surrounding the main nozzle. Both the main and auxiliary nozzles have removable thimbles. The intercepting valve is so arranged that, by admitting steam through a pipe connection from the cab, the locomotive can be worked single expansion at any time. When drifting, saturated steam can be admitted to the high pressure cylinders through a pipe connected with a lever valve placed in the cab.

The high pressure cylinder saddle is made in two pieces, the upper of which is riveted to the boiler shell, while the lower is cored out for the intercepting valve and pipe connections. All six cylinders are cast from the same pattern; they are of vanadium iron, so designed that bushings ¾ inch thick can be subsequently applied if desired. The pistons have dished heads of forged steel, with cast iron bull rings held in place by electrically welded retaining rings. The piston rods are of nikrome steel, without extensions. Vanadium cast steel is used for the crosshead bodies; they are of the Laird type, and are as light as is consistent with the strength required. The main crankpins are of nikrome steel, hollow bored, while the main and side rods and main driving axles are of chrome vanadium heat treated steel. Vanadium steel is used for the driving tires, and also for the springs. The valve motions are of the Baker type, controlled by the Ragonnet power reverse mechanism.

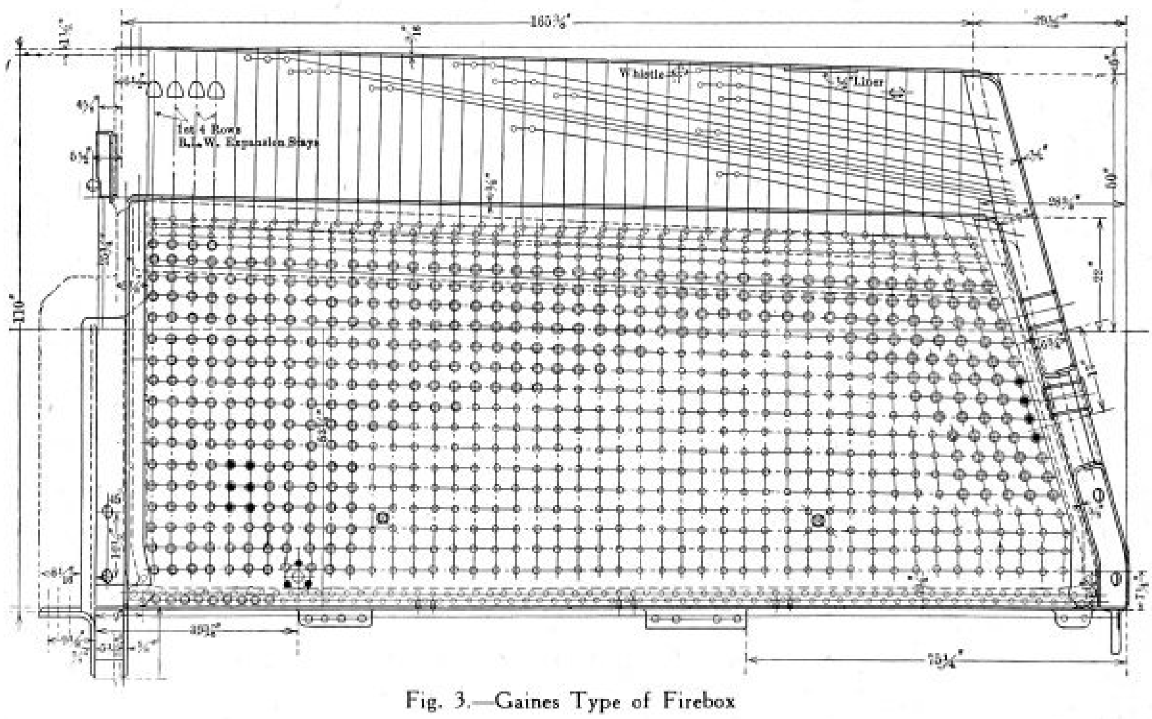


Fig. 3.—Gaines Type of Firebox

The frames are vanadium steel castings, 6 inches in width. The radius bars at the two articulated frame connections, are attached to horizontal transverse pins, and are fitted with case hardened spherical bushings, and embrace the hinge pins. This construction has been used by the builders in a number of recent Mallet locomotives. It provides flexibility in a vertical as well as a horizontal plane, and prevents binding at the hinge pins when passing over sudden changes in grade or poorly surfaced track. The structural details include a number of steel castings of unusual design. The waist bearers supporting the forward part of the boiler barrel, for example, and the three guide bearers, are all bolted to both the upper and lower frame rails, and constitute most effective transverse frame braces. The front bumper beam and deck plate are combined in a large steel casting furnished by the Commonwealth Steel Company and designed to house the Miner A-59 draft gear. This style of draft gear is used at the back end also.

The tank has capacity for 13,000 gallons; it is 33 feet 4 inches long, 11 feet 4 inches wide and 5 feet 9 inches deep inside. The top is rounded to a radius of 22 feet 1 inch and the top and side sheets are joined by a piece of plate which is bent to a 3-inch radius. This provides a neat finish and makes it impossible for water to accumulate on top of the tank. Supports for the tank are provided by the guide bearer of the rear engine, by two cast steel bearers placed respectively between the second and third and the third and fourth pairs of wheels of the rear group, and by three bearers composed of ½-inch plates, which are placed over the rear frame extensions.

The exhaust steam from the rear cylinders passes through a feed water heater, which is placed under the tank and consists of a long drum 22 inches in diameter. This drum is traversed by 31 tubes 2¼ inches in diameter, providing 437 square feet of heating surface. The exhaust steam passes through the tubes. The feed water is handled by a Blake & Knowles piston pump, which is placed between the tank and the heater. The pump is placed under the tank and back of the rear driving wheels. This arrangement requires a flexible connection in the steam line leading to the pump, but the latter handles only cold water and is far more reliable in service than it would be if placed between the heater and boiler, where hot water would be handled. The locomotive is equipped with two injectors also, for use in cases of emergency.

The tank is of such length that it overhangs the rear driving wheels by a considerable amount, and the weight of the overhang is carried by a four-wheeled, constant resistance engine truck of the Economy type. This truck has a total swing of 13¼ inches, and the load carried by it is equal to the total weight of an express passenger locomotive of thirty years ago. The leading truck, which is two-wheeled, is of the Economy type also.

Attention should be called to the sanding arrangements used on this locomotive. There are four sand boxes placed right and left over the boiler, two for the forward group of wheels and two for the middle group. Sand for the rear group is carried in a box which is placed on top of the tank. The pipes from this box are run to the bottom of the tank through two vertical pipes, 4½ inches in diameter. The sanders are of the Graham-White "Perfect" type, and in connection with them rail washers are placed at each end of the locomotives. A specially designed valve in the cab controls the supply of sand and washing water simultaneously. When the handle of this valve is turned in one direction, sand is delivered under the front drivers of each group and water is discharged through the washing pipes at the rear; while if the handle is turned in the opposite direction sand is delivered under the rear drivers of each group and water is discharged through the front washing pipes. Suitable nozzles are also provided for blowing out the sand traps and their pipe connections by means of compressed air. Flange oilers are applied to the front and rear driving wheels in each group.

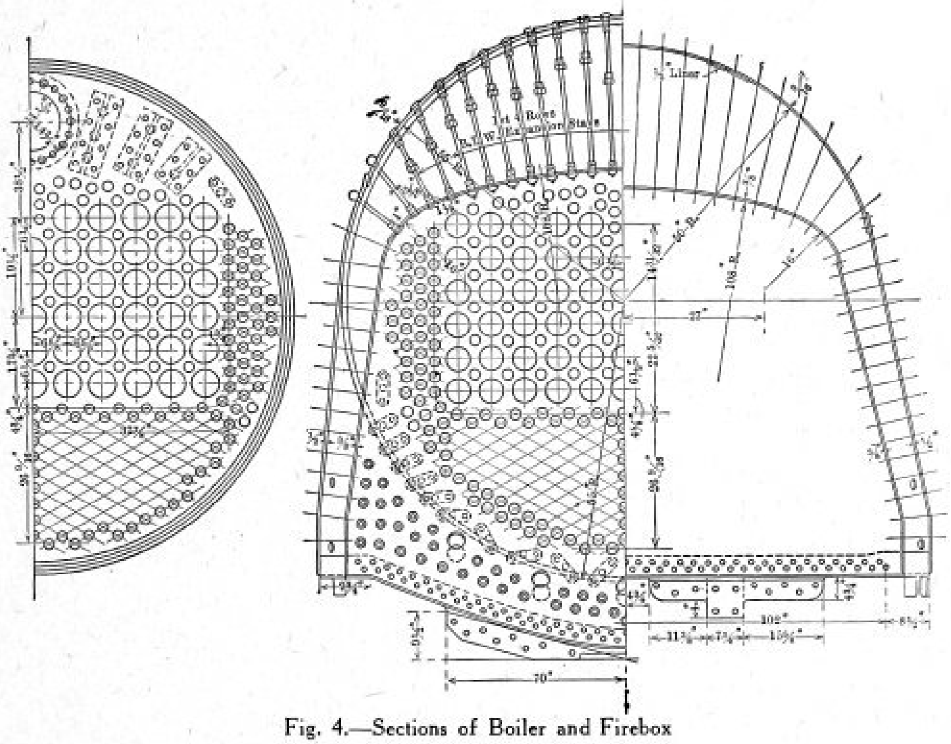


Fig. 4.—Sections of Boiler and Firebox

The cab is roomy and the fittings are conveniently arranged. The front wall of the cab is sloped to follow the inclination of the back head, in order to provide ready access to the staybolts. The advantage of a power reverse mechanism, as far as simplifying the arrangement of the cab fittings is concerned, is most apparent in a locomotive of this size. The equipment includes a pyrometer and a low water alarm.

Where practicable, the railway company's standard details have been used in this locomotive. The driving tires and driving boxes interchange with those of the class M-C Mikado type locomotives, which are used in heavy freight service on the low grade sections of the line.

Boiler

Type	Wagon-top
Diameter	100 inches
Thickness of sheets	31/32 in., 1 1/32 in., 1 1/16 in.
Working pressure	215 pounds
Fuel	Soft coal
Staying	Radial

Firebox *

Material	Steel
Length	188 inches

* Gaines furnace. Length of grate, 144 inches.

Width	108¼ inches
Depth, front	93⅝ inches
Depth, back	75⅞ inches
Thickness of sheets, sides	⅜ inch
Thickness of sheets, back	⅜ inch
Thickness of sheets, crown	⅜ inch
Thickness of sheets, tube	⅝ inch

Water Space

Front	5½ inches
Sides	5 inches
Back	5 inches

Tubes

Diameter	5½ inches and 2¼ inches
Material	Steel
Thickness	5½ in., No. 9, W. G.; 2¼ in., No. 11, W. G.
Number	5½ inches, 65; 2¼ inches, 365
Length	25 feet

Heating Surface

Firebox	359 square feet
Tubes	7,689 square feet
Firebrick tubes	72 square feet
Total	8,120 square feet
Superheater	2,059 square feet
Grate area	108.2 square feet

Weight, Estimated

On driving wheels	726,000 pounds
On truck, front	36,000 pounds
On truck, back	82,000 pounds
Total	844,000 pounds

Tank capacity	13,000 U. S. gallons
Fuel	12 tons
Service	Freight
Tractive force	166,300 pounds

Driving Heated Rivets Tight in Holes Through Cold Plates

BY H. W. HOOVER

We have conducted a number of experiments in driving heated steel rivets by the use of both hydraulic pressure and air hammers, from which we have derived the following:

First—That a uniform heat of a bright yellow color is required in rivet shank.

Second—That this heat is the best, regardless of the methods used in driving.

Third—That hydraulic pressure drives the best rivet, but—

Fourth—It does not fill the hole unless the pressure is held on to the rivet for a sufficient length of time after driving.

Fifth—The hydrostatic pressure required need be only sufficient to form a perfect end on the rivet, because—

Sixth—All pressure exerted in excess of this amount is wasted in so far as it does not insure a tight rivet.

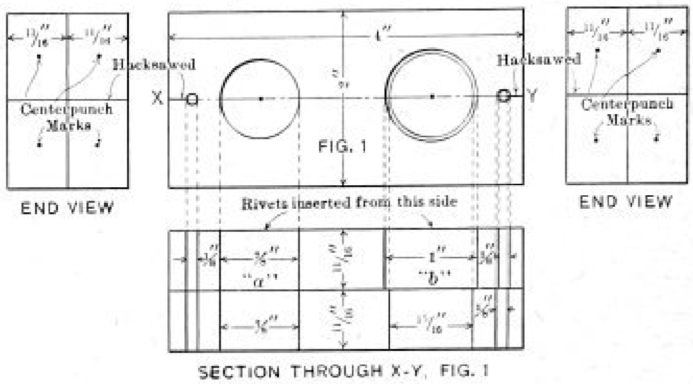
Seventh—Air-driven rivets do not fill the rivet holes.

Following is an explanation of the methods used in experimenting, also as proof for verifying the above assertions.

EXPERIMENT NO. 1

Two pieces of wrought steel plate were procured and each piece was machined on one side, the length and the width to 11/16 inch by 2 inches by 4 inches. They were then laid out and drilled for ⅞-inch rivets, as follows:

In the middle of the width, 1 inch from one end, a ⅞-inch hole was drilled in each piece. In the center of the other end of one plate a 1-inch hole was drilled, and in the other plate a 15/16-in hole (see sketch). Between the ends of each plate and these drilled holes a ⅛-inch hole was also drilled through the plates parallel to and 5/16 inch from the other holes, thus leaving a wall ¼ inch thick at this point adjacent to each rivet hole. The ends of each plate were then split by hacksawing them to these ⅛-inch holes. Center punch marks were then made, one on each side of this hacksaw cut on the ends of plates and accurately measured (trammed) at 1 inch for measurement after driving rivets in these rivet holes and for determining, if possible, which of the following two methods of driving rivets produced the greater pressure



Sketch of Test Specimens

on the inside of rivet holes—air hammer or hydraulic pressure.

These plates were then clamped together, machined sides in contact, with the ⅞-inch holes on one end, and the 15/16-inch and 1-inch holes on the other (see sketch). In the ⅞-inch hole (marked "a") a heated rivet was driven by using a 21-pound, long-stroke riveting hammer, operated by compressed air at 100 pounds gage pressure. After allowing it to cool, those center punch marks on that end were measured with trammel points and found to be exactly as they had been before rivet was driven into the hole, i. e., they measured 1 inch.

The plates were then taken to a hydraulic riveting machine and a heated rivet was driven in the other hole (marked "b"). The rivet was about ¼ inch longer than the other on account of size of holes to fill (see sketch). There was 120,000 pounds pressure on the ram of this machine and, consequently, on the rivet when it was driven. After allowing this rivet to cool, the center punch marks on these ends were trammed and found to have spread 1/16 inch (they measured 1 1/16 inch). The knowledge thus obtained was that there had been more internal pressure on the sides of the hole in which the hydraulic rivet had been driven than in that one containing the air-driven.

EXPERIMENT NO. 2

Two steel plates were obtained, one machined all over to 11/16-inch thickness, 5½ inches diameter, the other 5½ square and machined only on both sides 11/16 inch thick. Three rivet holes were laid out 2¾ inches P. C. from the center of the round plates, 2⅜-inch pitch. Both plates were then clamped together, central with each other, and ⅞-inch holes drilled through them. These holes were indelibly stamped No. 1, No. 2, No. 3. The No. 1 hole was filled by driving on a hydraulic riveting machine a ⅞-inch steel rivet heated to cherry red, with 120,000 pounds pressure on the rivet end and held for 15 seconds of time.

No. 2 hole was filled by driving on a hydraulic riveting machine a ⅞-inch steel rivet heated to bright yellow, with 120,000 pounds pressure on rivet end and held for one minute of time

No. 3 hole was filled by driving with a long-stroke, riveting hammer, weighing 21 pounds, operated by compressed air at 100 pounds gage pressure, a ⅞-inch steel rivet heated to bright yellow.

After cooling, the three newly-made heads, or ends, were cut off by hacksawing them close up to the plate (in order not to disturb the rivet shanks in their holes by chipping them off). No. 1 and No. 2 rivets were apparently tight, while No. 3 was loose and could be moved by twisting with the fingers. The plates were then taken to and bolted on a hydrostatic testing table, especially prepared to receive them, with water pressure on the side of plates from which rivet heads had been removed. A clamp was placed on top of No. 3 rivet as a precaution against blowing out. Pressure was then applied and at 50 pounds all the rivets leaked around their heads on the outside. These rivets were then drilled out and others substituted, as in—

Experiment No. 3.

These same plates were again used and ⅞-inch steel rivets heated to bright yellow were driven on the hydraulic riveting machine, with 120,000 pounds pressure on rivet held two or three seconds (as in ordinary boiler shop practice). These plates were then laid flat on a work bench and a Fahrenheit thermometer held in the center of plates (which was also the center of rivets pitch circle) until the highest temperature (180 degrees) of the plates, derived from the heat of rivets, was reached (after five minutes of time), when each rivet consecutively was given a squeeze on this hydraulic riveting machine, 120,000 pounds pressure, lasting two or three seconds. The newly-formed heads, or ends, were again cut off by hacksawing and the hydraulic test applied as before. All these rivets were then found to be absolutely tight, at 200 pounds gage pressure, which was maintained for ten minutes of time. This pressure was then gradually increased until 300 pounds was reached, when two of the rivets showed signs of leak and were slightly wet (sweating) around their heads; the other one was still absolutely tight. An explanation of the above is:

A certain amount of the heat from rivets is transferred to and absorbed by the metal surrounding them, which causes this metal to expand, but during this time the rivet is shrinking, not only lengthwise, but also in diameter, and, consequently, when both are again as cool as the surrounding atmosphere, the rivet holes are again the same size as when the rivets were driven in them, but the rivet has shrunk smaller in diameter than when driven and is not tight in the hole. By using the thermometer we were able to determine how long a time was necessary to elapse after driving rivets, until the plates had absorbed the maximum of heat from them; at that time the rivet holes would be the largest diameter, and at that time each rivet was given its final squeeze to make it then fill the hole and be a shrinking fit when cool.

We have also learned by experiment that the riveted joints in boiler construction, having the least slip, require less calking, not only on the hydrostatic test, but during the life of boilers. Consequently, as the hydraulic-driven rivets more nearly fill rivet holes than those driven by compressed-air hammers do, there is less lateral slip to plates, and after once calking them tight, they should remain so during the life of boilers, unless the chemical action of the water used for generating steam, or chemicals used for inside cleaning, attacks and eats through the calking from the inside.

Boiler Manufacturers Purchase New Plant.—The Chattanooga Boiler & Tank Company, Chattanooga, Tenn., has purchased the old Chattanooga Machinery Company's plant, which it will occupy after extensive alterations and improvements are made.

Application of the Golden Rule in Modern Business

George Oldham & Son Company, Philadelphia, Pa., relates the following incident as an illustration of the thoroughness with which the spirit of courtesy and liberality of the Ford Motor Company pervades every one of its numerous departments.

"We were searching for a better steel to use in one of the parts of our pneumatic tools, and had heard that the Ford Company was using in their axles a steel of proper quality to satisfy our requirements. We wrote to them, without introduction, and asked if they would be kind enough to let us have an analysis of this steel and also the name of the firm manufacturing it. They replied immediately, and not only answered our inquiries, but, from a thoroughly unselfish desire to assist us, they offered to make up, at their own expense, from various grades of steel, a number of the parts which were giving us trouble. They did this in order that we might find out by test which of the several varieties would most exactly suit our needs. We, of course, accepted their offer, and within a week we received the steel and also a letter telling just what kind of steel it was, and suggesting a formula for us to use in hardening it. Parts have been made up from this steel and treated in accordance with their formula, and have passed all of our tests.

"We cannot withhold a feeling of admiration for the generosity of this great company and for the painstaking interest which they displayed in helping us to solve our difficulty, and it gives us great pleasure and satisfaction to be able to express our appreciation publicly."

What Assistance Should a Boiler Shop Instructor Give Apprentices?*

BY F. C. REINHARDT

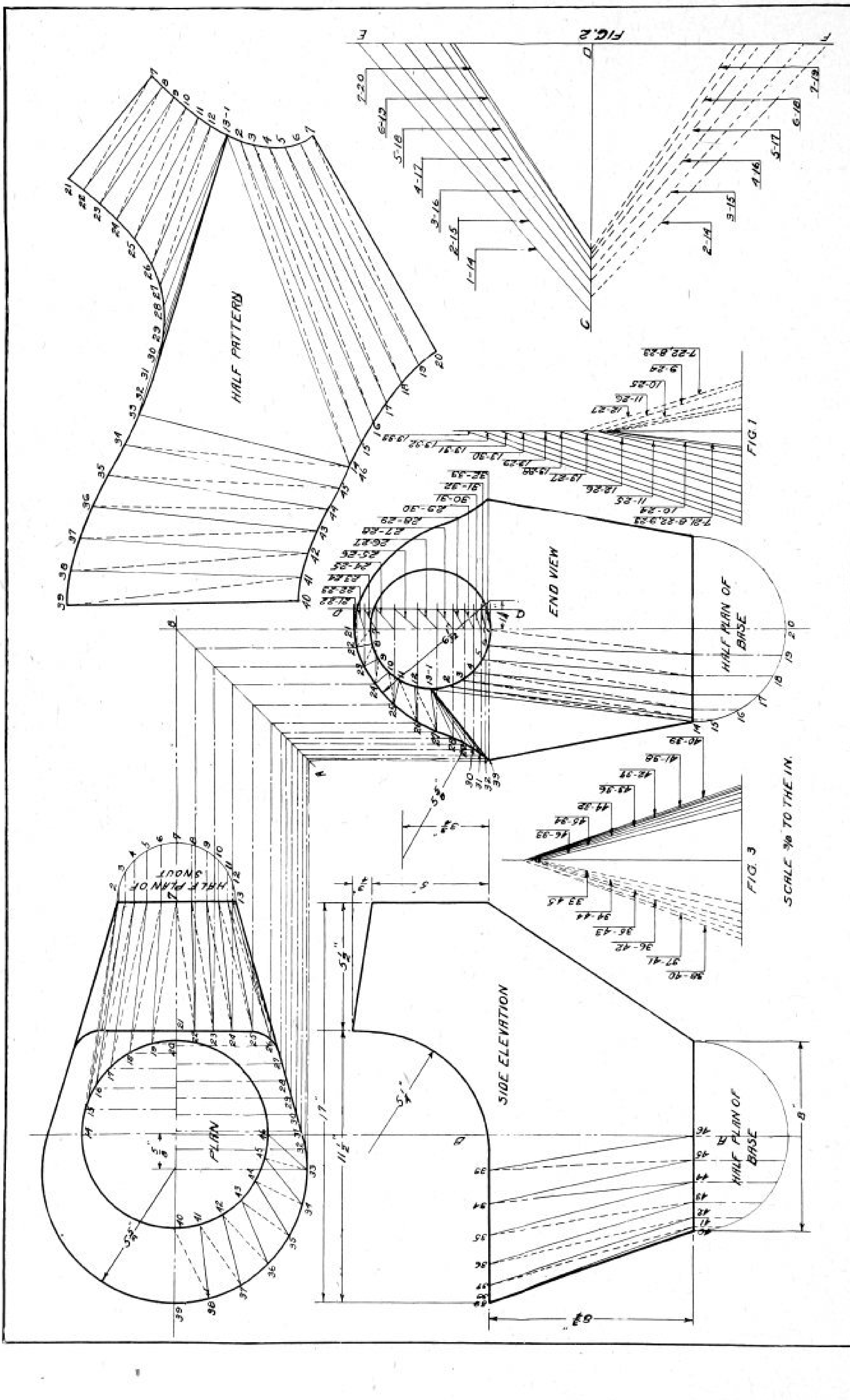
This subject was discussed by boiler shop instructors, and it was agreed that the instructors should not only tell a boy how to do the work correctly, but should actually show him. First explain the job to be done—that is, what is to be accomplished, the purpose and place for which used. Then show or demonstrate enough to give a correct idea both in handling tools and going ahead with the work.

There is not much danger of showing too much, but the instructor should not try to do all the work for an apprentice. The instructor should watch the work until sure that the boy can accomplish it satisfactorily. Strive at all times to gain and keep the confidence of the boys. Study each individual and handle according to personal requirements. There is a great deal of difference between boys even in the same shop. They cannot all be handled alike. Some will need more demonstrating than others.

Along this line it was also pointed out that the instructor should mix with the boys and be one of them. He should be prepared at all times to take hold and help the apprentices. This will result in their doing more and better work. It will take more time at first, but will save much time later on.

It was suggested that foremen in distributing work among the apprentices should notify the instructor when they put a boy on a new class of work, in order that the instructor may see that the boy is properly started.

* From proceedings of annual meeting of Apprentice Instructors, Santa Fe System, Topeka, Kan., May 25-27, 1916.



Layout of Patterns for Sand Bucket

Development of Sand Bucket

Triangulation Applied to Layout of Patterns for Sand Bucket—Location of Seams

BY R. J. HETTENBAUGH

First lay out the plan, side elevation and end views in accordance with dimensions shown. Since the design of the bucket depends largely on the dimensions used, they should be followed very closely.

Project the center lines from the plan and end views so they intersect at point *B*, and from this point scribe the forty-five degree line to *A*. Next scribe the half circle shown as half plan of snout and divide it into any number of equal parts, 13 being used in this drawing. Project these points to the object parallel to the center line. Next space off the line from 21 to 33 into the same number of points as was used in the half plan of snout. Project these points to the forty-five degree line *A-B* parallel with the center line of the plan view and thence at right angles to the end view, numbering the points the same as those in the plan.

Space off one-half of the small circle in the end view into the same number of points as was used in the plan and connect them with points 21 to 33, using dotted and full lines. In like manner connect the corresponding points in the plan. Next scribe the line *C-D* in the end view a distance from the center line equal to one of the spaces from 21 to 33 in the plan. Project points 21 to 33 so they cross this line and the center line at right angles and connect the intersections with diagonal lines. The use of these lines will be explained later.

Space off one-quarter and one-quarter of the top circle forming the bowl of the bucket into equal parts, as shown from 33 to 39 and 40 to 46 connecting the points with dotted and full lines. Scribe the half circle shown as half plan of base and space it off into the same number of points as was used in the plan. Project these points to the object and number the points to correspond with those in the plan.

Next project points 33 to 39 in the plan to the side elevation parallel to the center line *A-B* and number the points as shown. Connect the points with dotted and full lines. These lines are used as guides later in developing the construction triangles.

In like manner space off the opposite quarter of the base circle in the plan as shown from 14 to 20 and connect the points with points 1 to 7 in the half plan of snout. Also connect the corresponding points in the end view, using a half plan of base to get the lower points 14 to 20.

Construction Triangles

The next step will be to form the construction triangles. Fig. 1 shows the construction triangles for the arch, Fig. 2 shows the triangles for the throat and Fig. 3 shows the triangles for the bowl. To get the true length of line 7-21 in Fig. 1, take the distance between points 7 and 21 in the end view and place it on the base line in Fig. 1. Next take the distance between points 7 and 21 in the plan and place it on the perpendicular line in Fig. 1 and scribe a line intersecting both points as shown. This will be the true length of this line. In like manner get the true length of all the triangles in the arch of the bucket.

To get the distance between points 26 to 33 and their corresponding points in the snout, the points 26 to 33 must be projected at right angles to the center line in the plan as shown. This means that the distance between all points in the plan must be taken from the center line, the same as the length of line 7-21 in the plan was found. Thus to get the length of line 13-27, the distance on the perpendicular line in Fig. 1 must be taken from point 7 to the intersection of the projected line from point 27 with the center line in the plan. The distances on the base line are all taken from the dotted and full lines in the end view.

The triangles in Fig. 2 are found in the same manner. Project points 14 to 20 in the plan to the center line. To get the true length of these lines, take the length of the dotted and full lines in the end view as 13-14, 14-2, 2-15, etc., and place them on the line *C-D* in Fig. 2. Then take the distance on the base line *E-F* from point 7 and the intersection of the corresponding points with the center line in the plan. Thus to find the length of line 7-19, take the length of the dotted line 7-19 in the end view and place it on the line *C-d*. Then take the distance between point 7 and the intersection of point 19 with the center line and place it on the base line *D-F*. A line across these two points will be its true length.

The height of all the construction triangles in Fig. 3 will be the same as the height of the bowl, 8¾ inches, but the bases will be different lengths and will be taken from the dotted and full lines in the plan.

Forming the Pattern

The next step will be to form the pattern by piecing the construction triangles together. First scribe a straight line on the sheet and on this line place the true length of line 7-31 in Fig. 1. Next set a pair of dividers equal to the distance between points 21 and 22 in the plan, with one point on the line *C-D* at the intersection of the projected line from point 21 and open them up until the other point rests on the intersection of this projected line from point 22 and the center line. This will be the true distance between points 21 and 22. With point 21 in the pattern as a center scribe an arc equal to this distance.

Next take the length of line 7-22 in Fig. 1 and with point 7 as a center scribe an arc to cross the one just taken from point 21. The intersection of the two arcs will form point 22. Now set the dividers equal to one of the spaces in the half plan of snout and with point 7 as a center scribe an arc. Take the length of line 8-22 in Fig. 1 and with point 22 as a center scribe an arc to cross the one just taken from point 7. The intersection of the two arcs will form point 8. Continue in this manner until the arch of the bucket is complete.

Next take the true length of line 33-46 in Fig. 3 and with point 33 as a center scribe an arc, then take the length of line 1-14 in Fig. 2 and with point 13 as a center scribe an arc to cross the one just taken from point 33. The intersection of the two arcs forms point 14-46, and the triangle in the center of the pattern. With point 13 as a center scribe an arc equal to one of the spaces in the half plan of snout, then take the length of line 2-14 in Fig. 2 and with point 14 as a center scribe an arc to cross the one just taken from point 13. The intersection of the two arcs forms point 2. Continue in this manner until the throat of the bucket is complete.

Now with point 14-46 as a center scribe an arc equal to the length of line 33-45, and with point 14 as a center scribe an arc. With point 33 as a center scribe an arc equal to one of the spaces in the top of the bowl to cross the one taken from point 14. The intersection forms point 34. Now take the length of line 34-45 and with point 34 as a center scribe an arc, and with point 14 as a center scribe an arc to cross it equal to one of the spaces in the bottom of the bowl. The intersection of the two arcs will form point 45. Continue in this manner until the bowl is complete.

The bucket can be made with either two or three seams. If two are desired, fold the pattern on line 7-20 and cut out double; but if three are desired, cut out the half pattern and duplicate it. Three seams are generally used, as it saves considerable metal.

Fusible Plugs

At the present time there are used in boilers two types of fusible plugs. Their purpose is to protect the boilers from injury in the event of the water becoming too low. If the water gets below a safe level the metal in the plug melts and allows the steam to escape, thus apprising the attendant of the impending danger.

The two kinds used are "fire plugs" and "steam plugs." In the former the plugs are exposed to the products of combustion and are designed to melt when the water is below the plugs. In the latter, the plugs do not come in contact with the fire, being placed outside of the fire zone, as follows:

A one-half inch pipe is carried through the top of the shell (of a horizontal boiler), the lower end being open and just below the predetermined level. The upper end of the pipe, outside of the shell, is provided with brass castings, similar to an oil cup, in which is placed the fusible metal in the form of a wafer, held by a cap screwed in and having an opening through its center. The wafers are made to melt at any predetermined temperature within the range of steam pressures commonly carried. Similar wafers are used for sprinkler purposes and are well known. The operation of the steam plug consists in its melting and giving a steam blow signal when the water falls low enough to permit steam to enter the pipe.

The value of the steam form of fusible plug depends upon two conditions: First, the metal must be an alloy that will be certain to melt at or near the temperature of the steam under the pressure normally carried. Second, the pipe must be open and free at all times, and this should be looked after sharply by the inspector and the attendants.

The steam fusible plug is now used in the state of Wisconsin and in the city of Chicago. It has not been introduced, so far as we know, in other localities.

The fire form of fusible plug gives but little trouble when the feed water is ideal, such as in the New England States. However, with feed water carrying calcium or other heavy scale-forming matter, it has not given good results. With the common horizontal tubular boiler, for example, scale soon covers the plug and may cause the fusible metal to melt when the water is at proper level. Because of their non-dependability, fire fusible plugs are not used on railroad locomotive boilers, and they are of a type that really need a good low water signal.

The foreign marine insurance companies will not permit the use of fire fusible plugs in boilers of ocean vessels, although they are required by the United States Government Rules. Such boilers, when inspected in our harbors, have a fire fusible plug installed at the time the inspection is made, and when the inspector leaves the ship the plug is removed and a solid steel plug inserted.

In general, the objection to fire fusible plugs is sustained by the experience of the marine insurance companies and the railroads, and this leads us to say that there is room for an inventor to design a more practical low water signal than the present type, and that such a signal should also show "low water" with an empty and cold boiler, a situation not covered either by fire fusible or steam fusible plugs.—*Monthly Bulletin, Fidelity and Casualty Company of New York.*

Corrosion of Firebox Sheets Around Rigid Stays

Probably most boiler makers are familiar with the conditions resulting from the corrosion of firebox sheets in the immediate vicinity of the rigid stays by which they are held in place. It has been demonstrated, to the satisfaction of the sponsors of the flexible staybolt at least, that this trouble does not manifest itself when stays of that type are used, which suggests a very plausible diagnosis of the phenomenon. This is merely that, through the contraction and expansion of the sheets, the rigid bolts put the material adjacent to its point of attachment under repeated tension and compression; in a word, imposes on it the stresses incident to buckling action, thereby opening the surface fiber ever so slightly and exposing it the more readily to attack by the corrosive elements in the boiler water.

With flexible bolts applied under this condition, it was found that the corrosion of the plates was materially reduced, in fact it was almost negligible, but that the bolts themselves, near their rigid ends, suffered the corrosive effects of the water. With plates and bolts of the same general characteristics as before, this is a natural result and serves to substantiate the above diagnosis, since under the last-named condition greater freedom of the plates is allowed and greater flexure is imposed on the fixed end of the bolt, which causes a breaking up of its surface structure in that region and exposes it to corrosion. Accepting a corrosive quality of the boiler feed water as inevitable, as may be expedient under certain conditions of operation, it is well to keep this phenomenon in mind, so that the stays, whose failure is readily detectable and whose renewal is a comparatively simple and inexpensive matter, can be sacrificed in favor of the plate. In the instance referred to, the stays were attacked at their points of greatest weakness—i. e., at the threaded end close to the plate where the flexure was naturally greatest. This suggests an added value of the practice followed by some roads in reducing the diameter of the mid section of the stays below the diameter at the root of the threads; not only are the stays thus made more flexible, but the susceptibility of both bolts and plates to corrosion is lessened in proportion as localization of flexure is avoided. This consideration is of as great utility to the flexible as it is to the rigid stay. Incidentally, it shows a further reason why it is worth while to avoid breaking down the structure of the plate by drilling staybolt holes instead of punching them.—*Railway Review.*

The Acme Boiler & Sheet Iron Company, St. Louis, has been incorporated with a capital stock of $15,000 by A. J. Getz, Frederick Jones and others, to manufacture metal products.

The Northern Boiler & Structural Iron Works, Mill street, Appleton, Wis., has purchased five lots adjoining its present shops and will build an addition in the spring. Plans have not yet been prepared.

Locomotive Inspection Laws and Rules; Their Purposes and Achievements*

Establishment of Federal Locomotive Boiler Inspection Bureau—Scope of the Inspection Laws and Duties of the Inspectors

BY FRANK MC MANAMY †

Since the Locomotive Boiler Inspection Law was passed, the Department has investigated about 330 cases of locomotive boiler explosions. The result of the law has been to bring about a reduction in the number of such accidents. Because a correct and uniform understanding of the locomotive inspection laws and rules is essential to a proper observance or enforcement of their provisions, I have taken for my subject, "The Locomotive Inspection Laws and Rules, Their Purpose and Achievements."

I might, with equal propriety and perhaps more effect, have taken for my subject the popular terms, "Preparedness and Conservation," because they just as correctly represent and as accurately describe the purpose and achievements of not only the locomotive inspection laws, but all Federal safety legislation; not primarily preparedness for war, which is the popular understanding of the meaning of the term, but preparedness for industrial progress and development during times of peace; not primarily conservation of forests and water power sites or other natural resources, except to the extent that fuel is a natural resource, but conservation of the most valuable of all the nation's resources, either in time of peace or war, and the lives and limbs of the producers.

Need of Federal Inspection Laws

If doubt exists in the mind of anyone with respect to the need for Federal laws and the regulations established thereunder for the promotion of safety, it will surely be removed by a study of the records of the Interstate Commerce Commission, which show that during the fiscal year ended June 30, 1916, 9,366 persons were killed and 180,380 were injured in railroad accidents, and during the past twenty-five years 223,721 persons were killed and 2,184,339 persons have been injured in such accidents. It is true these figures include passengers, trespassers and others as well as employes, but during the fiscal year ended June 30, 1916, there were 2,758 employes killed and 163,448 injured, which is an illustration of the extent to which the employes are interested, and such laws have only been enacted when the list of casualties has made it apparent that employes and travelers upon railroads are not as fully safeguarded as they should be.

Railroad employes should recognize and be proud of the fact that they are daily engaged in solving what is no doubt the largest and most important industrial problem of the age; in fact, since the dawn of civilization the transportation question has been the one big problem that has been worked out by every age to meet its immediate needs, yet has continued to be the paramount problem for each succeeding generation, and the civilization or material progress of no nation or age can be more accurately measured than by its transportation facilities.

The evolution of modern transportation methods from the stage-coach to the complete, complex and remarkably efficient railroad systems of the present has been wonderfully rapid and has been made possible by the development of the locomotive. Without motive power the entire transportation system becomes useless. Its efficiency as a whole, therefore, depends entirely upon and is in direct ratio to the condition in which the motive power is maintained. In view of this, there can be no question that Federal laws requiring better maintenance of locomotives not only promote safety of employes and travelers, but are a direct benefit to the railroads from an efficiency standpoint.

Some railroad officials and employes appear to regard the passage of laws to promote safety as a reflection on the sincerity of their efforts to prevent accidents or on their ability in that direction, and as an unnecessary restriction of the right of the company.

These views may seem to be partly right and yet are entirely wrong. No one questions the fact that railroad men as a class are actuated by just as keen a desire to conserve life and property as anyone, but the pressure from sources which need not be enumerated here is often so great that they cannot do what they know should be done. The railroad operating organization is a steam-driven, high-speed machine which is worked to its capacity and the pressure is increasing each year. Federal laws are safety valves to regulate this pressure and prevent it from wrecking the machine.

The purpose of the locomotive inspection laws can perhaps be no more accurately or clearly expressed than it is in the title of the act, which reads in part as follows: "An act to promote the safety of employes and travelers upon railroads," and this appears in the title of and is the purpose behind every Federal law governing railroad equipment.

Duties of Federal Locomotive Boiler Inspectors

Under the law the duties of the Federal Locomotive Inspection Bureau are administrative, and the final determination of disputed points is a function of the courts. It is a well-established rule of law, however, that the practical interpretation of a law or rule by the department charged with its administration is entitled to the highest respect, and if acted upon for a number of years will not be disturbed except for very cogent reasons. Following this rule is an effort to avoid appealing to the courts, except in cases of irreconcilable differences with the carriers, as to the meaning of the law or rules, we endeavor to explain any parts which may be capable of more than one interpretation, believing that a uniform understanding of the requirements is the first step towards a proper observance of them.

Section 1 of the law provides that it shall apply to any common carrier or carriers, its officers, agents and employes, engaged in the transportation of passengers or property by railroad in the District of Columbia, or in any Territory of the United States, or from one State or Territory of the United States or the District of Columbia to any other State or Territory of the United States or the District of Columbia.

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* From Proceedings of St. Louis Railway Club.

† Chief Inspector, Division of Locomotive Inspection of the Interstate Commerce Commission, Washington, D. C.

Section 2 makes it unlawful for any such carrier to use any locomotive engine propelled by steam power unless the boiler of said locomotive and the appurtenances thereof are in a proper condition and safe to operate in the service to which the same is put, and the rules provided for in section 5 were intended to more clearly and definitely show just what was meant by the requirements of section 2, thus avoiding disputes with respect thereto.

We have, therefore, in these brief extracts from the title and sections 1 and 2 of the law a general outline of its purpose, to whom it applies, and what it requires.

Under date of March 4, 1915, an amendment to the locomotive boiler inspection law, extending its provisions to the entire locomotive and tender and all parts and appurtenances thereof, was enacted, making a locomotive inspection law out of what was formerly a locomotive boiler inspection law.

Enforcement of the Laws

The method provided by the law for enforcing compliance with its provisions is important. Recognizing the impossibility of 50 Federal inspectors actually inspecting the 68,000 locomotives in the United States, Congress placed that duty upon the carriers and made them responsible for the inspection, the repair, and the condition of their locomotives, and the duties of the Federal inspectors largely supervisory. To this end, section 6 of the law provides that the first duty of the Federal inspector shall be to see that the carriers make inspections in accordance with the rules and regulations established or approved by the Interstate Commerce Commission, and that carriers repair the defects which such inspections disclose before the locomotive or appurtenances pertaining thereto are again put in service. It further provides that:

"Whenever any district inspector shall in the performance of his duty find any locomotive apparatus pertaining thereto not conforming to the requirements of the law or the rules and regulations established and approved as hereinbefore stated, he shall notify the carrier in writing that the locomotive is not in serviceable condition, and thereafter it shall not be used until in serviceable condition."

It will thus be seen that the law first requires carriers to maintain their locomotives in a proper condition and safe to operate in the service in which they are put, and provides that the first duty of the Federal inspector shall be to see that this is done and that carriers make inspections in accordance with the rules. It further provides in cases where these duties are not performed by the carrier that the inspector shall issue a written order withholding the locomotive in question from service until the requirements are complied with.

In this the locomotive inspection laws differ from other laws governing the condition of railroad equipment: therefore, the method of enforcement has necessarily been worked out along somewhat different lines.

Achievements of Locomotive Boiler Inspection Law

The locomotive boiler inspection law was enacted more than five years ago and numerous explanations of what we believe it requires have been made; therefore, there are no good grounds for any claim that it is not fully understood and further explanation of its requirements should not be necessary.

Before taking up the locomotive inspection law, I will give you a brief summary of the achievements of the locomotive boiler inspection law during the five years for which the records have been completed.

During the five-year period from July 1, 1911, to July 1, 1916, 383,389 locomotives were inspected by Federal inspectors, of which 15,388 did not meet the requirements of the law and were ordered held for repairs. During the same period the number of accidents per annum caused by failure of locomotive boilers or their appurtenances decreased 59 percent, the number killed 68 percent and the number injured 59 percent.

The locomotive inspection law is comparatively new and is so comprehensive that explanations will, no doubt, be of substantial value in assisting carriers to meet the requirements. First, I shall make clear one point with respect to which we are receiving numerous inquiries, and that is that the locomotive inspection law and rules in no way affect or change any of the requirements of the locomotive boiler inspection law or rules. It is true that the form of reports for monthly and annual inspections was changed somewhat, a combination form covering the entire locomotive, including the boiler, having been adopted. This was done to avoid the necessity of requiring additional sworn reports and not for the purpose of modifying in any way the boiler inspection requirements.

In the preparation of the rules, which were approved by the Commission in their order of October 11, 1915, effective January 1, 1916, it was considered advisable to follow as closely as practicable the general plan of the locomotive boiler inspection rules, particularly with respect to making inspections and filing reports by the carriers. The purpose of this was to avoid, as far as consistent with a satisfactory compliance with the rules, inconvenience and expense to carriers in the matter of making such reports.

I shall not attempt to explain or define each rule, and it should not be necessary, as most of them are specific in their requirements and can scarcely be misunderstood. I will try, however, to make clear those that may be somewhat general in their terms and also any with respect to which numerous questions have been asked.

Explanation of Rules

It will be noted that rule No. 101 of the locomotive inspection rules is identical in its requirements with rule No. 1 of the boiler inspection rules, and makes the railroad company responsible for the general design, construction and maintenance of locomotives and tenders. Rule No. 102 is identical with rule No. 7 of the boiler inspection rules, and makes the officer in charge at each point where inspections are made responsible for the inspection and repair of all locomotives under his jurisdiction. Rule No. 103 is exactly the same as boiler inspection rule No. 8, defining the meaning of the term "Inspector." And they are intended to accomplish the same general results.

Rule No. 104 of the locomotive inspection rules reads as follows:

"Each locomotive and tender shall be inspected after each trip, or day's work, and the defects found reported on an approved form to the proper representative of the company. This form shall show the name of the railroad, the initials and number of the locomotive, the place, date and time of inspection, the defects found, and the signature of the employe making the inspection. The report shall be approved by the foreman, with proper written explanation made thereon for defects reported which were not repaired before the locomotive is returned to service. The report shall then be filed in the office of the railroad company at the place where the inspection is made."

Rule No. 104 was intended to accomplish the general purpose of the act that carriers shall "make inspection in accordance with the rules and regulations established or approved by the Interstate Commerce Commission and that carriers repair the defects which such inspections disclose before the boiler or boilers or appurtenances pertaining thereto are again put in service," and in connection with rule 102 to definitely place the responsibility for failure to make inspections and repairs. It was also intended to, and if properly observed does, protect the foreman or other officer in charge of the mechanical department who is responsible for the condition of locomotives from pressure which in many instances they are unable to withstand to send out defective locomotives in an effort to avoid terminal delays. No railroad man can truthfully claim that in the long run there is economy of either time or money in using defective equipment, and if delays due to defects are to occur it should be at terminals where repairs can be made without blocking the main line thereby.

Government Rules Fix Minimum Requirements

It should be borne in mind that Government rules are not stop standards, or intended to represent the general condition of equipment, but are minimum requirements, or limits which mark the point at which the Government will take action to bring about necessary improvement in the condition of equipment. In other words, they represent the extreme condition in which the locomotive will be permitted to continue in service.

Form No. 2, which is required by rule No. 104, was intended to accomplish two definite purposes: First, to show that an inspection of each locomotive was made at the prescribed periods. Second, to require the foreman or officer in charge to know the condition of the locomotive, and to say why defects reported were not repaired before the locomotive is returned to service.

One of the reasons for this is that in many cases it is practically impossible when an accident resulting from defective equipment occurs to fix the responsibility for the defects in question. The officials in charge of the work will often insist that the defect was not properly reported, or not reported at all; therefore, that they should not be held responsible for failure to make repairs. The person whose duty it was to report such defects insists with equal vigor that the defect was properly reported, perhaps had been reported numerous times, but had not been repaired. Failure to find the reports of a defect after an accident has occurred does not always indicate that such reports were not made, because frequently carbon or other copies of such reports are obtainable when the original reports cannot be found.

Rule 104, which requires an inspection after each trip or day's work, and a report showing the defects found, with the signature of the employe making the inspection, and requiring that the report shall be approved by the foreman, with proper written explanation made thereon for defects reported which were not repaired before the locomotive is returned to service, will assist in definitely fixing the responsibility for operating defective locomotives. It also makes it necessary for the foreman to exercise more careful supervision over the work, so that he may properly sign the report. These inspection reports must be kept on file in the offices of the railroad company, where they can be inspected.

One of our chief difficulties is getting form No. 2 approved by the foreman, "with proper written explanation made thereon for defects reported which were not repaired before the locomotive is returned to service," as required by the rule. We expected some difficulties in getting the inspections properly made, even though the rule differs, but little, if any, from rules which were supposed to be in general use, but we did not expect that it would be more difficult to get the foreman to perform his part of the work than it would be to get proper inspections made, and any foreman who disregards the rules himself can never hope to bring about a proper observance on the part of his subordinates.

If I were to be asked what in my opinion is the principal cause of locomotives being operated with defects which are violations of the rules, I would without hesitation say that the one important cause is lack of proper supervision. The average person in any line of work will follow the standard set by, and which is acceptable to, the person in charge of the work; or, in other words, they will give you just what you will take. It avails nothing to fix a high standard by rule, and then day after day on job after job to accept work that is away below the standard thus set. This willingness to accept work that is below the standard has a demoralizing effect on the force, and is the principal cause for poor work being turned out.

The requirements of rule 104 are practically identical with the system which has been said to have long been in force on all the important railroads in the country. The instructions shown on the form of report are, in effect, the same as those contained on similar reports which have been in general use. The only difference is that now there is a Federal rule that these inspections be performed and the defects reported, and that the foreman shall say why repairs were not made, while prior to January 1, 1916, it was a rule of the carriers only, and, as was stated by one general manager, "There is a great difference between a Federal rule, which must be observed, and the same rule adopted by a railroad company, which may be varied from at pleasure."

Rule No. 5 cannot and was not intended to modify or change the act of May 30, 1908, known as the Ash Pan act, requiring every locomotive to be equipped with an ash pan which can be dumped and emptied or cleaned without the necessity of an employe going under such locomotive. It was intended to, and does, provide that such ash pans shall be securely attached and properly supported, and that the operating mechanism shall be properly arranged and maintained in a safe and suitable condition of service.

Our inspections have disclosed numerous cases where ash pans are not maintained in accordance with the requirements of the Ash Pan Law, the best evidence of which is the fact that it is comparatively an easy matter to find some man under a locomotive hoeing out the pan, because the devices for cleaning it are inoperative or inefficient.

Investigation of Accidents

Another important duty which the law places on the Federal inspector is the investigation of all accidents resulting from failure from any cause of the locomotive or any of its appurtenances resulting in serious injury or death to one or more persons.

The question has frequently been asked, "What is a serious injury?" We have been following in this the rule long established by the Interstate Commerce Commission that injury which causes the loss of three or more days' time within ten days immediately following the accident is serious and should be reported. As a matter of fact, every accident is serious and should be investigated, because in most instances the number injured, or the extent of their injuries, is governed by circumstances. Every accident is an indication that something is wrong, either in the condition of equipment or in methods of operation, and whether anyone was injured at all should not be the determining factor as to whether an investigation should be made to find the cause and remedy the improper condition which may have existed; for instance, crown sheet failures, arch tube failures, flue failures, or, in fact, any failure of a locomotive may occur without resulting in injury, yet the cause is just as surely present as though serious or fatal injuries had resulted therefrom, and just as diligent efforts should be made to locate and remove it.

One of the principal reasons why the locomotive boiler inspection law had such remarkable success in reducing accidents was because it requires all accidents to be investigated and does not confine its work to only spectacular accidents which cause a great loss of life or which are unusual. Such accidents, when they occur, are given wide publicity and are usually very thoroughly investigated by both Federal and State authorities and active steps are taken to prevent a recurrence, for a time at least.

By far the greater percentage of killed and injured in railroad service is due to accidents of a character which are never brought to the attention of the general public because they are considered as a part of the day's work of railroad employes. In the regular course of his employment an engineman may be scalded or otherwise injured, a trainman may lose a finger, a hand or a foot, and none except his immediate family and co-employes are aware of the occurrence, yet to the person injured and to his family the injury is just as serious as though it had resulted from a spectacular accident which would receive columns of newspaper comment. These are the accidents which swell the list of killed and injured, and an investigation of each one of them to correct whatever may be wrong with the equipment or with the methods either of the man or the company will do more to reduce the accident list than special investigations of spectacular accidents which, after all, may be traced back to some minor cause.

Causes of Accidents

To illustrate, I showed you a few minutes ago views of an accident which resulted in the death of six persons, serious injury to ten and caused a property damage estimated at $15,000, and this accident was caused by failure to properly hook up the steam heat hose at the rear of the tender.

In another case of record where a serious accident is directly traceable to a minor defect, a local passenger train was stopped between stations by the failure of the pipe leading from the main reservoir to the air signal whistle. Before the pipe could be repaired and the brakes released or the flagman could get back far enough to protect the train, it was struck by a through train which was following, killing eleven and injuring ten persons. While in this instance the flagging was not above criticism, the first step in the sequence of events leading up to the accident was the failure of the signal pipe which had been reported the previous night, but had not been repaired.

Accidents almost without number which result from similar minor causes might be cited, but this is sufficient to establish the point and to impress upon all the importance of giving attention to details and remedying all minor defects before serious results follow.

The Locomotive Inspection Bureau in its relation to the railroads has always frankly taken the position that the work of preventing accidents and promoting safety to employes and the traveling public can be most successfully accomplished where a genuine and intelligent interest and hearty co-operation between the railroads, their employes and the government exists, for which coercive measures are but a poor substitute.

It must not be assumed from this, however, that the question of co-operating with us in this work and to what extent will be left to the discretion of the railroads, and where our best efforts fail to bring about this very desirable condition, then, of course, other measures must be resorted to, the extent of which will depend entirely on the carriers.

Realization of a Uniform Boiler Code*

BY J. C. M'CABE†

In every city and state where any regulation has been instituted, there seems to have been a studied effort to provide a regulation that would be different from any other regulation existing. I do not believe that this attitude was based on any desire to do harm to the manufacturer, but as a means or opportunity to incorporate ideas that reflected local opinion. In Detroit boiler inspection was started on September 20, 1881. A perusal of earlier ordinances in that city shows that the regulations were entirely without force. No provisions were embodied to control quality of material, design, or safety factor. The whole matter was left to the judgment of the inspector. I am informed by an engineer friend that one inspector in the early days of the work insisted that a boiler shell was twice as strong at the longitudinal joint as elsewhere, because the shell had twice the thickness of plate. Another inspector believed that a boiler with a pressure of 100 pounds would be as safe with a factor of four as another boiler would be with a pressure of 175 pounds under a factor of six. It will be seen that the first boiler would be allowed a unit load of about 15,000 pounds and the second 10,000 pounds, or a difference of 50 percent.

In the early days the appointment of inspectors was a matter of politics. In one Western city a hatter was made inspector, while in another city a butcher was appointed. In another case a near riot occurred in a labor meeting where a plasterer sought endorsement of the labor men in order to secure the appointment. I mention these three cases just to show the futility of any inspectional work under such conditions, both as it relates to public safety and as it relates to square dealing.

The belief seems to exist in some sections that any set rules may be enacted and enforced. This is a serious mistake. The only excuse for boiler inspection is such an amount of supervision as will make a boiler reasonably safe. It has been said frequently by able men that no law can be enforced that goes beyond the moral consciousness of a community. It seems to be an American habit to make drastic laws and then proceed to forget their existence. Our great need is a level, fair-dealing, universal and uniform code of laws throughout the United States.

It is well for inspection authorities to remember that their sole excuse for existence is based on the question, "Is inspection of steam boilers necessary to protect life and property?" If we answer the question affirmatively, we must then proceed to effect the desired result in a reasonable manner. It must be apparent to all of us that we must make the best use of available methods and materials. Were it mandatory that steamboat boilers be made from platinum or gold, boilers would be rather scarce. Therefore, reasonable limits must be made that will not make the purchase price for reasonably safe boilers prohibitive. The general demand for better materials in all lines will, because of increasing consumption, bring a lower price with the higher standard because of the refinement methods.

The present conditions of conflicting boiler laws is in effect as senseless and irritating as was the old toll-gate

* From an address delivered at the American Uniform Boiler Code Congress, Washington, D. C., December 4, 1916.
† Chief Boiler Inspector, Detroit, Mich.

Are Fire Box Sheets Welded With The Oxwelding Process Efficient?

Answer:

The tensile strength of a single lap riveted seam is approximately 52% to 60% of the strength of the metal itself.

By tests, it has been proven that the tensile strength of a seam welded by the Oxwelding Process is from 80% to 85% of the metal itself.

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on every few miles of highway. The toll-gates that heedlessly and needlessly impede the progress of the boiler maker are still with us. Every large manufacturer has just as many toll-gates to pass through from his factory as there are conflicting boiler codes. It is no uncommon thing for a boiler man to say to a buyer, "I'm sorry, old man; we have some boilers that are good in Saskatchewan, but they won't go in Oklahoma."

The tendency to uniformity in all lines must be fruitful. We must bear in mind that the courts will not uphold conflicting laws relating to boiler inspection. The final test before the courts must be: Is the boiler a reasonably safe one? This being true, it must be evident to all that the basis of action is to get all States dawn to uniform rules. This uniformity should be so thoroughgoing that the paragraphing, paging and indexing of the regulations would be identical in all States in the Union. To bring this about, the American Uniform Boiler Law Society has done much good work. Uniformity of boiler laws has taken on an aspect that is national in its scope. The American Society of Mechanical Engineers, our great national society, have prepared a code which must eventually satisfy every demand for safety and engineering horse-sense. Let us go back to our State, adopt the A. S. M. E. code and be reasonable. Reasonableness means safe boilers from good material, methods and workmanship. Under our Interstate Commerce Law no barrier to commerce can stand.

Among Indiana Boiler Shops—II

Handy Floor Plate—Freezing of Air Pipes—Cutting Out Reinforcing Pads—Useful Coal Box

BY JAMES FRANCIS

In one boiler shop which the writer visits occasionally—and he never went there yet without finding a new "kink"—they have in constant use one of the most handy appliances he has found in any shop, large or small, east or west. The device is a large floor plate 77 inches by 54 inches and 4 inches thick. It has thirteen rows of square 2-inch holes in each row, and there are eight rows of the holes spaced 5-inch centers with 5 inches of solid iron on all sides outside of the holes.

The floor plate, shown by Fig. 1, was not quite accurately drawn. In making the sketch the mistake was made

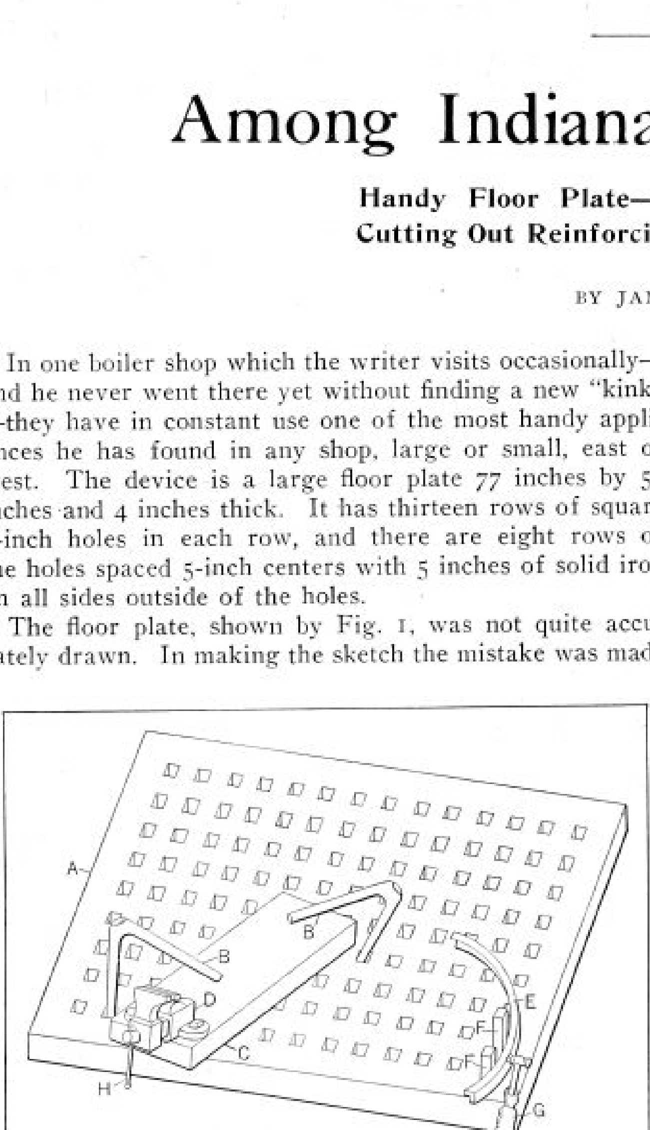

Fig. 1.—Floor Plate

of putting in thirteen spaces between holes instead of thirteen holes, thus making the pictures 5 inches too long. The same thing was done with the rows of holes, nine showing, where there were only eight rows in the plate sketched. And the writer did not change the sketch to correct the error, for—life is short, and the plate sketched is better than the real one, therefore if you make a plate like it, you will know how many holes and rows of holes a plate of stated dimensions should have, which is a bit different from the one shown by Fig. 1.

The men in that shop do lots of things on this floor plate. They have some "boomberang clamps" with which they can hold almost anything upon the plate, either work or tools for handling work. Two of these clamps are shown at *B B*, also the manner in which they are used. Each clamp is made of 1½-inch round iron, the middle of which has been upset for about 6 inches until it is 2¼ inches in diameter. Then each clamp is cut 38 inches long, with the swelled or upset portion in the middle, then bent to about 60 degrees as shown in the engraving.

The clamps *B B* are shown in action, holding fast the plank *C*, to which is permanently attached the heavy vise *D*. The writer tested the holding power of the clamps by attempting to move the plank *C*. A piece of iron about 4 feet long was placed horizontally in the vise jaws, projecting in one direction only. The writer then applied his 220 pounds at the end of the iron, but was unable to make plank *C* slip on the floor plate.

The driving down of the clamps *B B* causes them to cramp in the floor plate holes, and as each fraction of leg length is driven downward by lusty sledge blows upon the thickened portion of the clamp, the clamp sinks farther and farther into the floor plate and springs open a bit, gripping the vise plank with all the force of the spring developed in the clamps. As one of the shop men put the matter, the clamps held tighter than "death to a nigger!"

The floor plate was located near the smaller flanging forge, which also served as a forging fire, and the vise *D* was used by the smith as needed. No other vise was provided for his use in that shop.

As a measure of the tightness with which *B B* held the vise in place, the writer saw a man cutting off pieces of 2-inch T-iron with which to reinforce some milling machinery steel cases. In order to cut the T-bars, the workman placed a piece in the vise *D*, with the point to be cut in line with one end of the vise jaws. Then, with a handled cutter, he drove a cut closely beside the vise jaws—in fact, he used the vise jaws as one part of a shear, the cutter forming the other jaw of the shear, and with it he cut both flanges from the edges to the center, shearing it right along the vise jaws. Then he turned the cutter down flatwise and cut the vertical flange which was clamped between the vise jaws. This was cut from the bottom upwards as far as the cutter could be driven, on account of the corners of the steel shape.

The next step was to discard the cutter, and the helper delivered heavy sledge blows upon the top of the T-shape, striking as closely as possible to the end of the vise jaws. It only required a few blocks to cause the bar to shear itself off—the small part of which had not been cut—and the T-bar quickly came in two, close to the end of the vise jaws and the cut presented all the appearances of having been sheared off in a special shear for structural shapes.

One thing which this workman did when he was getting ready to cut the T-shape was very bad and should not be done by any *good* mechanic. The objectionable thing which he did was the tightening of vise *D* by striking on handle *H* with a heavy hammer. The vise seemed to work a bit hard or stiff, so the workman struck a few blows on handle *H* to tighten the vise against the work. This is very bad shop practice. Don't do it. Instead, just oil the screw of the vise and you will then be able to tighten the vise with both hands on lever *H* so it will hold fast any work put between the vise jaws. But *don't* tighten a vise with a hammer. It's not mechanical. It's worse than stealing candy from the baby. Don't do it!

Freezing of Air Pipes

During cold weather it is a very necessary matter to so arrange pipes leading from the air compressor or from the receiving tank that the water which always manifests itself when air is compressed may not collect in some depressed portion of one of the pipes, freeze and cause all kinds of trouble. In the shop where the floor plate is located the compressor is located pretty close to the floor. In fact, the arrangement of this compressor was described in a former issue of The Boiler Maker, in one of the writer's stories, under the caption of "A Shop of His Own."

When the compressor was installed the pipes were laid in an open trench along the floor of the shop and left thus in order to be able to thaw out any stray water which might have been caught and frozen inside the pipes. But one morning the pipes were found plugged fast, and when they went to remove the cause of the trouble, lo and behold, there were no pipes in sight. "The Kid," as the shop foreman designated the young man who was in charge of the compressor, had occupied some of his leisure moments by laying a very neat brick pavement all around the compressor and the pipes were frozen tight beneath two inches of frozen bricks and three inches of shop dirt floor.

The remarks with which the foreman spiced his labor as he tore out the brick pavement would not look well in these columns, but the remarks must have been effective, for the bricks came up in record time and a few shovelsful of hot coals from the flanging forge quickly removed the ice from the air pipe. After this occurence the foreman did what he might have done in the first place. He let "the Kid" bend up some odd strips of boiler plate in U-shape. These strips were then buried in the shop floor, just flush with the surface thereof, with the air pipe inside the U. Then a flat piece of thin plate was thrown on top of the U-shape, and there was the air pipe safely located in a fine "getatable" conduit of its own where it was only the work of a minute to remove the cover plate and throw in hot coal when there was too much frost in the pipe.

But "the Kid" says he has no use for hot coal for thawing the pipe. He says it's far too much work to dig the coal out again. He does the thawing by dumping a pint of gasoline from the "Old Man's" automobile tank into the pipe conduit, sets the gas on fire, slips the cover partially in place, and the ice is gone before he can get the compressor started.

Shaping Small Angle Steel

Another floor plate job which I saw handled nicely in this shop was the shaping of small angles to fit some steel machinery guards which were being put together in the shop. The angles had been rolled, but proved to be on too small a radius, but they were quickly and easily "opened" on the floor plate, as shown at *E* in the lower right-hand corner of Fig. 1.

They have a number of square steel plugs which fit the holes in the floor plate and two of these plugs are shown at *F F*. These plugs are driven into the plate until they stand firmly, then the piece of angle *E* is placed against the plugs as shown, and a little hammer solo as represented at *G* soon "opens" the circle of the angle to the desired radius.

By handling the angles in this manner they are at all times kept straight in the other direction, being, in fact, made actually upon a surface plate where any tendency to twist or to bend out of shape sidewise would be promptly detected and could be remedied right then and there by a few hammer blows delivered vertically.

Cutting Out Reinforcing Pads

While the writer was in this shop, one of the men was given the job of shearing out 48 reinforcing pads,

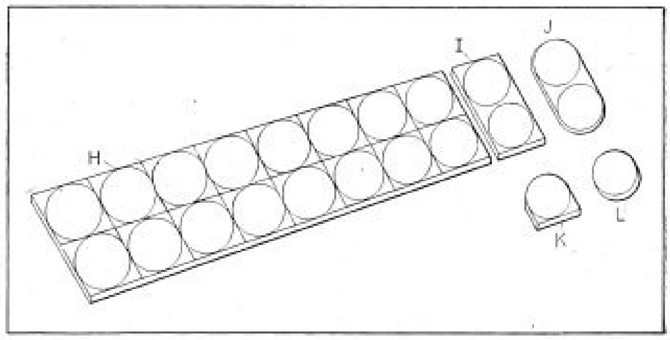

Fig. 2.—Method of Shearing Reinforcing Pads

each about 5 inches in diameter. There was no circular shear in this shop and the workman went about the job as shown by Fig. 2. No attempt was made to use small waste pieces of plate for this job, which fact caused me to ask the foreman why waste pieces were not used. His reply was that it was desirable that the pads for this job be all of the same thickness and to hunt out pieces of waste plate which would make out the order. To select those of the proper thickness would cost far more for time than the difference in cost of the material would amount to, therefore he sheared all the reinforcing pads from the same plate and was sure that they were of the proper thickness.

The first thing the workman did was to mark out and shear a pattern from thin sheet iron—stove pipe iron, in fact—and then to shear off as many strips *H*, Fig. 2, as would make the required number of pads. The strips of plate were made just wide enough for two pads, as shown at *H*, about 10 inches, and after the strips had been sheared off, they were marked by the sheet-iron pattern, thus avoiding entirely all divider work.

The next step was to shear the strips across the end into blanks of two disks, each as shown at *I*. All the strips were thus sheared up into blanks of two pads each, after which they were all gone over again and the ends rounded as shown at *J*. This operation was performed, as were all subsequent shearings, with the blanks held in a pair of stout tongs of regular blacksmith's pattern.

The shear used was a small affair, with jaws about 12 inches long and so adjusted that the close corner never opened and the end of the jaws most open never closed during a stroke. A stout bearing bar was arranged of just the right height to keep the plate flat while bearing on the upper side of the tongs. With this outfit the workman proceeded to shear out the pads from the pieces *I*, Fig. 2, first shearing off both ends, as already stated, to bring the blanks to the condition shown at *J*.

The peculiar method followed by this man was to place the blank between the shear jaws while they were closed, then, as the jaws opened, he pressed the blank toward the heel of the shear, keeping it at all times in the exact position necessary for the shearing cut. In this manner the shear was always properly located upon the circumference of the circle, and when the shear reversed and the jaws closed the blank was right in position to receive the cut, with no further manipulation necessary.

As the shear jaws moved at rather slow speed, the workman was able to swing the tongs sidewise a little as the cut proceeded, so as to make the shear jaws follow the circular mark quite closely, thereby cutting to almost a true circle—so closely, in fact, that only a few rubs of each pad against an emery grinder was necessary in order to bring the finished pads to a pretty true circumference one-half way around, as shown at *J*.

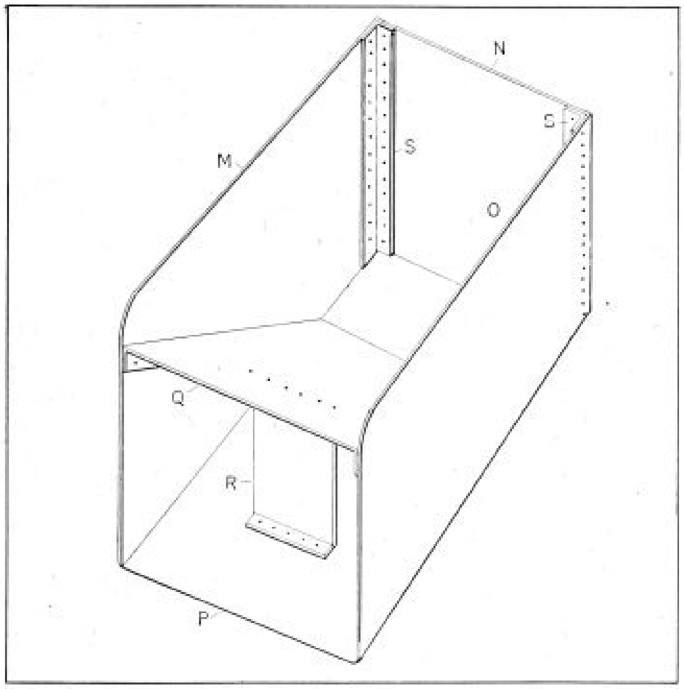

Fig. 3.—Construction of Steel Coal Box

Then the rounded-end blanks were cut in two, as shown at *K*, after which each piece was rounded, forming the finished pad as visible at *L*. The operation proved to be very speedy, far less time being required than it takes to read about it and the 48 pads were all sheared out and ready for drilling in less than an hour and a half.

A Good Coal Box

Far too many boiler shops are real slovenly in regard to the smithing coal used in the several fires and forges. Far too often there is found a slovenly pile of coal in one corner of the shop, from which each man takes a supply with a shovel as required, often having to carry the shovelful of coal 50 to 70 feet, dropping bits of fuel all along the line. Sometimes a wooden box or bin is provided for the coal supply, but when this is the case the wooden receptacle is usually in such a state of dilapidation that there may be more coal outside than inside of it.

The most excellent steel coal box illustrated by Fig. 3 is easily made up, the bottom *P*, sides *M* and *O* and the end *N* all being in one piece, the corners cut out and the sides and ends bent up and riveted to angles *S, S*. The front corners of sides *M* and *O* are rounded to a generous radius, then the inclined end or shovel-surface *Q* is riveted in, the sides and bottom being flanged over as shown. This piece, being flat, had best be supported by a wide brace *R*, which is to be flanged top and bottom and riveted in position as shown. The box which was the subject of this sketch was made of 3/16 inch tank steel and seemed to fill the bill completely. The space below the shovel-board *Q* was utilized by the smith, who used it as a place for stowing away the various swages and other contraptions which he used around the forge.

The writer suggests that, should any reader build some of these coal boxes for shop use, in addition to the brace *R* another sheet be put in abutting against brace *R*, the new sheet to lie in a horizontal position, the ends flanged and riveted to vertical sides *M* and *O*. The new bit of plate would then form a shelf underneath shovel-board *Q*, by means of which the space under that sheet would be much more convenient for the bestowal of the smith's tools and appliances.

What Work Should Be Given Apprentices Transferred from the Larger to Smaller Shops or Vice Versa

BY J. H. LEWIS

Certain classes of work are not performed in the smaller shops, and other work not at the larger shops. To remedy this instructors should see that each boiler maker apprentice should be transferred sometime during his apprenticeship, preferably during his sixth or seventh six-months' period, so that he may get the various classes of work offered in both the larger and smaller shop.

Apprentices should be transferred from the smaller to the larger shops to get laying out, patch welding, flanging, flue sheets, door sheets, fitting up new work, etc., and any other work that is not done in the smaller shop. Apprentices should be transferred from the larger to the smaller shops to get roundhouse experience, running repairs, hot work, front ends, etc., patch bolt patches, and other kindred work common to the smaller shops.

In connection with this the following schedules of work have been adopted:

From Larger to Smaller Shop or Roundhouse

Six weeks grates and hot work.

Six weeks patch bolt patches and hand riveting.

Six weeks staybolts and plugging cracks.

Four weeks inspecting, hydrostatic tests and staybolt tests.

Four weeks front ends and ash pans.

From Smaller to Larger Shops

Six weeks flue and door sheets and welded patches.

Six weeks fitting up new work.

Six weeks laying out.

Two weeks flange fire.

Four weeks radial stays.

Four weeks driving staybolts and radial stays.

Four weeks gas welding.

Four weeks inspecting, testing, etc.

Two weeks welding and swedging flues.

Two weeks flues.

Also, if possible, keep him for a year, giving him the remainder of the time on general boiler making work.

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NOTICE TO ADVERTISERS

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 25th of the month, to insure the carrying out of such instructions in the issue of the month following.

In the present National crisis an opportunity presents itself to American boiler manufacturers to serve their country in a manner which is of the utmost importance. On account of the ruthless destruction of merchant shipping by German submarines, there has been created an urgent need for new vessels to maintain the overseas commerce with the allied nations at war. In order to accomplish this purpose without unduly interfering with the foreign trade to neutral countries, the newly created Federal Shipping Board has determined to build a large fleet of medium-sized wooden cargo boats. It is estimated that the resources of the United States are such that by October first next something like 200,000 tons of vessels of this kind can be produced each month, and the plans of the Shipping Board contemplate the construction of from eight hundred to a thousand such vessels. The resources which must be depended upon for this construction are not only the immense forests in this country, but also the smaller machine shops and boiler shops throughout the land. These vessels must be equipped with either oil engines or steam machinery of sufficient power to give the vessels a speed of ten knots at sea, and for this purpose hundreds of marine boilers will be needed as soon as they possibly can be constructed. Every boiler shop in the United States which is so situated and equipped that it can undertake work of this kind should immediately place its facilities at the disposal of the Federal Shipping Board and give government orders the preference for the next twelve or eighteen months. If the plans of the Shipping Board succeed, the combined production of steel and wooden vessels in this country will exceed any possible rate of destruction by the German submarine warfare, and the Central Powers cannot fail to see that it is beyond their power to overcome the resources of the forests, shops and labor of the United States. No opportunity of greater importance for service to this country has ever before been presented to American boiler manufacturers, and a prompt response to this urgent need, when the call comes, will be one of the most effective means of overcoming Germany's ruthless aggression on the high seas.

The American Uniform Boiler Law Society, Erie, Pa., has issued a condensed report of the American Uniform Boiler Code Congress held in Washington, D. C., on December 4 and 5, 1916. The booklet comprises eighty-five pages 8½ by 11 inches in size and gives stenographic reports of the speeches and resolutions presented. The addresses which are quoted in full were delivered by Hon. T. J. Duffy, Industrial Commission of Ohio; Dr. F. R. Hutton, vice-president American Museum of Safety; Prof. L. P. Breckenridge, Yale University; J. C. McCabe, chief boiler inspector, Detroit; D. M. Medcalf, Ontario; Henry Hess, Philadelphia; Edward N. Hurley, late chairman of the Federal Trade Commission, and others. The Congress adopted resolutions recommending the universal adoption of the boiler code compiled by the American Society of Mechanical Engineers.

Those who were unable to attend this important congress should secure a copy of this report and read the highly instructive and interesting addresses. Few, we believe, can fail to be convinced of the great need of the universal adoption of the A. S. M. E. boiler code, and all, we hope, will do everything in their power to further this project.

The latest cities to adopt the American Society of Mechanical Engineers' Boiler Code are St. Louis and Kansas City, Mo.

In designing an efficient steam boiler, careful consideration must be given to the design of the furnace. As the majority of boilers are built with hand-fired furnaces, the information given in a recent publication issued by the Bureau of Mines, Department of the Interior, Washington, D. C., on the subject of combustion in the fuel bed of hand-fired furnaces will be found of great value. As a result of very thorough investigations, it is found in general that about one-half of the fifteen pounds of air used to burn one pound of coal in the furnace is supplied through the fuel bed—that is, from beneath the grates—while the other half must be supplied over the fuel bed. A thick fuel bed reduces the rate of combustion and thus reduces the capacity of the boiler. These facts should be kept in mind when designing a boiler furnace, and it should be remembered that sufficient space in the furnace and combustion chamber must be provided for a thorough mixing of the gases distilled from the fuel bed and the air supplied over the fuel bed, which in itself comprises about one-half of the total amount of air necessary for completely burning the fuel.

Engineering Specialties for Boiler Making

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

American Staybolt Development

Due to human fallibility, it is a fact that practically all new devices have to be developed toward perfection by service and that one seldom hears of a new thing being perfect at the start. This is very true of railroad specialties and particularly so of locomotive staybolts, which are subjected to stresses in service that cannot be approximated on any testing machine yet devised. The American Flexible Bolt Company started with a theory of a staybolt structure to overcome the troubles and expense due to the use of the ordinary rigid staybolts and with some few months of shop experience in production, together with favorable opinions as to their theory from many railroad mechanical department officers.

The American Staybolt was first brought out in 1913, being made at that time of two pieces of half-round iron laid together, the ends being upset and welded and the body twisted. The use of this design, while it served to demonstrate the principle involved, also disclosed several points on which improvement could be made, and accordingly, early in 1914, a change was made to the use of round iron instead of half-rounds.

The change was made in the face of heavy orders, involving haste in making the change and production for some months following. The practice was and is to slot out the body and re-form it to a round and twist it, in order to obtain the principle of relative body flexibility obtaining in the original design.

As a result of shop and road experience, many improvements have been made in minor details of the design and production, culminating recently in changes which are now announced and may be summed up as follows:

The body slot has all edges and ends worked and rounded so as to present no square or sharp edges on which lateral vibration can register.

The fillets formerly used, joining the body to the threaded ends, have been changed to long tapers, giving better lines for the flow of the material from the ends into the reduced diameter body.

Both of these structural changes are in line with well-known principles in machinery design where lateral stresses are involved.

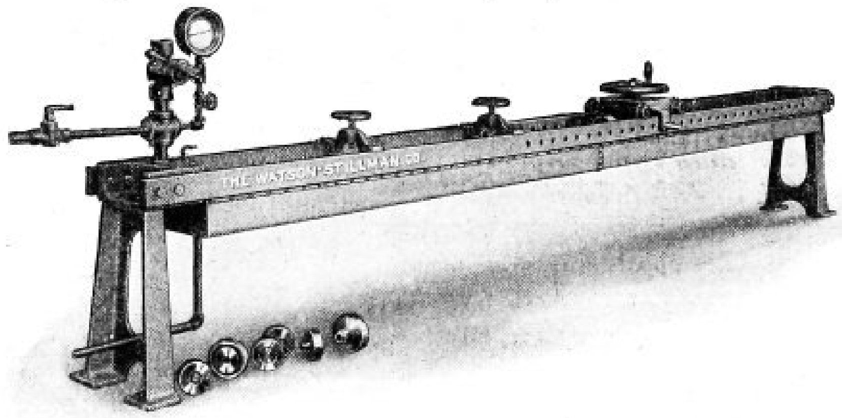
The re-forming or forging down of the body was formerly done by hammering, but the hammers have now been eliminated and the entire forming of the body, after slotting and working, including forming of the end tapers, is done by rolling, the subsequent operations being twisting and then straightening in a press, at which time the square for application is formed.

All of the forging operations are completed with one heating of the blank, the forged bolts being piled up still red hot for slow cooling before machining.

Laboratory tests prove that the working as now done to produce the body structure of American staybolts effects a material improvement in their strength and ability to withstand lateral stresses. The ratio of yield point or elastic limit to the tensile strength as shown by some sixty tests on six of the leading brands of staybolt iron was .676. The average ratio for the American staybolt body as produced with above described methods was .738, an increase of 9.17 percent or an indication of great gain in the ability of the structure to withstand service stresses and fulfill claims made for the American staybolt. Vibratory tests also show great improvement over the record attainable with former product.

The rolling process effects very little change in the original structure of the iron, which, being piled with regard to service intended, is added to in value by the reduced outer fiber stress of the body sections to withstand maximum lateral vibrations.

The American Flexible Bolt Company is well into its second million of American staybolts marketed, about half of these being for 913 locomotives ordered prior to January 1, 1917, three-quarters of which are of the heaviest types of passenger and freight power. A number of roads have standardized it for their requirements in maintenance as well as for new power and the company is in receipt of good business at the present time.



New Machine for Testing Boiler Tubes Up to 4¼ Inches Outside Diameter to a Pressure of 1,200 Pounds per Square Inch

Watson Stillman Boiler Tube Testing Machine

The Watson Stillman Company, of New York, has added to its line of hydraulic machinery a new testing machine for subjecting boiler and other tubing to internal hydrostatic pressure. The machine is designed to be used either with a hand or power driven pump, so that it is adaptable to shops of only occasional testing or for large capacity.

The machine consists of a frame with two rectangular tie bars, at one end of which is a stationary abutment; at the other end a moving abutment in the shape of a carriage mounted on rollers, which can be adjusted to the length of the tubes to be tested and then secured to the side frames by pins, and a high pressure hydraulic pump to subject the tubes to a predetermined internal hydraulic pressure.

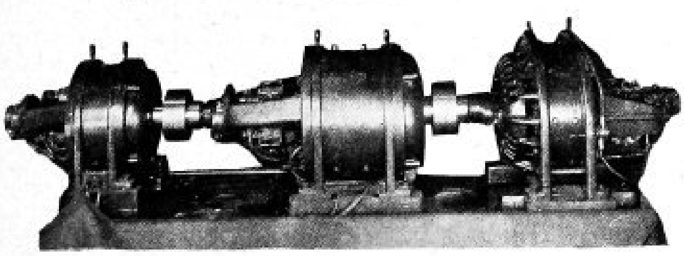
The tube to be tested is placed in the machine with one end against the fixed abutment, the moving abutment is then brought to bear against the other end of the tube, pinned to the frame, and the tube is made pressure tight by turning the hand wheel. Two intermediate clamps operated by small hand wheels prevent the tube from buckling while under pressure. The tube is then filled from a water main or overhead tank or by a low pressure pump. After the tube is filled, a high pressure hand or power pump is used to raise the pressure to the desired test, as shown on the gage.

There is a pan under the bed of the machine to catch the waste water, which will serve also as a reservoir if a pump is used for the initial filling.

The machine illustrated is designed to test boiler tubes up to 4¼ inches outside diameter to a pressure of 1,200 pounds per square inch. The minimum opening is 5 feet, maximum opening 15 feet and weight of machine 2,000 pounds. Other sizes to meet special requirements can be built, using the same general design.

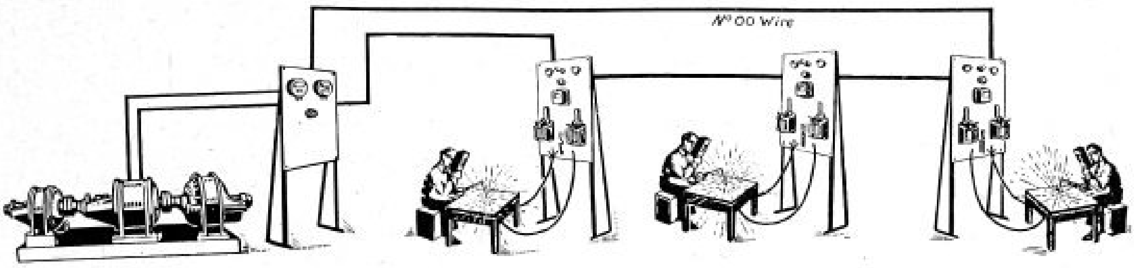
Constant-Current, Closed-Circuit Arc Welding System

Arc welding practice as it exists to-day is based on operation of arcs from constant-potential circuits, and since arcs operated under these conditions are unstable, it is necessary to connect in series with each arc a ballast



Self-Regulating Electric Welding Generator

resistance. In the early days, comparatively high voltage circuits were used and enormous quantities of energy wasted in resistance. Later, as arc welding became of greater industrial importance, generators were constructed specially for the purpose, and the voltage was made as low as possible, until finally it has settled down to from 60 to 70 volts. Automatically controlled resistance which changes with the value of the current permits the use of a lower voltage, but the arc still has the constant-potential characteristics.

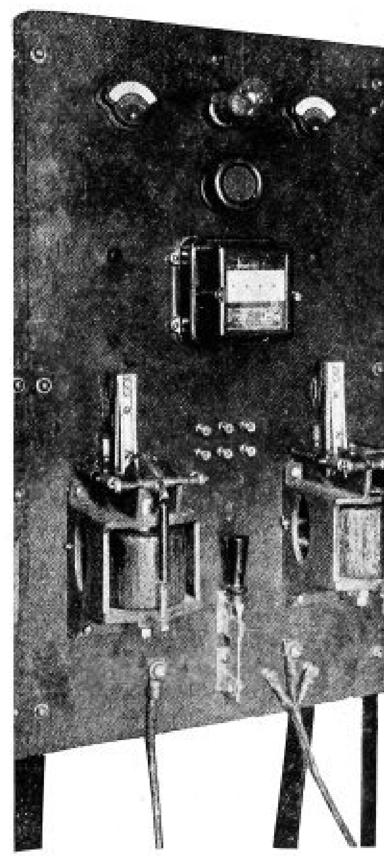


Wiring Diagram, Constant-Current, Closed-Circuit Welding System

A normal welding arc consumes about 22 volts. However, depending upon the operator and upon the work, it may vary from 18 to 28. Therefore, any voltage produced by the generator in excess of this must be absorbed in resistance and wasted.

The constant-potential arc, when operated in multiple with other arcs, requires a separate circuit from the generator end of the line, or at least from a point in the distribution system where the voltage regulation is close, otherwise the coming on and the going off of the various arcs will disturb the regulation to an intolerable degree.

On account of the expense of low voltage distribution circuits for constant-potential arcs, practice has drifted



Automatic Arc Heat Controller for Constant-Current, Closed-Circuit Operation

toward the single-arc unit, portably mounted. The Electric Welding Company, electric welding contractors who have been in electric welding business for nearly ten years, developed in their practice a new system of arc welding, and, in order to place this system on the market, organized the Arc Welding Machine Company as a separate corporation. The Arc Welding Machine Company has perfected the system, now known as the constant-current, closed-circuit system, which operates arcs in series.

This method, it is claimed, has all the advantages of series distribution, namely, the size of wire is uniform throughout the system and carries a uniform current, independent of the length of the circuit as well as of the number of operators. The circuit is simply a single wire of sufficient cross-section to carry the current for one arc, run from the generator to the nearest arc, from there to the next, and so on back to the generator. Wherever it is desired to do welding, a switch is inserted in the line and a special arc controller provided with suitable connections plugged in across the switch whenever work is to be done. These controllers may be made portable or permanently mounted at the welding station.

The generator is a special machine and consists of two units—the generator proper, which furnishes the energy for welding, and the regulator, which automatically maintains the current at a constant value. The regulator is excited from a separate source, and by varying its excitation with an ordinary field rheostat the main welding current may be set at any value within the range of the machine that is desired, and once set it will automatically maintain that value.

Each arc that is operated on the system is equipped with an automatic controller, which serves two essential purposes: (1) It maintains at all times the continuity of the circuit, so that one arc cannot interfere with any of the others when it comes on, or goes out of, the circuit; (2) it controls automatically the heat which can be put into the metal of the weld. The current through the arc, together with the size of pencil, determines the flow of metal from the pencil, and this current is adjusted by shunting any desired portion of the main current around the arc. The regulation characteristic of the arc is adjusted by a series parallel resistance, which is patented.

For a given flow of metal through the arc the temperature of the metal is determined by the length of the arc—that is, by the voltage. With this controller the length of the arc limited by the voltage is adjusted to suit the work and the operator, and if exceeded the arc is short-circuited automatically and remains short-circuited until the welder is ready to begin again. Provision is also made for stopping the arc at will without lengthening it. Therefore, with this system it is claimed it is impossible to draw a long arc and burn the metal; the most important of all, the arc is not broken when the welding operation is stopped, but is killed by a short-circuit which is placed across it.

Stopping an arc by short-circuiting and limiting the heat production in the same way is also patented. A great step in advance has been made, it is claimed, by short-circuiting the arc instead of breaking it, because it is impossible to avoid leaving a crater with pinholes by any other means than reducing heating of the metal, and this is the most effective method of doing it. On account of the fact that the arc heat is auomatically controlled and limited, it is possible to use a lower grade of labor in welding operations with this system. The number of arcs that can be connected in series is limited only by the voltage, and up to the present time 12 is the maximum number for which machines are constructed.

PERSONAL

E. E. Stillwell, general master boiler maker of the Waters Pierce Oil Company, was promoted on March 1 to the position of master mechanic for the company at its refinery at Tampico, Mexico.

Harrison W. Craver, chief librarian of the Carnegie Library of Pittsburgh since 1908, has tendered his resignation to the library committee of the board of trustees of Carnegie Institute, to take effect April 1. Mr. Craver has accepted a position as director of the library of the United Engineering Societies of New York, and left Pittsburgh the latter part of March to assume his new charge. His new position will put him in direction of what is believed to be the largest engineering library in the world, with approximately 150,000 volumes on technological subjects on its shelves.

NEW BOOKS

Proceedings of the Twenty-Fourth Annual Convention of the International Railroad Master Blacksmiths' Association. Edited by A. L. Woodworth, secretary. Size, 5½ by 8¼ inches. Pages 200. Numerous illustrations. Lima, Ohio, 1916: International Railway Master Blacksmiths' Association.

The principal subjects discussed at the twenty-fourth annual convention of the International Railroad Master Blacksmiths' Association, held at the Sherman House, Chicago, April 15 to 17, 1916, included flue welding, frame making and repairing, drop forgings, tools and formers, spring making and repairing, frogs and crossings, carbon and high speed steel, oxy-acetylene and electric welding, case hardening, shop kinks, heat treatment and methods, heat treated steel, powdered coal as fuel for blacksmith shops, piece work and reclamation. In most cases the topics were covered by either committee reports or individual papers; but where no reports were submitted the subjects were discussed by the members of the association on the convention floor. Those subjects of special interest to boiler makers are, of course, flue welding and oxy-acetylene and electric welding.

How to Make a Business Pay. By Edwin L. Seabrook. Size, 6 by 9 inches. Pages, 175. Numerous illustrations, New York, 1916: The Sheet Metal Publication Company. Price, $2.

All too frequently first-class boiler makers who have every qualification for handling shop work have attempted to establish shops of their own, only to find that they were unable to conduct the business on a profitable basis. This has been due to no lack of knowledge on their part of boiler making itself, but to a lack of understanding of the fundamental principles on which successful business is conducted. It is very evident that for such men business training is necessary, and for them this book will give much valuable information.

The book was developed from a long personal business experience of the writer in one of the branches of the building trades and an active official connection of twelve years with a large national trade organization identified with that field. It starts out by explaining the mental qualifications for conducting business, and then takes up the methods of ascertaining the true cost of conducting business and approved methods of estimating on contracts. Although the information given here does not apply directly to boiler making, nevertheless an understanding of the methods explained would be of great help to a boiler manufacturer or sheet metal worker. We have no doubt that these chapters alone will be of immense help to many men now having difficulties in making their business show profits.

Other subjects taken up in detail are bookkeeping, effective collection methods, plans for extending business by publicity, correspondence and how to utilize it for profit, securing and retaining custom, office equipment and its uses. The book is strongly recommended not only for the beginner in boiler manufacturing, but also for the well-established manufacturer who wishes to increase his business along paying lines.

Questions and Answers for Boiler Makers

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

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

Address your communication to the Editor of the Question and Answer Department of THE BOILER MAKER, 461 *Eighth avenue, New York city.*

Washing Out Boilers—Drafting a Locomotive Boiler—Staybolt Inspection—Effect of Low Water—Tube Leakage—Drumming of Boilers

Q.—(1) Will you kindly tell me the proper way to wash boilers, what nozzles to use and when to use them?

(2) Also please tell me how to draft a locomotive and what signs and indications they have to go by?

(3) I would like to know the correct line to follow when inspecting and how to tell defective and broken staybolts with hammer?

(4) Also why, when an engine, with water below her crown sheet, burns and does not blow up sometimes until injector is put on. How does water going over the sheet effect this?

(5) Also why sometimes when a complete set of tubes in a locomotive are leaking, two or three licks on the sheet will stop them from leaking?

(6) I have had experience lately with a leak located in the throat sheet, which does not blow only when engine is in operation. Why is this?

(7) I have had several explanations on why a locomotive and some stationary boilers drum on being fired up. I would like this explained.

W. J. D.

A.—(1) There are two methods employed in washing boilers, viz., by the cold water method and by the use of hot water. There are advantages to be had in using hot water, as the work involved in cleaning a boiler is shortened, therefore the engine may be put into service quicker than if cleaned by cold water. Hot water cleans the boiler surfaces better than cold water and does not produce contraction of the boiler parts which arises in the use of cold water. Time is saved in getting up steam after the boiler is cleaned by refilling with hot water, thereby also saving fuel required to get cold plates and water hot.

The following steps in the operation of washing a boiler with cold water are usually observed.

(a) Cool the boiler by drawing the fire; then if there is sufficient steam pressure start the injector and fill the boiler with water until the injector stops. Then continue filling the boiler by connecting a hose with the boiler feed pipe and main water supply. When the temperature of the boiler shell is cool enough to allow the hand to remain in contact with it, remove the wash out plugs, open blow off cock to drain the water off.

(b) With a hose using a straight nozzle wash the crown sheet and its sides, working through the plug holes in the back head. With bent nozzle clean the door sheet and about the door ring.

(c) Clean the cylinder courses and flues from the front end, washing the scale and mud to the firebox. Use a bent nozzle to clean the flues and a straight nozzle to clean the bottom of the shell courses.

(d) Wash the legs of the boiler through the side plug holes, using a bent nozzle, and be careful to remove all sediment, scale, etc, from the mud ring and mud ring corners.

(2) There are a number of conditions that prevent the proper draft in a locomotive boiler; namely, improper adjustment of either the petticoat pipe or deflector plate; or to tubes that are filled with cinders due to improper firing; or to too strong a draft through certain tubes; or when the tube ends in the firebox are honeycombed with slag; or the exhaust steam may not produce sufficient vacuum to create the required draft.

An engine with a poor draft cannot be operated economically; therefore, to remedy such a condition, first clean the flues and remove the honeycombed mass from tube ends in the back flue sheet. Next determine if the petticoat pipe or deflector plate are properly adjusted; this must be found out by trial. When the fire burns strongly at the back end of the firebox, it shows that the draft is stronger through the upper rows of tubes. By raising the sleeve of the petticoat it will retard the flow of gases through the upper tubes. When the proper adjustment is made the fire will burn evenly. By lowering the apron of the deflector it will produce the same result. If the fire burns strongest in the front end of the fire, raise the apron of the deflector plate, which will relieve the strong draft through the lower tubes. When the fire door and crown sheet are covered with soot, it indicates poor combustion due to a choked draft. There are no set rules to follow in making such adjustments of the draft appliances, as what would serve for one engine may be valueless for another.

(3) Locomotive boilers are now inspected by the U. S. Government at regular intervals for corrosion, grooving that affect the condition of plates, stays and flues, etc. Both internal and external examinations are made for defects of material that weaken the boiler, etc. In previous issues of THE BOILER MAKER the methods followed in making such inspections have been fully treated on. Therefore, we desire to call our subscriber's attention to them.

The hammer test is made to determine broken stays and the condition of the plates. The test for locating broken stays is as follows: A helper holds a sledge against one end of the stay while the inspector taps the other end with a hammer. If the stay is solid, the blow given the hammer reacts quickly; whereas, if the stay is broken there is a dull sound and very little reaction from the blow. In some cases it is difficult to determine a solid stay from one that is partially cracked, especially when the broken ends are in close contact. A good plan in such tests is to subject the boiler to an air pressure of from 40 to 60 pounds per square inch; this pressure is sufficient to keep the broken or cracked stays apart.

(4) A crown sheet without water is liable to burn, and as a result the tensile strength of the plate is lowered. Cold water in striking the hot crown plate causes contraction of the metal, which sets up a stress that very often cracks the plate. When the sheet is in a weakened condition, it is liable, from the action of the pressure upon it, to drop or bulge, forcing apart the crown sheet braces, etc., and in such a damaged condition the boiler is liable to explode unless precautions are taken by reducing the pressure. This may be done by deadening the fire, closing the dampers and starting the injectors.

(5) We do not exactly understand this condition, but we will state that possibly in striking the sheet as mentioned it has the tendency of placing the expansion stresses in the plate (due to heat), so that the tubes conform to the shape of the holes in the tube plate, thus taking up the leaks. Let us hear from our subscribers on this matter.

(6) The leak referred to may be caused when the injector is in operation. A good fire should be kept when flues and seams in the firebox are leaky, so that the feed water will not cool the plates and tubes. The cooling effect of the feed water causes contraction of the metal and the heat from the fire causes expansion, which sets up stresses that may produce leaks in seams and tubes.

(7) The drumming noise in the firebox is due to an improper combustion of the fuel. The gases from the fuel in such cases, when mixed with the air in proper proportions, explodes causing the drumming effect. This condition is remedied by opening the fire door.

Layout of Ship Ventilators

Q.—Please illustrate the development of a ship ventilator having longitudinal sections, also one with sections having cross or girth seams? PHILIPPINE.

A.—A ventilator made up of strips or segments is shown in the perspective, Fig. 1. The joint lines are shown running lengthwise of the ventilator. In forming the strips of such an object, they are raised or hammered so that the sections form a symmetrical curved surface when assembled together.

The triangulation method is employed in developing the patterns of the segments as shown in Fig. 4. Draw a side and front elevation indicating the arrangement of the segments. The location of the inlet opening, which in this case is elliptical in shape, is drawn first in the front view in its proper position. Divide its outline into the desired number of spaces. Do likewise with the profile shown below the front view. Project the points *a, b, c, d, e* to the base of the front view. Then draw the curved lines connecting the points *a-a, b-b, d-d, e-e*, etc. These curves are drawn in an arbitrary manner. From the front

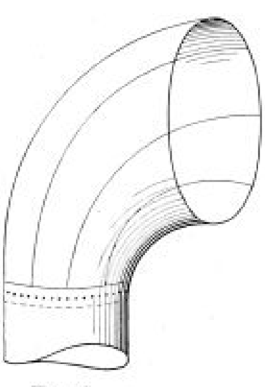


Fig. 1

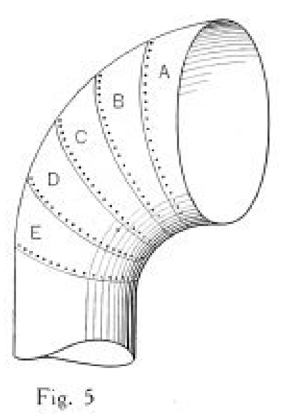


Fig. 5

view project the points located on the ellipse as at *a, b, c, d*, etc., to the line *c′-g′* in the side view. Upon the lower base locate the points *c′, b′, a′, h′, g′*, by transferring the vertical distances between the points *a-b, b-c, a-h, h-g* of the profile view. Draw in the side elevation the curved lines between the points *c′-c′, b′-b′, a′-a′, h′-h′, g′-g′*. These curves may be drawn in at will, and it is advisable to sketch them in first so as to obtain well-proportioned segments.

The next step is the location of the construction lines in both views from which triangles are constructed to determine their true lengths. With these true lengths the patterns are to be constructed. In this case the section defined by the curves *b-b* and *c-c* will be laid off as an example. Divide the curves *c′-c′* and *b′-b′*, side view, into a number of equal divisions. Number them so that their relative positions can be fixed in both views. Connect the points with dotted and solid lines as shown. For the bases of the triangles use the lines shown in the front view. Their corresponding heights are projected from the side elevation as shown. The spaces between the points *c′*-1, 1-2, 2-3, etc., on the curved line *c′-c′* are shown in the true length in the side elevation. The spaces on the curved line *b′-b′* of the side view are not shown in their true length; therefore, to determine their true lengths construct Fig. 3. In this case it is done by extending the line *c-c* of the front view. Upon it locate the distances between the points on the curve *b-b* of the side view, and

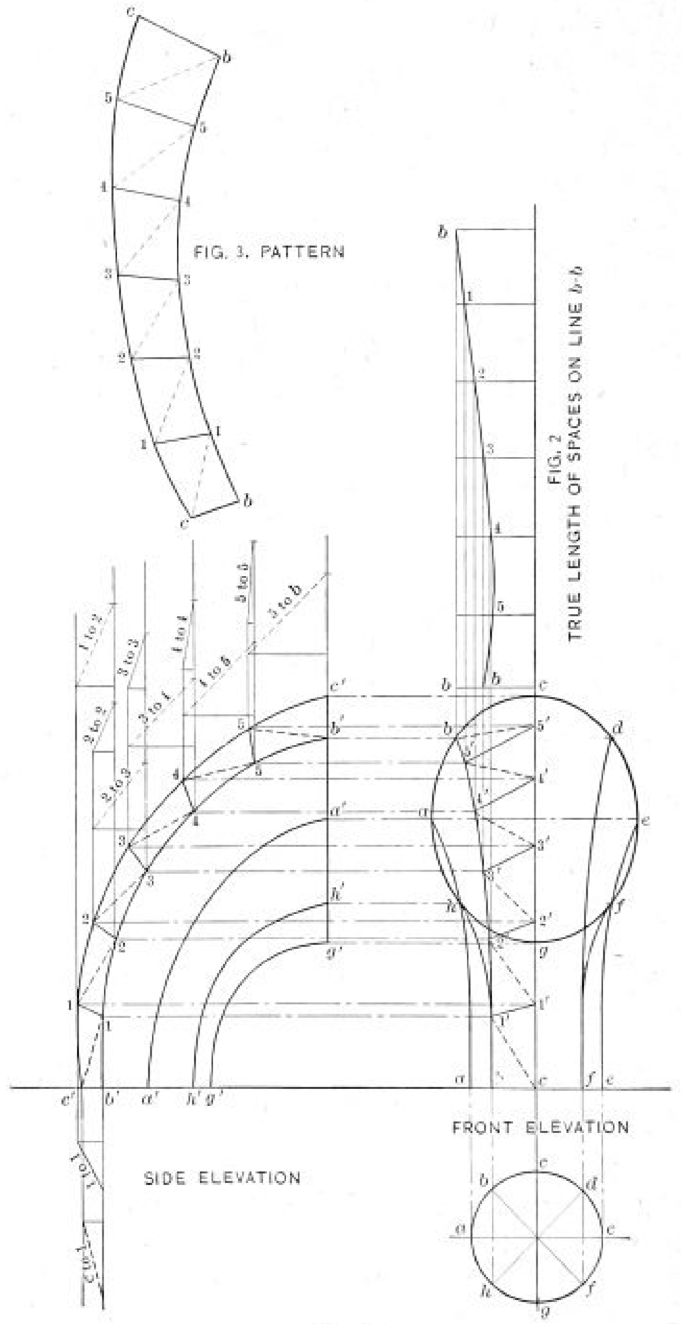


Fig. 4

draw perpendiculars to the line *c-c* from these points. Then from the points *b′*, 1′, 2′, 3′, 4′, etc., of the front view, draw the vertical construction lines to intersect as shown at *b*, 1, 2, 3, 4, 5, etc., Fig. 3. The pattern is laid off for this section in Fig. 3 by assembling the true lengths of lines in their proper positions. The arc lengths between the points *c*-1, 1-2, etc., at the top of the pattern are transferred directly from the side elevation, being equal to the corresponding ones between the points *c*-1, 1-2, etc., of the arc *c′-c′*. The spaces for the lower edge line of the pattern are transferred from Fig. 3.

In Fig. 5 is illustrated a ventilator made up of sections having girth or cross seams. Fig. 6 shows its side and front elevation. Any number of sections may be employed; the greater the number the more uniform will be the curvature of the ventilator, thus giving a good appearing object. In this case five sections are shown in the side view at *A, B, C, D* and *E*. Draw the two views as for the preceding example, but define only the position of the two outer curves in each view. Draw in the miter lines *k-n, j-o, i-p* and *h-q*, as shown in the side view. Locate the center of each miter line as at *b, c, d* and *e*. The shape of each section on the miter lines being elliptical in form, it is required to determine their short axes through the points *b, c, d* and *e* of the side view. This is done by drawing parallel horizontal lines from the side

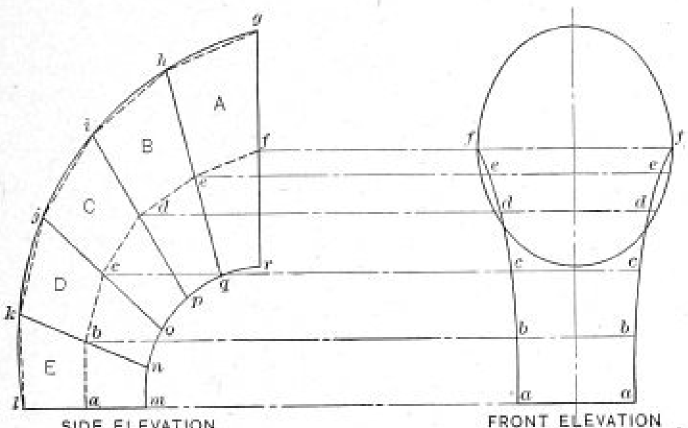


FIG. 6

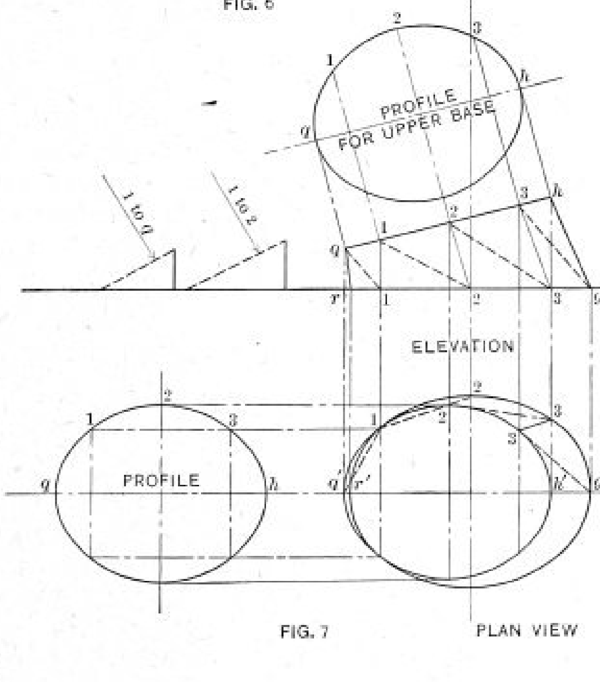


FIG. 7

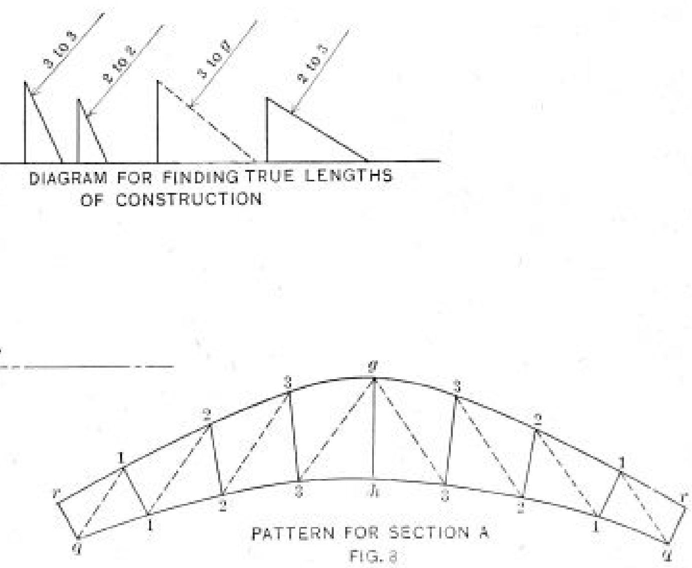


FIG. 8

Layout of Ventilator Made Up of Sections Having Girth or Cross Seams

view to the front view, thus locating the minor axes as *f-f, e-e, d-d*, etc.

The next step is shown in Fig. 7, where a plan and elevation is laid off for section *A*. If a person thoroughly understands the construction of these views and the pattern, Fig. 8, no trouble should be met with in laying off the other sections. Draw the two views by transferring the section *A*, Fig. 6, to the position shown in Fig. 7. This may be quickly done by the use of the dividers. Lay off the profile view of the smaller base of the section *A* at right angles to line *q-h*. The view is an ellipse. The major axis equals *q-h* and the minor axis equals *e-e*, shown in the front view, Fig. 6. About these axes construct the ellipse. Divide its outline into any number of divisions, and project the points so located to the elevation, thus locating points 1, 2 and 3 on the miter line *q-h*. In the plan lay off an ellipse equal in size to the one shown in the front view, Fig. 6. Then determine the foreshortened view of the miter on *q-h* by transferring the profile view to the left of the plan as shown, and drawing lines from points 1, 2, 3, parallel with the line *c-c'* to intersect the corresponding vertical ones drawn from the elevation. Through the points of intersection so determined draw in the foreshortened view of the smaller base. Connect the points in the plan with construction lines as 1-1, 2-2, 3-3, etc., and do likewise in the elevation so that the lines in both views correspond. The next step is to find the true lengths of these lines. This may be done as already explained for the other problem. The bases of the triangles in this case are taken from the plan view, and the corresponding heights from the elevation. The pattern may now be laid off, using the true lengths so found and the arc lengths between the points located on the ellipses.

Pressure Required in Dishing Large Heads

Q.—Will you kindly advise how many tons pressure will be necessary to flange and dish an 8-foot still head in one operation under a four-post column hydraulic press, the head to have a 12-inch dish, 5-inch flange, ½ material? B. N.

A.—There is no fixed rule by which the required pressure in such work can be calculated. It is a matter of experiment and development. Thick metal plates that are heated and then distorted by hydraulic flanging require a very heavy pressure to produce a permanent set in the plate, according to the form of die used. For plates that are to be flanged or dished much depends upon the degree of heat in the plates; a red-hot plate will require a greater pressure to form it to shape than a white-hot plate, etc.

The largest hydraulic presses employed in locomotive shops for flanging their heaviest plates and largest heads have approximately 450 tons plunger pressure. The head referred to in the question could be dished and flanged in one operation on a hydraulic press of about 150-ton capacity. We would suggest that you take this matter up with the manufacturers of hydraulic machinery for more specific information. Some experiments have been made in this work and their results recorded in some transaction of the Society of Mechanical Engineers.

Letters from Practical Boiler Makers

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

Back Pitch of Rivets

In the Questions and Answers Department for February question No. 7 reads, "What is meant by back pitch of rivets?" and is answered, "The term 'back pitch' evidently means the pitch in the back row of rivets."

May I respectfully suggest that the answer, as given, is slightly misleading, and that the term "back pitch" is intended to mean the distance between the rows of rivets; in other words, the distance between any two rows that are adjacent and parallel, and might be called the cross pitch?

INSPECTOR.

In the definition of the back pitch of rivets in THE BOILER MAKER of February, it is stated that the term back pitch evidently means the pitch in the back row of rivets. This definition was not corrected in the March issue, so I am sending the correct definition, which is: "The distance between the center lines of any two adjacent rows of rivets measured at right angles to the joint is what is termed back pitch."

I believe the term is a new one, as I have had twenty years' experience as a boiler maker and inspector in different parts of the United States and never heard the term used until two years ago, so a great number of readers of THE BOILER MAKER will have the wrong idea of the back pitch unless the proper definition is given.

Olean, N. Y. JOHN H. FLAHERTY.

Good Advice

If you had for several years been employed as an assistant foreman, and felt that you had instructed yourself to be able to fill the position of your immediate superior whenever his position might become vacant, and felt sure that you would be selected now that there were to be some promotions or shifts made—you would feel pretty sore to see a new man brought in from the outside, wouldn't you? Well, that's exactly what happened to a young assistant of my acquaintance. Of course he got "hopping mad" and came near throwing up his job, feeling that the fellow who got the place must have had a pull; that there was favoritism being shown to friends of the firm. But he didn't throw up the sponge. What he did was to go to the general manager and ask why they selected a man from outside the works, and what chance had a fellow if they were going to let outsiders fill in the higher positions?

The reply given by the general manager was: "You observe this new fellow who has filled the position that you felt was to be yours, and you will understand why you were not selected."

This the young assistant did and found that he was only partly ready for the next step, and while he was very successful in his present position he had, in his own mind, fitted himself for the promotion. He had not broadened his knowledge of the growing business and had specialized too much in shop work.

The new man brought with him many and successful ideas, which, by persistent devotion to the business interests, were soon put into operation. Output began to increase and competitors began to feel keenly the marked advance in the selling market of the firm's products. Labor conditions became more satisfactory—in fact, there were but few things which did not seem to improve under this new man brought in from the outside.

There was no secret to his success. He called the young assistant into his office and told him that he liked the manner in which he put forth his efforts to become an asset to the organization, and that he wanted him to be able to head a new department which they were going to create, but in order to do so he (the young assistant) must gather some knowledge of the costs and the technical details entering into the producing and selling of not only this firm's products, but of other firms in the same field of business.

To be able to properly superintend the construction or direction of the shop work is but a small share of the real present-day executive's qualifications. He must not only have a knowledge of how the boiler plate, rivets, etc., are made, their physical characteristics, etc., but he must know what the real results of the finished product are in order to improve the manufacturing conditions.

As the young assistant did try, he was amply repaid for his efforts. He heeded the advice and is now further advanced than the next step—he has really jumped a few steps, and now passes on the same advice.

Concord, N. H. C. H. WILLEY.

The Day's Work

The business of metal working to-day is far less simple than a generation ago; indeed, its complexities increase year by year. Once upon a time three materials only, iron, steel and gunmetal, represented the choice open. Cast iron, a foundry material, a mixture of standard pig from a couple of sources and a varied quantity of scrap and gunmetal of the formula favored by the particular firm, settled the foundry. Bar iron in a couple of qualities or amalgamated scrap sufficed for the smith. Steel in the shape of bar for cutting tools and files, the latter in many instances serving other ends to finish their career, carved up the products of the foundry and forge to a finished state.

While organization has tended to uniformity in the matter of shape and economical use—grading the material to the end required—the choice open in the way of material on the market has so widened that selection is at once easier and more difficult.

Once the metallurgist and chemist were let loose, change became rapid, and actually to-day the engineer is dependent upon specialist work in so many fields that the poise of balance of utility may be upset from a number of quarters. It is not contended for a moment that the change is other than beneficial; it is desired to point out that the original factors in the equation of production were few, while to-day they are again subdivided and the end of such subdivision is not yet in sight. There are few concerns where the mechanically trained man is all-sufficient; he produces mechanism from material, the latter from the circumstances of the case is mostly apart from his province, although his is the ultimate choice.

In short, the engineer of to-day in an executive or administrative position is so far from being a specialist that he may be regarded as the co-ordinator of many (at times) conflicting specialist activities. Each representative of a particular field has to convince a man less a technical specialist than a technical business chief. This is true no less of the vendor of supplies than of the staff under the control of the mechanical chief.

When the directorate delegate authority to a single chief, responsible for direct management, they are apt to imagine that he is concerned with the finished product and that hustling up its production fills his day.

Actually he is primarily concerned with a number of things quite apart from, although involved in, the total results. For examples, labor and the troubles incident thereto, material and its proper selection, seeing that full activity is in operation in the shops, passing of opinion on the starting or paper stage of new work—otherwise design: these occupy a large portion of each day. If each of these activities are delegated to a responsible assistant, there yet remains the insoluble and intractable to engage his daily attention. Finance and routine may be none of his business, yet he finds need for clerical assistance and must have a systematic office for his own needs.

Chasing the daily difficulty may best perhaps explain his chief end and aim in life. This takes a variety of forms, labor, material, transport, finished product, delivery, design—no matter how he delegates his authority, or subdivides his responsibility, or clear his road of mere routine, he is the final arbiter of all difficulties and it is impossible for him to keep clear of a strenuous day.

It may be shortage of fuel or a perverse and unreasonable customer, there is always one bad hour in every twenty-four. Everyone else by consultation can divest themselves of responsibility, receive help and shift troubles. Not so the man in control; he can consult, elicit information, but the decision (to which he has to adhere) must be his, and whatever misgivings he may feel they do not reach his subordinates.

His own insight and experience must be his aid in the question of labor; for material problems he can have scientific assistance, on that of design there are his competitors' efforts, the accumulated tradition of the firm, and always the ultimate market to watch. There is the organization always altering in detail to keep whole, the balance of production to watch, system to contrive, isolated facts to co-ordinate into schemes. His initiative must be acute, his control thorough, his mentality wide and devoid of prejudice, his temper even, his nerves proof against exasperation. Anger, it should be remembered, is more tiring than physical effort.

When to extend, when to organize, are equally important with their actual need. He must be quick to see which department is of greatest future promise. The allotment of appropriation for new plant, obtained perchance at great effort, must be rightly placed to give the greatest returns.

Owing to causes not under his control, and in spite of every human precaution, the dividend may not be satisfactory, the year's work prove worth less than that anticipated. Everyone else feels sure that so long as they please him (a single individual) their position is secure. His position is never secure if he values his work in terms of final result.

To be the "Deux ex Machina," the ultimate arbiter and final referee, is only comfortable to the man having peculiar characteristics, of which vitality is only one. If filled there exists sheer pleasure in the position and the shouldering of the responsibility which must inevitably fasten on his shoulders and of which he cannot divest himself.

Scores of men make capable assistants, only few make first-class chiefs. It is nearly impossible to forecast merit in this direction, since only under the incidence of the actual task can capacity reveal itself.

It is sufficient to add that when and where such a man is found, the boundaries set to mark management do not represent his ultimate value. Given opportunity his abilities would grace any field in which he cared to exercise his talents or put his merit to the proof.

Usually his existence is so full, however, that further trial of strength is beyond the bounds of a working week. For the reasons alleged we have in the mechanical profession by reason of their own choice more first-class brains in the strict sense of the term than almost anywhere else. For it is reasons of natural aptitude which made most of us choose the business, the interest is perennial and the responsibility came in gradual steps to sift out our ability.

Every step in the road is one of test and elimination. A small cunning may serve to gather wealth in many directions, but the exercise of a liberal profession carries its own rewards, more alluring perhaps than simple acquisition of monetary gain.

Anyhow, there are few who would prefer to be elsewhere, even if the work were less and the reward greater.

A. L. H.

Factors of Evaporation

In the March issue of The Boiler Maker, on page 80, appears an article entitled "Something About the Use of Factors of Evaporation." The formula, as expressed, is not altogether correct, and even if it were the liability of error through misuse remains.

In the first place the latent heat of steam at 14.7 pounds absolute pressure is 970.4, not 966.1. In the second paragraph, mention is made of "boilers operating under varying conditions, as to pressure, feed temperature, etc.," but in the formula and text no mention is made of anything but pressure, and feed temperature. For superheated steam and different atmospheric conditions the formula would or should take these into account.

A simple way of expressing the formula for *saturated* steam would be

$$\frac{H - h}{L}$$

where H = total heat of steam above 32 degrees F.,
h = sensible heat of feed water *above* 32 degrees F.,
L = latent heat of evaporation at existing atmospheric conditions (from barometer reading).

I would also like to call attention to the formula given on page 69, for calculating the area of segments; that is also inaccurate, as the radical sign should be extended to include the decimal fraction .608. As it now appears this decimal fraction is to be subtracted from the other value obtained.

Brooklyn, N. Y. A. G. Reach.

Boiler Compounds

The attack by Mr. Wilson in the January issue upon my article in the December issue is very prejudiced and his attitude is discourteous. A comparison of the two articles is sufficient to establish this much. Upon first reading it I felt disposed to allow his reply to pass unchallenged, and wish at once to state that I am not and never have been interested either in the manufacture or sale of any treatment apparatus. Since the positions adopted by Mr.

Wilson and myself are more or less irreconcilable, to argue pro and con would mean eternal repetition.

To briefly review Mr. Wilson's criticism: He starts by damning with faint praise. I am partially correct, and since a half truth is ever the blackest of lies he is out to expose my fallacies. Yet in the same breath he says that "the article, which is all wrong in its statements and conclusions, will do no serious harm, because the reader who has the slightest knowledge of the subject will discover the fallacies and will not be misled." What does Mr. Wilson mean by the above? If I am partly correct even I have more than the slightest of knowledge, although I confess without shame that I am not a water treatment expert, nor am I in parenthesis a quack with a nostrum at an inflated price to dispose of to the credulous.

Mr. Wilson next propounds a query, "What in the world do I mean by differentiating between analyses and contents." The answer to which can be found in the original article, but it is perhaps as well to extend the paragraph therein contained. Practically every marketed boiler compound is a closely guarded trade secret; like a patent medicine its formula as to ingredients is jealously withheld from public gaze. The analysis furnished is a statement signed and sealed by a duly authentic chemist that under test he finds no injury caused by the remedy to boiler plate. As, however, the duration of such test is and must be limited, it proves that short-time exposure of plates to the solution gives insufficient difference to be discernible.

My original statement that "a boiler is a vessel to raise steam and not a place for carrying out chemical changes in the constitution of the feed water," quoted by Mr. Wilson, is true in every particular in the sense indicated and read in conjunction with the context.

To deal with another point, combustion is a matter of chemical reaction, but the change of state from water into steam is assuredly not chemical reaction. To cast aspersions of this type with an intended sarcastic reference is termed confusing the issue. The question of feed water concerns the water space of the boiler where chemical reactions are undesirable and I have yet to learn that any boiler fluid is intended to operate on the fire side of the plate. Some have done so by affecting seams, but of this more later.

I reaffirm that the intention of the original article was to advocate prior treatment of feed water in the proper place—e. g., outside the boiler—and Mr. Wilson has correctly interpreted this much. The use of the term chemical, disparaged by the criticism to which this is a reply, is the meaning in common usage. This is understood to be alteration by known means into fresh substances, not merely the liberation of steam from water (i. e., reaction). In dealing with the failure of treatment plants, more evidence is needed than their failure; for example, they may conceivably have been ineffective plants of a type now obsolete. Further, it is possible by present-day means to treat by special apparatus practically every type and kind of bad feed water, every water injurious to boilers can be made innocuous for the purpose and the evidence is all on my side.

Although the original article was so composed as to disarm controversy of the type raised, I am not altogether surprised that, like Hamlet, I have raised a ghost who after the first surprise emits warning. Having endeavored to discredit me personally by "abuse of plaintiff attorney," because there was no case, we are invited to consider "that most corrosion which takes place in boilers is due solely to certain conditions therein; and since these conditions are apparent in the boilers and not outside, it is foolish to go anywhere except to the base of the trouble, which is in the boilers themselves, to correct it." There is an appearance here of sound sense, but bearing in mind that Mr. Wilson, contrary to all known authorities and the dictates of common sense, advocates the use of boiler compounds in boilers, the paragraph will not bear critical examination. Everyone in the business knows that the corrosion takes place in the boiler, and one of the main reasons alleged is that of bad (unsuitable) feed water. My contention was and is that if you eliminate the undesirable alien elements in the feed water you attack the cause of the trouble before it occurs. That they can be eliminated by treatment apart from the boiler itself, Mr. Wilson is forced to admit. In a scientific treatment plant chemical reagents do not get into the boiler at all, not even in small doses to prove cumulative in their effects; if they do, and the possibility is very remote, there is bad operation somewhere or the plant is wrongly designed or wilfully queered.

The ideal water treatment is that of distillation, which gives absolutely pure feed water; the process is, however, effective though expensive. It costs 1 pound of coal to produce from 25 to 30 pounds of chemically pure water, and this is the solution for the alleged waters unsuitable for chemical precipitation. To term water treatment experts as "wild-eyed treatment plant fanatics" is abuse and it may be left to stand at that.

It is refreshing to be accorded the adjectives used in the criticism—fallacious, misleading, ill-considered, dangerous—and still to agree that feed water can be improved by treatment. How Mr. Wilson reconciles the abuse with his ultimate paragraph it is difficult to imagine. As I have accidentally trod on my critic's best corn, I now am prepared to tread on his other foot. I feel, moreover, that his castigation in ten times more ill-considered than the quite rational statements of my original article.

If hundreds of thousands of dollars have been wasted on treatment plants which now stand "as idle monuments to fallacious advice," the sum must be multiplied by at least ten to cover the damage done to boilers by quack remedies from potatoes to sawdust to the latest specific marketed under a fancy name as a boiler compound. It is foolish to imagine that the introduction of anything as a corrective into a boiler can suspass the results of good, plain, wholesome feed water with its original deleterious materials removed. No experienced marine engineer, central station engineer, or rational thinker is going to put into a boiler a substance of which he knows nothing upon faith; in the same manner as the patent medicine vendor sells pills to cure all the diseases the flesh is heir to. It is a counsel universally true that one piece of mechanism is for one specific end; a boiler is made to raise steam and assuredly not to treat feed water. Every central station for the generation of electric power in Great Britain uses a water treatment and grease separation plant and treats its feed water apart from its boilers. Every ship in every navy afloat has a treatment plant in the shape of a distilling apparatus of adequate size.

Where watertube boilers are in question ordinary town water, save in exceptional circumstances, cannot be employed. Since this type of boiler becomes more usual every year the number of treatment plants installed increases in direct ratio. So far from a treatment plant being an alternative, it is an absolute necessity for watertube boilers.

A boiler is no more a place in which to treat or alter the constitution of feed water than is the human body a place to purify drinking water. In both instances health, otherwise efficiency, depend upon the use of a pure material. To adopt the argument of boiler fluid reasoning, it would be enough to drink infected water, and to correct its possible effects, take immediately an anti-typhoid pill. The government or local authorities in every civilized country spend large sums on the purification of drinking water. The public could always buy corrective pills at a fancy price and so save the public expense. All the expense involved by keeping sewage away from water sources is unjustified by the boiler fluid argument.

All modern remedial measures are the common sense expedient of destroying the cause rather than effecting a subsequent cure. Malaria can be treated with quinine. The effect is to turn the human body into a chemical factory or a battlefield between patient and parasite, the drug aiding the patient's recovery. If the patient has a good constitution and his workmanship and resistance is first class, he recovers; if he has less specific resistance, he dies. It has, however, been found more expedient to destroy the insect disease carrier. It is less painful humanly, anyhow, than to combat the disease with a drug, which takes its own toll from the patient.

The analogy may be directly applied to a boiler. On the one hand you have an acknowledged source of boiler corrosion, bad (diseased) feed water. You can fight the ill effects with some type of pale pills for pink plates, or, on the other hand, you can remove the cause by forestalling the trouble in treating the feed water to begin with.

Mr. Wilson prefers the pale pills; the writer, in common with thousands of experienced engineers, prefers the more scientific method. The case against boiler compounds can be put in a different way:

1. It is too late to treat the water in the boiler. The boiler is for steam raising and not for chemical precipitation purposes.

2. Boiler compounds often make the contents of the boiler excessively alkaline. This causes foaming, priming and the giving off of wet steam with its attendant risks.

3. Any volatile constituents in their composition pass off with the steam. In some cases it is a corrosive gas which attacks the fitting of both boiler and engine.

4. If the steam is not for power purposes, but is otherwise used, as in brewing, dyeing or textiles, the results of the volatile constituents may prove ruinous.

5. Exorbitant prices are often charged for these compositions greatly in excess of the value of the constituents. It is credulity which is exercised, and like secret medicinal remedies faith is exploited in terms of cash.

The simplest treatment of feed water is the use in due proportion of common washing soda. In any treatment plant the reagents are known together with their chemical reaction and are obtainable in the open market at a fair price. There is, therefore, nothing secret about them. It is possible by distillation to obtain a chemicallly pure water at reasonable cost, and if its very purity is a deterrent of trouble, any addition made is under complete control, both as to quality and quantity. Ample preheating to the boiling point will precipitate lime and magnesia in some states, and pre-heating to precipitate what otherwise becomes boiler scale is largely practiced. As witness in proof the interior of a household kettle in a hard water district will serve. In any chemical treatment plant an analysis of the water is essential and exact prescription of the re-agents required. Further, the crux of a treatment plant is that there shall be an exact and reliable automatic means of measurement for the introduction of the re-agents.

In my original article I explicitly stated that water treatment and the necessary plant was a matter for the specialist. Most boiler fluids are sold as universal panaceas for all ills, one pill for all diseases. This fact alone condemns them from a common sense standpoint.

Bad as the effect of either hard or soft scale is in the economy and upkeep of a boiler, the presence of grease is infinitely worse. A very thin film of oil on a heating surface causes a loss in heating effect of from 8 to 15 percent. Another authority states that "a film of grease one hundredth of an inch thick offers resistance to the passage of heat equal to a steel plate 10 inches thick." Grease, therefore, offers one thousand times the resistance of steel to the passage of heat. Simple filtration will not eliminate grease. No matter what boiler fluid is used or whatever its effects, it cannot remove grease, and if chemical reagents may, as hinted by Mr. Wilson, leak over to the boiler and become cumulative in their effect, which the present writer believes is virtually impossible with good modern plants, the boiler fluid itself must accumulate and it cannot separate grease.

The point is mentioned, as there are water treatment plants extant which, in addition to the rectification of unsuitable boiler feed waters, also eliminate grease.

I have by now, I think, justified my original contribution up to the hilt. If Mr. Wilson has any more expletives to sling about and the editor will print them, I am open to meet and let him have another dose to go on with. I have no interest in any system of feed water treatment and have only the interest common to every mechanical engineer in the results of proven experience.

If Mr. Wilson, or, for that matter, a boiler fluid salesman or manufacturer, likes to tackle me further on the subject, I shall be happy to collect evidence enough to satisfy the impartial onlooker that feed water treatment should be outside the boiler to prevent corrosion within. Finally, a boiler is a vessel designed for the purpose of raising steam; if a chemical factory is wanted it can be had at a price, but not in the boilers under the care of

London, England. A. L. Haas.

Handling Men

Some of the important factors that constitute competence and success in managing men and the product of their labors are as follows:

1. A thorough advanced knowledge of the work that the labors of the man are to produce.

2. A character and personality that demands their respect.

3. Unlimited capacity for planning and laying out their work.

4. Proper judicial exercise of authority.

5. Self-control, complacency and tact.

6. Willingness to impart information and lend assistance.

7. An ability to understand the human element that necessarily enters into the harmony of the organization.

8. Broad training, both practical and technical.

It is needless to say that when an executive embodies the above qualifications he commands his position and the confidence of the trust placed in his hands by his employer.

Concord, N. H. C. H. Willey.

Boiler Makers Needed.—The United States Civil Service Commission has announced that boiler makers are needed at once for service in various navy yards along the Atlantic coast.

Selected Boiler Patents

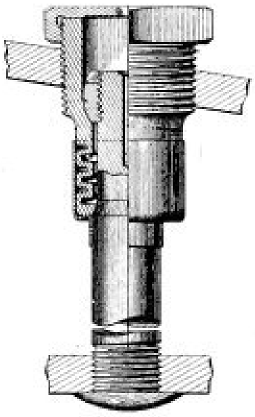
Compiled by

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

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

1,201,989. STAYBOLT FOR BOILERS. BENJAMIN E. D. STAFFORD AND ETHAN I. DODDS, OF PITTSBURG, PA., ASSIGNORS TO FLANNERY BOLT COMPANY, OF PITTSBURG, PA.

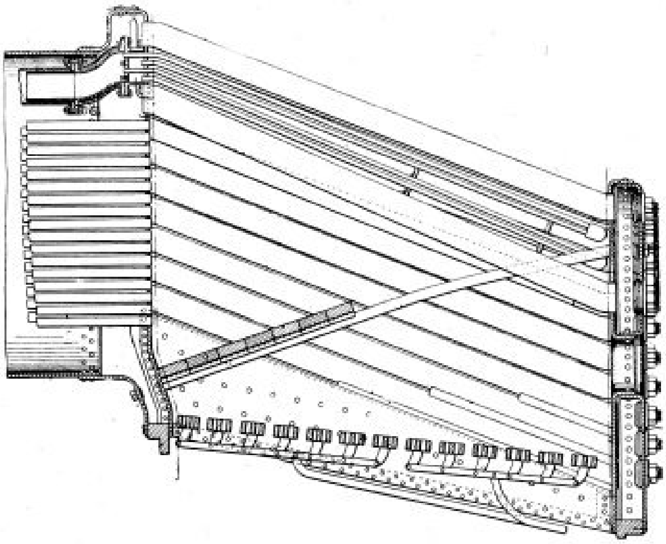
Claim 1.—In staybolt construction, the combination of a sleeve adapted for attachment to a boiler sheet and having a seat for the head



of a staybolt, and a yielding extension at its inner end and a staybolt having a head for said seat and also having means for engaging the free end of the yielding extension. Eight claims.

1,203,376. BOILER AND FIREBOX CONSTRUCTION. JAMES M. McCLELLAN, OF EVERETT, MASS.

Claim 1.—In a firebox, a side wall comprising a series of large circulation tubes inclined downward from one end of the firebox toward the



other end and extending longitudinally of the latter, said tubes being welded together intermediate their ends to form in effect a continuous integral side closure. Thirty claims.

1,202,387. BRICK FOR BAFFLES OR ARCHES OF LOCOMOTIVE FIREBOXES. WILLIAM L. HITCHCOCK, OF PORTSMOUTH, OHIO.

Claim.—An arch brick for locomotive fireboxes, having a plurality of ribs on its lower face, the said ribs extending lengthwise the brick and

throughout the length of the latter, and having concaved seats at their ends to engage two arch tubes, the said seats being of less depth than the ribs so as to leave a passageway between said ribs over the said tubes.

1,202,443. LOCOMOTIVE ARCH BRICK. WILLIAM SMITH, OF CHICAGO, ILL., ASSIGNOR TO UNIVERSAL ARCH COMPANY, OF CHICAGO, ILL., A CORPORATION OF ILLINOIS.

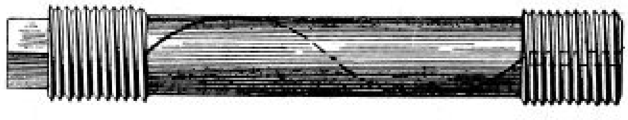
Claim.—A locomotive arch, comprising a series of bricks grooved along opposite edges to rest upon water tubes, a depending flat and short projection from the under face of each brick, each of said projections being of diamond-shaped formation and arranged with a point thereon adjacent the front, rear, and side edges of said under face of said brick, and each of said points lying approximately at the center of the edge with which it is associated, the projections on said brick when a plurality of bricks are assembled dividing the under face of the baffle into a plurality of gas channels, and said sloping faces of the projections diverting the gases into said channels from opposite directions, whereby they are caused to collide and mix.

1,200,783. OPERATING MECHANISM FOR SHAKING-GRATES. HERMAN R. WEBER, OF DENVER, COL., ASSIGNOR TO THE ECONOMY FURNACE COMPANY, OF DENVER, COL., A CORPORATION OF COLORADO.

Claim 1.—The combination with a grate having pivoted bars, of means for operating the said bars for shaking or dumping purposes, comprising a lever having a disk member, a bracket having a co-operating disk member, the latter having a series of perforations therein and the disk member of the lever provided with a perforation adapted to register with the perforations of the said bracket disk member, means adapted to be inserted through said registering perforations for locking the lever in the desired position, the disk member of the lever also having openings in its periphery, and a handle adapted to enter said openings for operating purposes. Two claims.

1,203,505. STAYBOLT FOR BOILERS. ETHAN I. DODDS, OF PITTSBURG, PA., ASSIGNOR TO FLANNERY BOLT COMPANY, OF PITTSBURG, PA.

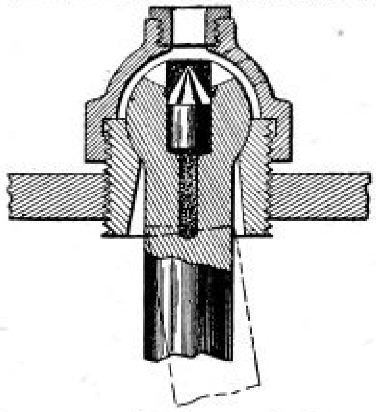
Claim.—A staybolt having a single slot extending spirally around the shank throughout the length of the latter and inwardly past the center



of the bolt, but not wholly through the same, the said slot extending approximately around the shank.

1,203,517. STAYBOLT STRUCTURE FOR BOILERS. JOHN ROGERS FLANNERY, BENJAMIN E. D. STAFFORD, AND ETHAN I. DODDS, OF PITTSBURG, PA., ASSIGNORS TO FLANNERY BOLT COMPANY, OF PITTSBURG, PA.

Claim 1.—A staybolt having a tell-tale hole, a pointed projectile within said tell-tale hole, means within said tell-tale hole for expelling said



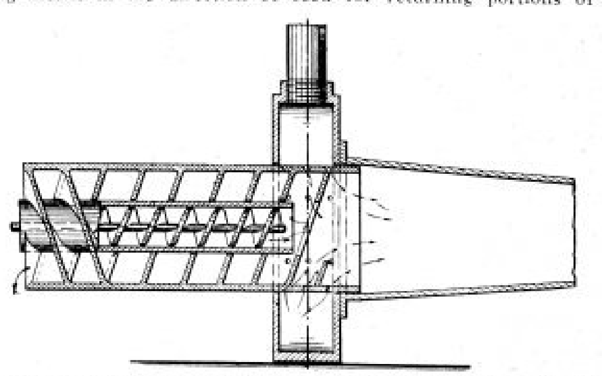
projectile upon the entrance of moisture, and a destructible envelop encircling the end of the pointed projectile. Three claims.

1,199,926. FURNACE GRATE. JOHN C. QUINN, OF NEW YORK, N. Y.

Claim.—A grate frame, comprising rectangularly arranged bars comprising vertical web portions and inwardly projecting top flanges provided with draft openings, the corner joints of the frame being characterized by one of the bars having its flange cut away at the end to receive the flange of the other bar, the web of the first-mentioned bar being intact opposite the end of the second bar, and said first-mentioned bar having an inward projecting ledge on which the web of said second bar rests.

1,214,753. SYSTEM FOR FEEDING PULVERIZED FUEL. VIRGINIUS Z. CARACRISTI, OF ALBANY, N. Y., ASSIGNOR TO LOCOMOTIVE PULVERIZED FUEL COMPANY, A CORPORATION OF DELAWARE.

Claim 1.—In a burner for pulverized fuel, comprising feeding means for feeding fuel, return means concentric with said feeding means and extending beyond the point where the fuel is discharged from said feeding means in the direction of feed for returning portions of the



feed fuel, and air feeding means at the discharge end of said fuel feeding means for feeding air to said fuel as it leaves the fuel feeding means and as it commences its return movement in the return fuel means, said air feeding means concentrically surrounding the discharge end of the fuel feeding means and directing the stream circumferentially against all sides of the fuel as it leaves the fuel feeding means, said air feeding means being located intermediate the point where the fuel is fed from said feeding means, and the point where it is returned by said return means. Eleven claims.

THE BOILER MAKER

MAY, 1917

Electric Arc and Oxy-Acetylene Welding

Results Obtained from Destructive Tests of Steel Tanks Welded by Oxy-Acetylene and Electric Arc Methods

BY C. W. R. EICHHOFF

In the following the writer intends to give his personal observations and experiences regarding the advantages and disadvantages of electric arc and oxy-acetylene welding equipment. These observations were made with two electric welding outfits, each manufactured by a different concern; also with two oxy-acetylene welding outfits, also of different make.

I might say that the following remarks refer mainly to the welding of steel plates in boiler and tank work, and do not refer to welding of cast iron with the electric arc. There was no occasion to cover such work, but with the oxy-acetylene process welding cast iron the results were highly satisfactory.

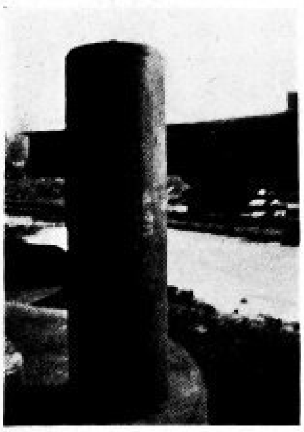


Fig. 1.—Electrically Welded Receiver Before Testing

Fig. 2.—Oxy-Acetylene Welded Receiver Before Testing

Fig. 3.—Tank No. 1. Electrically Welded Tank After Test

Not going into the details of the construction and operation of the two outfits, let us only mention that in the electric arc welding outfit the necessary current travels from the switchboard to the electrode holder, through the metal electrode, then forms the arc across to the object, passes through same and returns back to the switchboard, completing the circuit. The electrode (filling rod) deposits molten particles on the object.

In the oxy-acetylene process the oxygen and acetylene gases each pass through a separate hose to the welding torch, and after being properly mixed in same leave the torch to form a flame which when properly adjusted should be in most cases a neutral one when performing the operation of welding. In the oxy-acetylene process welding can be performed without the filling rod.

In electric arc welding the first objectionable feature is the intense brightness of the arc. In fact, during the whole operation of welding this brightness is not a continuous, uninterrupted one, but consists of a succession of numerous flashes. This continuous flashing has a decidedly troublesome effect on the eyes and nerves of men working near such an electric outfit. It is, therefore, necessary that electric welding be done in an enclosed room, so as not to interfere with other work in the vicinity. The fumes generated during the welding do not cause any harm. The operator's head, hands and body must be thoroughly covered. It is not sufficient to cover only the eyes with a pair of colored glasses. Even an exposure of several minutes to the intense rays of the electric arc causes an irritation and afterward peeling. The effects on the nervous system in the first days are such that they discourage many persons to continue the trials of becoming an electric welder. After a few days the traces of these effects disappear. The clothes are in most cases sufficient protection for the body of the welder, but to protect the eyes a hood with a small protecting window of one or more heavy colored glasses has to be used. This hood, to the beginner, is a very annoying fixture, especially in the hot season. Simply holding a frame with colored glasses in the left hand before the eyes, as some firms advocate, is also objectionable and troublesome to the novice. The hood must be made of some non-conductive material, owing to the possibility of touching the electrode to it in a moment of carelessness. Such carelessness might be cause for receiving a disagreeable shock. The window in the hood is liable to get hot, and if in this condition brought too close to the eyes might inflame the latter.

In electric arc welding a great speed can be realized, but, on the other hand, the welder has to stop frequently to rest from the strain. For hand protection the welder should use gauntleted gloves of pig or buck skin. Objects to be welded have to be brought into the enclosed welding room. It is objectionable to install sub-stations throughout a shop, as the effect of the intense brightness affects the efficiency of other workmen not directly connected with welding. The installation of such sub-stations is a rather costly affair, considering the current high prices for copper wire. To be successful in electric arc welding, this department should be one for itself, with all necessary handling devices and other necessary equipment for the building of tanks and platework. The man in charge of an electric outfit, to be successful, should not only be a welder, but should have some fundamental knowledge of electricity and his apparatus; in other words, he should be an electrician besides being a welder.

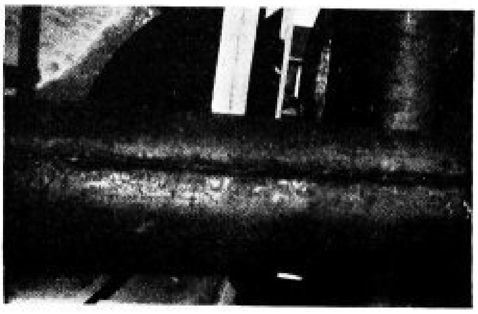


Fig. 4.—Tank No. 1, Showing Bursted Horizontal Seam

Fig. 5.—Tank No. 1. Enlarged View of Part of Bursted Seam

In a recent publication issued by a concern manufacturing electric welding outfits the claim is made that any unskilled person can learn to weld in a few days' time. Such a statement is utopian and only apt to be an obstruction to the advance of the promising field of electric welding. There is, in the writer's opinion, no doubt that electric welding has many advantages, but it is absurd that a concern should make such a statement. A similar statement was made when the writer had his first experience with an electric outfit. When the outfit was put into use, even the operator sent with same to demonstrate failed in his work to show the superiority of electric welding. On the other hand, it cannot be denied that very good results have been obtained by skillful and experienced electric welders. Such good results have been observed in the writer's experience.

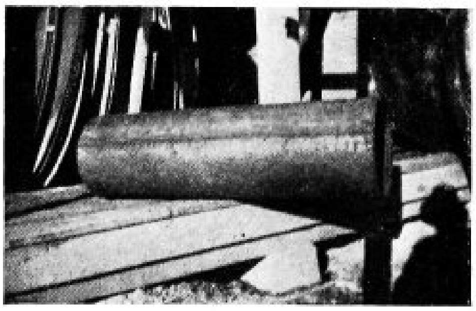


Fig. 6.—Tank No. 2. Electrically-Welded Tank After Test

Fig. 7.—Tank No. 2. Part of Bursted Seam Shown in Larger Scale

In the oxy-acetylene process there is not in existence such an intense brightness, the light is less harmful to the eyes; no hood is necessary for the protection of the face; no gauntleted gloves necessary; the effects on the nervous system are more harmless, and the work in general is less strenuous to the operator. The operator can control his flame at all times without leaving the work; the whole apparatus is more simple and the principles of construction and operation easier to understand for the average mechanic. The operator, having lighter-colored glasses, can easier watch the flow of material than in the case of electric arc welding with the use of darker glasses, which are mostly two or three in number. One very important feature of the apparatus is that it can be operated at any place in a shop without interfering with the efficiency of the workmen working in the vicinity.

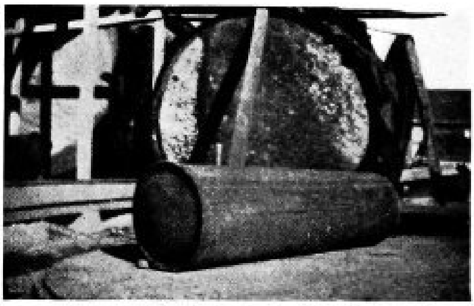


Fig. 8.—Tank No. 3. Oxy-Acetylene Welded Tank After Test with Head Bulged Out

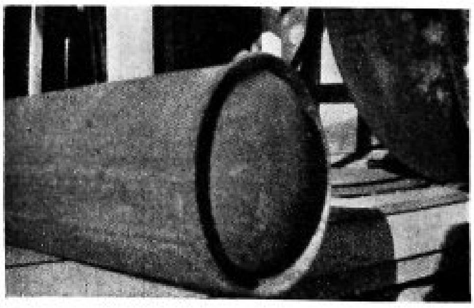


Fig. 9.—Tank No. 3. Head Bulged Out, Arrow Points to Small Leak

In the writer's opinion, it is easier to make a successful oxy-acetylene welder than an electric welder, for reasons explained. In a recently written article on the subject someone interested in the betterment of electric welding apparatus admits that even the expert welder fails at times on account of the difficulty of proper control of the current.

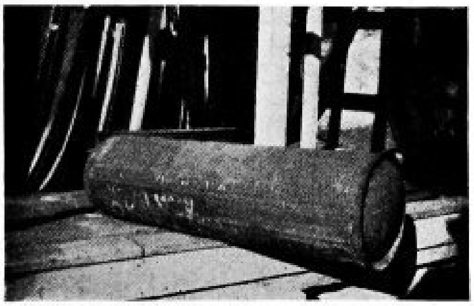


Fig. 10.—Tank No. 4. Oxy-Acetylene Welded Tank After Test, with Head Bulged Out

From tests made it was shown that very strong joints can be made by the arc process, but the average did not come up to those obtained from pieces welded by the oxy-acetylene method. The test pieces made by the arc process showed an absence of the metallic lustre characteristic to good oxy-acetylene welds. Theo. Kautny, the highest authority on autogenous welding, calls attention to the fact that when the arc is not of the proper length results are defective. If too close to the object the material is burned, and if too far the weld is subject to cold shots and pinholes. The results of a test lasting about 60 days gave the following information:

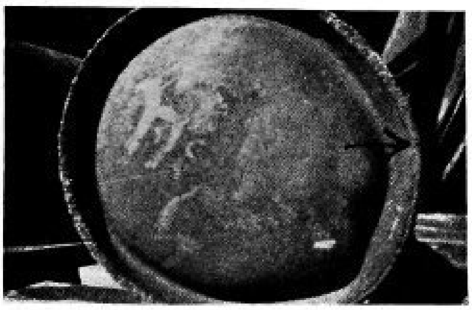


Fig. 11.—Tank No. 4. Bulged Head. Arrow Points to Leak

Fig. 12.—Tank No. 4. Part of Undisturbed Seam After Test

They showed that welding by the arc is cheaper as far as labor and material are concerned, but the electric arc welding developed a greater number of leaks and defective spots than the welding with the oxy-acetylene flame. The cases of leaks in oxy-acetylene welded tanks were exceptional. Such leaks in the oxy-acetylene process can only be attributed to carelessness of the welder. The leaks in the electric process can be ascribed to the following causes:

First—The electric arc process uses short pieces of wire (electrodes). These are about 12 inches long. From this only about 9 inches can be used for welding. When this rod is used up to about 3 inches the operator has to stop his work, remove the short piece and insert a new 12-inch piece. It is essential that good welding should be performed without stoppage until a seam is completed. The weld should not be broken. When starting again such an interrupted weld there is liability for a defective weld causing a leak. When welding with the oxy-acetylene flame longer pieces (30 inches) can be used; in fact, such pieces can be rolled in a coil and the welder is able to perform his work without interruption. Before welding new material the welder can bring the object into a molten state again before adding new material from the filling rod.

Second—The operator welding with oxy-acetylene, using lighter glasses, can easier watch the material flow together. This is difficult to do in electric arc welding with the darker glasses; besides, in electric arc welding fumes are formed at the spot of welding, which are an obstruction to the view of the operator.

Third—The ability to watch this flow is the cause of the gas welder to more evenly distribute his material where the joining of the original stock and the new material occurs. A gas-welded joint has more the appearance of Fig. 13, and that of an arc-welded such as shown in Fig. 14.

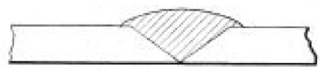


Fig. 13.—Gas-Welded Joint

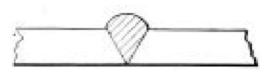


Fig. 14.—Arc-Welded Joint

Fourth—Characteristic of an arc weld is the fact that after completion the surface next to the weld is covered with red oxide. This is caused by oxidation of the metal by atmospheric oxygen when the metal is brought to the melting point.

To compare the two welding methods in regard to the reliability of the welds, also the tensile strength of the same, tests have been made, the results of which were reported in a previous article in THE BOILER MAKER. Since the latter article was written destructive tests have been made on four tanks. Two of these were welded by the oxy-acetylene process and two by the electric arc process.

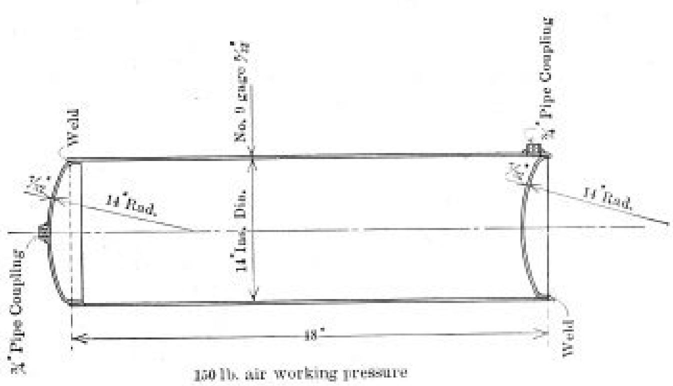


Fig. 15.—Sketch of Tanks Used for Welding Tests

The tanks are used for air receivers and designed amply strong enough to carry a working pressure of 150 pounds per square inch.

A sketch of these tanks is shown in Fig. 15, and in Figs. 1 and 2 are shown photographs of this style of tank before having been tested. The tests were made with a hydraulic pressure pump, and it was the intention to test these tanks to destruction. The results were as follows:

Tank No. 1.—Electrically welded, burst at a pressure of 550 pounds per square inch, the full length of the horizontal seam, as shown in Figs. 3, 4 and 5. The latter figure shows part of the open seam magnified. The dished heads were not affected.

Tank No. 2.—Electrically welded, burst at a pressure of 475 pounds per square inch. The results are shown in Figs. 6 and 7. The heads did not show any deformation.

Tank No. 3.—Oxy-acetylene welded. At 565 pounds per square inch the inverted head bulged out, springing a leak on the ridge seam, as shown in Figs. 8 and 9. The horizontal seam was intact.

Tank No. 4.—Oxy-acetylene welded. At 572 pounds per square inch the inverted head bulged out, springing also a small leak on the ridge seam. The horizontal seam was in its original condition as far as could be detected with the open eye. The results of this test are shown in Figs. 10, 11 and 12.

It seems that the oxy-acetylene welded tanks give better results than electrically welded. However, the results on the electrically welded tanks could probably have been better if a highly skillful welder would have welded same. The oxy-acetylene welded tanks were welded by a man with about 6 months' experience in tank welding. But it should be mentioned that electrically welded tanks give more trouble in testing for leaks than such welded by the oxy-acetylene process.

It is not the intention to condemn the arc-welding method, but it is the writer's opinion that at present oxy-acetylene welding is preferable to electric arc welding.

A few words might be said in regard to cutting with the arc and oxy-acetylene flame. Gas cutting is done faster and neater, resulting in a smooth, narrow slot; electric cutting is cheaper, but leaves a broader, ragged slot, which must be dealt with.

Oxy-Hydrogen vs. Oxy-Acetylene Flames for Cutting Mild Steel Boiler Plate

Experience and Data Showing Comparative Merits of Hydrogen and Acetylene as Preheating Gases for Cutting Purposes

BY S. E. WESTOVER*

Due, no doubt, to a considerable extent to the fact that acetylene, either as generated from carbide or compressed in cylinders, when burned through a torch using oxygen is the best gas for welding for most, though not all, metals, it has been very generally used as a pre-heating gas in connection with oxygen for cutting purposes, and consequently more manufacturers of cutting torches have developed their torches for the use of acetylene than for hydrogen.

During the past three or four years, however, hydrogen of an exceptionally high degree of purity—99.8 percent, or higher—has been produced in increasingly large quantities by plants using the electrolytic process for the decomposition of distilled water. Some torch manufacturers, born, no doubt, with the old pioneer instinct strong within them, have developed torches adapted to this now generally available and cheap gas. My own experience and data derived from expert and unprejudiced tests, which have recently been held on the comparative merits of hydrogen and acetylene as preheating gases for cutting purposes, convince me that for cutting any thickness of steel greater than ¼-inch, hydrogen has decidedly the advantage over acetylene in any form at any price for the latter, due to the fact that:

1. Considerably less oxygen is required per foot of cut.
2. Speed per foot of cut.
3. Smoothness of the edges, both vertical and horizontal of cut.
4. Absence of the possibility of carbonizing the edges of the cut; the cut edges being no harder to machine than the rest of the steel.
5. Perhaps more important than all, for my purpose, is the fact that steel of greater thicknesses and more plies of steel can be cut.

With reference to the last item I would state that under my supervision seven thicknesses of steel, each ⅞ inch in thickness riveted together, were readily cut through by the use of the oxy-hydrogen cutting torch, using oxygen at a pressure of 150 pounds, and hydrogen at a pressure of 75 pounds.

I am creditably informed that the oxy-hydrogen flame is used for cutting purposes in the plants manufacturing armor plate for the navies of this and foreign countries, thicknesses of 22 inches and no doubt greater being cut, thereby at an enormous saving in cost over any other present method.

EFFICIENCY OF GAS FLAMES FOR CUTTING

It is often stated in good faith, but due to a lack of proper consideration of the facts in the case, that acetylene must be the more efficient gas in connection with oxygen for cutting, due to the fact that the oxy-acetylene flame has such a high temperature and that the British thermal unit-value of acetylene is so high.

It is not the high temperature nor the high British thermal unit-value of the preheating flame which does the work in cutting steel. It is the effect of properly directing a jet of oxygen of the highest purity against steel heated to cherry red. Neither the temperature beyond that necessary to bring the steel to a cherry red, nor the British thermal unit-value of the gas producing this condition, is of any value for this purpose, and if, as in acetylene, the preheating gas in combination with oxygen produces any inert gas, such as carbon dioxide, the efficient effect of the oxygen jet, which does the so-called cutting, will be retarded, thereby necessitating the use of an excess of oxygen. Herein lies one of the advantages of using hydrogen as enumerated in item No. 1 above.

To make this last point clear before going further in the matter, the following equations of the chemical union of acetylene with oxygen, and hydrogen with oxygen are given:

$$2C_2H_2 + 5O_2 = 4CO_2 + 2HO$$
$$4H + O_2 = 2H_2O.$$

Necessarily a considerable portion of the carbon dioxide

* General Boiler Foreman, Oregon-Washington Railroad & Navigation Company, Portland, Ore.

is drawn into the cut with the jet of oxygen. If the volumes entering into the reaction, as shown are considered now:

$$\underset{4\ \text{volumes}}{2H_2} + \underset{2\ \text{volumes}}{O_2} = \underset{4\ \text{volumes}}{2H_2O}$$

$$\underset{4\ \text{volumes}}{2C_2H_2} + \underset{10\ \text{volumes}}{5O_2} = \underset{8\ \text{volumes}}{4CO_2} + \underset{4\ \text{volumes}}{2\,2H_2O}$$

it becomes more apparent why hydrogen, as a preheating gas in cutting, is more economical from every standpoint than acetylene.

The following table gives the results of the comparative cost of oxy-hydrogen and oxy-acetylene for cutting mild steel plate:

Thickness of Metal	Cutting Speed Feet Per Hour		Pressures at Which Gases are Used				Gas Consumption Cubic Foot Per Hour			
	Oxy-hydro.	Oxy-acet.	Oxy-hydro.		Oxy-acet.		Oxy-hydro.		Oxy-acet.	
¼ inch	90	103	3	2	12	10	47	35	140	71
½ "	45	50	5	2	15	10	56	35	160	71
1 "	40	39	12	5	35	10	90	71	242	71
1½ "	33½	32	15	5	40	10	104	71	263	71
2 "	30	28	20	5	55	10	123	71	327	71

The matter of the relative safety of hydrogen and acetylene is one in regard to which many people are misinformed. One of the principal points to be considered is that hydrogen is a chemical element and hence not subject to decomposition. On the other hand, acetylene is a chemical compound and one in whose formation a large amount of heat has been absorbed. This chemical compound, acetylene, is not only subject to decomposition, but very liable to decompose with explosive violence.

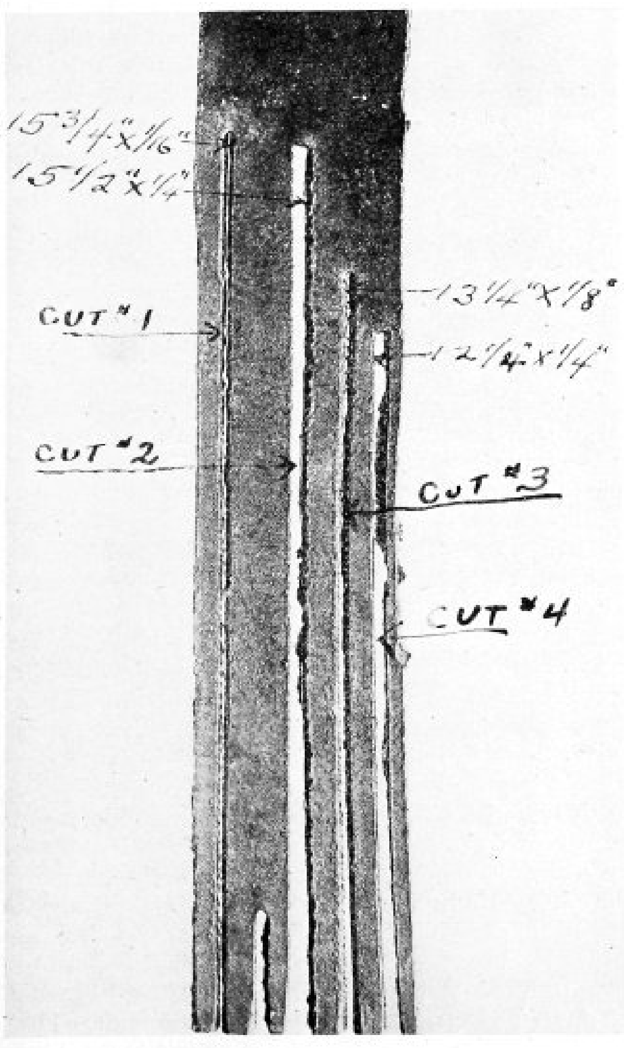


Fig. 1.—Cuts Made in 1-Inch Mild Steel Plate with Oxy-Hydrogen and Oxy-Acetylene Flames

Acetylene gas under a greater pressure than about 20 pounds per square inch will explode spontaneously if it is subjected to percussion or violent shock of any kind. On the other hand, hydrogen is no more dangerous than the most inert gas, due to any pressure it may be under. Both hydrogen and acetylene are inflammable gases and both will form an explosive mixture with air or oxygen. However, in no proportion of either air or oxygen is hydrogen as powerful an explosive as acetylene.

Fig. 1 shows a photograph of a piece of 1-inch mild steel plate on which four cuts were made. Each cut was the maximum amount of work obtainable with the minimum amount of the respective gases used in two minutes.

Cut No. 1 was produced by electrolytic oxygen 99.5 percent pure and electrolytic hydrogen 99.8 percent pure and is 15¾ inches long by 1/16 inch in width.

Cut No. 2 was produced by electrolytic oxygen and acetylene and is 15½ inches long by an average of ¼ inch in width.

Cut No. 3 was produced by atmospheric oxygen, taken from stock and found to be 97.4 percent pure and is 13¼ inches in length by ⅛ inch in width.

Cut No. 4 was produced by atmospheric oxygen and acetylene and is 12¼ inches in length by an average of ¼ inch in width.

Both oxy-hydrogen cuts were made by the same operator, using the same torch and regulator, and both of the oxy-acetylene cuts were made with the same apparatus and by the same operator as the oxy-hydrogen cuts, substituting oxy-acetylene tips.

Cut No. 1 required 12 pounds pressure of oxygen, 5 pound pressure of hydrogen.

Cut No. 2 required 35 pounds pressure of oxygen, 10 pounds pressure of acetylene.

Cuts Nos. 3 and 4 required gas pressures approximately 20 percent greater than cuts Nos. 1 and 2.

I am indebted to Walter P. Schuck, chemical engineer, Portland, Ore., for the chemical formula of cutting data in this article.

Plant of Sharpsville Boiler Works Enlarged

The Sharpsville Boiler Works Company, Sharpsville, Pa., builder of steel plate construction, has added a new building to its plant, 110 by 150 feet in size, of heavy steel construction throughout. The building was furnished and erected by the Independent Bridge Company, of Pittsburg. In this building the company has installed a new 10-ton, three-motor electric crane furnished by the Euclid Crane & Hoist Company, Euclid, Ohio, and has also installed a large amount of modern machinery, consisting of punches, rolls, bevel shears, drill presses, compressors, etc., for the fabrication of steel plate work. All power is electric, each machine having its own individual motor. The company manufactures all classes of knocked down, riveted, and welded steel plate work, such as tanks of all sizes and for all purposes, smokestacks, self-supporting and guyed, riveted steel pipe, penstocks, standpipes, or bins and coal hoppers. It is also taking up welded steel plate work, and is making a specialty of building large storage tanks, which it ships riveted, ready to unload and install.

The Pencil Electrode Method of Welding for Boiler Joints*

For Joints in Plates 2½ Inches Thick to Withstand 500 Pounds Pressure Welding Proves Superior to Butt Riveted Joints

BY E. A. WILDT

This paper has special reference to the welding of joints of drums and not boiler shells as the latter term is commonly understood. The trend of the times is towards that type of boiler in which all the tubes are bent, particularly in the large units such as those at the Commonwealth Edison Station in Chicago, the Delray Station in Detroit, the Ford Automobile Factory and the Solvay Process Company. Since the dimensions of the boiler rooms are growing out of all proportion to the size of the engine rooms, and every item making for a decrease in the size of parts so as to reduce the room for the boilers is in demand, much higher pressures will be resorted to—an item for making the reductions required. Drums are to be used up to 60 inches in diameter, and in order to bear a pressure of 300 pounds or 500 pounds the thickness of the plate will be very close to 2½ inches.

Welding Joints in Drums of Watertube Boilers

With regard to making the joints in such a drum, is it not more feasible to weld them instead of employing the usual butt strap? There are several methods of making this joint by spot welding, and that which seems to have forged its way to the front is the pencil form of electric welding, which is now fairly generally used in steam boiler work, although as yet recognized only for low pressures. The weld made by this process is not so hard as others of the autogenous kind.

In a weld, two pieces of metal heated to the proper temperature are united into one solid piece. Success of the process depends on bringing the pieces of metal to the proper heat. For this purpose we have the oxy-acetylene torch, the thermit process and the electric arc, the last of which is the form of modern welding particularly referred to here.

Electric Pencil Method of Welding

Electricity is used only to supply the heat, and in the pencil method only just enough heat is obtained to accomplish the joining of the two metals. No reference is here made to any particular design or set of apparatus: some are built to use a uniform voltage, others to use uniform amperage or uniform wattage. All autogenous welding is accomplished by adding new metal to the joint to be made, and it is only in the pencil electric arc method that positive incorporation of the added metal with the metal to be joined is secured. The opposite was the case in some recent failures in other forms of electric and gaseous welding wherein fluidity of both the added metal and the pieces to be joined is a necessary condition. By the electric pencil method fluidity is avoided and only just enough heat is used to make the plate and the electrode plastic, and there appears also to be an action in it which in the direction of the current tends to pull the metal from the electrode to and into the plate when just at the proper heat. This is so much in evidence that welding can be carried on overhead without the metal dropping upon the operator.

* Abstract of paper presented at the Steam Boiler Session of the annual meeting, December, 1916, of The American Society of Mechanical Engineers.

The temperature in the added metal in the gaseous and electric carbon type wherein fluidity is a condition approaches 2,800 to 3,000 degrees F., while in the electric pencil method the temperature in the metal being added is not more than 1,500 degrees F. As a result the added and the adjacent metal in the weld is not rendered so hard as would otherwise be the result. This is also proved by the fact that, while cutting can be done with other methods, no cutting can be done with the metal electrode.

This point that the temperature of the arc is so high, so hot, that there is danger of the metal becoming vaporized, is answered by the fact that the conditions surrounding this particular form of spot welding are analogous to and the same as for "forge welding" as carried on by the everyday blacksmith at his anvil; there he has a fire very much hotter than the pieces to be welded are required to be heated to; in fact, it must be so; there must be a considerable surplus of heat for quick action; the blacksmith watches and if through carelessness the pieces are overheated, he says they are burned and spoiled and has to begin over again.

No other form of welding has the characteristic this one has, wherein there is an automatic action which prevents overheating, actually showing that in this regard it is equal, if not superior, to "forge welding."

Forge Welding Approved by A. S. M. E. Boiler Code

The form of welding approved in the A. S. M. E. Boiler Code, known as forge welding, entails in its operation the production of big expansion strains, because the whole seam and the seam only is made at a welding temperature, producing an upsetting of the plastic metal by the unexpanded portion of the adjacent metal, so that when the forged welded seam has cooled off, the adjacent unexpanded metal produces tensile strains of very considerable strength, tending to pull the welded portions apart as it contracts, to the extent of close to ⅛ inch per foot of the seam. In comparison with this, the metal electrode pencil method is a great improvement, because due to the very small area of metal heated the expansion strains are but fractional and may be considered negligible. Both the approved forged welding and this method of welding which is hereby submitted to the Boiler Code Committee for approval are exactly alike in the particular that the metal is not heated in either beyond the point just necessary to produce welding; when it comes to expansion strains they are less in the latter, and in both methods the weld improves with age.

Although the electric heat reaches an estimated temperature of 6,500 to 7,000 degrees F., in this process the metal wire does not have time to reach this temperature before it is added to the plate or in the usual groove which is to be filled with the welding metal. As fast as the metal wire becomes just plastic, the pencil must be advanced towards the work, or the arc gap will become too long for the electric arc to maintain its circuit. The distance needed for the arc does not amount to much more than 1/16 inch, because the voltages used are low, rarely exceeding 60 or 70, and failure on the part of the attendant to maintain this distance by constantly advancing the pencil is met at once by the extinguishing of the arc, because the gap becomes too long for it to maintain itself.

Only in this process, carelessness is practically eliminated, both as to overheating and heating any considerable area, and the heated area is confined to the smallest dimensions of any; therefore the expansion and contraction strains are smallest. The wire forming the electrode only gets red hot at the point, showing the very localized character of the heat, the balance of the wire remaining black; while in the carbon form of electric welding, the carbon gets very hot from the point up to the holder.

Welded Joints in Drums Carrying 500 Pounds Pressure

Tests have shown that for pressures of 500 pounds per square inch, and with plates of 2½ inches or similar thicknesses, this method of welding makes a better joint than straps and rivets. The maker of such joints can always know by the hydraulic test whether his work is done perfectly or not. Test after test shows there are no leaks; all you have to do to insure a perfect job is to secure an operator willing to do a good job, pay him well, and it is fair to say that it is then practically impossible to do a defective weld by this method.

In electric carbon arc welding of rolled stock, the metal in the weld cannot have the same properties as that in the original piece; it may have the same tensile strength but it will not have the same elasticity. This is a limitation in *any* welding process, but in this particular process the metal in the weld is changed the least of any, and in fact shows a tendency towards a fibrous condition. The metal of the weld can be controlled by the kind of metal that is added; low carbon steel will make the weld more ductile, high carbon steel will make it higher in tensile strength. A test piece made up entirely of the welding wire showed an elongation of 16 percent.

In order to be sure that a joint so made will be stronger than the plate, and last indefinitely, it is only necessary to keep on adding new metal until the cross-section on both sides amounts to more than the plate itself. This can be carried to extremes, and may as well be, just filling the groove, usually V-shaped, the extra metal to lap over on each side ⅜ or ½ inch and made in bulged form, both inside and outside of the drum, taking on the form somewhat of a butt strap joint.

Rivetless Boiler

There has just recently been put into service, with a view of trying it out in actual practice, a small watertube steam boiler of the vertical two-drum type, with all the tubes bent tubes, the drums in which have not a rivet in them. Heavy tests have been applied, and there is not the slightest doubt that the men who have to do with the erection of this boiler do not anticipate any danger to anyone from it. Of course, it is realized that the construction has not been approved, but it is necessary for some one to take a stand and bring it to a head. Without something to show and to test, there will be no basis on which to ask for an approval. The situation is somewhat analogous to the man who wants to obtain a job as a stationary engineer—not having a license he cannot obtain the job and not having the job he cannot obtain the license.

Steel Fireboxes in British Locomotives.—Before the war European practice favored the use of copper for locomotive fireboxes, but since the war started mild steel has steadily gained favor for this purpose, especially in British locomotives.

Canadian Boiler Laws*

BY D. M. MEDCALF

In our work in Ontario, if a manufacturer desires to build a boiler, he must first submit designs in triplicate delineating the construction of the boiler, giving the complete dimensions and fully detailed, and fill out specifications for which we supply blank forms. When the drawings are received, they are transferred to our surveying department and checked over very carefully. All the figures in our calculations are filed there. If the boiler design has been prepared to meet with our requirements, one copy of the design is returned to the manufacturer, officially stamped, with the allowable working pressure indicated on the plans, and a registration number given, from which he may build as many boilers from that one design as he may wish, without making any change. If the design does not meet with our requirements, it is marked up with red ink and returned to him for correction. It is absolutely necessary that he call in an inspector before any work is done on the plates. They are examined for any defects, and as to thickness, etc., and if found to be correct he is told to go ahead. The work of construction is again inspected before any riveting is done. If this work is found to be good and according to the approved design, he can go ahead until the final inspection is made. The boiler is stamped on the front head, and the inspector makes out his final report, which forms the data from which we issue the official certificate for the boiler, and forward it to the manufacturer in duplicate. The manufacturer gives one certificate to the purchaser of the boiler, and retains the other for his files.

Boilers Imported from the United States

In the matter of boilers coming from the United States, we accept the inspection of any person employed by any boiler insurance company, but that inspection must not be an individual inspection. We do not want the inspector to go and make the inspection and merely send in a report because that boiler is going to Canada; but that inspection is supposed to be made with the full knowledge of the company by whom he is employed. I have arranged with some of the insurance companies that they notify me when their inspector has been called on to make a certain inspection. The inspector who attends to this work fills out a shop report and forwards it to us, and if, after we check it over, we find that it is in accordance with our requirements, it is accepted and the certificate issued. There is a fee of $5 for the shop inspection. You might wonder what the $5 is for, because we do not do any labor for it. It is none of our business whether the insurance company charges five dollars or $1,000. If it were not for Section 136 of our regulations, we would be compelled to come across to the United States at least three times, to wherever the boiler is being built, and the manufacturer would be required to pay our traveling expenses, plus the fee. I think the idea of accepting the insurance company's inspection is a pretty fair proposition from our department, and I believe is much appreciated by the manufacturer and owner of the boiler.

The regulations in Alberta, Saskatchewan and Ontario are exactly the same, word for word. British Columbia is slightly different. We had a conference in Toronto two years ago, with the object of having uniform regulations adopted throughout the Dominion. We are completing that work now by correspondence, but it is very slow work.

* From an address delivered at the American Uniform Boiler Code Congress, Washington, D. C., December 4, 1916.

If a boiler is built according to the requirements of the Province of Saskatchewan, they would not allow us as great a working pressure on it as they would in Ontario, because they make no provision for shop inspection, and add to their factor of safety point five. We will accept the inspection of the insurance companies in the United States on boilers constructed from a registered design. They will not accept the inspection of any person, not even our own inspectors, although I might say that a year ago I went out through the West and talked to them about accepting our inspection on boilers under construction, but they would not consider the proposition at all. British Columbia did, however, with the result that we are now inspecting all boilers built in the Province of Ontario for use in British Columbia, and that makes a difference of between 12 and 18 pounds' pressure for the manufacture of a boiler.

If a second-hand boiler is brought into Ontario, we would figure on the allowable working pressure according to the different formulæ contained in our regulations, and then make a further reduction of at least 10 percent. I think that is a mighty wise thing to do, because until three years ago the Province of Ontario, which in my opinion is the banner province of the Dominion of Canada, was really the dumping ground for not only the other provinces of the Domininon of Canada, but for the United States as well. We have stopped that, too. I do not know what pressure you would allow over here for an old boiler coming from Ontario; probably you would reject it entirely, or at any rate allow a very low pressure.

Locomotives for South Australian Railways

Description of Locomotives of English Type with Copper Fireboxes and Tubes, Built in Australian Railway Shops

BY JOHN O'TOOLE*

Locomotives built in the Government railway shops in South Australia in general follow English practice rather than American practice. All of the fireboxes and tubes in these locomotives are made of copper, and in this particular they differ widely from American locomotive boiler construction.

In South Australia two distinct gages of railroads are used, namely: 5 feet 3 inches and 3 feet 6 inches. The former is used for mail and trunk lines, while the smaller gage is used for opening up the country districts where the volume of traffic does not warrant the greater outlay required for the wider gage railway.

The three different classes of locomotives illustrated are manufactured in the railway workshops at Islington, South Australia, after the designs and under the supervision of B. F. Rushton, chief mechanical engineer. Fig. 1 shows a class R^{x} locomotive of 5 feet 3 inches gage with cylinders 18 inches diameter by 24 inches stroke. The boiler is of the Belpaire type, designed for a working pressure of 175 pounds per square inch. The total heating surface is 1,437.94 square feet divided as follows: Firebox, 105.3 square feet; tubes, 1,332.64 square feet. The grate area is 20.27 square feet. In working order, the engine weighs 45 tons 2 cwts. and the tender 24 tons

* Representative of THE BOILER MAKER, 81 Darby street, Newcastle, Australia.

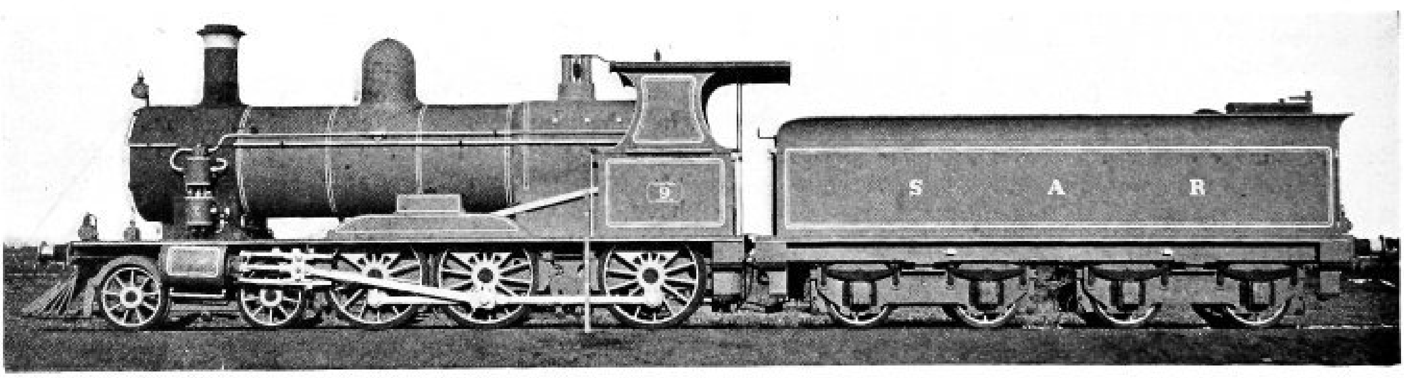


Fig. 1.—Express Passenger and Goods Engine, Class R,* Gage 5 Feet 3 Inches

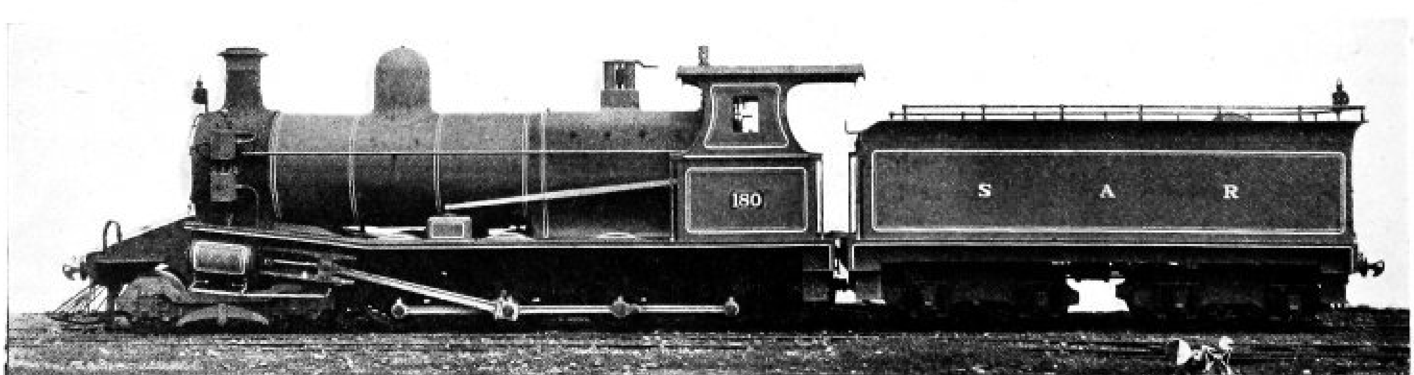


Fig. 2.—Tender Goods Engine, Class T, Gage 3 Feet 6 Inches

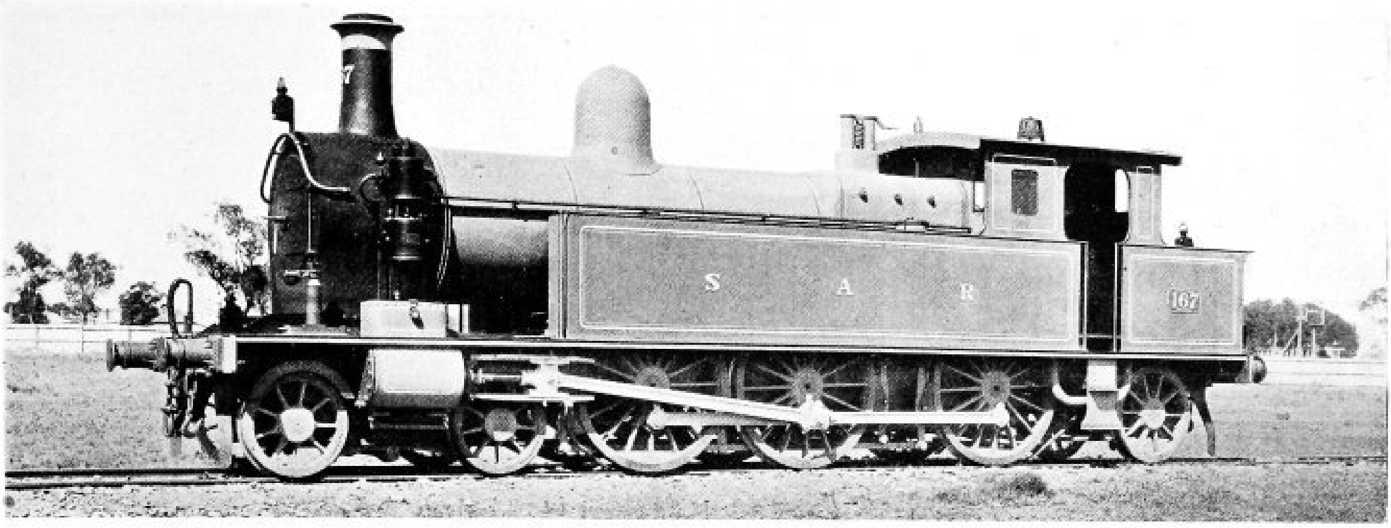


Fig. 3.—Suburban Tank Engine, Class F, Gage 5 Feet 3 Inches

5 cwts., making the total weight in working order 69 tons 7 cwts. The engine has a tractive power per initial pound pressure of 144.

Fig. 2 shows a T-class engine manufactured at the same works. It has a gage of 3 feet 6 inches and cylinders 16½ inches diameter by 22 inches stroke. The tractive power per initial pound of pressure is 139.29.

The boiler of this engine is also of the Belpaire type, designed for a working pressure of 185 pounds per square inch. It has a total heating surface of 1,048 square feet, made up as follows: Tubes, 939 square feet; firebox, 109 square feet; with a grate area of 17.3 square feet. The weight of the engine in working order is 41 tons and the tender 30 tons 13 cwts., making a total weight of 71 tons 13 cwts.

The suburban tank engine, Class F, shown in Fig. 3, has a gage of 5 feet 3 inches. Its cylinders are 17½ inches diameter by 24 inches stroke, and the tractive power per initial pound pressure is 116.6. The boiler, of the Belpaire type, is designed for a working pressure of 185 pounds per square inch. It has a total heating surface of 999.88 square feet, of which 869.20 square feet is supplied by the tubes and 130.68 square feet by the firebox. The grate area is 18 square feet and the total weight of the locomotive in working order is 57 tons 10 cwts.

Welding School Building Destroyed—The Chicago Welding Institute's school building for instructing in antogenous welding, which is managed by the Imperial Brass Manufacturing Company, Chicago, Ill., was destroyed by an explosion on April 17. The building was razed and windows blown out within a radius of two blocks. Several persons were injured, but none seriously. No apparatus was in use when the explosion occurred, and it is believed to have been purely an accident.

Agent for American Manufacturers in France.—At the suggestion of the American Chamber of Commerce in Paris, France, Max Baumann, who has offices in Paris (10°) at 64, Faubourg Poissonnière and in Epinal (Voges) at 61, Rue de la Manutention, writes to The Boiler Maker that he is in a positon to represent in France and her colonies American manufacturers interested in any of the following lines: Efficient production of steam and other motive power; service, operation and facility of manufacture; steel tools; industrial production and accessories; safety in the factory; modern industrial production.

Remarkable Metal Flumes

BY FRANK C. PERKINS

The accompanying illustrations show the difficult construction of some remarkable metal flumes constructed in sections at Denver, Col., at the Hardesty sheet metal plant. One of these flumes designed in Denver has a diameter of 8 feet 4 inches and a length of 2,400 feet, the average height of structure being 30 feet. It has concrete inlets and outlets, and the approximate cost of structure was $30,000. It is owned by the Upperhanover Water Users' Association, of Warland, Wyo. Some of the bents are 52 feet in height.

A remarkable flume suspended on wooden truss was installed on the Greeley Poudre Canal at Greeley, Col., with a span of 70 feet and a diameter of flume of 5 feet. Another metal flume on a steel structure was erected by the Twin Falls Canal Company, Twin Falls, Idaho. This flume is 14½ feet in diameter and 300 feet long.

A most interesting flume has been installed for U. S. Indian Service at Albuquerque, N. M. This is a small flume, erected on steel, having concrete piers, which were cast in corrugated pipe. A great flume 9 feet in diameter and 10,000 feet long was installed on the Trinchera Irrigation District at Blanco, Col. These flumes are used as short cuts across gulleys and low places and are cheaper than detouring around the head of the draw, on grade with the canal, and have the advantage of shortening the canal, saving grade, eliminating seepage and preventing breaks. They are much cheaper and more durable than any kind of siphon construction, and have the additional advantage of being open, which prevents clogging with weeds and trash.

It will be seen that these flumes are semi-circular and have much larger carrying capacity for the same area of cross-section than closed pipes, as they have a larger hydraulic radius and an absolutely smooth interior. In many places, instead of the old, obsolete method of making an extensive and expensive earthen fill, with the canal at the top, liable to break at any moment, with seepage losses cutting down the supply of water that should be used for sustaining crops, a metal flume is used to cross the low ground. Loss of valuable land adjacent to the canal line is reduced to a minimum and breaks are impossible, seepage unheard of.

Fig. 2 shows the details of construction of the Hess type of metallic flume, also developed at Denver, Col. In many instances the metallic flumes are attached to concrete head walls. It is only necessary to groove the

REMARKABLE METAL FLUMES

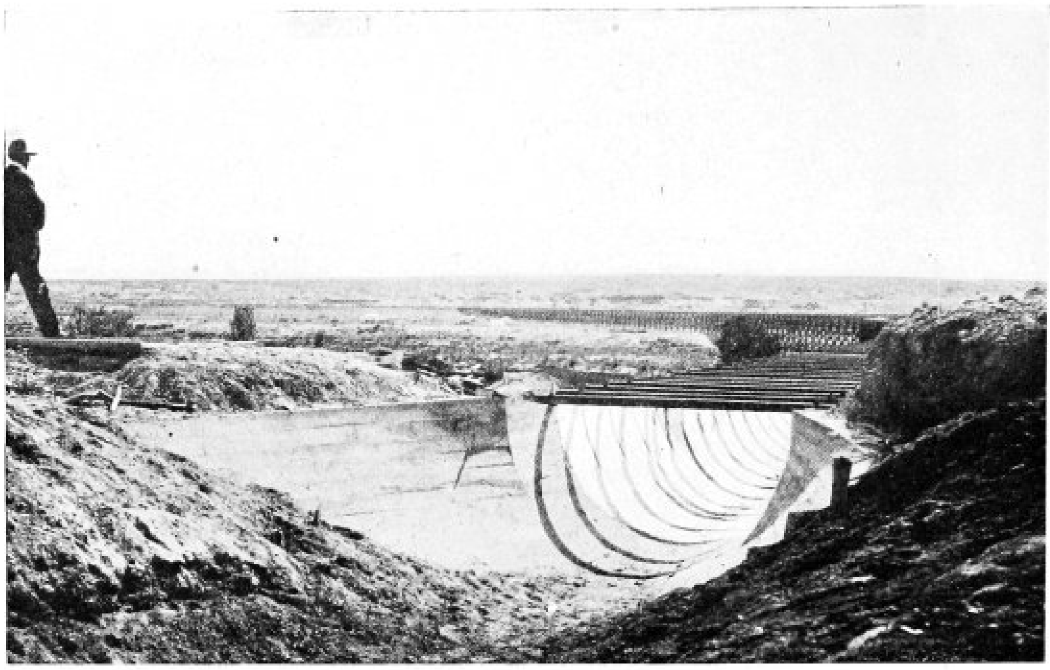


Fig. 1.—Flume 2,400 Feet Long, 8 Feet 4 Inches Diameter of Upperhanover Water Users' Association, Warland, Wyo.

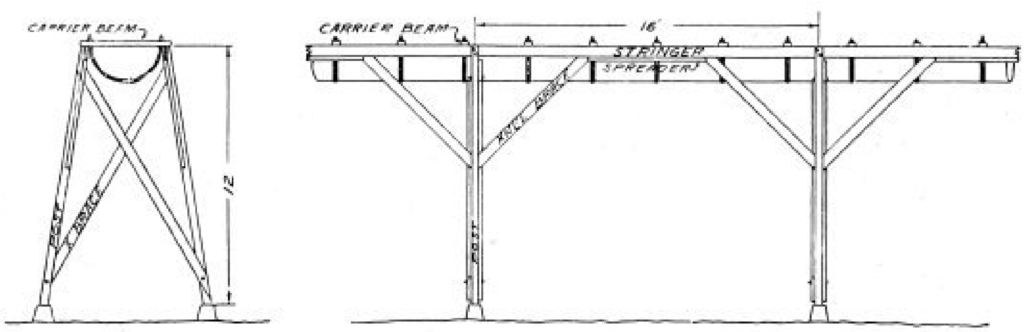


Fig. 2.—Details of Construction of Hess Type Metallic Flume

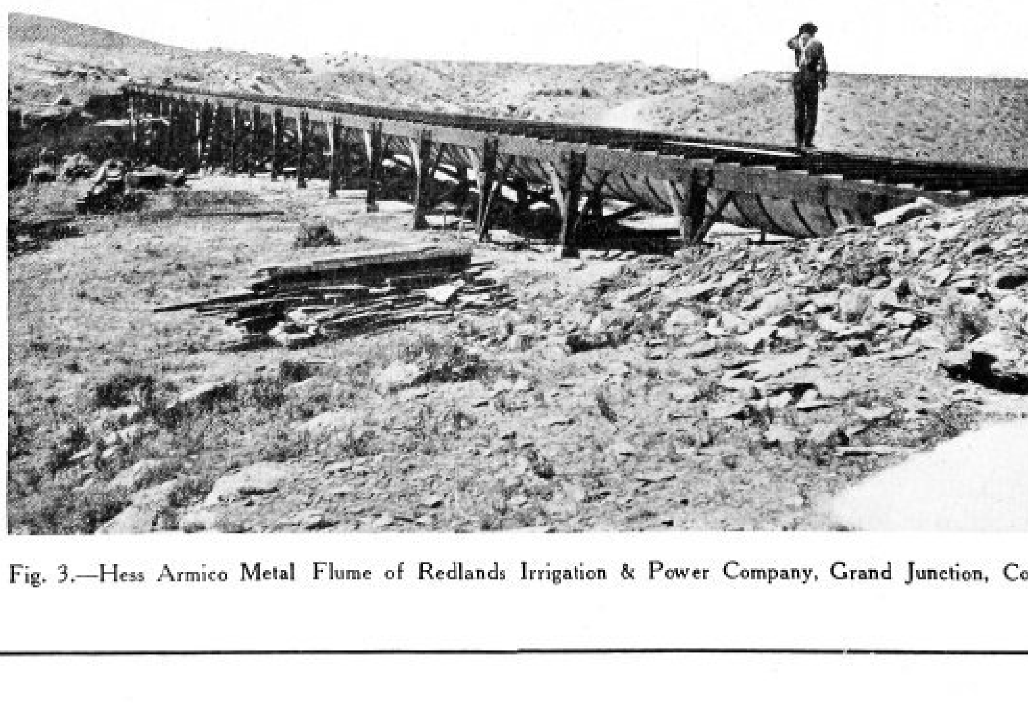


Fig. 3.—Hess Armico Metal Flume of Redlands Irrigation & Power Company, Grand Junction, Col.

concrete head wall section of a width and depth required to take the bead of the flume sheet, and set one anchor bolt at each end of groove and then fit cast shoes over these bolts, under the cross bar. When the nuts are tightened down on the cross bar the shoes force the bevel bar collar into place, holding it securely, and before attaching the metal flume section to the concrete it is necessary to fill the groove with fibre cement or oakum; then place flume

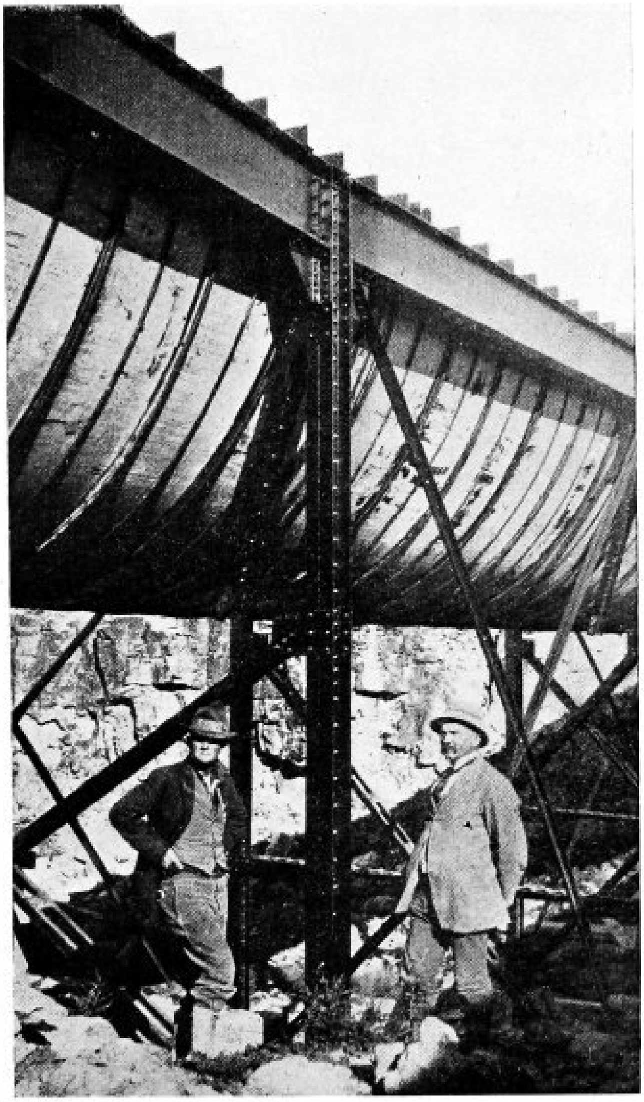


Fig. 4.—Steel Substructure of Flume of Twin Falls Canal Company, Twin Falls, Ida.

section and register the bevel bar collar in the flume section groove. The shoes are placed over the ends of the bevel bar, the cross bar placed, and then the nuts are tightened on the anchor bolts until bevel bar fits snugly in place.

It is claimed that this method gives an absolutely watertight joint, at the same time permits of adjustment should any part become loosened. Thus the first flume section becomes an expansion joint and removes all danger of the flume being torn away from concrete through expansion and contraction. In cases where it is necessary to install both head walls before flume is assembled, the distance, center to center, of grooves in concrete must coincide very closely with exact length of flume, the groove in one head wall where last sheet is to be placed may be made 4 inches to 5 inches in width to allow for any error of measurement. In such cases it is necessary to leave out anchor bolts and provide hole in concrete depth of anchor bolt and of diameter equal to width of groove. The last sheet is placed as above, and then anchor bolts are adjusted to register with bead on outside of flume sheet, and finally the anchor bolt is sealed with cement and, after allowing the cement to set, the above procedure follows.

Boiler Inspection

BY R. C. SERMON

It is but natural that boiler makers often wonder why it is that boiler makers, instead of engineers, machinists, firemen and, in fact, all other classes of mechanics except boiler makers, are not appointed boiler inspectors. Once I even heard that in Chicago a butcher was appointed boiler inspector.

Every time I read of some other mechanic receiving an appointment as boiler inspector from either the State or national government, or from insurance companies, I feel that boiler makers have been insulted. Yet from time immemorial engineers have usurped the positions of boiler inspectors. As their right to these positions has never been questioned, they have come to believe that they alone should be the only mechanics considered for the position of boiler inspectors. To substantiate this, it is only necessary to call attention to the proposed boiler inspection bill* that was presented to the state legislature of Minnesota on January 22, 1917. The bill reads in part:

Proposed Minnesota Boiler Law

"Section 4. Each candidate for chief examiner shall have had not less than fifteen years' experiences as a practical steam engineer previous to his appointment, and each candidate for district examiner or deputy examiner shall have had not less than ten years' experience as a practical steam engineer previous to his appointment."

Imagine a bill being made for the sole purpose of giving to the people of Minnesota a more reliable inspection of steam boilers which has embodied in it a section that says the mechanic who has all the qualifications of years of service in the construction and repairing of steam boilers which is necessary to make them the best boiler inspectors, shall not be allowed to qualify for the position for inspectors! That is the interpretation that must be taken by reading section 4 of the above bill.

On the face of it this is just as ridiculous as the enactment of a law providing a department of State board of health and then not allowing a doctor to qualify for the position of health inspector, or a law creating a plumbing inspection department and then not allowing a plumber to be an inspector. The average person would naturally think that a boiler maker would be given the preference for the position of boiler inspector, or at least allowed to qualify; but such is not the case, as by the wording of this bill the mechanic qualified to become inspector is a steam engineer.

An Injustice to Boiler Makers

But who, if not the boiler makers themselves, are to blame for the engineers being allowed to usurp this authority upon themselves? To comprehend more thoroughly the injustice that would be perpetrated, if this bill were passed without being changed, it will be necessary to analyze the qualifications of a steam engineer and those of a boiler maker as to their fitness to act as boiler inspectors.

A steam engineer is a mechanic who by experience has learned to fire a steam boiler so as to raise steam in the boiler to a safe working pressure sufficient to operate the steam engine and other steam appliances used in connection with the boiler. Upon the extent of this knowl-

* This bill has since been defeated by the co-operation of the boiler makers and the Duluth Mechanical School.

edge, supplemented by additional knowledge gained during this time regarding the care and maintenance of a steam engine, depends the rating of the engineer designated by special, second, first class or chief engineer. But at no time during an engineer's apprenticeship is he taught how to repair or construct a steam boiler so that it will be safe to operate under a certain amount of pressure. In the event of the boiler under his care starting leaking he at once sends for a boiler maker to ascertain the trouble and the necessary repairs to put the boiler back into a safe working condition. Still, Mr. Engineer is supposed to be the only mechanic qualified to be a boiler inspector!

Qualifications of a Boiler Inspector

The vital necessity of a boiler inspector having a thorough knowledge of the construction and repairing of steam boilers can be seen when we take into consideration that a boiler having 30 square feet of grate surface, 1,350 square feet of heating surface with a pressure of 125 pounds per square inch weighs 25,000 pounds, while the water weighs 6,920 pounds and the steam 31.19 pounds. The total energy stored in this boiler is 71,284,592 foot pounds, and the height to which this boiler would be projected with the energy all expended in raising it would be 2,851 feet at an initial velocity of 428 feet per second. Or, again, the energy that is in a cubic foot of water at the temperature of 317 degrees F. due to 70 pounds pressure is equal that of a pound of gunpowder. The water in this boiler, therefore, is equal to 115 cubic feet or 115 pounds of gunpowder. We all have a wholesome regard for a pound of gunpowder, but none for 115 cubic feet of water as a temperature due to 70 pounds of pressure. A pound of powder burned gives 170 foot tons energy.

Boiler making and boiler inspection to-day are sciences commanding scientific education and knowledge by actual experience in the repairing and construction of steam boilers. The writer can go back mentally to the days when boiler making was apparently in its infancy as compared with the science of boiler making to-day. Then the moderate demands for power and the very low pressures were well suited to the low grade materials manufactured. Boiler designs were crude, the seams out of all proportion, the bracing out of reasoning and the ignorant boiler inspector, whose only evidence of qualification was his capacity for John Barleycorn and his ability to collect the boiler inspection fees, was in evidence. I am sorry to say that there are still plenty of them left.

Better Education Necessary

Boiler making to-day is the result of evolution. High pressures are necessary. Care must be used in the selection of materials. The construction must be such as to give strength and durability under the action of hot gases and corrosive elements. The boiler must be accessible for cleaning and repairing. Safety appliances of ample proportions must be provided and properly applied. Thus comes the necessity for better education in boiler repairing and construction, and a more complete knowledge of the materials used, which can be had only by aid of practical experience. Thus it can be truly said that the trade of boiler making has now attained a high degree of perfection.

To substantiate further the claim that a boiler maker is the most logical mechanic for the position of boiler inspector, we will refer to the railroads. It is a well-known fact that the railroads are leaders in the matter of efficiency in the management of their business. Their officials and mechanical men are selected for the different positions by reason of their qualifications and not on account of any influence that they may yield. In the management of a railroad results count, and those results must be had in the shortest time possible with a minimum of expense and without the sacrifice of quality or efficiency. So when they select a boiler maker instead of a steam engineer for the position of boiler inspector, it must be for a very good reason, and that reason is that they consider a boiler maker better qualified due to his mechanical training in the care and maintenance of boilers to render more reliable and precise judgment in the examination and inspection of steam boilers.

Take, for example, the positions of master mechanic and locomotive engineers. In order to become an engineer on a railroad a man must fire a locomotive for three years, and then he must take an examination that is so stiff that if the average stationary engineer of this country was compelled to take the same examination to-morrow eighty percent of them would not be able to obtain a license. Still, the railroads do not select locomotive engineers for boiler inspectors.

Railway Boiler Inspectors

In the case of the master mechanics these men are men of superior mechanical training and are in full power over the repairing and maintenance of the locomotives under their jurisdiction. In the event of failure of the machinery on any of the locomotives, they inspect them without consulting the engineer and order the necessary repairs made, but if the boiler gives out the master mechanic seldom takes the responsibility to inspect the boiler and order the repairs made without consulting his foreman boiler maker or inspector, although he has the power to do so. The reason for this condition of affairs is because with his superior mechanical training the master mechanic more fully realizes the large responsibility that lies in a boiler when under a full head of steam. He first seeks the advice of his foreman boiler maker or inspector, knowing that they are from a life's occupation in the repairing or construction of steam boilers better fitted to pass judgment upon them. That this method of procedure is logical is evident when the fact is taken into consideration that an error in judgment on the part of the master mechanic might mean the loss of the lives of many people and the destruction of valuable property.

The same line of reasoning might be applied to the inspection of the boilers in our large buildings or manufacturing plants throughout the country. Experience has shown the havoc which might be wrought by the explosion of one of these boilers through incompetent inspection of the boiler. I am sure that greater consideration would be given to the enactment of boiler inspection laws and the securing of a reliable boiler inspection, if the facts and reasoning for the necessity of them were properly brought before the representatives or senators in our different State legislatures.

Probably some day the boiler makers will awaken to the realization of the danger menacing the people of the country by not having reliable boiler inspection laws and competent inspectors, and when they do let us hope that they will take the proper means to bring about the proper enactment and enforcement of these laws and in doing so gain the consideration and respect that has long been due to the trade of boiler making.

Locomotive Brick Arch Tests.—Brick arch tests recently made on a modern Mikado type locomotive of 320,700 pounds weight at the Pennsylvania Railroad test plant showed that the drawbar horsepower of the locomotive was increased from 11.5 to 16.7 percent at combustion rates varying from 7,000 to 4,000 pounds of coal per hour by the installation of the brick arch.

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Among Pennsylvania Boiler Shops

Methods of Riveting—Use of Oxy-Acetylene Welding for Boiler Work—Guards for Shop Machinery

BY JAMES FRANCIS

For nearly seven weeks the writer has been among the Pennsy mountains, on the head waters of the Schuylkill River, among the coal mines, culm piles and the Pennsylvania Dutch. His business was the supervision of the installation of a "traveling Breaker" for loading on cars some of the numerous culm piles so abundant in the anthracite region, and which piles have now assumed a very desirable commercial value.

Machine erection with "native talent" is no joke, and when it comes to the breaking in of a native son to care of boiler and engine—well, a sample of the whole business is that for nearly a day the "fireman" was unable to get up steam in a little 20-horsepower vertical boiler, and tried all manner of means to clear from the boiler tubes the deposit which he claimed had filled them solid from burning soft coal. After several hours' struggle the man found that the boiler steamed in an excellent manner after he had opened the tightly fitting damper in the boiler stack! And the above is a fair sample of matters and things during the past seven weeks.

High Grade of Work

There are some excellent boiler shops within a radius of 50 miles of this "crack in the mountains," and that at least one of these shops does most excellent work the writer can testify from actual experience. A new stack was ordered, in two pieces, with an offset in one of them. When the stack arrived it was found desirable to remove one length of sheet from one piece and attach it to the other piece of stack, which necessitated the cutting out of several ⅜-inch rivets which had been driven cold by a pneumatic riveter.

Since cutting out those rivets in that little stack the writer has had a vast deal of respect for the method of riveting noted above, for even after the heads of the rivets had been cut away it was found almost impossible to drift the rivets out of their holes. To be sure, the poor facilities for "holding on" when driving out the rivets had considerable to do with the difficulties experienced, but it truly seemed that new holes could be punched in the solid sheet almost as easily as those cut-off rivets could be knocked out of the holes which they filled so fully and completely that the rivets had apparently been almost cold-riveted to the stack sheets.

Hand vs. Pneumatic Riveting

Not much like hand work is good pneumatic riveting. The writer has many a time cut off hand-driven rivets and had the body of the rivet fall out of the hole as soon as the head was removed. But not so with pneumatic or hydraulic rivet driving. There, as in brazing, each and every part of the rivet hole is fully filled with the metal, which flows like wax under the rapid blows of the "gun" which drives them. The difference between hand-driven seams and those driven by air is apparent at once, even during the testing of the boiler, for with hand riveting it used to be necessary to calk the entire boiler, then tighten this seam, that rivet, then this one, as the water pressure sought out the defective riveting. But, with modern pneumatic work the boiler-shop foreman is apt to "talk Dutch" to a gang which has driven the seams of a boiler in which he finds more than two or three leaky rivets at the test, and these are usually at the laps, where three sheets meet.

Oxy-Acetylene Welding in the Boiler Shop

The writer recently had quite a talk with the proprietor of a very lively little boiler shop, which, by the way, had a welding outfit which seemed to be in use very seldom, judging by the thick coating of dust which covered the apparatus. When the writer spoke to the proprietor in regard to the seemingly infrequent use of the welding outfit the owner expressed himself very emphatically that while oxy-acetylene welding was mighty good in its place, and was a very handy apparatus in case of emergency, that he, the proprietor, used that process very sparingly indeed in boiler construction.

"It is fine for stopping leaks, for mending cracked pipes, collars, etc.," the proprietor said, "and sometimes the outfit is worth its entire price on a single repair job for the cutting out of sheets which have to be replaced or patched. But," he added very emphatically, "I do not like to trust welded sheets or other pressure-carrying parts under steam stress, for the reason that, however good may be the steel in the sheet before welding, no man can tell what manner of metal is in the weld after it has been fused by the oxy-acetylene flame!

"The flame of the welding torch," he continued, "contains, one might say, almost an entire metallurgical laboratory, and a steel boiler plate, after having been fused by that flame, may be of the same composition as before the fusing, or the metal may have been carbonized into hard steel, or even into cast iron, with all the brittleness of that metal. On the other hand, the metal of the weld may have been decarbonized into pure iron almost as soft as brass, which in itself may not be dangerous, but surely is not desirable.

Uncertainty of the Weld

"Therefore, in oxy-acetylene welds we have a constant mystery, and I for one do not care to put faith in an oxy-acetylene weld for withstanding steam pressure except in such places and under conditions where the possible failure of the weld through carbonizing or oxidizing of the welded parts by the oxy-acetylene flame can do no damage should failure thereof occur while the steam vessel is under pressure. And, as such places are not very plentiful in steam boilers, you see why I use the oxy-acetylene welding process sparingly in my shop."

In the opinion of the writer, the position of this boiler maker was well taken. Undoubtedly, a perfect oxy-acetylene weld will hold as much stress as any other form of weld, but the trouble is that nobody knows, after the weld has been made, whether the portions of the metal adjacent to and forming the weld are of the same nature as they were before the weld was made. That is where the risk comes in in relation to oxy-acetylene welds, and the risk is a great one with the odds upon the side of the metal being "off color" as far as its nature is concerned after welding.

It is one of the basic principles of boiler construction and operation that as few risks be taken as possible, and no risk at all shall be taken when it is possible to avoid a risk. Some risks are always present in the actual unknown quality of the metal in some of the boiler plate, even in spite of the most rigid test and inspection. There is also the risk of defects in workmanship, which may be covered up in the seams and joints. To be sure, the "factor of safety" is for the purpose of taking care of these risks which cannot be eliminated, but the present factor of safety was never intended to cover the possibilities which exist in the oxy-acetylene weld, as it may be made under some working conditions; therefore, that form of weld should be eliminated from pressure work.

Bear in mind that the writer has no desire to, or any intention to, "knock" the very useful and almost indispensable oxy-acetylene weld. Far from it, for this form of welding cannot be dispensed with. But look out for it in boiler work, and don't take the risk of changing the nature of the steel to some unknown condition during the process of making an oxy-acetylene weld!

"Protecting" Shop Machines

The writer recently visited some shops where the machinery had been recently looked over by an inspector of the Employers' Liability Commission, or whatever its official title may be, and the protective schemes and devices ordered by said inspector were certainly enough to "make a horse laugh!"

The air compressor was ordered boxed up or railed off; the latter method, if used, to be at a distance of 17 inches from any moving part of the machine, and this in spite of the fact that, owing to the very long and narrow dimensions of the shop, it was necessary, when bending a wide sheet in the rolls, that the edge of the sheet should pass by the end of the compressor about 12 inches therefrom. That made no difference to the inspector, who, by the way, also ordered wire-caged the revolving balls of a little Gardner governor which was perched on top of a 10-inch by 10-inch horizontal steam engine.

But this was not the limit, by a great deal, for before the inspector had finished with the shop tools he actually ordered guards around the swinging arm of a radial drill which stood at one side of the shop! Luckily, the shop at that time did not happen to be building any U-boat hulls, or in all probability the inspector would have ordered wire cages around the propellers of said craft.

Recently the writer saw by personal observation one of said inspectors visit a gravel digging and loading machine similar to a steam shovel, except that a swinging elevator took the place of the usual bucket. And what did Mr. Inspector do but order boxing or guards around the link driving chains in the machine, and even ordered guards around a set of bevel gears so high above the floor that a man must stand upon his toes in order to reach said gearing! And, judging by past experience, the writer is every day expecting to see wire guards around the doors of each steam boiler, less the swinging doors may bark the inspector's shins when he comes around. The railroad people must look out, too, or some of those "Liability Inspectors" will order guards around each locomotive engine which hauls trains along the railroads. Guards around an engine, you know, might prevent said engine from striking a section hand or a hobo who might be counting ties along the right of way. But, certainly, the findings of some of the inspectors above mentioned are simply fierce, and said inspectors should, before being sent out, be themselves inspected by someone to determine if said inspectors really know what they are talking about when they visit boiler shops and other manufactories and order the expenditure of several hundred dollars for grotesque and utterly useless cages, screens and protective railings which, after being placed in commission, are as useless as a fifth leg to a dog.

There are many places and machines in a boiler shop where protective devices are needed and should be applied at once without waiting to be jacked up by a kid-glove inspector with his hair and his name parted in the middle, and who, for his life, couldn't tell the difference between a dolly-bar and an air-gun!

In the shop mentioned above, where the inspector demanded 17 inches between guard rail and machine, and where no more than 12 inches could be spared on account of room needed for material passing through the bending rolls, there the shop man played a good one on the inspector, who never knew the difference when he "approved" of the guard work and appliances.

A piece of No. 18 sheet steel was cut to shape, one end bent over to fit the pipe rail, then the sheet was hung to the upper bar of the railing where the 17 inches of space was supposed to exist. Either the inspector didn't see it or didn't know the difference, for the work was approved and the shop man showed the arrangement to the writer with considerable fun sparkling from his eyes.

A neat and most excellent way of fastening a gate made of pipe and fittings was shown to the writer in this same shop. A common strap hinge was used, one end being wrapped around the pipe and held by a small bolt put through both portions of that end of the hinge. The other strap was cut off about 3 inches long, a hole drilled or punched in it close to the end and large enough to receive the pipe forming the gate.

The end of the hinge was then sawn open, right down into the hole, and when the gate was closed the pipe entered the open side hole, holding the gate securely and being found very easy indeed of opening by simply throwing upward and back the free end of the sawn-off strap hinge.

Some Good Machine Guards

Like about everything else, there are both good and bad ways of building and attaching machine guards. About the worst way of all is to build a wooden box over or around the part to be "protected," and even this clumsy way can be made worse by fastening the wooden contraption to floor or wall, or, perhaps, to both. When repairs or adjustments are found necessary the wooden "guard" will be found to be literally a child of the devil and must almost be torn in pieces in order to move it out of the way.

The next "worst" machine guard is the one made solid of plain sheet steel, after the fashion of the wooden affair above described. It is possible to inprove somewhat the sheet steel guard by cutting open panels into the sides and other surfaces of considerable area, but in so doing the completeness of protection is sacrificed somewhat because of the panel openings, which allow damphools to put their hands or heads into danger through the panel openings in question.

There are several good guards, and the best of all is made with a frame of light angle steel, perhaps 1 inch or 1½ inch, according to the size of the guard, the frame being covered with galvanized wire cloth made from not less than No. 16 wire, woven to a mesh between ¼ inch and ¾ inch square. This makes the best guard which the writer has as yet come in contact with. The wire should be well fastened to the angle frame either by means of clips and rivets or by thin bars and small bolts, the wire cloth being caught between two flat surfaces of metal, which are then bolted or riveted securely together, the wire cloth having first been stretched as much as possible.

Another guard, good, but not as good or as durable as the one just described, may be made by building a wooden frame of 1½-inch or of 2-inch square stuff, fastening the parts together by means of threaded rods with nuts and washers thereon. The frame, after fully fitted up, should be painted, preferably a lead color, and then covered with wire cloth with wire and mesh as described in a preceding paragraph. A guard made in this manner with wooden frame is a good proposition and will answer fully all requirements, but it is not as good looking as the guard with the angle steel frame, and the wooden one is far less durable than the all-steel construction. Better use the steel frame, even if it takes a little longer to build and costs a bit more. It will pay in the long run.

The writer has seen wire-cloth guards built upon pipe frames, but he is not particularly well impressed by such construction. Such guards are not any better than those made with steel angle frames. They are harder to build, require more "fiddling" in order to get all the connections fully tightened up while the required dimensions are held. The pipe frame is also much harder to attach wire cloth to and there is also the added danger of the screwed joints yielding under stress and letting the guard go "all of a skew," something which never happens with the angle steel frame, well riveted together.

And, just a few more words concerning the machine-guard business. Once you have made such guards as you have decided to use, proceed to put them in place subject to two requirements. The first is that the guard be firmly fixed or supported in such a manner that, even should a man be thrown against the guard with considerable force, the guard cannot be demolished by the impact or torn from its protecting place.

The other requirement is that the guard shall be so securely fastened in place that it cannot be torn loose, but can be easily and quickly removed when necessary to clean or adjust the machine which it guards.

Piece Work and the Bonus System

BY H. W. HOOVER

We shall endeavor to show the disadvantages of both of the above methods when used in manufacturing plants, and more especially as applied to the employees. Although the use of these methods does not always guarantee the maximum production, they nearly always are a means of guaranteeing large profits on capital invested at the expense of excess energy on the part of employees, which means shortening their days of usefulness and, perhaps, even their length of life.

Piece Work

A price is determined upon and fixed for every operation on every part of a manufactured article. This price includes a percentage of overhead and operating expense, interest on capital invested, insurance, loss, etc.; in fact, every expense due to manufacturing, plus a percentage of the profits. After a plant has been in operation for a short period of time under this system, the manufacturer learns that a few of the employees have become expert in their particular operation and are earning a higher rate of wages than is paid in that locality for the same class of operators in other plants. The result is only too well known—the price for that particular operation is cut so as to enable the manufacturer to either increase his already large profit, or to undersell a competitor, while the employee is forced either to use more energy to earn his previous wage, so as to enable him to live in the same comfort to which he has become accustomed, or to change his mode of living.

Why is the manufacturer not satisfied with eight or ten percent net profit on capital invested? Why not keep the services of these expert operators by allowing them to reap the benefits of being expert? "A little recreation now and then is relished by all of us." Why not grant these experts leave from your plant after completing a fair day's output, and after earning what you think is a fair day's wage? Would not this be an incentive (by example) for other employees to follow?

Bonus System

A stated amount, per schedule, must be produced each day by each and every machine and employee, so as to counterbalance the cost of production. This includes overhead and operating expense, interest on capital invested, insurance, loss, etc.—in fact, every expense due to manufacturing, plus the profits; after which a bonus is paid for excess production, which is nearly all profit for the manufacturer.

Bear in mind, dear reader, that a large part of these expenses are based on *twenty-four hours every day, three hundred and sixty-five days each year*. I have in mind a bonus system that is worked something like this: An operator is in charge of a machine, and for each piece this machine finishes he is paid two cents. One hundred and fifty pieces are considered one day's work for machine and operator, and will counterbalance all of the cost of production plus profits. Consequently, any excess output on this machine is nearly all excess profit for the manufacturer.

The operator, therefore, is paid a bonus, the munificent sum of half the regular price, or *one cent* for each piece more than one hundred and fifty. Why? I do not know! There is no incentive for this operator to increase his production.

For example, let us use the plant which is working its employees eight hours per day. Suppose A's output for seven hours' work equals B's output for eight hours, and suppose, also, that the output for each man is the calculated output when working on an eight-hour basis; then there is no reasonable argument why all output in excess of the calculated output should not be paid for as overtime, according to the standard as in force in that plant, either pro-rata or pro-rata plus fifty percent and not fifty percent of the pro-rata.

"It is just as easy for the rich man to enter the Kingdom of Heaven as it is for a camel to go through the eye of the needle." Perhaps the manufacturers throughout the country have heard about this and are striving to save the souls of their employees.

Making the Little Business Grow.—Making a business grow is a matter of efficiency only, and that efficiency does not consist of ready-made rules. Efficiency is no coat the donning of which will change all things and conditions for the better—no magic Aladdin's lamp. It is rather a state of mind, a desire, a purpose and a habit, which must pervade not only some one man in a business organization, but all things, both animate and inanimate. We have in many books and writings the experiences of others who have striven for and obtained efficiency, but the successful application of these experiences and suggestions to a particular business is not tellable on paper or by word of mouth; it is for each individual to work out his own salvation, making use of the experiences of others as a foundation on which to build.

The Boiler Maker

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NOTICE TO ADVERTISERS

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 25th of the month, to insure the carrying out of such instructions in the issue of the month following.

At a meeting of the Executive Board of the Master Boiler Makers' Association, held in Chicago on May 2, it was decided on account of war conditions to postpone indefinitely the eleventh annual convention of the Association, which was to have been held May 22 to 25, at the Jefferson Hotel, Richmond, Va. This action is in line with the decision of other associations composed of men identified with the mechanical departments of railroads. In every case it is considered that in view of the national crisis men in all departments of railroad service should remain at their posts and keep the transportation facilities of the country in a condition of highest efficiency.

Previous to the above decision the Executive Committee of the Boiler Makers Supply Men's Association had decided to postpone indefinitely the annual exhibition that was to have been held by the Association at the Jefferson Hotel, Richmond, Va., in connection with the Master Boiler Makers' Convention. This action was impelled by the unanimous opinion among the members of the Association that they should, as patriotic citizens, conserve their time and resources, holding them subject to the call of the country's necessities. All work that had not already been carried out, in connection with this exhibition was immediately stopped, and while necessarily some money was spent, further notice will be given relative to the refunding of subscriptions for exhibition space when the expenses incurred in connection therewith have been totaled and the Executive Committee takes the necessary action.

New Jersey has enacted a law providing for the appointment of a Board to formulate rules and regulations for the safe and proper construction and use of steam boilers in the State. The Board is to consist of the Commissioner of Labor, the members of the Steam Engine and Boiler Operators' License Bureau and two citizens to be appointed by the Governor. No boiler shall be installed or used in this State unless it conforms to the rules adopted by this Board. The Board has been given a free hand and is at liberty to adopt the best boiler rules that can be obtained. For the sake of uniformity it is hoped that the Board will adopt outright or embody in substance the A. S. M. E. Boiler Code. These rules represent the best boiler practice, and, due to their widespread adoption by other States, they should be adopted by the Board of Boiler Rules in New Jersey.

According to statistics compiled by the Hartford Steam Boiler Inspection & Insurance Company, a total of 499 steam boiler explosions occurred in the calendar year 1916. These explosions resulted in the death of 199 persons and the injury of 375 persons. In tabulating the work of the Boiler Inspection Department of the company, it is pointed out that by far the greater portion of the defects discovered in boilers in 1916, as has been the case in past years, were due to impure feed water. The large number of cases of scale, sediment and corrosion bear out this statement. In all, the company's inspectors examined during the year 386,245 boilers; 28,212 cases of sediment or loose scale were found, of which 1,593 were dangerous; 42,877 cases of adhering scale were found, of which 1,612 were dangerous; 19,008 cases of internal corrosion were discovered, of which 793 were dangerous, and 10,968 cases of external corrosion were disclosed, of which 814 were dangerous. The other most serious cases of defects were found in leakage around the tubes and defective tubes or flues, while over 9,000 defective boiler settings were found.

To Our Readers

A proposition is before Congress to increase by several hundred percent the cost of mailing copies of technical journals to their subscribers. We have kept the subscription price of The Boiler Maker at the nominal amount of $1 in order that the publication may be within easy reach of anybody interested. If, however, the proposed action of Congress is enacted into law, we may be obliged to increase the subscription price of The Boiler Maker to $2, or even $3, especially to those subscribers who are in the far West, hundreds upon hundreds of miles from New York. We want to urge every one of our subscribers to write to his Congressman, begging that Congress do not radically increase the cost of mailing technical magazines and thus increase the subscription prices to unreasonable amounts. We urge every reader to send such a letter at once—otherwise it may be too late.

Engineering Specialties for Boiler Making

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

Rome Merchant Iron Mill Reincorporated

The Rome Merchant Iron Mill, of Rome, N. Y., has been reincorporated under the name of Rome Iron Mills, Inc. This change was made to provide for an increased capitalization on account of the large increase in their facilities for the manufacture of hollow iron. There has been no change in the management.

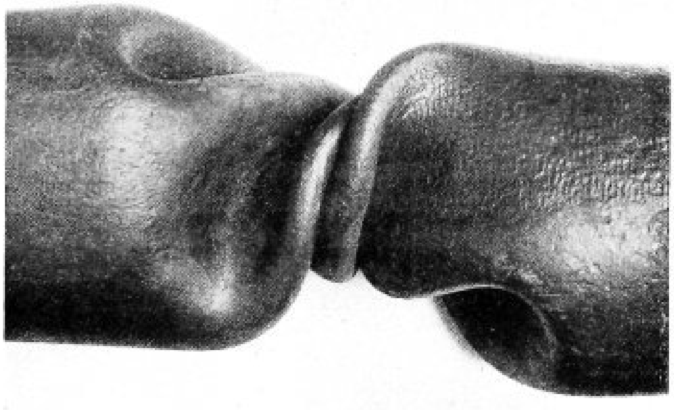
Staybolt iron made hollow without drilling has some well-recognized advantages. Rome Iron Mills, Inc., have been making a hollow iron of their "Superior" quality for some time. They have subjected this iron to various unusual and exacting tests. It is now on the market and has been placed in service by a large number of railroads.

Hollow iron has the advantage of making unnecessary the usual hammer tests prescribed by the Federal Boiler Inspection Laws. This eliminates the cost of removing grate bearers and brick arches for staybolt hammer test. It inspects itself.

Rome hollow iron is made in the same mill and under the same careful supervision that has characterized their "Rome Superior" staybolt iron for almost a half century.

Torsional Strength Test of 8-Inch National Pipe

In a test recently conducted by the National Tube Company, Pittsburg, Pa., a piece of 8-inch line pipe was subjected to a stress of 713,000 inch-pounds in torsion. The appearance of the pipe, which weighs approximately 29 pounds per foot and has a wall thickness of about 1/3 inch, after being subjected to this strain, is clearly brought out in the accompanying illustration. The test specimen shows the homogeneity, ductility and high tensile strength of the steel.

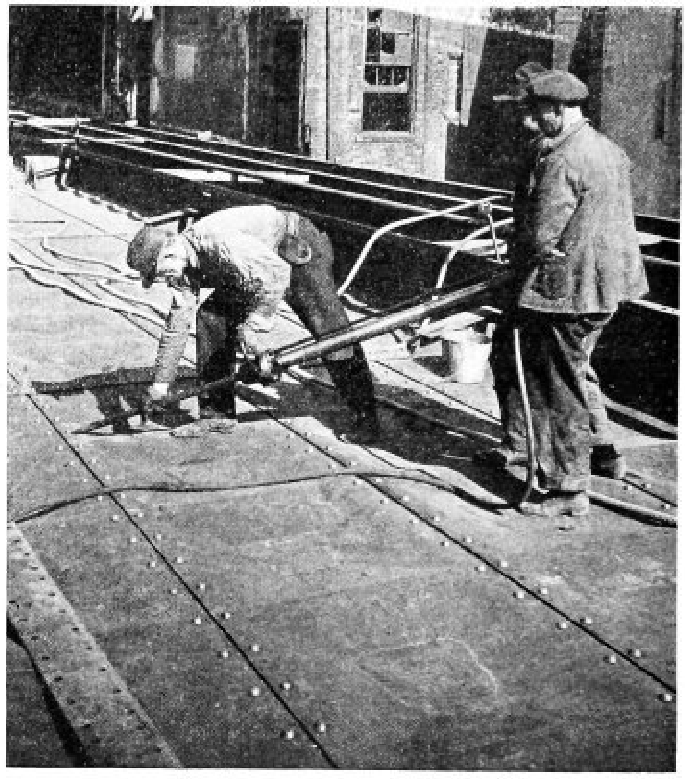


Section of 8-Inch National Pipe After Torsional Test

Rivet and Bolt Head Cutter

The Rivet Cutting Gun Company, 220 East Second street, Cincinnati, Ohio, after exhaustive tests, has put on the market a pneumatic tool for cutting off the heads of rivets and bolts, and which is also intended to back the rivets out. The manufacturer claims that about 75 percent in cost is saved over the hand method of using a cutting bar and sledge. It is also claimed that by the use of a long cutting tool rivets and bolts can be reached that are located where a scaffold would be required when employing the ordinary hand method.

The machine as illustrated is operated by three men where heavy and quick work is required and is so simply constructed that repairs are said to be reduced to a minimum. It consists of an elongated cylinder in which there is a piston mounted on slides. At the lower end of the cylinder a cup-shaped casting is provided that carries the cutting tool. The shank of the tool is passed through the casting and projects into the lower end of the cylinder. It is fitted into a tool-holder, between which and the end of the cylinder is a spiral spring to absorb any abnormal shocks, or, in other words, to take the impact of the piston in the event that the tool shank slips out of its holder.



Pneumatic Rivet Head Cutter, Weight 71 Pounds, Handled by Three Men

At the bottom of the cylinder is an exhaust port connecting with a pipe that leads back to the valve chamber at the top of the machine. This pipe serves also as one of the handles for the operators. By using a three-way valve the operator can reverse the pressure and force the piston back to the head of the cylinder where another exhaust port is provided. A quick turn of the valve again forces the piston forward.

The machine operates successfully on air pressure of from 45 to 125 pounds. It is also used for punching holes in plates preparatory to reaming them to the correct size. The manufacturer also claims that it is especially valuable in structural steel work and can be used advantageously in awkward places where the ordinary maul and chisel would be handled with great difficulty.

In railway repair plants where holes are to be drilled in

⅜-inch sheets for applying hand holds the men simply take the back-out bar, which is less than ½ inch in diameter at the point, and punch the hole through the sheet. Where holes are desired through 11/16-inch cast steel truck bolsters the back-out bar is again used for punching the hole. This work is, of course, done much quicker than it can be done with the drill, and is, therefore, preferable to drilling, which takes much more time. In straightening sheets, the blunt end of a 1½-inch bar is simply placed against the sheet, and the machine started, which drives the sheet back into its original position. On ⅝-inch countersunk rivets in some places they are simply backing them out without cutting the countersunk head off. This saves time and is done much faster than it originally was by the old method of drilling the head off.

Shipbuilding plants are using this tool for cutting off ¾-inch, 1-inch and 1¼-inch rivets on the hull of the ship and then the backing out of these rivets is very easily accomplished with the tool. The advantage of this tool is about ten to one as against the bar and sledge on straight work.

This tool is covered with patents and weighs but 71 pounds. There are no steel castings used in the tool, although several parts are made of nickled steel, which, of course, makes the tool very substantial.

Combined Steam Turbine and Centrifugal Boiler Feed Pump

Since it must handle a comparatively small amount of water against a relatively great head, the centrifugal boiler feeder should be fitted with small diameter impellers running at high speed. It is, therefore, well adapted for steam turbine drive. Fig. 1 shows an early steam turbine-driven boiler feeder built in 1910 by the De Laval Steam Turbine Company, Trenton, N. J. The two-stage pump has a capacity of 1,600 gallons per minute against 700 feet head at 2,800 revolutions per minute, and upon test gave an efficiency of 60 percent. The pump is entirely independent of the turbine, a coupling being interposed between the pump shaft and the turbine shaft, and it could therefore have been driven just as well by electric motor or by rope or belt as by a steam turbine. The unit, however, realized the advantages peculiar to the centrifugal boiler feeder, viz., reliable and uninterrupted service with little, and often unskilled, attention, absence of pulsation, shock, water hammer, vibration or overpressure in pipe lines, elimination of relief valves, suitability for use with

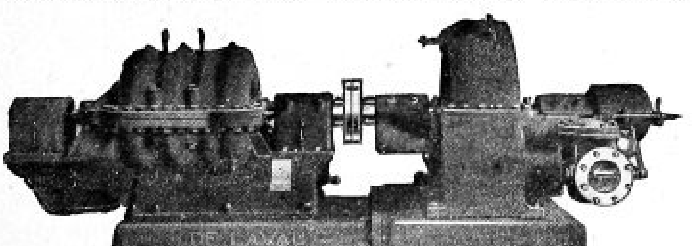


Fig. 1.—De Laval Turbine-Driven Boiler Feeder Built in 1910

automatic boiler feed regulators acting independently at each boiler and with feed water meters, close governing, either by speed governors or by pressure governors, freedom from injury by overloading, lightness and compactness, accessibility, elimination of valves, packing, sliding surfaces and air chambers, small upkeep and attendance expense due to simplicity and few wearing parts, lower cost of maintenance of piping system, small consumption of oil, efficiency, and in the turbine-driven type, ability to use superheated steam or to run upon either high- or low-pressure steam, oil-free exhaust and independence of the main units.

A still further development in the direction of compactness and simplicity is shown in Figs. 2 and 3, illustrating a 3,000-horsepower, two-stage centrifugal boiler feeder combined in one casing and on one shaft with a velocity-stage steam turbine. This unit, which also has

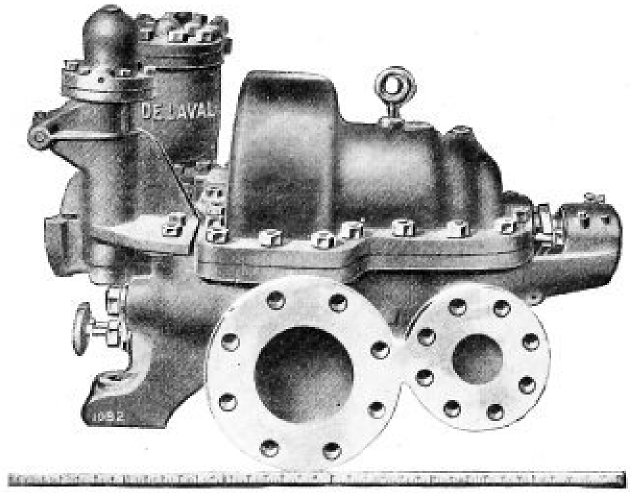


Fig. 2.—3,000 Horsepower, Two-Stage, Turbine-Driven, Centrifugal Boiler Feeder

been developed by the De Laval Steam Turbine Company, weighs only about one-tenth as much as a duplex reciprocating pump of the same delivery and occupies only about one-tenth as much floor space and one-fifteenth as much cubical space.

The pump end contains two single-suction impellers cast from a special bronze and carefully finished to exact contours. Two impellers are used for pressures up to 200 pounds per square inch, and three impellers for higher pressures. Single-stage boiler feed pumps have been built, but two or three stages are preferable because of the much longer life of the impellers at slower speeds. Each impeller discharges into a volute chamber by means of which the

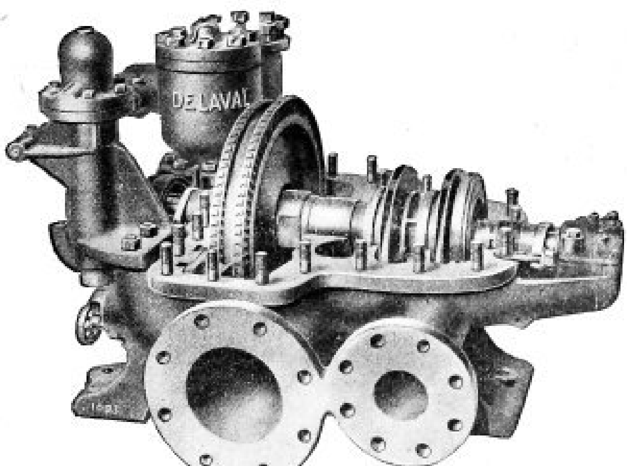


Fig. 3.—Turbine-Driven Centrifugal Pump with Cover Removed

velocity in the water as it leaves the impeller is converted into pressure before the water is led to the eye of the succeeding impeller. This means of energy conversion is superior to the use of diffusion rings, as it is efficient over a wider range of delivery, and, more important still, does not involve the use of small and sharp parts, like diffusion blades, which are subject to rapid erosion.

The pump is hydraulically balanced, and only one pair of labyrinth rings, surrounding the suction opening is required for each impeller except the last, which has two sets of rings. The whole back of the impeller is subjected to a pressure equal to that existing at the periphery of the impeller, the same pressure acting on the front of the impeller, except for the area of the circle enclosed by the labyrinth ring about the suction opening. The last impeller, that is, the one from which the water is finally discharged, is equipped with two sets of wearing rings, one on the suction side and one on the reverse side of the web. As some water from the discharge of this impeller will leak between the wearing rings into the space back of the web, this impeller would be equally as unbalanced as the other impellers in the pump if there were no escape for the leakage water. To provide for diminishing the pressure in this balancing space as much as may be required to bring the whole series of impellers into balance, a leakage outlet is provided from which water can be conducted back to the suction of the first impeller.

The steam end of the unit consists of a velocity-staged

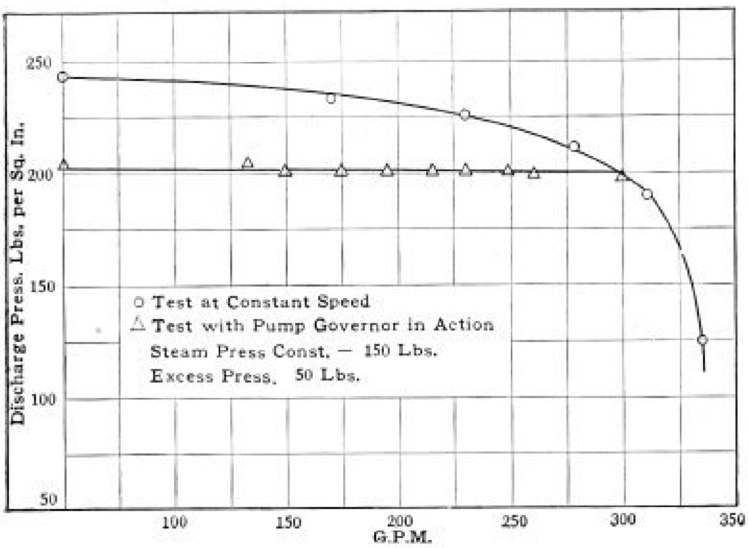


Fig. 4.—Head Delivery Characteristics of De Laval Turbine-Driven Centrifugal Boiler Feeder

turbine with either two or three rows of moving buckets, according to the steam economy desired. The nozzles can be proportioned for either high-pressure steam exhausting to feed heater or to condenser or for low-pressure steam exhausting to condenser, or the unit can be made interchangeable, thus permitting of a great degree of flexibility in plant design. Where the exhaust steam from the boiler feeder is consumed in heating feed water, the thermal efficiency of the turbine-driven boiler feeder is much greater than that of a boiler feeder driven by electric motor, or even than that of the main unit itself.

In specifying the capacity of boiler feeders, the temperature of the water to be pumped should always be stated, as the capacity is nearly 50 percent greater with water at 75 degrees F. than with water at 210 degrees F. For the same reason, capacity and efficiency tests of a pump should be carried out with water at the temperature at which it will be received by the pump in actual service.

PERSONAL

Professor C. R. Richards, professor of mechanical engineering and head of the department since 1911, has been appointed dean of the College of Engineering and director of the Engineering Experiment Station of the University of Illinois, to succeed Dr. W. F. M. Goss, who has resigned to become president of the Railway Car Manufacturers' Association of New York.

Dean Richards is a graduate of Purdue University, 1890, and has been successively instructor in mechanical engineering, Colorado Agricultural College, and professor of practical mechanics, professor of mechanical engineering and dean of the College of Engineering, University of Nebraska. Since entering the University of Illinois he served for two years as acting dean of the College of Engineering during an absence of Dean Goss.

Harvey B. Slaybaugh was elected secretary of the American Arch Company, effective March 1, 1917.

H. A. Howard, for many years connected with the C & C Electric Company, Garwood, N. J., and until recently associated with the Diehl Manufacturing Company, has been appointed manager of the New England office of the C & C Electric & Manufacturing Company.

W. F. Schaphorst, M. E., advertising engineer, has established an engineering advertising service office in the Woolworth Building, New York City.

The American Steel Export Company, Woolworth building, New York, announces with pleasure the appointment of Mr. Charles S. Vought as assistant general manager of sales. Mr. Vought is well fitted to assume the duties and responsibilities of this position, having largely directed the immediate sales policy of the company and having devoted his personal attention to practically all of the many hundred orders handled during the last year. Mr. Vought has an entire familiarity not only with the various export markets of the world and their peculiarities and special requirements, but has also a thorough knowledge of mill conditions and the technicalities involved in the production of steel and steel products, and was formerly one of the managers of the order department of the Cambria Steel Company.

NEW BOOKS

EXPORT TRADE DIRECTORY, 1917-1918. Compiled under the supervision of B. Olney Hough, editor *American Exporter*. Size, 6 by 8¾ inches. Pages, 536. New York, 1917: Johnson Export Publishing Company. Price, $5.

For those who are engaged in export trade, or who contemplate entering this field for the merchandising of their products, this directory will be found of great value. It is divided into twelve separate parts, giving complete classified lists of export merchants, manufacturers, export agents, foreign exchange bankers, foreign freight forwarders, steamship lines, foreign consuls, etc., in the principal ports of the United States. The book also gives useful information regarding the marine insurance companies of New York city, and has a chapter devoted to methods of shipping and foreign markets.

STEAM POWER. By C. F. Hirshfeld, M. M. E., and T. C. Ulbricht, M. E., M. M. E. Size, 5¼ by 7¾ inches. Pages, 420. Illustrations, 232. New York, 1916: John Wiley & Sons, Inc. Price, $2 net.

To use his knowledge to the best advantage a boiler maker should know something about steam and its uses in addition to the details of the boiler itself in which the steam is generated. In this book the authors have endeavored to give in a brief and concise manner a working knowledge of steam power plants, including engines, boilers and auxiliaries. No attempt is made to enter deeply into the theoretical considerations of the subject involving higher mathematics. In fact, anyone familiar with elementary algebra should be able to understand the comparatively simple mathematical calculations which are given. Specifically, the book is intended to be serviceable as a text-book for such engineers or other classes of men who deal with steam power plants in an industrial way and not from the viewpoint of design.

Questions and Answers for Boiler Makers

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

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

Address your communication to the Editor of the Question and Answer Department of THE BOILER MAKER, 461 *Eighth avenue, New York city.*

Patented Methods of Installing Tubes

Q.—Will you please provide me with information on all the patented methods of installing tubes? M. C.

A.—Your inquiry was referred to the U. S. Patent Office. The chief clerk replied as follows:

"Replying to your letter relative to patents covering 'methods of tube installations as applied in boiler construction,' you are advised that such patents are scattered through the classification, and the office cannot undertake to make the search which would be required to select the same. The records of this office pertaining to all patented inventions are open to public inspection, and it would be advisable for you to employ a local attorney or expert to make an examination of same, selecting therefrom just such patents as you desire."

Draft Rigging of Locomotive Boiler—Box Patch

Q.—Please explain the draft rigging of a locomotive boiler, and also a box patch and how it is flanged. C. L. H.

A.—An explanation of the draft rigging of a locomotive is explained in answer to another inquiry.

The flanging of a box patch, Fig. 1, may be done by hand or by the use of formers in a hydraulic press. If done by hand, suitable bending and clamping blocks must be employed, also such hand tools as wooden mauls, sledges, flatters, tongs and clamps commonly called *dogs* to hold the plate while being formed.

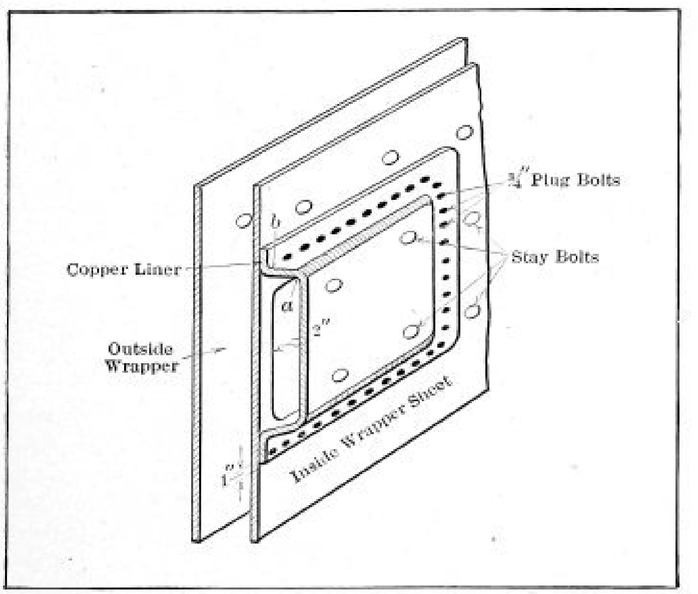


Fig. 1.—General Arrangement of Box Patch

The flange being made up of two different bends, as at (a) and (b), it is necessary to do a great amount of heating and hand work to form such a patch. The bend at *a* would be made first, then the one at *b*. Owing to the shape of the patch it is difficult to shape the corners, as a large amount of material must be worked up within a small space; also because there are two different bends. The side flanges for *a* should be turned before working up the corners. A number of heats are necessary to finish each corner, and they should be worked up uniformly.

Too much lap is a bad feature in firebox patches, for a 3/4-inch patch bolt or rivet allow 1 inch from center of rivet hole to outer edge of patch.

The purpose of boxing a patch, as in Fig. 1, is to provide a water space that will tend to keep the lap cooler than the fire, thereby preventing the lap from burning away.

Care of Boiler Shop Tools

Q.—I would like to know of the best way to take care of all tools in general in a railway boiler shop; to return them each night to the tool room or for each boiler maker to keep his own tools in his locker. J. T. R.

A.—The method of handling tools depends largely on the equipment of the shop and methods of handling the work. Each boiler maker and apprentice should have a sheet metal box equipped with at least three flat chisels, three cape chisels, one round nose chisel, one ripper, monkey wrench, center punch, three different sizes of drift pins, hand hammer, calking tools, one spud bar. These tools should be turned into the tool room at the end of each week, checked up and new tools supplied for broken ones. Each boiler maker and apprentice should be given tool checks, the number on such checks to correspond with their clock number. Each person should have at least five checks. These are used to obtain tools as air hammers, drills, taps, flue expanders and rollers, alligator wrenches, air motors, etc., from the tool room. The air tools should be returned to the tool room every night. Air hammers are usually placed in a vat of oil over night. Air motors should be thoroughly oiled every morning before they are put into service. Sledges, holding on bars (as dollies), wedge bars, flatters, hot and cold hand cuts should have suitable racks adjacent to the work where they are employed and put there at the end of the day's work. The system of allowing the tools to be kept in employees' lockers is not good practice, as very often tools so kept are usually out of service and no one knows where they are.

Corrugated Furnaces

Q.—I would like to get some information in regard to corrugated furnaces. (1) How is the working strength calculated when the pressure is internal? (2) What change will internal pressure have on a corrugated shell with heat applied as on a return tubular boiler? (3) What effect does heat have on the tensile strength of boiler plate? C. P.

A.—(1) The strength of a cylindrical boiler shell to resist a bursting pressure is not affected by its length. A cylinder subjected to external pressure is liable to collapse when it does not conform to the shape of a true circle, and this danger increases with its length. The corrugations given to flues, as the Fox, Purvis, Morison, etc., increases their strength and flexibility, thus enabling them to withstand greater external pressure than plain cylinders. The corrugations also increase the heating surface and tend to retard the flow of hot flames and gases.

Owing to these good features, such flues are used for furnaces in high pressure boilers. In calculating the strength of such flues to resist bursting pressure, the strength of the section at the weld must be known; then by the use of the same rules employed in determining the strength of plain cylindrical shells the allowable working pressure may be found.

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

in which P = pressure in pounds per square inch,
TS = tensile strength 55,000 pounds per square inch,
E = strength of weld expressed in percent as compared with solid plate,
R = inside radius of weakest course of flue,
F = 5, factor of safety,
T = minimum plate thickness of flue.

Example.—A corrugated flue measures 42 inches at its greatest inside diameter, strength of weld equals 80 percent of the strength of the solid plate, minimum plate thickness equals fifteen-sixteenth inch and factor of safety is 5. Determine the allowable internal pressure.

Substituting the values in the formula we find that

$$\frac{5/16 \times 55{,}000 \times .80}{21 \times 5} = 131 \text{ pounds pressure, approximately.}$$

(2) Internal pressure on a corrugated flue tends to lengthen it and force the corrugations to have the shape of a plain cylinder.

(3) The following brief explanation bearing upon experiments made by the United States Navy Department in 1888, on the effect of temperature on the tensile strength of boiler steel, is taken from H. de B. Parson's treatise on Steam Boilers:

"The tensile strength of all steel varies between zero and 200 degrees F.; the maximum strength is between 400 degrees and 600 degrees, and beyond 600 degrees the tensile strength increases from 200 to 600 degrees, the elastic limit steadily decreases from zero upwards, and steel having an elastic limit of 35,000 pounds per square inch at zero has its elastic limit reduced to 20,000 pounds per square inch at 600 degrees F.

"In furnaces from ½- to ¾-inch thick, under 200 pounds steam pressure, the temperature of the plate, when clean, approaches a temperature of maximum tensile strength; therefore, the use of hard, brittle steel is rendered dangerous, especially with furnaces of very rigid design."

Riveted Pipe

Q.—Please send me a formula for figuring vacuum on riveted pipe. I have a pipe to make 42 inches diameter, 40 feet long, to stand 28 inches vacuum. I would like to know the correct way to find the thickness of steel plate for this pipe. No reinforcing rings or flanges are to be used. R. F. A.

A.—In explaining the solution to this problem it may be well to state first what is meant by *atmospheric pressure* and *vacuum*, and how they are measured.

Air is everywhere and exerts pressure on all objects in every direction. The atmospheric pressure varies for different altitudes, degrees of moisture and temperatures, etc. At sea level and at a temperature of 32 degrees F. the atmospheric pressure is 14.696 pounds per square inch, but in engineering calculations a value of 14.7 pounds is usually employed.

The heaviness of air also changes with the altitude, as the higher the altitude the lighter or more rarefied its state becomes. The atmospheric pressure is measured by instruments called *barometers*.

The action of the atmospheric pressure may be better understood by making this experiment. Fill a glass tube, Fig. 2, that is closed at one end, with mercury. Close the open end of the tube by placing the thumb or finger over it; then place the tube in a jar which also contains mercury. After the mercury in both the tube and jar attain a state of rest, the mercury in the tube will stand 29.92 inches, say 30 inches high, above the level of the mercury in the jar. The weight of the mercury in the tube offsets the upward pressure of the mercury in the jar which is produced by atmospheric pressure.

Consider that the sectional area of the tube equals 1 square inch. Mercury being 13.59 times heavier than water, and as water weighs .03613 pound per cubic inch,

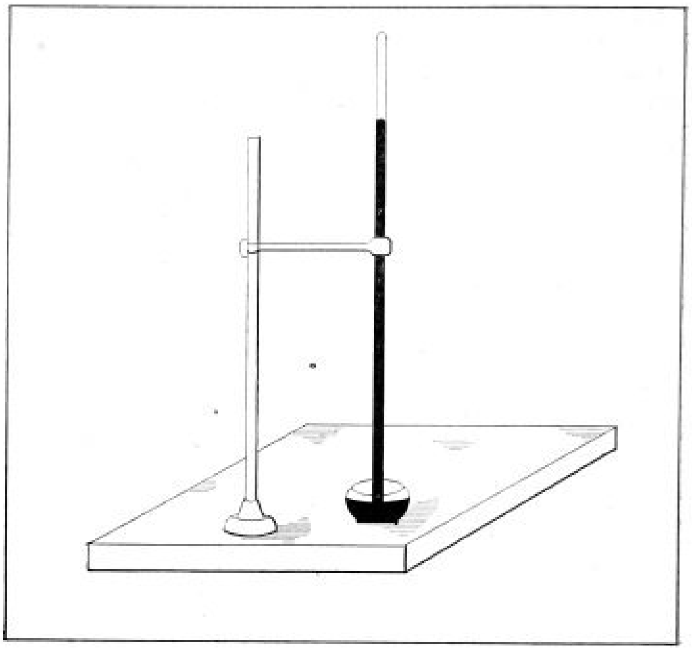


Fig. 2

it is evident that the weight of the mercury in the tube equals 13.59 × .03613 × 29.92 = 14.7 pounds, approximately, at sea level.

A *perfect vacuum* means that there is no internal pressure within a closed vessel. For example, the space between the mercury level in the tube and the closed end of the tube is devoid of all substance, and therefore of internal pressure. If a gas of any kind were in this space, it would expand and fill it, thus exerting a pressure causing the mercury to fall, thus shortening the height of mercury in the tube. If the column of mercury falls 6 inches, so that the height is 30 — 6 = 24 inches, engineers say that there is 24 inches of vacuum.

The pressure exerted by a partial vacuum being not equal to the atmospheric pressure, it is evident that objects so affected must be designed to resist a collapsing pressure. The extent of internal pressure due to partial vacuum being based upon the fall in the column of mercury and its weight, it is evident that if the mercury falls 6 inches the pressure produced by the partial vacuum equals 6/30 × 14.7 = 2.94 pounds per square inch.

The vacuum in the example in question is 28 inches. This shows that there is enough air in the pipe to depress the mercury column 2 inches, thus producing an internal pressure of 2/30 × 14.7 = .98 pound per square inch. The atmospheric pressure is 14.7 pounds per square inch on the outside; hence, the collapsing pressure tending to crush the pipe equals 14.7 — .98 = 13.72 pounds per square inch. The length of pipe is a factor in determining the plate thickness. For pipes of great lengths, the strength of the reinforced ends does not affect the strength of the plate to resist collapsing pressure. For practical purposes, Nystrom's formula given herewith is well suited for finding the allowable external pressure on pipes of great lengths:

$$P = 692{,}800 \frac{t^2}{d \sqrt{l}}$$

where t = plate thickness,
d = diameter of pipe, } all in inches.
l = length of pipe,

Using the values given in the example and the external pressure, which equals 13.72 pounds per square inch, we have the following solution in solving for plate thickness.

$$t = \sqrt{\frac{13.72 \times 42 \times \sqrt{480}}{692{,}800}} = .13 \text{ inch, approximate.}$$

For a pipe 40 feet long, a plate thickness of .13 inch would be entirely too light, since the pipe might collapse from its weight. Nystrom considers a factor of safety of 4 in his formula as good practice, therefore the plate thickness would equal .13 × 4 = .52 inch, say ½-inch plate.

Efficiency of Joint and Allowable Working Pressure on Bumped Head

Q.—Please give formula for finding the efficiency of joint and the allowable working pressure on the heads shown in accompanying figures.
L. O.

A.—For bumped heads that are single riveted to the shell, the following formula gives the maximum allowable pressure on the head:

$$P = \frac{t \times (1/6 \times T)}{\frac{1}{2} \times R}$$

in which t = plate thickness in inches,
T = tensile strength of plate in pounds per square inch,
R = radius of dish in inches,
P = allowable pressure in pounds per square inch.

Substituting values given in the example, we find according to the formula that for a single riveted joint

$$P = \frac{\frac{1}{2} \times (1/6 \times 55{,}000)}{\frac{1}{2} \times 120} = 70.6 \text{ pounds.}$$

If the head, Fig. 3, is double riveted to the shell, allow an increase of 20 percent to the pressure found for single riveted seams. Then for a double riveted joint in this case the maximum pressure allowable on the head is found as follows:

70.6 × .20 = 14.12
70.6 + 14.12 = 84.72 pounds per square inch

The next consideration is to design a double riveted lap joint that will be strong enough to safely carry the pressure on the head. Basing the calculations from the standpoint of a double riveted lap joint for a longitudinal seam, proceed as follows:

According to the "American Boiler Manufacturers' Association" the pitch between rivets for such a joint equals three times diameter of rivet hole. Diameter of rivet hole is made 1/16 inch larger than the diameter of rivet. The diameter of rivet hole in this case equals 15/16 inch.

.9375 × 3 = 2.8125 inches.

Effective efficiency of net section of plate in this pitch equals

$$\frac{2.8125 - .9375}{2.8125} = 66\tfrac{2}{3} \text{ percent.}$$

Tensile strength of solid plate equals 2.8125 × ½ × 55,000 = 77,343.75 pounds. Area of a circle 15/16 inch in diameter, which is the driven size of rivet, equals $(15/16)^2 \times .7854$ = .69 square inch. Shearing strength of two steel rivets in the given pitch equals 44,000 × .69 × 2 = 60,720. Effective efficiency of rivets as compared with solid plate equals 60,720 ÷ 77,343.75 = 78 ½ percent. This shows that the plate section is the weakest. The maximum allowable working pressure is figured from the weakest part.

To find what pressure is allowable on a girth seam, use the following formula, but bear in mind that the pressure

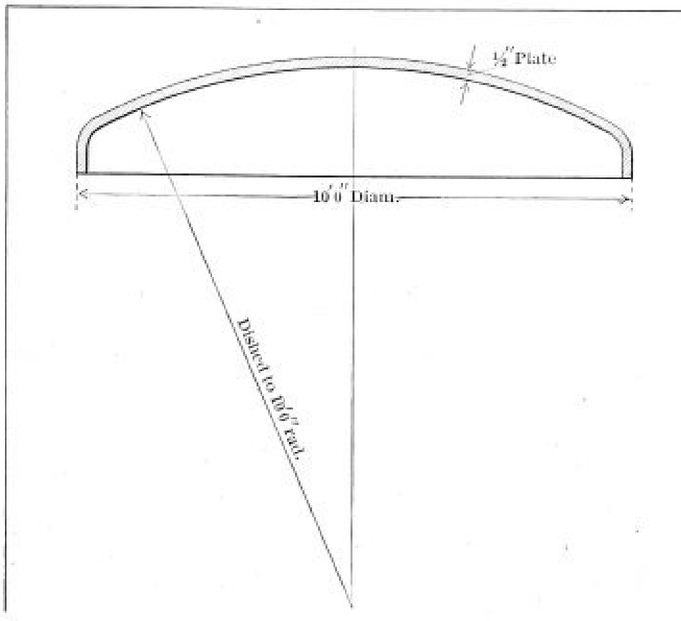


Fig. 3.—Bumped Head

so determined is not the allowable one on the head, that was found to be 84.72 pounds per square inch.

$$P = \frac{2 \times T \times \frac{1}{2}}{r \times f} \times E$$

in which T = tensile strength of plate in pounds per square inch,
r = radius of shell,
f = factor of safety,
E = lowest efficiency of joint.

Using the values found and substituting them in the formula we have

$$P = \frac{2 \times 55{,}000 \times \frac{1}{2}}{60 \times 5} \times .66\tfrac{2}{3} = 122.2 \text{ pounds.}$$

This proves that the joint is amply strong to carry the pressure of 84.72 pounds per square inch on the head.

It is now required to find out whether this pitch is suitable for the stretchout of the shell course, so that an equal pitch will be had between the rivets in its entire length. Considering a plate thickness of ½ inch, the outside diameter of the shell equals 120 + ½ + ½ = 121 inches. Circumference of circle 121 inches in diameter equals 3.1416 × 121 = 380.1337 inches.

380.1337 ÷ 2.8125 = 135.2 spaces requiring 136 rivets for the longest row of rivets and one less of this number for the shorter row when the rivets are staggered. The decimal fraction .2 being so small, the stretchout would be spaced into 135 equal spaces, thus making the pitch practically 2.8125 inches.

(2) Maximum allowable pressure on this head, when single riveted to shell, according to formula given for (1) is

$$\frac{\frac{1}{2} \times (1/6 \times 55{,}000)}{\frac{1}{2} \times 72} = 127.3 \text{ pounds per square inch.}$$

The strength of the joint with bolts is determined in the same manner as explained for the previous example.

Letters from Practical Boiler Makers

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

Defining the Foreman Boiler Maker's Job

Between the management and the boys in blue there is a great gap, and to fill this gap Providence has provided what is called boiler shop foremen. Now, the boiler shop foreman represents the management to the men, and the men to the management. By reason of labor trouble or managerial decree he is likely to earn undeserved criticism and his normally difficult position as an intermediary be made more acute than is pleasant.

He is the man upon whose shoulders most of the blame for incorrect work is apt to rest. Two sets of critics dog his footsteps and he is of necessity conscious of both; one the management, who are articulate and call him to account for causes beyond his control; the other, his men, who, though inarticulate, are nevertheless severe critics, and who manage to make their adverse verdict felt.

He is expected as a matter of course to shoulder all the burden of the day for an extra payment of a small margin over that of his men. His position demands peculiar

J. L. Didier

Readers, meet Mr. Didier! Read what he has to say about the Foreman's Job. He knows whereof he speaks. He's a master boiler maker himself—and one of the best.

abilities, and these of high order. He provides the essential link between the drawing office and shop, between design and actual practice.

His work takes all his time to perform adequately. Throughout the day's work he must decide offhand, mostly with little or no time for reflection, and his decisions must be binding and correct. In spite of his scant leisure, he must exercise foresight, plan ahead, provide for emergencies, keeping all hands occupied without wastage of time and material, be prepared at any moment for reproof from above or resentment from beneath.

He is expected to be guide, counselor and friend of his men, at the same time a rigid disciplinarian, often without the opportunity of exercising real power, his decision being overset by superior authority. Through him the management expects to feel the pulse of the shop and forestall trouble. He is expected to safeguard the interests of the management while retaining the confidence and regards of his men. He must be a judge of men. He should be impartial and without prejudice, an assimilator of new ideas, loyal to his employer, able to act without consultation and keep his dignity on all occasions.

His memory is more often than not a thing to marvel at, and no general has need for greater organizing power. In spite of any contrary opinion, it is contended that no one in the business has a more anxious and difficult task, whose equipment mentally, morally and physically needs to be of higher caliber, or upon whose activity more depends.

For his manifold and sterling qualities the management would suffer little, if the facts were more openly recognized. It is a broad criticism applying to the entire trade that few responsible men in management have had experience in the capacity of foreman boiler maker. Hence arises more difficulties and much misunderstanding between the office and the shop.

Now, dear boiler makers and apprentices, the position of foreman boiler maker would be a pleasant one if everyone would try and become a foreman—not necessarily have charge of a shop, but learn to be a foreman, a foreman on your own job. And from that on to a shop superintendent, and then to a master mechanic, and so on up the line. It may be too late for some of us, but there is a great opportunity for the young men of to-day.

Spencer, N. C. J. L. Didier.

Safety First in Boiler Installation

The most important point to bear in mind in the erection or installing of boilers is accessibility. This has a direct bearing on safety, and means providing for the proper operation, cleaning, repairing and inspecting, and is a point often given too little consideration.

We will take, for example, a horizontal tubular boiler, which is a common type of stationary boiler. The most approved method of setting a boiler of this type is by the outside suspended method, the boiler being supported entirely independent of the brickwork. The columns should be set outside the setting and rest on a solid foundation and the bases embedded in concrete. Diagonal bracing between columns will add greatly to the rigidity of the structure.

The beams should be amply strong and so arranged as not to obstruct access to any connections or fittings which may be placed on top of boiler. Sufficient head room should be allowed to permit of free access to all valves, manholes, etc., as it is sometimes necessary to make slight adjustments or repairs, and anyone who has had occasion to crawl in on his stomach to attend to some work of this nature while a boiler is in operation will appreciate the importance of this.

The walls should be braced with buckstays and the fronts secured with tie rods extending through the side wall and fastened to rear buckstays. The fire side of setting should be lined with firebrick. A door should be provided at rear or side to permit access to or cleaning of back connection; by making this door level with floor line and bottom of combustion chamber level with outside floor, the removal of ashes, etc., will be greatly facilitated.

The minimum amount of space in front of a boiler for hand firing should be 6 feet. It is false economy to restrict the space in front of a boiler, as it does not permit of proper firing or cleaning of fires, and this detracts from the economy of operation, and operation, or making steam, is what a boiler exists for. By following the general principles laid down in this article it will be possible to pay proper attention to the firing, cleaning, repairing and inspection.

The writer has in mind hundreds of cases where a little more consideration given to these matters would have saved the owners large amounts of money in greater efficiency, time saved in the various operations of cleaning, repairing, etc. Another point and a very important one in the interests of safety, it permits of thorough inspection.

Brooklyn, N. Y. A. G. R.

Obtaining Curvature in Butt Joints

I would like to call attention to an article on page 78 of the March issue of THE BOILER MAKER, in which information is given in answer to an inquiry re butt joints.

It states that the edges of plates may be formed to the proper curvature by *hammering* down with sledges.

This is not good practice and not permitted on boilers built under the A. S. M. E. Code, as specified in paragraph 191 of the A. S. M. E. Code.

This is a very important point in the construction of boilers, and the failure of many lap-joint seams has been ascribed to this cause. A. G. REACH.

Brooklyn, N. Y.

Factors of Evaporation

Mr. A. G. Reach's letter in the April issue of THE BOILER MAKER, page 111, impels me to make reply.

Concerning my letter in the March issue of the paper relative to the use of factors of evaporation, to which Mr. Reach refers, I would say, in the first place, that it is not likely that any person would use the method outlined unless he knew the principles involved. Knowing these, he could not very well misuse the formula, as intimated by the correspondent. The principle of application of the formula is correct and may safely be used by anyone who knows just exactly what he wants in relation to that matter and has a knowledge of fundamentals.

Now, with regard to the factor 966.1, which appears in the formula, it is in a steam table that is still in use, in spite of the fact that a later steam table (the Marks' and Davis'), gives 970.4 B. T. U. as the latest heat of evaporation at atmospheric (14.7 pounds) pressure. Possibly, Marks' and Davis' table may become the standard in preference to all other tables in use at present. But many engineers still use the older tables. The difference between the factors in various tables is in the neighborhood of one-half of 1 percent, which for practical industrial work is generally considered sufficiently close, so that it does not really matter which table is used. But, aside from this, if there is in any given case a certain preference for any one steam table in particular, the method of application and operation is exactly the same. The only change will be in the numerals in the factor under the line in the formula, and a slight difference in the quotient, which is the factor of evaporation to be used.

If it were expected in any case that legal complication might occur later, then as a matter of surety and protection it should be agreed upon by all concerned what steam table must be employed in the calculations for results.

Again, if superheated steam is to be considered, then a factor of evaporation may be found by the use of a formula for that purpose, but, once finding that factor, the method of application and operation is just as I have given it in the March issue, page 80. In short, an engineer knowing his business will not make any mistake or any misuse of the methods given. The formula given by Mr. Reach differs from the one given by me *only in the form* of expression. The results obtained from both formulas are identical so long as the steam table is the same for both. These formulas relate to *saturated* steam. There are formulas for superheated steam which are the same in principle, though different in structure. No matter whether saturated or superheated steam is to be considered, nor as to what steam table is to be employed and the formula to be used (as long as sound knowledge and judgment is in evidence), the rule given is still applicable for the purpose set forth in my article.

BACK PITCH OF RIVETS

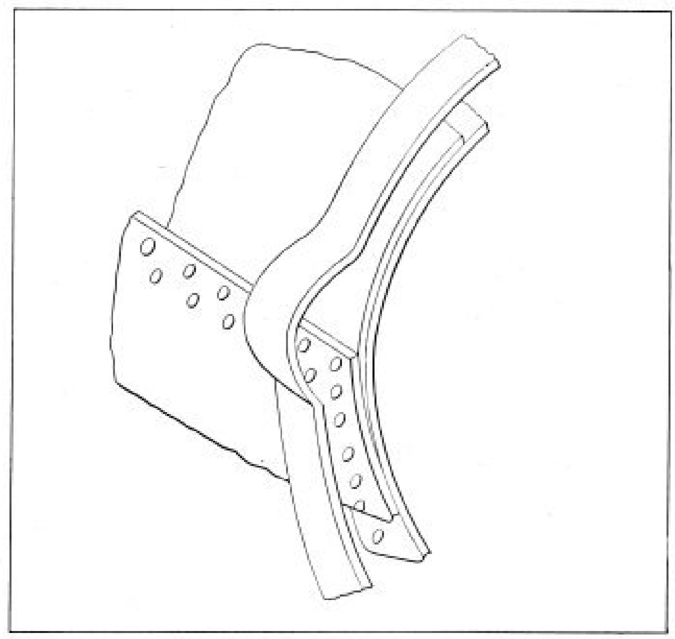
Also, I am considerably interested in the matter of "back pitch" of rivets, as given by Mr. Flaherty, April issue, page 110. I do not wish to discountenance the statements of Mr. Flaherty, but it seems to me that the definition given by him is not logical. The term "back pitch" evidently is new, as stated. Someone has casually used it in the way and sense referred to, and so has set a precedent. But is that possibility in itself enough to warrant the continued use of that term? How can the distance between rows of rivets that are zigzagged be termed a *pitch* distance? In the case of *chain* riveting it might apply, but I cannot quite see how it reasonably could otherwise. In any case, what is the need of the term, when "distance between rows of rivets" has been clearly understood for so long? I am asking for reasons and opinions on the subject—not fault finding, but rather truth seeking. I hope others will venture an opinion.

Scranton, Pa. CHARLES J. MASON.

Oil Tank Seams and Straps

Recently a battery of cylindrical tanks laid horizontally came under the writer's notice. There was nothing out of the way about the kerosene storage plans; as a whole it was, indeed, most usual and very ordinary.

Closer inspection, however, revealed one inconspicuous detail worth publicity which also pointed to the fact that some thoughtful individual had been busy. As usual in such an installation above ground level the tanks were strapped over with flat iron straps. At the point where these intersected the longitudinal seam they were given a semi-circular outward loop. It is always difficult to trace leakage unless a seam is entirely bare. A strap of the kind cannot lie close and a good fit upon a seam and rivets, consequently (when exposed to the weather



Curvature of Flat Iron Strap at Shell Joint as usually fitted) the opening so formed becomes a lodgment for moisture and corrosion is both rapid and inevitable. The device of the loop obviates this difficulty, allows the seam to be in view and corrosion out of sight and out of mind is avoided.

If strength alone be considered the strap with the loop needs to be thicker. From various reasons such straps minus the loop are always fitted much in excess of their duty, so that no increase in scantling of the strap material is even needed. It is corrosion which is in view in dimensioning the strap, not simple strength.

The design illustrated in the sketch has a fairly wide application, tank and road transport cars for transport of fluid are always stayed by means of banding. There seems no reason why in the interests of freedom from corrosion at a vital point the design should not be universal. By increase in the thickness of the material of the band the loop, which is an obvious remedy, can be applied to satisfy those critical of strength. For that matter, why not double the material of straps at point of loop by riveting another piece on top, or utilize the gas welding torch and so thicken up the band? The cost of extra material in this wise would be trivial.

London, England. A. L. HAAS.

Boiler Compounds

I have noticed with some interest the two-page attack on boiler compounds written by Mr. A. L. Haas, of London, England, published in your April issue, and, despite the fact that Herr Haas has attempted to ply a little Prussian militarism in attempting to shove me off the sidewalk by intimating that the editor of THE BOILER MAKER should not print the expressions of one who would dispute him, I feel that his absolutely wrong statements should be corrected for the benefit of others who may have read this article or others which precede it.

Perhaps the editor may not, as Mr. Haas intimates, care to publish any further discussion on this subject, but in that case it would devolve upon him to make the corrections in the interest of the readers of his journal. So far as Mr. Haas is concerned it must be very evident to all readers of this publication that it is useless to attempt to carry such a discussion further.

Mr. Haas absolutely ignores my statements in the December issue, to the effect that I agree with him that "patent and secret nostrums under fancy names" are to be avoided. He directs his attack against boiler compounds in general, and bases his argument on the patent and secret nostrum idea. The manufacturers of boiler compound who have made a success of the business do not pursue such tactics.

Now then, I leave it to the readers of this journal; what are we to say to the man who presents such a silly argument as the following:

"The ideal water treatment is that of distillation * * * it costs 1 pound of coal to produce from 25 to 30 pounds of chemically pure water * * * every ship in every navy afloat has a treatment plant in the shape of a distilling apparatus of adequate size."

Since Mr. Haas makes such a positive statement it would seem possible that he does not know of the work of Lieutenant-Commander Lyons, who developed a boiler compound for the American Navy, and that his work was crowned with such success that the advertisement for bids on this boiler compound for the fiscal year of 1916-1917 covered an estimate of 435,000 pounds of what is known as the "Navy Standard" boiler compound (a fancy name).

It is true that the vessels of the American Navy are equipped with distilling apparatus, but it is absolutely not true that distilling the water is a "perfect treatment," otherwise what would be the need for this enormous amount of boiler compound? The distilling apparatus is used because it would be ruinous to use salt water for "make-up."

The above is what I had in mind in my previous article, when I stated that absolutely pure water is not always good boiler water.

I note with considerable amusement that Mr. Haas this time eliminates all reference to the treatment of water for railroad locomotives, but, since he brought up the subject, I refuse to drop it without further reference to his recommendation of distillation thus applied.

Several railroads in the United States have each more than 2,000 locomotives, or more than 3,000,000 horsepower for each of these large systems. They also have in the ranks of their officials some of the best-known mechanical authorities in the world. Does any reader suppose that he could safely go into one of their offices with the proposition that the one railroad concerned should daily distill 50,000,000 gallons of water at the expenditure—using Mr. Haas' figures—of 1,666,666 pounds of coal every day? This in the face of the necessity, proved by the experience of the United States Navy, that a boiler compound would have to be used to prevent corrosion, even after this was done.

The expletives which Mr. Haas charged me with using in an earlier article would be very mild indeed compared with those which would be applied in such a case.

Just a word with respect to other methods of treatment, which Mr. Haas advises; after years of study the only practical treatment for use in stationary treating plants, where the raw water deposits a sulphate scale in the boilers, is soda-ash and lime. When the water is treated with soda-ash the chemical reaction leaves in solution sodium sulphate. This sodium sulphate goes into the boiler with the water; it cannot be precipitated, and in the steaming process in the boiler it gradually concentrates and causes foaming. We are then brought to the necessity for the use of an anti-foaming compound, after all.

Mr. Haas says he is not a chemist, but he could probably have found a chemist within the city block in which he has his office in London who could have told him this.

Now, if Mr. Haas wishes to discuss further "quack nostrums" or "pink pills" I wish to express myself as not interested.

Boiler compounds are consistently used in the United States in stationary plants, the operation of which are directed by mechanical minds. The railroads, which, it goes without saying, are directed by thinking men, use boiler compounds in enormous quantities, but they do not buy without knowing what they are buying, and if any of them are designated by fancy names it is not to conceal what absolutely cannot be concealed.

To my personal knowledge, the greater number of the larger railroads which are equipped with treating plants are using anti-foaming compound to offset the unavoidable effects of the stationary treatment. Other railroads which seem to be getting better boiler maintenance figures are using boiler compound directly applied in the boilers in preference to the stationary treating plant system.

If Mr. Haas still doubts these facts I can very easily mention the names of more than thirty of the largest railway trunk lines in the United States and Canada which are currently using boiler compound, and if Mr. Haas feels that American mechanical talent is not up to the English standard I will say that all three of the big trunk lines in Canada, which, I understand, are to a certain extent English owned, use boiler compound. One of them discontinued the stationary treating plant system several years ago after a number of years of expensive trial.

With brief reference to Mr. Haas' silly and weak attempt at a comparison between the ills of the human body and those of the steam boiler, in which he states that authorities would prefer to attack the causes before they become evident, rather than after, I might state without fear of any contradiction except that coming from Mr. Haas, that eminent health authorities frequently place chemicals in city water which pass into the human body as drinking water. This is precisely and exactly the same as putting boiler compound into boiler feed water, because they do not either start or finish any chemical reaction before the supply is used. How widely this is a practice I do not know, but I do know that in our own little city of Chicago this is done for the purpose of killing typhoid germs.

Mr. Haas says:

"Mr. Wilson prefers the pale pills; the writer, in common with thousands of experienced engineers, prefers the more scientific methods."

If the proper boiler compound to fit the case is pale, and if the proper form for the most efficient application is pills, then Mr. Wilson prefers "pale pills." Whether or not this preference is "in common with thousands of experienced engineers" or not, Mr. Wilson will not say, but certainly it is a *practice* which is common among thousands of experienced engineers."

Chicago, Ill. L. F. Wilson.

Layout of 90-Degree Transition Piece

The layout of a 90-degree transition piece in the November, 1916, issue was very instructive. May I submit a method which is very simple and accurate?

Set up the elevation of the piece desired. At the large and small ends strike semi-circles as shown and divide them into equal parts. Extend a line below the base line, and from point *o* set off the different lengths of lines in the small circle and number them. From points 2-3-4-5-6 on the large circle strike lines across as shown; also mark off dotted lines; set off the length of these lines from point *o* on the base line and connect up to the same numbered points at the top of the elevation. This gives us our true lengths.

To mark the pattern, take the length of line *I-I* from the elevation and set it off as shown. Set dividers to the length of the arc on the large circle and strike off an arc at the bottom of line *I-I*. Take the length of the dotted line 1-2 on the elevation and set it off from line *I* at the top, intersecting the arc at the bottom. Set dividers to the length of the arc on the small circle and set it off from point *I* at the top. Take the length of the solid line 2-2 on the elevation and set it off from point 2 at the bottom, intersecting the small arc at the top. The remaining lines are taken in the same manner.

For the sake of clearness, I have not connected up all of the lines on the plan, and would advise anyone to go over the drawing with dividers to make the actual work clearer. This method can be used to good effect on many pieces of work, and when thoroughly understood will save much time.

Lorain, Ohio. Joseph Smith.

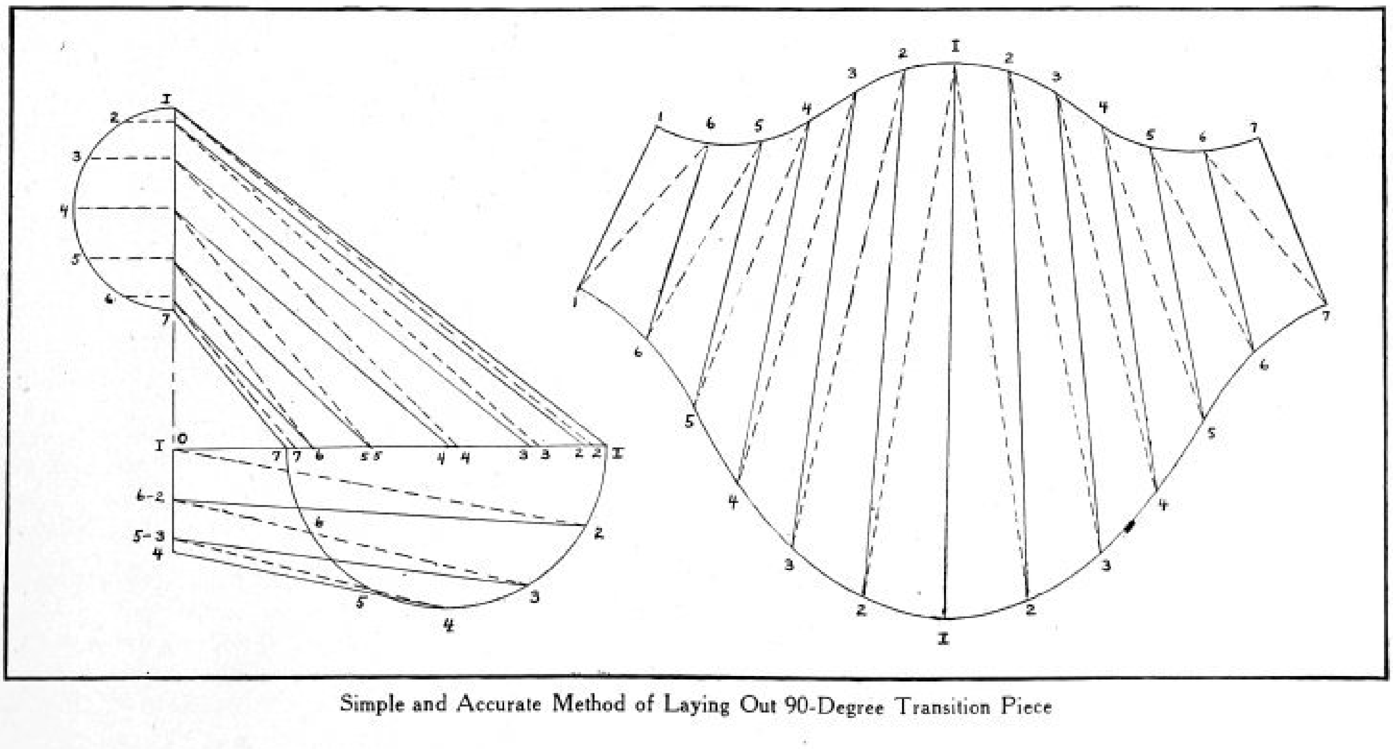
Holding Down the Job

Times are pretty prosperous now and at the shop during the noon hour one hears lots of talk from some of the fellows about the jobs they have had in the past and how they quit because they did not get a raise or because they had some swell job offered them. To hear some of them tell of the different places and lengths of time worked at each place you would think that they must have been at the business of making boilers when they were kids. After listening to their tales you wonder why they did not get to be supers. Some of them talk as if they knew more than the foreman. They do not openly criticise him, but they tell other fellows and their friends his weak points.

When times change and business slacks up, and when time for a lay-off begins to appear they are the first to feel as though the pink lay-off ticket will be found in their envelope on Saturday.

Holding down a job in slack times is an art only developed by those who try to get the real hang of things, get on to the shop's methods, put in a little personal interest in their work and the use of the shop's tools and give their employers credit for having executive and business ability.

To hold down a job in a worth-while shop you have to



Simple and Accurate Method of Laying Out 90-Degree Transition Piece forget the whistle or bell, use a few minutes of *your* time in getting ready to start work and not to have your hat and coat on in readiness for the quitting signal.

There is only one fellow in the shop who can help you to get along, and that fellow is yourself. Do not get restless and worried about the raise in pay that the other fellow gets, perhaps he has earned it, even if you don't think so. It won't help you any to worry and get sore—*dig in* and make them take notice of you. You don't need any pull with the boss other than that produced by good workmanship and a cheerful manner.

Be happy in your work—it will help a lot. Don't pay too much attention to the fairy tales told on the bench during noon hour. Your time is better spent fixing up your tool kit or properly digesting your lunch and the news of your trade journal and daily paper.

Concord, N. H. C. H. W.

Chart for Rivets in Single or Double Shear

This chart will be found useful for determining the shearing strength of rivets. Boiler makers, especially, will find it handy. Its range is wide enough to cover almost any material (10,000 to 100,000 pounds per square

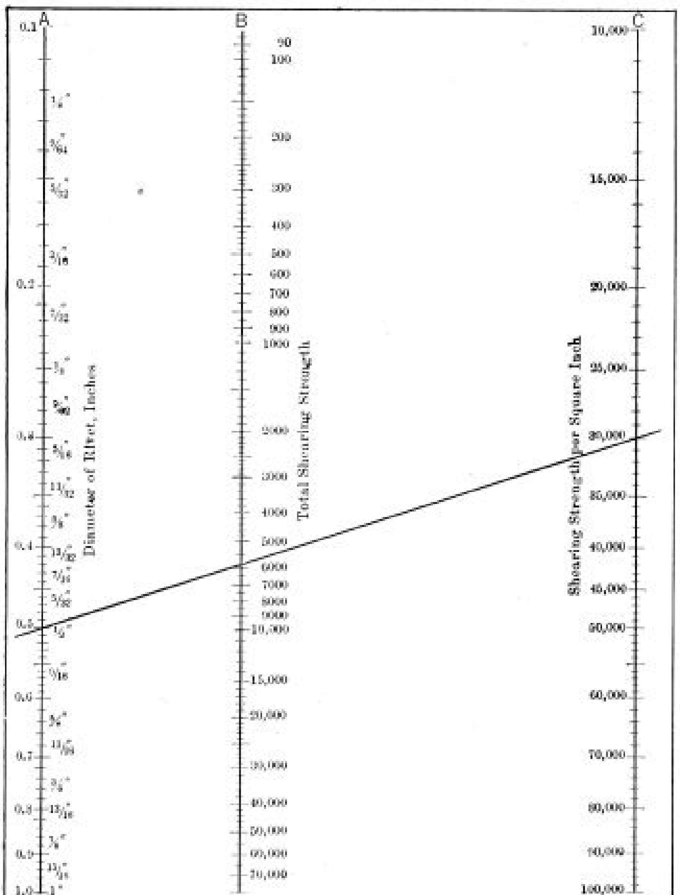


Chart for Rivets in Single or Double Shear

inch—see column C), and all rivets from 0.1 inch in diameter to 1 inch in diameter (see column A). Then, by stretching a thread across the chart from the diameter to the shearing strength the total strength of the rivet in single shear is instantly found in the middle column.

When computing for double shear the best way is to just double the stress, mentally, use that figure in column C and the middle column will give the strength in double shear.

For example, the dotted line drawn across the chart shows that a ½-inch rivet stressed to 30,000 pounds per square inch will hold about 5,900 pounds. Should the rivet be in double shear use 60,000 pounds per square inch (which is easily found mentally), and the chart will show a strength of about 11,800 pounds for the rivet.

N. G. NEAR.

Chart for Finding the Weight of Steel Plates

This chart wil be found useful by boiler makers and all who want to estimate the weight of steel plates without the annoyance of looking up the weights in tables and without doing any computing.

For example, what is the weight of a steel plate 0.25 inch thick by 12 inches wide by 120 inches long? The dotted lines drawn across the chart show how it is done. Connect the 0.25 (column A) with 36 (column D) and locate the intersection with column B. Connect this point of intersection with 120 (column E), and the weight is immediately found in column C. You can see that it is "just a shade" over 300 pounds. Computing it "longhand" you will find that the weight of such a steel plate is 305 pounds. We can, therefore, consider the chart accurate enough for *all* practical purposes. In fact, the chances are we would

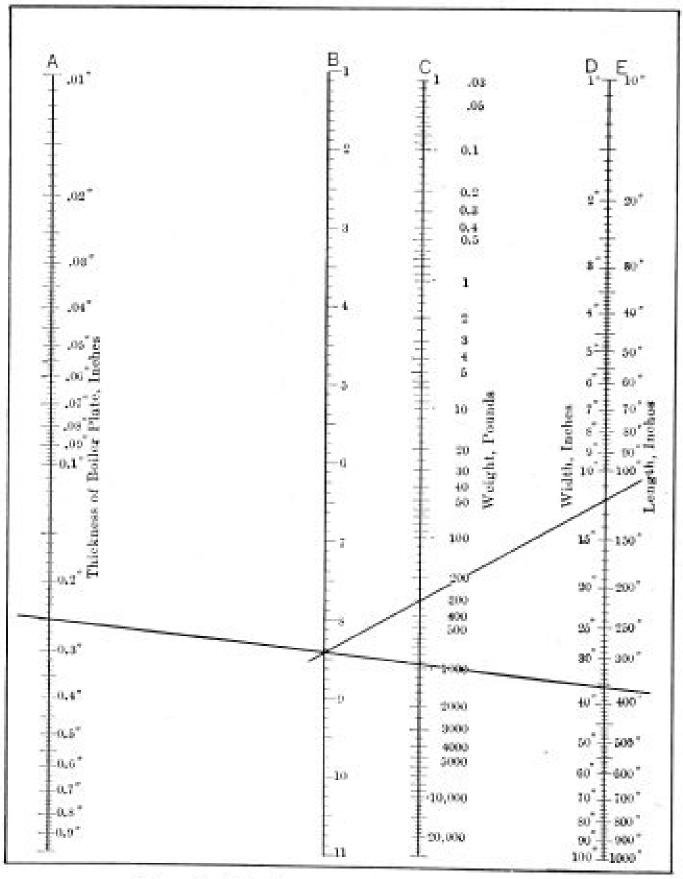


Chart for Finding Weight of Steel Plates

very likely call it 305 pounds, or 310 pounds when judging the exact location of the line.

It will be noted that the range of the chart is very wide—from thicknesses of .01 inch to 1 inch, and the width and length dimensions easily cover most every-day problems.

N. G. NEAR.

SHOPS OF KELLY SPRINGFIELD ROLLER COMPANY DESTROYED BY FIRE.—The entire plant of the Kelly Springfield Roller Company, Springfield, Ohio, was destroyed by fire on April 11. All of the buildings, comprising the plant, including the boiler shop, were burned to the ground.

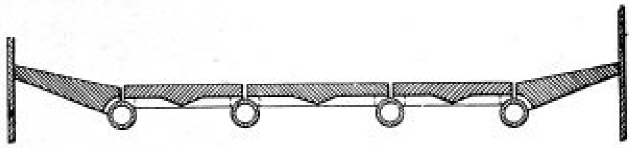
Selected Boiler Patents

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

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

1,194,086. LOCOMOTIVE ARCH BRICK. WILLIAM SMITH, OF CHICAGO, ILL., ASSIGNOR TO UNIVERSAL ARCH COMPANY, OF CHICAGO, ILL., A CORPORATION OF ILLINOIS.

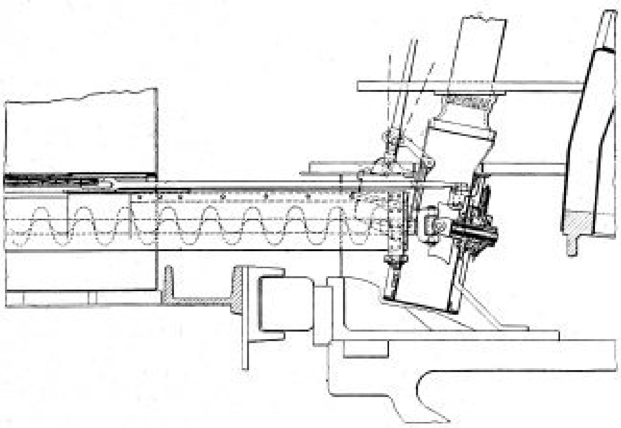
Claim 1.—A locomotive arch brick, comprising a body formed with intersecting ribs on its under face extending from opposite corners of the bricks, and inwardly extending ribs running from the termini of the intersecting ribs, said inwardly extending ribs being grooved to fit over a



tube, and the adjacent edges of said inwardly extending ribs being spaced apart to provide a space between the body of the brick and the outer periphery of the tube to permit a circulation of heat completely around the tube. Two claims.

1,195,532. MECHANICAL STOKER FOR LOCOMOTIVES. CLEMENT F. STREET, OF SCHENECTADY, N. Y., ASSIGNOR TO THE LOCOMOTIVE STOKER COMPANY, OF WILMERDING, PA., A CORPORATION OF PENNSYLVANIA.

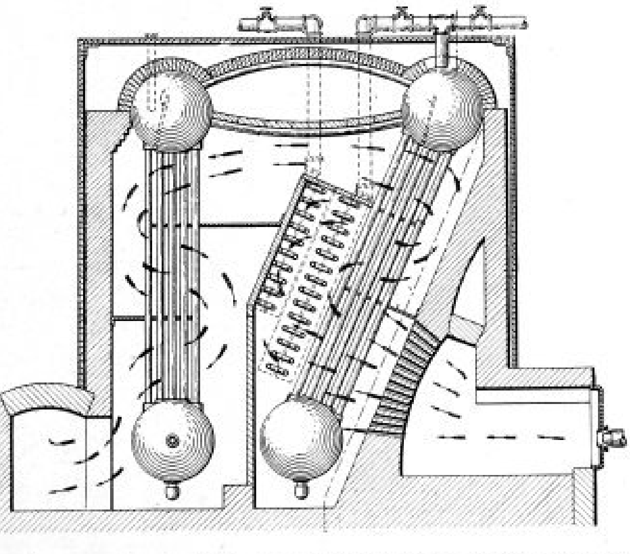
Claim 1.—In a mechanical stoker for a locomotive tender, the combination with a fuel bin on the tender, a fuel receptacle on the locomotive, and means for feeding fuel therefrom to the furnace, of a rigid



conveyer trough pivotally connected at its forward end to said receptacle and extending at its other end beneath the fuel bin on the tender, a conveyer in said trough, a support for the rear portion of the trough, and a plate slidably mounted on said support and rigidly secured to said trough. Fourteen claims.

1,195,072. GAS-FIRED STEAM BOILER. KARL A. NORRMAN, OF LYNN, MASS., ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

Claim 1.—A steam boiler comprising groups of vertical tubes and inclined tubes, drums connected to the ends of each group, tubes con-



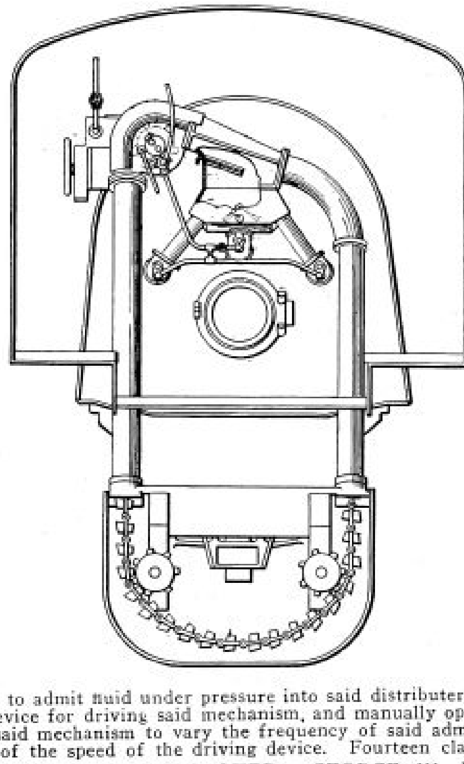
necting the upper drums, baffles in said upper drums, means for feeding water to the upper drum of the vertical group, a combustion chamber, and substantially horizontal baffle plates associated with each group of tubes for causing the hot products of combustion to traverse first the inclined tubes and then the vertical tubes in a serpentine course. Five claims.

1,195,064. STEAM GENERATOR. WALTER A. MOFFAT, OF DENVER, COL., ASSIGNOR TO THE IMPROVED BOILER FEED COMPANY, OF DENVER, COL., A CORPORATION OF COLORADO.

Claim 1.—A steam generator consisting of a steam storage reservoir, a multiple flue boiler, pipes connecting the bottom of said storage reservoir and extending down into said multiple flue boiler below its steam space, a steam conveying pipe connecting the upper end of said boiler and the upper end of said storage reservoir, a second hot water circulating boiler, circulating pipes in said hot water circulating boiler, a drum to which said circulating pipes are connected, means for cutting off communication between the steam spaces in said multiple flue boiler and said reservoir, a valve controlled pipe leading from the lower end of said drum to the lower end of said reservoir, a preliminary water heater extending above said drum, a valve controlled pipe connecting the lower end of said preliminary heater and the lower end of said drum, and a valve controlled pipe connecting the upper end of said preliminary heater and the upper end of said drum. Three claims.

1,195,533. MECHANICAL STOKER. CLEMENT F. STREET, OF NEW YORK, N. Y., ASSIGNOR TO THE LOCOMOTIVE STOKER COMPANY, OF WILMERDING, PA., A CORPORATION OF PENNSYLVANIA.

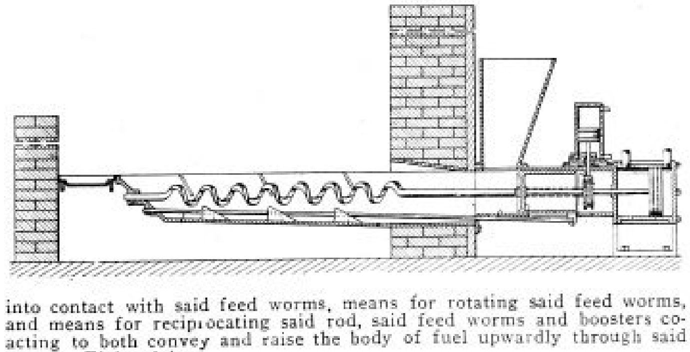
Claim 1.—In a mechanical stoker of the type described, the combination with a source of fuel supply and a distributer connected thereto, of



mechanism to admit fluid under pressure into said distributer periodically, a power device for driving said mechanism, and manually operable means to adjust said mechanism to vary the frequency of said admissions independently of the speed of the driving device. Fourteen claims.

1,206,071. AUTOMATIC STOKER. GEORGE W. WOOD, OF CAMDEN, N. J.

Claim 5.—In an automatic stoker, the combination of a retort, two feed worms rotatably mounted in said retort and spaced apart, a rod movable in a plane extending between said feed worms and said rod having portions thereon forming boosters for raising fuel between and



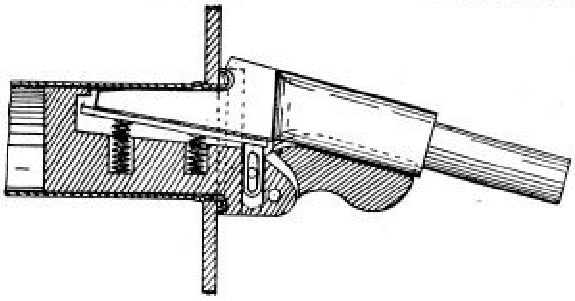
into contact with said feed worms, means for rotating said feed worms, and means for reciprocating said rod, said feed worms and boosters coacting to both convey and raise the body of fuel upwardly through said retort. Eight claims.

1,207,301. WATERTUBE BOILER. GEORGE T. LADD, OF PITTSBURG, PA.

Claim 1.—A boiler having in combination an upper and a lower drum, three sets of tubes connecting said drum; a baffle arranged at an angle to the first set of tubes and adapted to cause products of combustion from the fire-box to flow across the lower ends of the first set of tubes; a baffle arranged between the first and second sets of tubes adjacent to their upper ends and adapted to cause products of combustion to flow transverse of the first set of tubes; a baffle for preventing products of combustion from flowing from between the space between the first and second sets of tubes across the second set of tubes; a baffle arranged between the second and third sets of tubes adjacent to their lower ends and adapted to cause products of combustion to flow transverse of the second or intermediate set of tubes, and a vertically arranged baffle adapted to prevent the flow of products of combustion transverse of the upper portions of the third set of tubes. Three claims.

1,206,080. FLUE-CALKING MACHINE. JOHN F. BECK, OF GRAND RAPIDS, MICH.

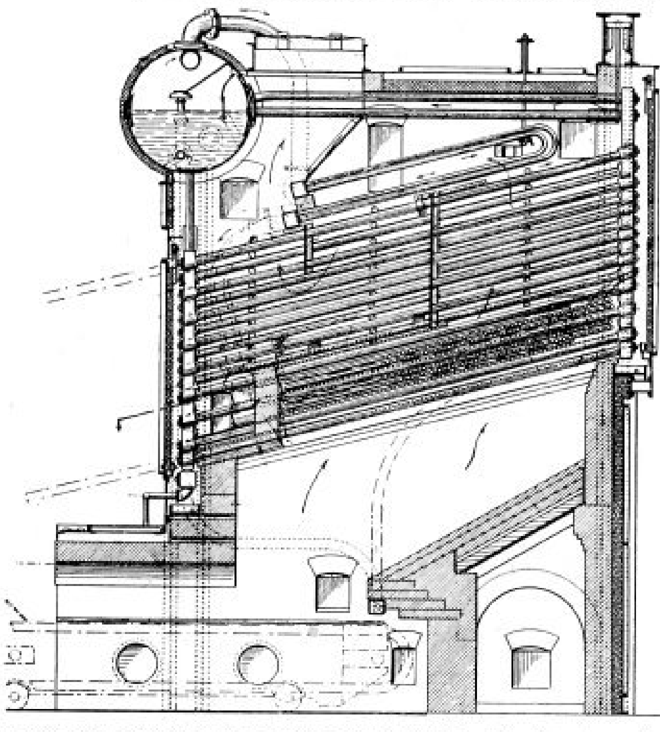
Claim 1.—In combination with an ordinary tool for calking the ends of locomotive boiler tubes, a cylindrical body fitted to enter the end of the tube, and having a longitudinal slot therein, a slotted flange integral with said body and having an annular groove therein, semi-circular in cross section, a ledge projecting over the back end of the groove, a sup-



porting plate pivotally and slidably mounted in the groove, springs for forcing said plate against the surface of the tool to force its other edge against the inner surface of the tube. Two claims.

1,206,246. 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.

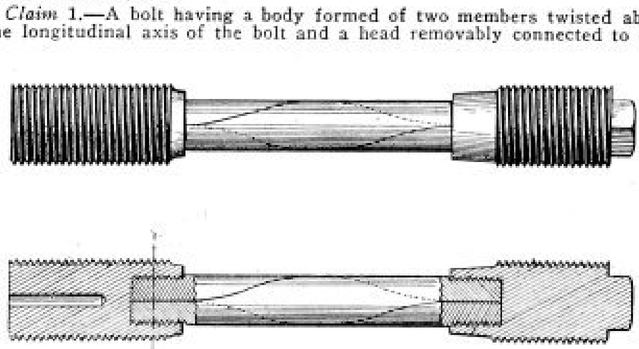
Claim 3.—A watertube boiler having front and rear headers connected by inclined water tubes, a primary superheater above the bank of watertubes, a secondary superheater having curved tubes extending



transversely of and between rows of watertubes, and pipe connections between the steam drum and primary superheater and between the latter and the secondary superheater. Five claims.

1,207,391. STAYBOLT. JOSEPH A. FRAUENHEIM, OF ZELIENIENOPLE, PA.

Claim 1.—A bolt having a body formed of two members twisted about the longitudinal axis of the bolt and a head removably connected to one



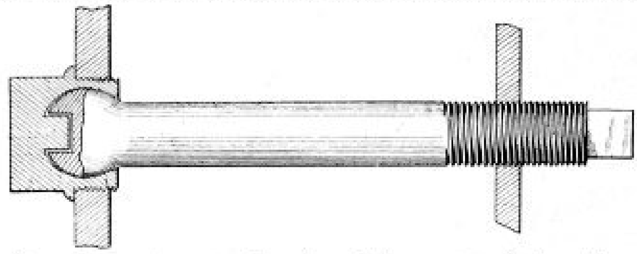
end of the body members, the other end of said body members being provided with screw threads. Three claims.

1,207,768. UNDERFEED STOKER. WILLIAM J. KENNEY, OF WILMETTE, ILL., ASSIGNOR TO UNDER-FEED STOKER COMPANY OF AMERICA, OF CHICAGO, ILL., A CORPORATION OF NEW JERSEY.

Claim 1.—In combination, a furnace, a retort and supports beside the same dividing the furnace into an upper combustion chamber and a lower air chamber, twyer blocks on the retort communicating at their inlet ends with said air chamber, said supports having openings therethrough, means for admitting air under pressure to said air chamber, and partitions separating the space proximate to the under side of the supports from the remainder of the chamber, said partitions having openings therethrough, and a manually operated valve for controlling said openings. Two claims.

1,207,562. BOLT. DANIEL P. KELLOGG, OF LOS ANGELES, AND CHARLES M. ECKLAND, OF STOCKTON, CAL.

Claim.—In combination with the inner and outer sheets for a boiler or the like, of connecting means for the said sheets, said means including a bolt that has a threaded portion engaging a threaded opening in the inner sheet, and a squared end extending beyond the said threaded portion, the other end of the bolt being provided with a spherical head which projects through a threaded opening in the outer sheet and which



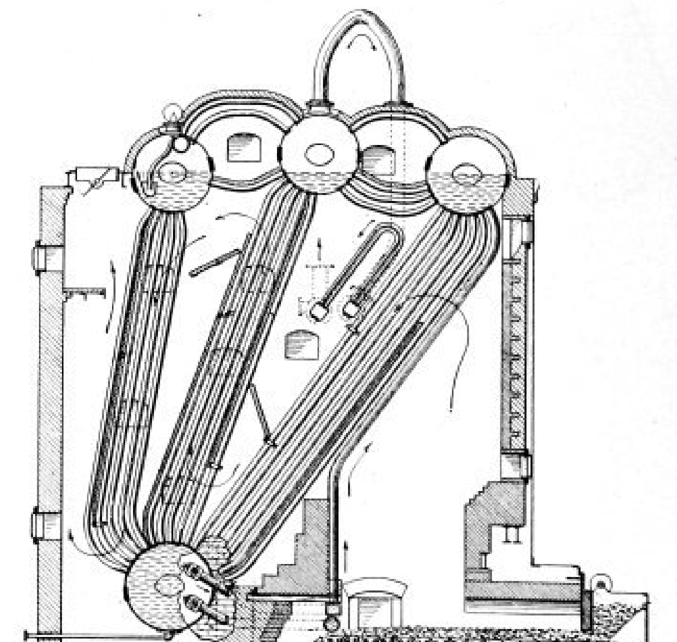
has its major portion extending beyond the center of the said outer sheet, the said head being centrally formed with a substantially square depression, a cap having a spherical socket receiving the head, and the inner wall of the said socket being spaced from the head, said socket being formed with a projecting square lug which is received within the depression in the bolt head, but which is spaced from the walls provided by the said depression, and the said cap having an exterior flange which contacts with the outer face of the outer sheet.

1,208,082. STEAM BOILER. CARL KNUT EDVARD BILDT, OF NORRVIKEN, SWEDEN, ASSIGNOR TO CLAS GABRIEL TIMM, OF ENGELSBERG, SWEDEN, AND HJALMAR JOHAN DANIEL BRAUNE, OF STOCKHOLM, SWEDEN.

Claim 1.—In a steam boiler of the locomotive or like type, a shell forming a gas producer and a gas combustion chamber, a constricted passage connecting said producer and combustion chamber, the walls of said passage being in contact on all sides with the water of the boiler, and means for introducing air for combustion, said means consisting of twyers passing through the water space and projecting into said passage, said twyers being surrounded by water for substantially the whole of their length from the point where they enter the shell of the boiler.

1,215,765. STEAM BOILER. JOHN E. BELL, OF BROOKLYN, N. Y., ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, N. J., A CORPORATION OF NEW JERSEY.

Claim 1.—A steam boiler furnace comprising a chain grate stoker, a bridge wall, and two water boxes placed one above the other at the rear of the stoker, the lower of said boxes being curved in section



and the upper square or rectangular in section, said boxes being connected at one end to the mud drum and at the other end to a steam and water drum. Five claims.

1,215,068. FIRE-BOX. SAMUEL W. SIMONDS, OF BOSTON, MASS.

Claim.—A fire-box having a rear wall containing a fire door opening, a rear arch above said opening, a front arch extending from the front wall of the fire-box toward the rear arch and separated from the latter by an intermediate throat through which the products of combustion pass from the fire-box to the boiler tubes, air heater tubes extending through the rear wall for supplying heated air to the said throat, and additional means for supplying heated air below said throat, said means including an apertured fire door associated with said opening, and a deflector on said door arranged to direct the air entering through the door downwardly into the fire-box and cause it to be heated before impinging on the arch portions forming the sides of said throat.

THE BOILER MAKER

JUNE, 1917

Oxy-Acetylene Welding and Cutting

Successful Application of Oxy-Acetylene Welding Apparatus to Locomotive Boiler Repairs—Use of the Cutting Torch

BY E. P. FAIRCHILD*

Fig. 1 shows a smokebox extension partially welded. It will be noticed that on the bottom of the smokebox the weld was made from the inside, while on top the weld is made from the outside of the smokebox, thus eliminating overhead welding and making an effectual saving in gas consumption, besides making the job more convenient for the operator.

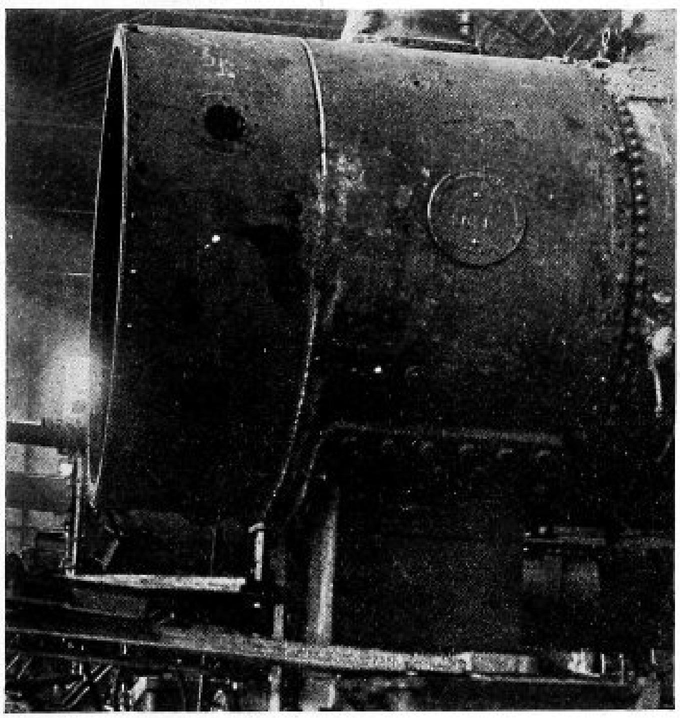


Fig. 1.—Smokebox Extension Partially Welded

Fig. 2 shows the door sheet of a Pacific type locomotive boiler. In this particular type of boiler considerable trouble was experienced with the flanges of door sheet cracking out from rivet holes and around the furnace door hole.

A door collar was applied and welded to the door sheet first and lap welded to the back head. These door collars are carried in stock, and the flange has a 2½-inch inside radius. This large radius almost entirely eliminates fire cracks around furnace floor.

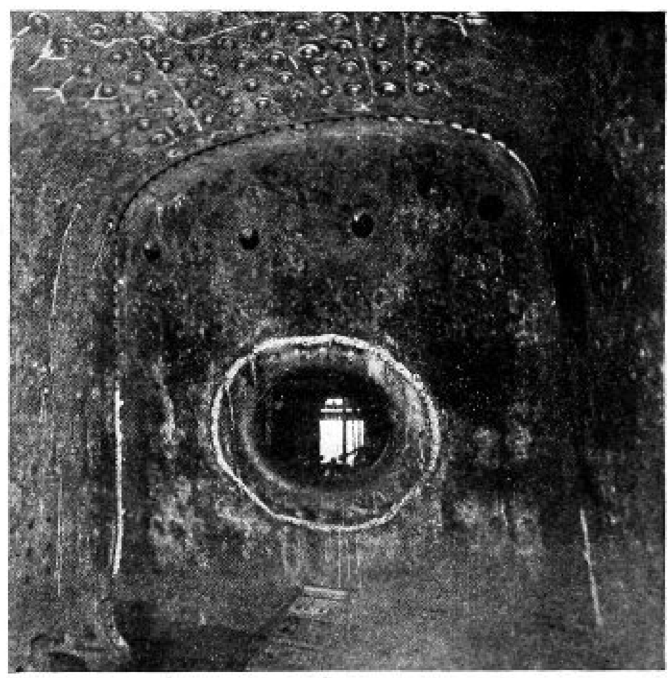


Fig. 2.—Welded Door Sheet—Pacific Type Locomotive

After all the rivets are removed from the door sheet flange the flange is cut through the center of rivet holes and set back flush with the crown and side sheets. Both sheets and flange are beveled and welded. In this illustration the weld is painted white, to bring out the weld more clearly.

Fig. 3 shows some side and crown sheet seams that were badly fire cracked and gave considerable trouble. Rivets were removed, laps cut through the center of rivet holes; two rows of staybolts were removed and the side sheets set flush with the crown sheet, beveled and welded. It will be noticed that small, round patches are in place ready to weld in the crown sheet arch pipe holes.

*Assistant Boiler Shop Foreman, Atlantic Coast Lines, Waycross, Ga.

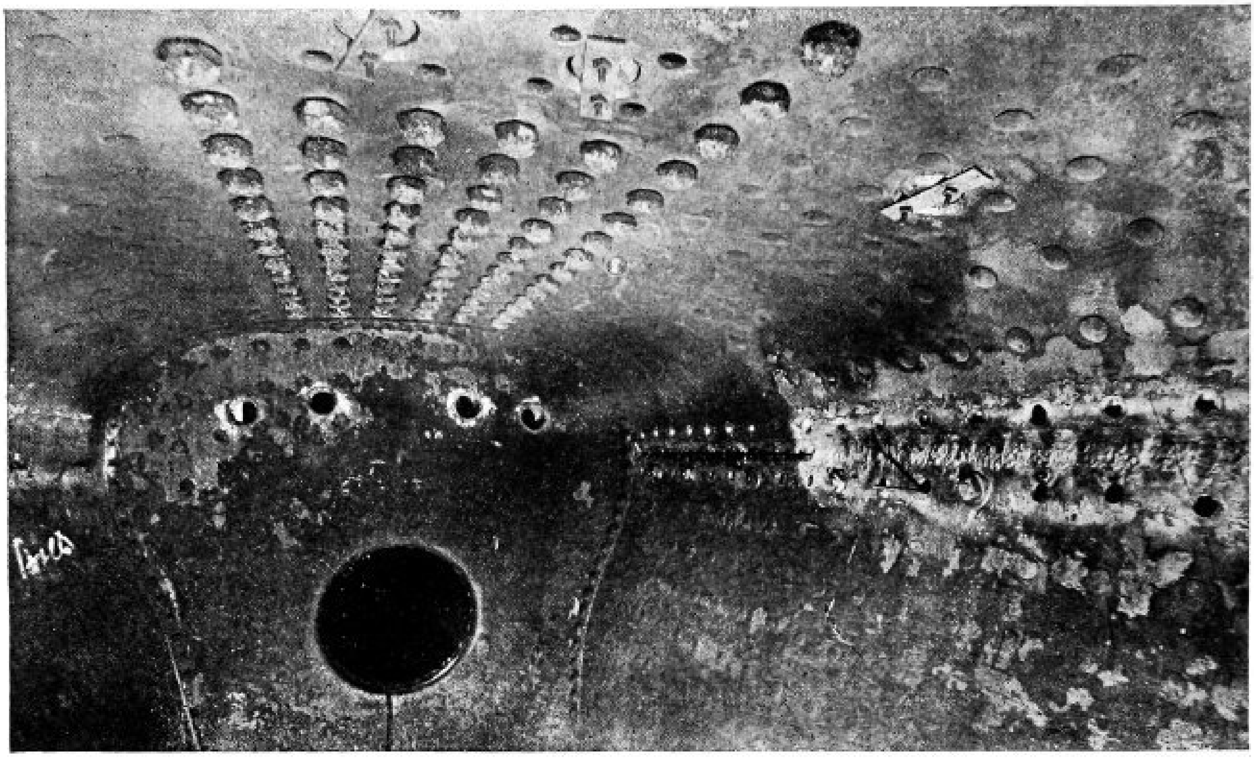


Fig. 3.—Cracked Side and Crown Sheet Seams Repaired by Welding

Fig. 4 shows the top of a back flue sheet that has been patched with oxy-acetylene welding. Special care is taken to weld as few flue bridges as possible. After the welding is finished, the flange is layed up and riveted.

Fig. 5 shows a five-piece firebox, namely: side sheets, door sheet, flue sheet and crown sheet. This box was applied without removing the mud-ring or taking the boiler from the frames. All staybolts and radials are set and cut off ready to drive before welding. After the welding is completed, sling stays and crown bolts are applied. It will readily be seen that by this practice a large amount of time and labor are saved, with an accompanying decrease in cost.

The cutting torch is the most useful tool in the railroad shop, and is noted as a labor-saver aid for its rapidity. The cutting torch can be used to a great advantage in the

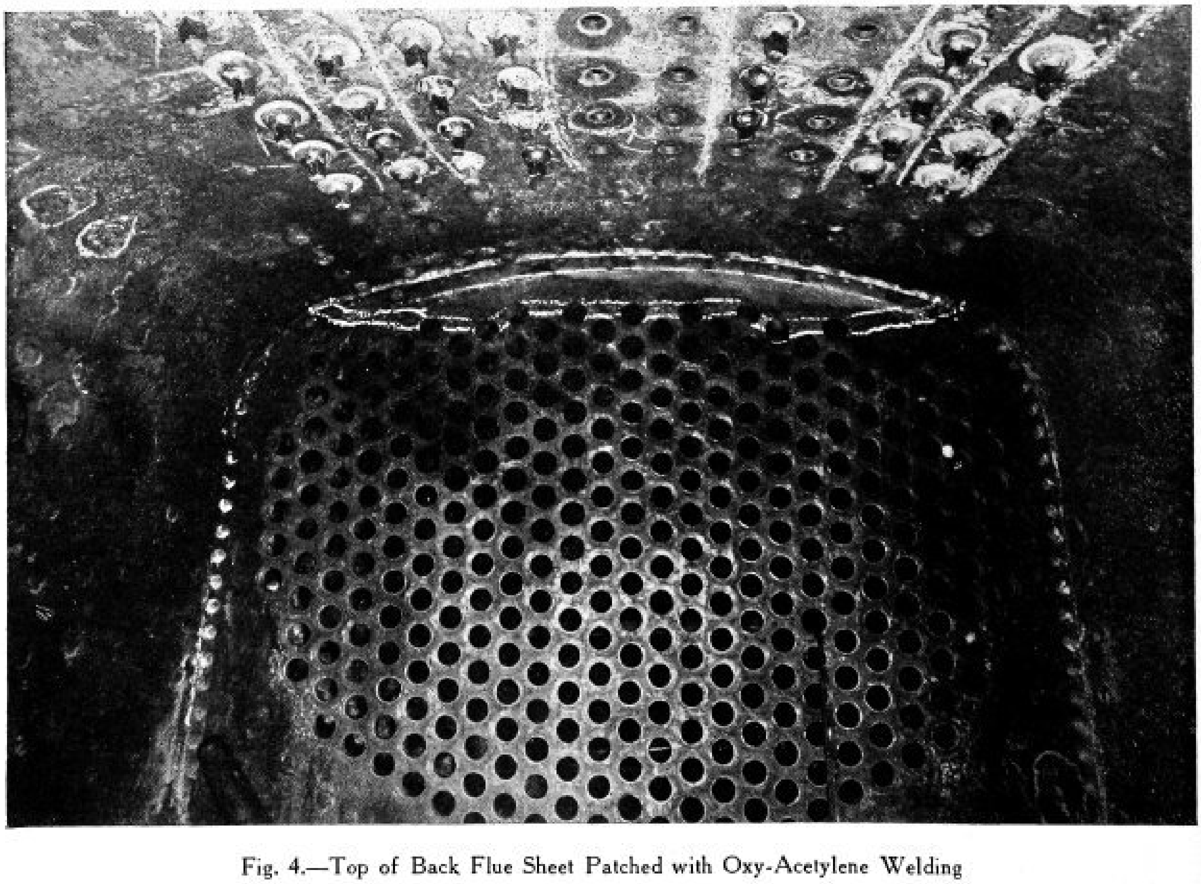


Fig. 4.—Top of Back Flue Sheet Patched with Oxy-Acetylene Welding

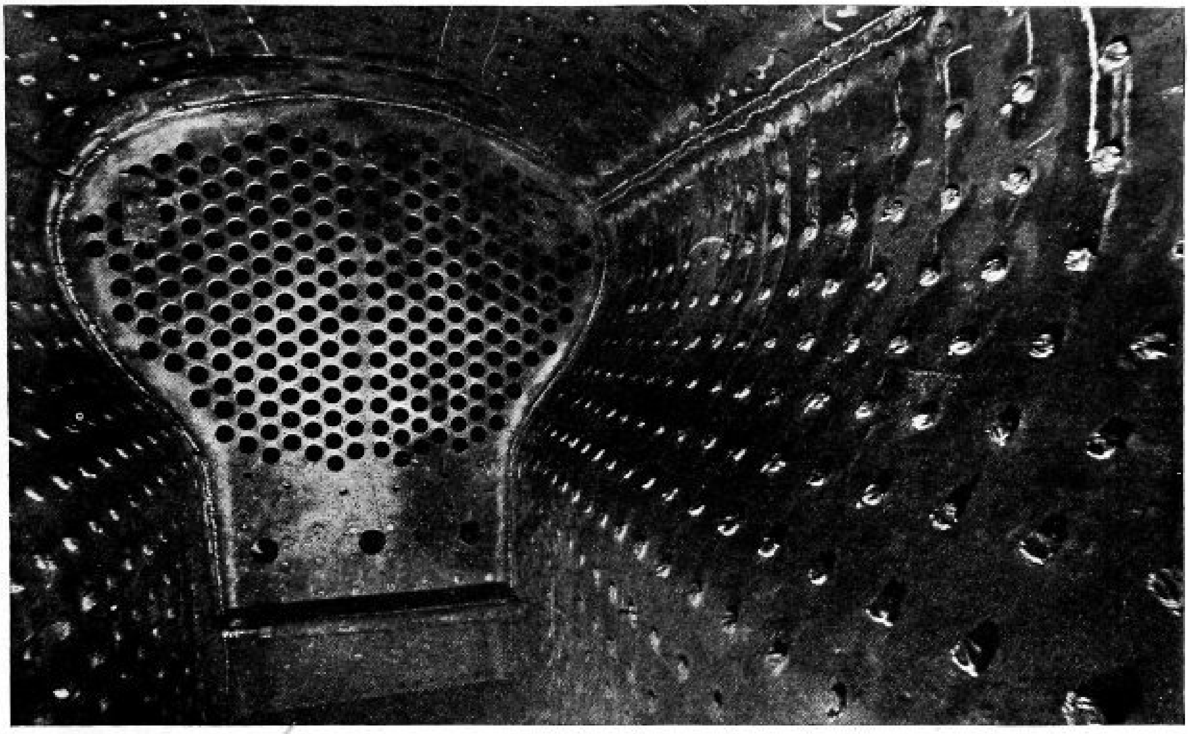


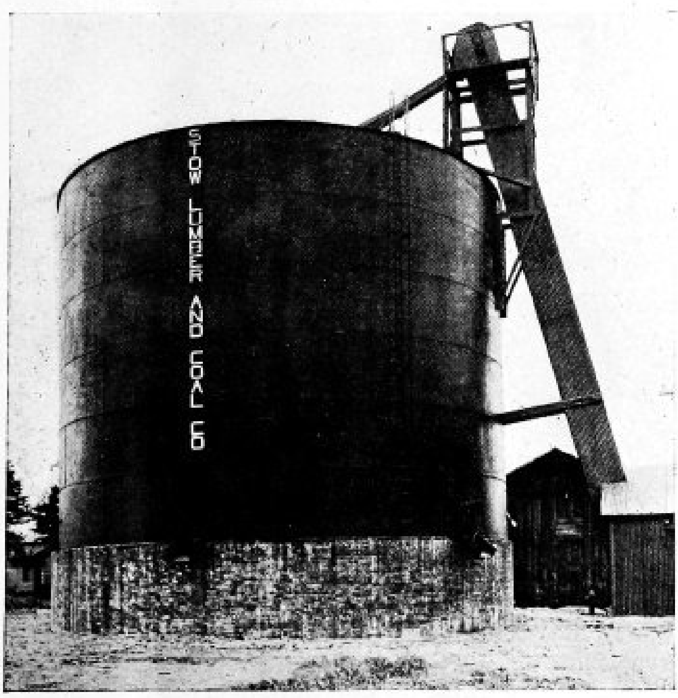
Fig. 5.—Five-Piece Firebox Applied Without Removing Mud-Ring or Taking Boiler from Frames

removal of staybolts, crown bolts and fireboxes and flues that have been welded to back tube sheet. When a flue sheet is to be removed, 90 flue beads can be cut off an hour, leaving all of the welded metal on the old flue sheet. The cutting torch is also very useful in removing arch pipes and for cutting arch pipe holes.

Large Coal Storage Steel Tank

BY FRANK C. PERKINS

The large steel tank illustrated is used for coal storage at Northeast, Pa. This circular steel bin is similar to a circular grain bin. The bin has a height and diameter, each about 40 feet, and rests on a brick foundation about 6 feet high.



Steel Tank, 40 Feet Diameter by 40 Feet High, Used for Coal Storage

It may be stated that the coal is unloaded into the bin and allowed to run from hopper-bottom cars into a pit under the center of the track. There is a bucket conveyor, inclosed in a chute, as shown at the right, and propelled by an electric motor, which carries it to the top of the bin, where it may be diverted into any one of six compartments.

It will be seen that as delivery is to be made to a retail customer, the driver backs his truck under the gate of the proper compartment. The coal runs from the bin through a chute, the bottom of which is a screen, so that it is cleaned while being loaded.

It is claimed that this method of handling coal is very economical and satisfactory, as the expense for labor is small and the proprietor is independent of that uncertain class of help upon which he must depend, and orders can be gotten out very rapidly when desired.

Summer Session of College of Engineering at University of Wisconsin

The nineteenth annual summer session of the College of Engineering of the University of Wisconsin will be held at Madison during the six weeks' period beginning June 25, 1917.

Special courses will be given in chemistry, electrical, steam and hydraulic engineering, gas engines, machine design, mechanical drawing, mechanics, shop work and surveying. All courses given in the University summer session are open to engineering students. Special courses have been arranged for engineering, manual arts and vocational teachers.

For information, address F. E. Turneaure, Dean, Madison, Wis.

The efficiency of a boiler shop is proportional to the efficiency of each individual employee.

Hydraulic Pressure Tests of Oxy-Acetylene Welded and Screwed Pipe Connections

Results of Tests Carried Out at University of Kansas to Determine Relative Strength of Screwed and Welded Pipe Joints

BY PROFESSOR F. H. SIBLEY*

The interest created by an article that appeared about a year ago giving a report of tests of oxy-acetylene welded pipe connections and screwed pipe connections tested under tension and compression, and the desire of readers for further information regarding the relative strength of welded and screwed pipe connections, encouraged the experimenters to carry on a second series of tests.

These tests were conducted in the machine construction laboratory of the University of Kansas and had for their purpose the determination of the relative strength of welded and screwed connections in steel pipe of various sizes when subjected to internal hydraulic pressure.

The pipe samples, which were cut from standard black steel pipe, were from the same stock, and hence probably of uniform quality. The welded specimens were made by operators of the Oxweld Acetylene Company, Chicago. The screwed connections were made up with malleable iron couplings and tees by expert pipe fitters. The pieces for the butt welds were cut at an angle of about 60 degrees in a pipe-cutting machine to get the necessary "V" groove for welding. The "T" welds were made by cutting a hole in the run and butting the outlet against the run. The ends of all the specimens were sealed by welding in plugs or disks made from boiler plate punchings. Two of these disks are shown at the bottom of Fig. 3.

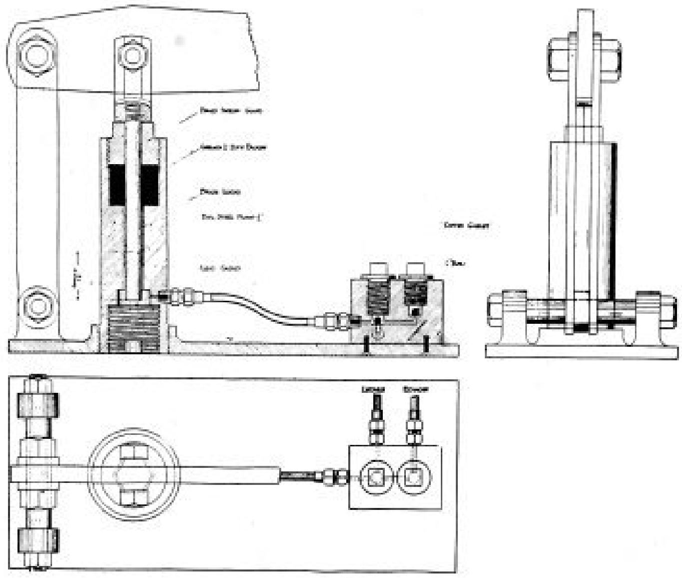


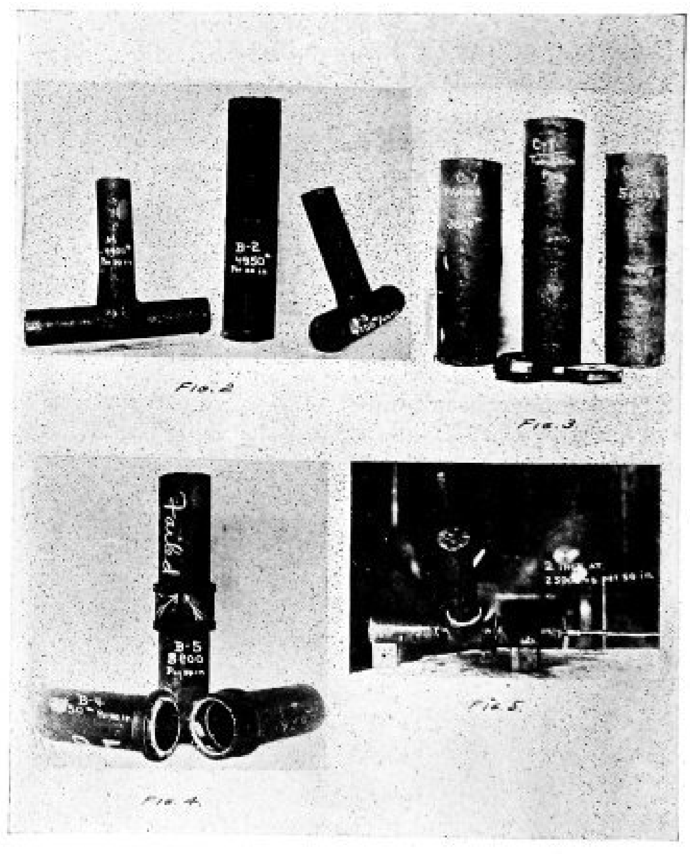
Fig. 1.—High-Pressure Pump, Capacity About 70 Cubic Inches Per Minute at 5,000 Pounds Per Square Inch

The specimens were subjected to pressure by means of a small hydraulic pressure pump, Fig. 1, which was made especially for this work. The specimen under test was placed about 25 feet from the pump and connected to it by means of a ½-inch copper tube. A pressure gage with a check valve opening toward the gage was placed between the pump and the specimen. The check valve was necessary to steady the pressure in order that satisfactory readings could be obtained because some of the samples carried pressures greater than 5,000 pounds per square inch before failing.

The illustrations show several of the specimens tested and their modes of failure.

Welded 2- and 3-inch specimens are shown in Fig. 2. These failed by splitting along the longitudinal seams of the pipe, the split stopping at the welded section. The 4-inch welded specimens in Fig. 3 bulged under the high pressure, but did not fail in either the weld or the pipe seam.

The modes of failure of two of the screwed connections are shown in Fig. 4. The bursting pressures for the screwed connections were way below that of the welded specimens and all failed in the fitting. Great difficulty was experienced in testing the specimens made up with screwed fittings because sand holes developed and the water leaked through the castings to such an extent that it was almost impossible to reach the point of rupture. Fig. 5 shows one of the screwed "T" specimens under test, and illustrates clearly the leaky condition just mentioned.



Test Specimens

Examination of the data given in the table shows that in only one case was there failure in the weld, and that was merely a leak which did not develop until 3,850 pounds

* Professor of Mechanical Engineering, University of Kansas.

per square inch pressure was applied. This brings out the point that, while leaks are much less likely to occur in welded than in screwed connections, they are the principal cause of difficulty. Therefore, pipe lines that are to be subjected to high pressure, if properly tested for leaks when installed, should give no trouble under service.

The results of these tests bear out the conclusions given in the previous series, namely:

a—The strength of a welded pipe connection is practically the same as that of unwelded pipe. By slightly building up the weld it can be made stronger than the rest of the pipe.

b—The strength of the welded pipe connections is very much greater than that of the malleable iron screwed fittings.

c—Although a careless or inexperienced operator might produce a leaky joint, nevertheless, if the pipe line is tested for leaks when installed, it should give no difficulty in service.

HYDRAULIC PRESSURE TESTS OF OXY-ACETYLENE AND SCREWED PIPE CONNECTIONS

Size Pipe Inches	Type Joint	Pressure at Failure Pounds per Square Inch	Maximum Pressure Pounds per Square Inch	Nature of Failure	Condition of Weld
2	Welded "T"	4,400	4,400	Tube seam split	O. K.
2	Welded "T"	2,200	2,200	Leak in tube seam	O. K.
2	We.ded "T"	4,750	4,750	Tube seam split	O. K.
2	Screwed "T"	2,350	2,750	Sand holes in fitting	.....
2	Screwed "T"	500	2,000	Sand holes in fitting	.....
3	Butt Weld	.....	5,300	....	O. K.
3	Butt Weld	4,950	4,950	Tube seam split	O. K.
3	Butt Weld	.....	4,250	....	O. K.
3	Coupling	3,950	3,950	Coupling split	.....
3	Coupling	3,400	4,400	Leak in coupling	.....
3	Welded "T"	.....	3,500	....	O. K.
3	Welded "T"	.....	4,250	....	O. K.
3	Welded "T"	.....	3,505	....	O. K.
3	Screwed "T"	350	2,700	Sand holes in fitting	.....
3	Screwed "T"	300	3,100	Sand holes in fitting	.....
4	Butt Weld	.....	5,100	Pipe bulged	O. K.
4	Butt Weld	.....	3,250	....	O. K.
4	Coupling	300	3,000	Leak at threads	.....
4	Coupling	750	2,600	Leak at threads	.....
4	Welded "T"	3,850	5,100	Leak in weld	Leaked
4	Screwed "T"	1,000	1,950	Sand hole in fitting	.....

The Awakening of Jimmie and Bob*

In Designing a Boiler the Boys Find it Necessary to Study the Construction and Operation of Boiler Accessories

BY W. D. FORBES

One cold morning Bob went to the drafting room for a blue print. Howland, the draftsman, had to make it, so Bob stood against the radiator warming himself. He eyed it pretty closely and then asked: "Mr. Howland, what's the use of sticking all those pins on the face of the radiator, does that make it cost more money, weigh heavier, or what?"

"No," said Howland, "that's to increase the radiating surface so it will give off more heat."

Bob thought a little and then asked: "You get an increased area by those little bumps?" Howland nodded.

Bob took the damp blue print and disappeared into the shop. Jimmie noticed that Bob seemed to be "off his trolley," as he put it, and did not get down to work on the boiler design, it being three weeks before he was able to get back to anything practical.

One night he broke out, saying: "I had a fine talk with that man who comes to sell the shop gages, tricocks, water columns, and so on. He gave me a catalogue and he had a little sample tube, and he doped out all the steam-gage idea.

Steam Gages

"He talked so you could understand it. He said there were two kinds of gages—one that worked with a diaphragm; that is, one of those things they have in a squirt can, that when you push on moves because it is kind of dished and is thin metal. The second kind uses a bent-up tube.

"When they use the diaphragm they don't make it just like the bottom of an oil can, but spin a lot of rings in it, which gives it more elasticity. If you had a diaphragm corrugated with rings in the bottom of an oil can, and then you took the nozzle out and screwed the oil can in some way onto a steam pipe and let pressure into the can, the diaphragm would rise and fall as you let the pressure in or out. Of course, they have to make the case for the diaphragm strong enough to stand the pressure, and they fasten a little rack to the middle of the diaphragm and fit a pinion to it which carries a pointer. Of course, as the pressure moves the diaphragm up or down the rack will move with it and turn the pinion which carries the pointer. Of course, as the pressure moves the diaphragm up or down, the rack will move with it and turn the pinion which carries the pointer. They have to make a dial to show what this movement is and mark on it the number of pounds which the movement of the pointer indicates.

The Bourden Tube

"The drummer said this style of steam gage is more used in the Old Country than here, but in the United States, what he called the Bourden's solid-drawn tube gage was more popular, and he thought a little easier to make and have accurate. He said a Frenchman named Bourden got it up. It works this way:

"They take a piece of solid-drawn copper tube, flatten it down and bend it like a question mark. One end of this tube is left round and is braised into a kind of receiver, which is threaded on the outside so that it can be screwed into a steam pipe. This is fitted into a brass or cast iron case and the tube is bent up, as I said, like a question mark, and the loose end is plugged up and so made that they can connect it with a pin to a rack or little gear. This mechanism carries a pointer just like the other gage. Of course, they have a dial, too. Now, when the steam comes into the bent tube the pressure tries to straighten it so that the loose end will have to move. The reason why it tries to straighten itself is because there's more surface on the larger radius of the interior of the flattened tube than there is on the smaller radius.

* Continued from February issue.

"They take these gages after they are made and test them with a water pressure and mark the dials, and I can tell you, Jimmie, those little gears and pinions are a mighty nice job. That work is no more like boiler work than a mosquito is like an elephant. A good deal depends upon having an accurate gage."

"Yes," answered Jimmie, "but a good deal more depends upon the man who watches it."

"You bet," says Bob, "I heard a man, who had been in some navy or other, say that he was aboard a ship where one of the boilers wouldn't steam, couldn't get a pound on it, and they were slicing and forcing the fire for all it was worth. They sent for the first water tender; he took a ladder and got up to the gage and began to cuss the gage makers because the pointer had been fitted up so that it pressed against the stop pin, and, of course, couldn't move. They always have these pins, you know. He broke the glass and lifted the pointer over the pin, and up she went to 600 pounds. He just got out of the boiler room when up went the boiler, killing a lot of people. When they came to investigate they found the pointer had gone clean around the dial without anybody noticing it, and, as it stopped against the pin, the chumps thought there was no steam making. There was a case where the gage was all right, but the men all wrong.

"But, come on, let's get down to some business. Let's take the safety valve next.

Safety Valves

"There are two kinds of safety valves they talk about in these books. One has a seat something like an ordinary globe valve, and the clapper is held down, usually by a lever with a weight on it. This same fellow, who was selling gages, told me about the kind his concern makes. They call it a 'pop safety valve.' The first kind was all right for low-pressure boilers, and it was cheaper.

"Sometimes these valves, instead of having a lever and weight, have a spring. Of course, if there was just a lever and weight it was a mighty easy thing to move the weight out or hang more on the lever, so really a safety valve made this way could be made no safety valve at all. When the valve began to leak, and that was generally pretty quick, the fireman was quite sure to move the weight out to stop the valve leaking, and a great many lives have been lost this way, according to the drummer. The boiler laws in various States put a stop to this fool stunt, and now they lock up the safety valves so they can't be monkeyed with. This old style safety valve didn't relieve the boiler very quick and would keep dancing up and down and sizzling all the time.

"The pop safety valve the drummer had I didn't understand at first, but the model he showed me put me wise. It has the same kind of seat and clapper that the old style of valve has, only around the clapper is an extension with a groove cut in it quite deep. When the clapper comes down on to the seat this rim just misses contact with the metal around the seat. Now, when the valve lifts a little and the steam comes out between the seat and the clapper the steam shoots up into that circular recess and makes what he calls a differential pressure there. As this recess is filled with steam there is more surface presented to the steam than there is to just the clapper itself, consequently the clapper lifts higher and lets out more steam for the same area of opening than in the old style safety valve.

"To put it another way, this pop safety valve system simply provides more surface for the steam to act upon after the valve has started to lift, and when it starts to close it closes down darn quick. Both styles of valve, when they are fitted with a spring, can be adjusted for any pressure and then locked up by the inspector.

"Now, let's see what this book says about safety valves. Here we have it; you must have a ½ square inch area of opening for a weighted safety valve to every 2 square feet of grate surface. If we are going to use a spring-weighted or lever safety valve we would have to provide 5 square inches of area opening for our safety valve. Our area table shows that an area of 5 square inches equals the diameter of 2 9/16 inches. That's not exact, but it is near enough."

Jimmie thought a moment and then said: "I don't believe they make safety valves to odd sizes like that. We would have to take a 2½-inch valve or a 2¾-inch. I think we ought to take the larger one, for safety's sake; but, look here, Bob, seems to me we ought to chase around a little more on this safety-valve business, as this rule does not say anything about steam pressures. It may not make any difference, but I should think it would. Let's chase it up a little more. Anyway, this area business has got me started on something that makes me think I am going daffy. I can't tell you about it now, but I must be a fool or the whole world must be a fool ever since steam engines began."

Bob lit his pipe and answered: "I'm kind of betting the world hasn't been a fool, but when you are ready to tell me, get it off your chest."

Jim pondered a minute, thumbing over a hand-book; then broke out, "that safety-valve rule is a fool thing. It makes me think of what Howland said: 'That a little learning is a dangerous thing." He got that out of some hand-book, I guess. We've been kicking because these hand-books don't give us exact rules; now here we've got one, and it's plain to me that it is a dangerous thing to use it."

"Why?" asked Bob.

"Because it takes no account of how fast you are making steam, or, to put it another way, if we were burning ten pounds of coal on every foot of grate we would be making so many pounds of steam, wouldn't we, in so many minutes? And the safety valve might let out all the steam that we could make above what the safety valve was set at; but suppose we burn 20 pounds of coal on every foot of grate in the same time we would certainly be making a lot more of steam, and the safety valve might not be able to let out more pressure than we were building up, so it might blow up. If we just took this rule it is quite possible that we would be running into a lot of danger, and just a blocked-out statement is the 'little learning' in this case, which might result in an accident.

"I guess, Bob, there is a whole lot to study yet about rules."

To which statement Bob agreed, with a nod.

(To be continued)

Large Orders for Locomotives

Including orders for 275 new locomotives constituting the 1918 programme of the Pennsylvania Railroad, involving the expenditure of $14,200,000, there have been placed in May up to May 19 inclusive, orders for 677 locomotives, bringing the total for the year to that date to 2,354, of which 541 are for export. This is a larger number than was ordered in all of 1915, and at the present rate the orders for 1917 will double those for 1916, which were 5,750.

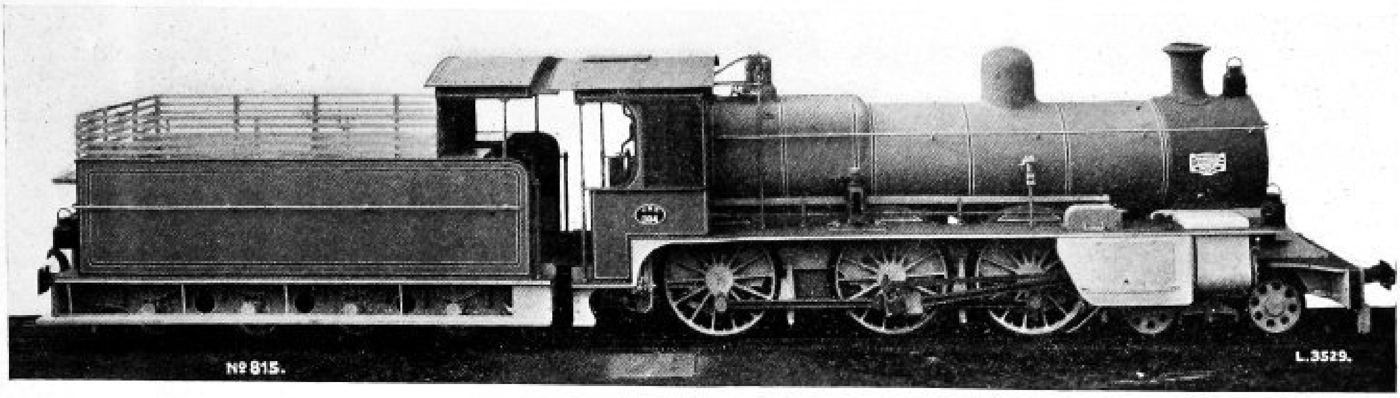


Fig. 1.—German Locomotive on the Assam-Bengal Railway in British East India

British East India Uses German-Built Locomotives

Details of Locomotives Built by the Hanover Locomotive Works for Railroads in British East India—Crampton and Belpaire Fireboxes Used

BY FRANK C. PERKINS

On account of the great war between Germany and Austria on one side and nearly all of the remainder of Europe on the other side, the use of German-built locomotives in British East India, as developed by Hanover Locomotive Works, is of special interest. The construction of railways was begun in India in 1850. The rolling stock was procured almost exclusively in England. It was only in 1869 that 10 locomotives were supplied to India from Switzerland and 20 from Germany, all of them for the East India Railway. Apart perhaps from some few small contractors' or industrial locomotives, these 20 locomotives remained, until the end of last century, the only German locomotives in East India. But in 1901-1902 there suddenly rose in India a great demand for rolling stock, so that English manufacturers were unable to cope with the requirements of that country.

Hanover Locomotive Works was the first firm to obtain an order for 40 broad gage 0-6-0 coupled goods locomotives for the East India Railway and ten 2-6-0 coupled goods train locomotives for the Assam-Bengal Railway. These were soon increased to 44, as 4 engines shipped meanwhile from England had been lost at sea. The 0-6-0 locomotives of the East India Railway were built entirely according to the existing English drawings, to which shortly before an English firm had supplied 58 engines. The general arrangement resembles the well-known English standard type with inside cylinders and long wheel base. The boiler has a Crampton firebox and a smokebox

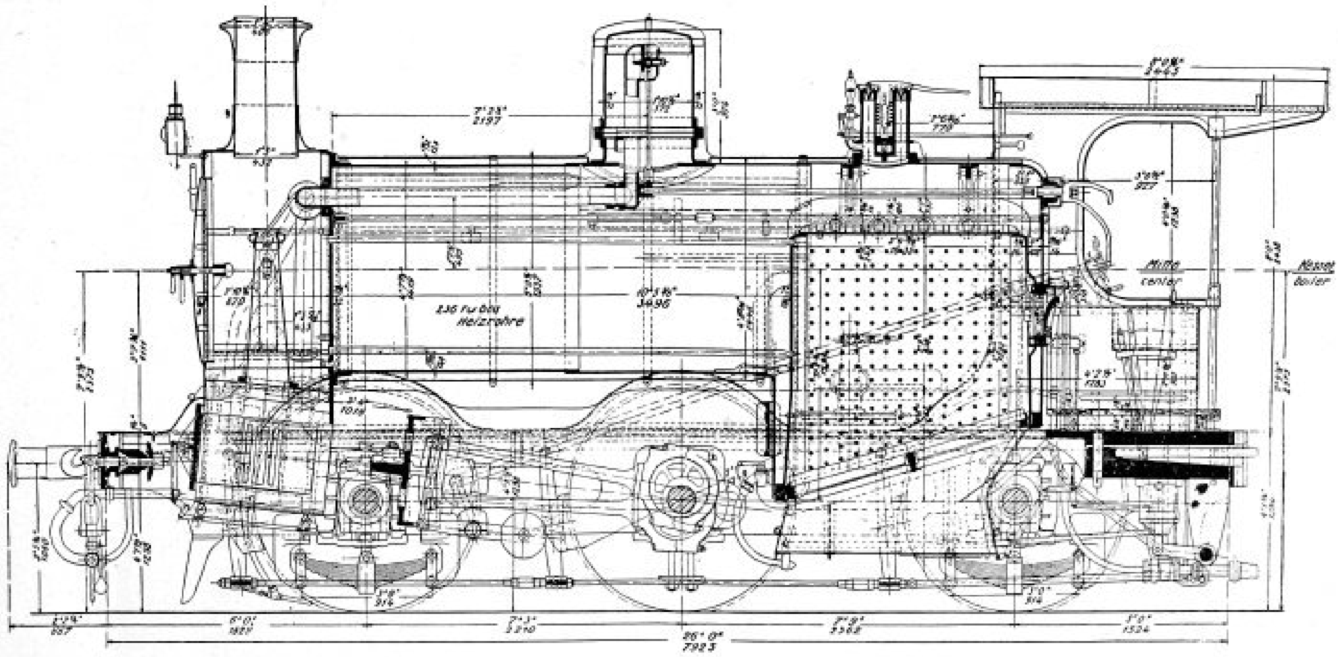


Fig. 2.—German Locomotive on the East India Railway

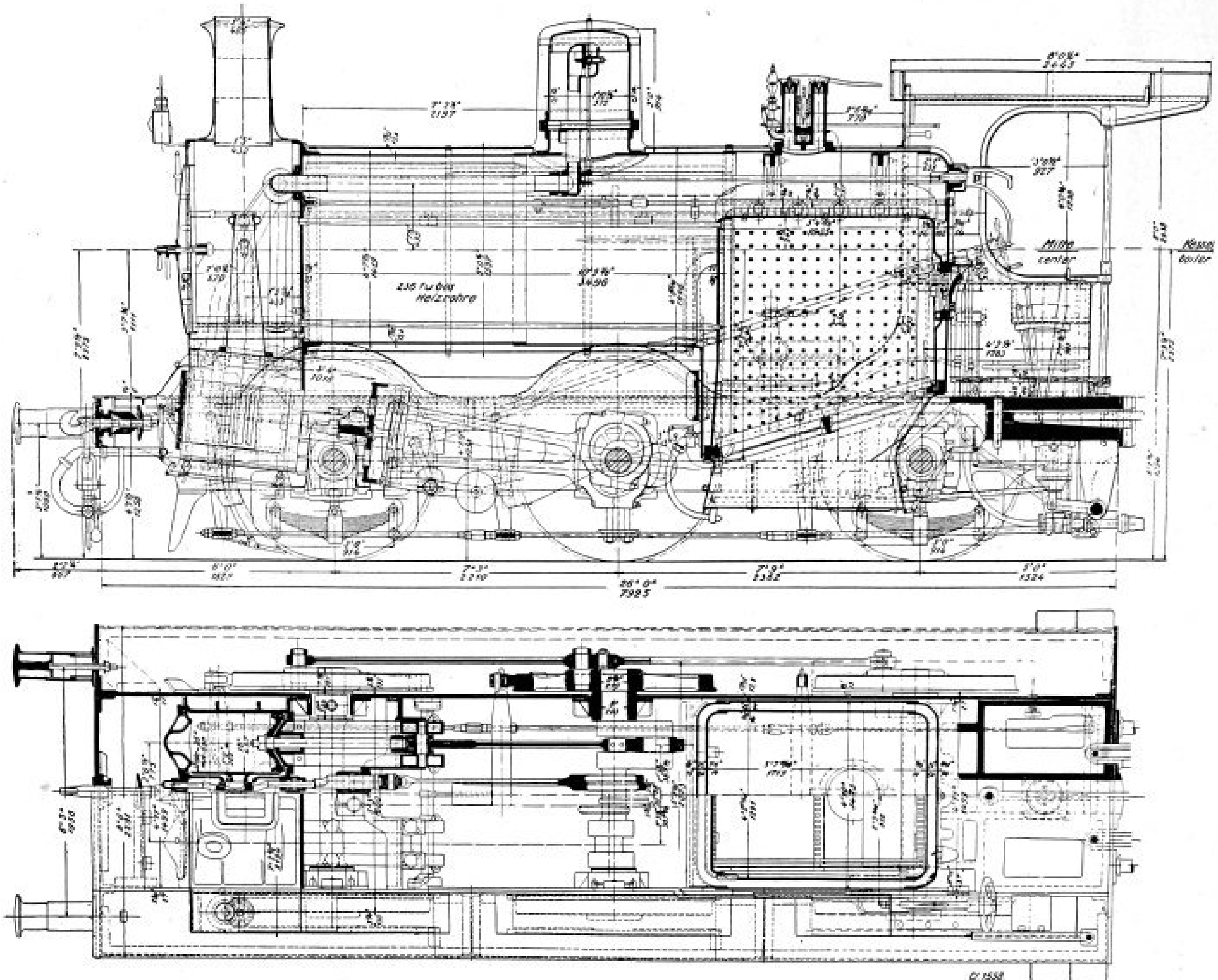


Fig. 3.—German Freight Locomotive in British East India

built on in front with an angle iron ring, which is directly connected to the cylinders underneath. Owing to the wider gage a clear space of 4 feet 11 inches results between the frames, and hence a width of grate of 4 feet 2 13/16 inches. The crown of the firebox is not stayed with staybolts, but with heavy longitudinal bars of Siemens-Martin steel. The tubes are of brass, the thickness of metal decreasing from the firebox towards the smokebox from 11 to 13 S. W. G. The throat plate differs from the German, being flanged very far forward, so that the front edge of the firebox casing runs through below in a straight line from left to right.

The 2-6-0 locomotives built for the Assam-Bengal Railway according to designs of the Hanover Works resemble more the German type. The boiler has a Belpaire firebox, which had to be considerably narrowed in in the downward direction, as a width of 2 feet 1½ inches only can be rendered available for the grate, which is 6 feet 7 inches long.

As in India English measurements are in use, both types of locomotives had to be built to English, instead of to metric, measurements. It is stated that for this purpose the offices and workshops were equipped with inch rules, as conversion into metric measurements and working to these was inadmissible. Original Whitworth gages were procured for the accurate checking of the dimensions of the various parts and in particular of the screw threads to be executed according to Whitworth gage. Nearly all parts were made to template, so that actual interchangeability was assured.

It is of interest to note that this method of working caused no difficulty whatever and has since been applied very frequently. The work was carried out under the supervision of the well-known engineering firm of Rendel & Robertson, now Rendel, Palmer & Tritton, of London. In 1911 this German firm supplied two 4-6-0 passenger train locomotives for the Morvi Railway. At the end of 1913, as English manufacturers were again very busy, this German locomotive works was entrusted with a contract for twelve 4-6-0 coupled passenger train locomotives for the Jodhpur Bikaner Railway and 6 almost identical locomotives for the Assam-Bengal Railway. The last-mentioned order was very soon followed by a further order for 4 locomotives. The German plant has, therefore, supplied in all 78 locomotives for East India. The two types of locomotives for the Jodhpur-Bikaner and Assam-Bengal Railways have in general the same structural arrangement. In the first place, the boilers are almost identical.

As the frame plates are only 2 feet 9¼ inches apart, the grate could not be made wider than 2 feet ⅜ inch. With a length of 7 feet 7 inches there consequently results a grate surface of 15.33 square feet. The tubes are of steel in the Jodhpur locomotives and of brass in the Assam-Bengal locomotives. The thickness of the brass tubes decreases, as is customary in English locomotive practice, from the rear to the front, from 11 to 13 S. W. G. A noteworthy feature is the fixing of the steel tubes in the tube plate of the firebox.

The boss, situated immediately in front of the tube plate, is made before the insertion of the tubes. The boilers of the Assam-Bengal locomotives are equipped with cleaners of the Hulburd Engineering Company. This consists of two different arrangements. The first has a basin placed transversely in the front part of the boiler at the water level, from which a tube is carried to the back plate of the boiler.

If the driver opens the scum-cock placed there the frothing water on the surface is discharged from the boiler into the open air. This cock should be opened before starting and at the end of the journey, as well as once or twice while on the way, if the engine is performing heavy work. The second arrangement is situated on the foundation ring and consists of a number of small nozzles which discharge into pipes shut off on the outside by cocks.

When these are opened the mud deposited on the foundation ring is blown off by the internal boiler pressure. This should only be done at the end of each journey. One of the Assam-Bengal locomotives is also fitted with Tate's movable staybolts.

As is well known, England manufactures for the greater part acid Siemens-Martin steel, while Germany manufactures basic. Consequently nearly all English specifications for contracts, as well as those modeled on the English, stipulate acid Siemens-Martin steel. Such material is in most cases not obtainable in Germany except with difficulty and at correspondingly higher prices. But the customer frequently insists on the use of acid steel because this is alleged to be better.

It may be stated that more than three years ago Professors A. Campion and J. G. Longbottom decided on making extensive experiments with acid and basic mild steel. The first part of the experiments relating to plates of ¾ inch to 1¼ inches has now been published. The principal figures given by the tensile tests both for the material in the state as delivered and for test pieces annealed at 1,472 degrees F. are as follows:

PLATES ¾ INCH THICK

	In the state as delivered Acid-Basic		Annealed Acid	Annealed Basic
Tensile strength, tons per square inch.	25.7	26	23.7	23.5
Elongation in 8 inches (percent).......	32	32	34.5	36
Reduction of sectional area (percent)	51.	57.	56.5	59.
Plates 1 inch thick				
Tensile strength, tons per square inch.	26.	26.	24.4	25.4
Elongation in 8 inch (percent).........	26.	31.	33.	33.
Reduction of sectional area (percent).	38.	55.	56.	52.
Plates 1¼ inches thick				
Tensile strength, tons per square inch.	25.7	26.	23.7	23.1
Elongation in 8 inches (percent)......	27.	29.	34.	35.
Reduction of sectional area (percent).	53.	55.	55.	59.

German authorities state that it was found as a result of all the mechanical tests made that in the case of the plates tested no difference in quality was to be discovered in any respect between acid and basic Martin mild steel. The principal result of the tests, namely, that there is no difference in quality in the material hitherto tested, is highly remarkable. In England the absolute superiority of acid over basic steel has again and again been most emphatically stated. This investigation, for the first time, clearly contradicts this, and they therefore look forward with great interest to its continuation, which is to deal with further qualities.

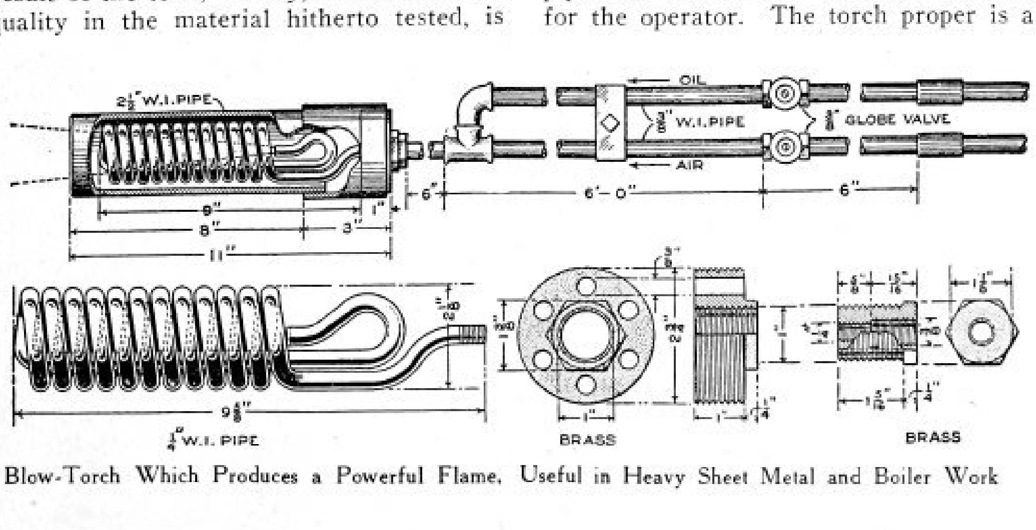
It was held that this result was very significant to the German steel industry, which had hitherto been obliged to fight principally against this prejudice in the international market. In view of the scarcity of ores for treatment on the acid hearth, which has made itself felt in an ever-increasing measure, this investigation will probably also claim very great attention in England.

It is urged that in judging whether basic or acid material should be used, there is a further circumstance which ought to be taken into consideration. With regard to many parts it is not customary, as in the case of, for instance, boiler plates and frame plates, to make tests of specimens from each piece, but only of samples taken from a small proportion. One is led to expect that the whole bulk of the material represented by these specimens tested would be fairly uniform. But, no doubt, in every country the greatest uniformity would be obtained with regard to whichever material was almost exclusively produced in their country. One may therefore expect, generally speaking, that in Germany basic and in England Siemens-Martin acid steel would turn out most uniform. This circumstance, in fact, has been taken into account in the specifications of some railways, which, in the case of International competition for tenders, require that for rolling stock the specifications of the State Railway or the principal railway company of the country of manufacture shall apply.

It was considered, before this great European war disturbed the calculations of all nations, that if, therefore, such a contract were placed in Germany the material would be made according to the German Railways' specifications; if in France, according to the "Cahiers des charges unifies."

Oil-Burning Blow-Torch for Sheet-Metal Work

The torch shown in the illustration was designed for use in railroad shops on boiler, tank, freight-car and other heavy sheet-metal work. By means of it a powerful flame may be directed on a limited area. The device is simple in construction, convenient in operation, and comparatively light. The oil fuel is admitted through the upper pipe, at the right, and the air for the blast through the lower pipe, the flow being controlled by ⅜-inch globe valves. The pipes are braced near the torch and form a strong grip for the operator. The torch proper is a coil of ¼-inch



Blow-Torch Which Produces a Powerful Flame, Useful in Heavy Sheet Metal and Boiler Work wrought iron pipe, fixed into a brass collar, having holes through it, as shown in the detail sketch, and covered with a 2½-inch wrought iron pipe, from which the flame is projected.

The upper sketch shows the general assembly drawing of the torch; the details are shown in the lower sketches. The cover for the coil is 11 inches long over all. One end of it is fitted with a brass plug, shown in detail at the center, below. Inside of this plug is a second brass plug, shown at the right, and into this are fixed the supply tube and the coiled pipe. The dotted lines in the upper view show how the flame is forced from the end of the coil, which is also shown in detail. It is 9⅝ inches long and 2⅛ inches diameter. The oil is heated to the proper temperature for ignition in passing through the coil, and the flame passes out through the center of it.—*Popular Mechanics.*

Some Experiences of a Boiler Inspector*

BY ROBERT J. HUDDLESTON

As old as the use of steam itself is the use of vessels for generating steam under pressure, and for just that length of time there have been boiler failures of different kinds.

Good design, good workmanship, regular, effective and thorough inspections constitute a part of good management that is quite essential. It is certain that a good boiler is practically safe for all time in the hands of a good engineer or fireman, provided the boiler is originally well designed, well constructed and properly set. Its safety is assured by a correct system of inspections which will serve as a check upon every defect of design, of construction and of operation. Workmanship on present boilers has been greatly improved as compared to the early methods of drifting the rivet holes until it was possible to force the rivets through; and it is no longer considered possible to set the sheets up loosely and expect the calking tool to cover the poor work and make the boiler tight for the time being.

Faulty Construction of Seams

I have seen hemp and white lead used in seams, the same as one would calk a boat, in place of setting the plates up in proper manner. I have also found longitudinal seams partly single and partly double riveted, and on new boilers butt strap joints designed so that the efficiency was not equal to that of a lap joint, single riveted.

It is not uncommon to find butt joints with the edges of the plates about 14 inches apart, with the inside strap looking like the half sheets on a boiler. The only excuse the builder could find was that he did not have any plate large enough, so he used short plates, believing the inspector would pass or overlook them; but the inspector did not, so the case was taken into court and the inspector was sustained on the one word *butt joint.* Of course the boilers had to be replaced with new ones.

I tested out in a boiler shop four new boilers, of the 6-inch tube type, which are difficult to make tight. On applying the hydrostatic pressure, I found no leaks whatever, but when the boilers were emptied out and I went in, I found about a barrel of horse manure in each boiler. The boilers were ordered thoroughly cleaned and a new test was made. Four days later they were tight enough to be accepted. I mention these things merely to show what an inspector has to contend with in shop inspections.

An order was given to make an inspection of a battery of boilers in a blast furnace which were not giving proper results. Upon inspecting the boilers it was found that the boiler cleaner had driven wooden plugs in the steam outlets to keep the hot water and steam from scalding him. After the plugs were removed the boilers were put into service and were satisfactory.

I have found large boilers in paper mills with quarter sheets, single riveted, longitudinal seams 6 feet long, and seams exposed to the heat of furnaces equipped with stokers. It is needless to say that these were replaced with new half sheets with longitudinal seams the same as in original constructions.

Thin Sheets Found in Boiler Shell

A certain manufacturer had ordered built two new boilers, 72 inches by 16 feet, to carry 100 pounds pressure. This was before the days of shop inspections. The boilers were shipped, set up, connected and ready for inspection. After being inspected and measured up, it was found that the boilers were only good for 83 pounds pressure, based on a factor of safety of 4. The cause of this was that the middle course of each boiler was built of 5/16-inch steel. This was reported to the manufacturer, who stated that we had made a mistake in our measurements. We then had his own men remeasure them and they could only make it 5/16-inch. After this was gone over, the boiler foreman acknowledged that he had had the sheet laid out and put in, thinking that the inspector would just simply pass over it.

Great care should be taken not to let any oil get into the boilers, as I have seen new boilers with the tubes warped so badly that they had to be replaced, and then they would only last a few weeks. I have found cases where firemen and engineers have lost their lives just on account of boilers containing oil. Fire sheets have sprung so that they had to be removed, and corrugated furnaces collapsed.

Safety Valve Missing

In making an inspection for the Supreme Court of United States of a Scotch marine, dry back boiler that had exploded on a dredge boat, I found that the furnace had given way near the lap seam, which was located on the left side near the bottom. Built to carry 100 pounds pressure, the boiler was about fourteen months old, and although the shell and tube sheets were badly distorted as evidence of excessive pressure, it was practically free from scale and deposit. In looking around for the safety valve, there was found in its place a cast-iron plug. Upon inquiry it was learned that the fireman of the boat, who, by the way, was the only one left, had been running the boiler without any safety valve for four weeks previous to the explosion, because they had had some trouble with the safety valve and were using the iron plug until they could get a new safety valve. The steam gage was found to be defective; in fact, it would not register at all, and the valve between the steam gage and the boiler was closed up with deposit. The grate bars and the bearing bars had been removed and the fire was being built directly on the furnace bottom, which caused overheating and burning of the plate at this point. With the above combination it is no wonder that the boiler left the boat. The boiler was carried about 650 feet and buried itself halfway into a marsh. It had been reported as defective in construction, but considering the report of the inspection it is doubtful whether any boiler would have stood such treatment.

* From a paper presented before the Ohio Society of Mechanical, Electrical and Steam Engineers.

It is just such cases as this that produce the idea that inspections should be made at regular intervals, and by an experienced inspector, one who is reliable and conscientious and possesses good judgment.

Thorough boiler inspections cannot be made unless the boiler is dry, empty and accessible in every part. A design which does not permit this should be condemned. More perfect inspections by effective methods must, however, be legally introduced and well enforced before steam boiler explosions can become extinct. There are about 1,500 boiler explosions of varying intensities each year in this country, averaging from 400 to 600 persons killed, 700 to 800 persons injured, and besides this, damage amounting to many thousands of dollars is done.

In my opinion it is sufficient for anyone desiring to purchase a boiler plant, after having determined the working pressure and the size and type of units required, merely to specify that the boiler be built to the A. S. M. E. code. By so doing he will get from any reputable manufacturer a well-constructed boiler entirely suited to its purpose.

I once made an investigation of an accident to a vertical "submerged" tubular boiler located in a sausage works. In talking to the man in charge, he said: "Well, I just filled the boiler full of water, put on a good supply of coal, and went over across the street to get a lunch, and when I came back the boiler was gone." The trouble was that he did not fill the boiler full of water, but did fill the furnace full of coal, and in place of getting a lunch he got drunk, and while he was gone the boiler exploded. It went up through the roof and buried itself in a neighboring garden.

Globe valves in the water columns should never be allowed, as I have seen new boilers explode due to the steam valve on the steam line being closed. Connections to water columns should be carefully attached, as boilers are sometimes completely destroyed, due to improper connections. I have found new boilers being operated for some time without any safety valves or water columns, but of course that was some years ago. Thanks to our new laws and codes these things are of the past.

If engineers are going to aid in the furthering of the "Safety First" movement, they can do nothing better about the plant than properly construct and valve the main steam lines, as elimination of accidents here will be of much benefit in safeguarding life and property against escaping steam.

Bagging and Blistering in Clean Boilers

Probable Causes of Bagging or Blistering of Plates or Tubes in Clean Boilers Amply Supplied with Water

BY W. A. LAILER

The matter of bagging, bulging or blistering of boiler tubes and plates is a question that is of vital importance to the power plant operator, because it concerns not only the safety and continuous operation of the plant, but also represents an item of great expense and inconvenience.

In the great majority of instances bagging or blistering of the tubes or plates of steam boilers is traceable to overheating due to the accumulation of mud, scale or oil. The intense heat of the boiler furnace is only kept from melting the steel plate forming the boiler shell or tubes because of the tremendous capacity of the water on the opposite side for carrying heat away from it. It therefore naturally follows that as soon as the heat absorbing effect of the water is lost, as is the case when a heavy coating of mud, scale or oil interposes itself between the water and the boiler shell, the intense furnace heat impinging on the steel plate will tend to soften it, due to overheating, causing it to bag or bulge, and it is assisted in this tendency by the high steam pressure maintained within the boiler itself.

Burning of Sheets and Tubes Often Due to Carelessness

The burning of the boiler sheets or tubes is also often occasioned by carelessness in allowing the water level in the boiler to fall to a dangerously low point, exposing certain portions of the shell to the heat of the furnace without the heat-conducting power of the water to carry it away.

In both the above cases the cause and explanation of the bagging or blistering can be traced to reasonable and logical conclusions—the natural result of improper operating conditions.

However, in some cases bagging and blistering have been reported where neither of the two factors mentioned above was brought into play—i. e., where the bagging has occurred in the boiler with clean pipes, i. e., immediately after being cleaned, or where scale, oil or mud accumulation is not experienced, and where an ample supply of water is present.

While on the face of it it appears unbelievable that bagging or blistering will occur in a clean boiler amply supplied with water, still it is a matter of record that such cases have been experienced and have been authenticated by actual evidence.

Possible Causes of Bagging and Blistering

The explanation for this action affords opportunity for considerable conjecture, and the whole proposition is so mystifying and so little actual data are at hand concerning it that only theories can be advanced as to the cause.

One theory as to the cause attributes the bagging of clean boiler plates to exceptional conditions of water circulation, or rather exceptional conditions of non-circulation of the water, it being contended that the space between the boiler shell and the lower set of tubes, or the space between the outer tubes and the side wall of the shell, and the space between the tubes themselves as well, may be so contracted and the flow therefore restricted to such an extent that inadequate circulation is provided under these abnormal conditions. In support of this theory it is argued that at certain times the furnace fire may become so intensely hot that it is capable of transmitting heat to the boiler plate faster than it can be absorbed by the water and carried away, and all because of the choked water circulation. It would naturally follow that the plate would become pliable under the effect of this excessive heat and would be forced or bulged outward by the internal pressure. In other words, due to poor and insufficient water circulation, the furnace is apt to impart heat to the boiler plate faster than the water can carry it away.

Then, again, where the heating surface of the boiler is restricted or too small for the size of the furnace such a similar condition could also exist—i. e., the heat would be supplied to the boiler shell in larger quantities than it could be carried away by the water, and hence a softening or overheating of the metal would follow.

Another theory advanced presupposes a possible concentration of the furnace fire upon a certain portion of the boiler shell, due to faulty firing, defective furnace construction, obstructions which divert the flames and hot gases (such as dislodged bridge wall bricks), etc. This concentration of the furnace fire would have much the same effect as a blowpipe throwing a strong flame against a restricted portion of the boiler plate. Such a condition, coupled with poor or sluggish water circulation that would not pick up the heat as fast as imparted to the plate, can well be said to come within the range of probabilities.

Still Another Theory

Following along the lines of the theory mentioned above —i. e., of concentrated fire impingement on the restricted areas of the boiler plate—another theory has been advanced, to the effect that this heating action may become so fierce and so intense that the limited area of the plate on which the flame and heat is concentrated becomes so intensely hot and the ebullition so violent that it actually drives the water away from it, leaving the bare plate momentarily exposed to the intense heat, which naturally causes softening and consequent bagging.

Along an entirely different line of reasoning is another theory advanced in explanation of this peculiar condition, a theory that places the responsibility for the bagging of clean plates on the defects in the makeup and composition of the boiler material itself. Boiler plate as it is manufactured in the rolling mills is really composed of a continuation of layers or laminations of the steel metal rolled or welded together. In this process of manufacture absolute perfection, of course, cannot be expected, and therefore, instead of a thoroughly homogeneous mass throughout, there will occasionally be found a sheet with a defect, in that the weld is not completely and thoroughly made. If such a section of the plate happens to be employed in the portion of the boiler subjected to the direct heat of the furnace the high temperature will cause the thin unwelded strips or portions to puff out in the form of a blister.

Impurities in Plate

Then, again, in the plate-rolling operation it is possible that impurities, such as iron scale or slag, are often allowed to lodge in the plate during the rolling operation, thus preventing the proper welding of the parts at that particular point. This slag or scale, being of a non-conducting character when compared with the steel plate, if subjected to the heat of the furnace, retards the full heat transmission through the metal sheet, causing a concentration of accumulation of heat at that portion of the plate, causing overheating and consequent bagging or blistering.

In the case of imperfectly welded plates the bag or blister may often only affect the thin stratum of plate that is not completely welded to the plate structure, and which is directly exposed to the fire. In this case the blister will be visible only on the outer surface of the boiler, a pocket not being apparent on the inner surface.

Another explanation for the bagging and blistering of clean boilers is that it is caused by excessive density of the water contained in the boiler—in other words, the density of the water may be so great, because of the presence of sodium chloride, sodium sulphate, and other soluble salts, that the circulation of the water and the liberation of the heat from it are so hampered that momentary overheating of certain portions of the boiler shell made be experienced.

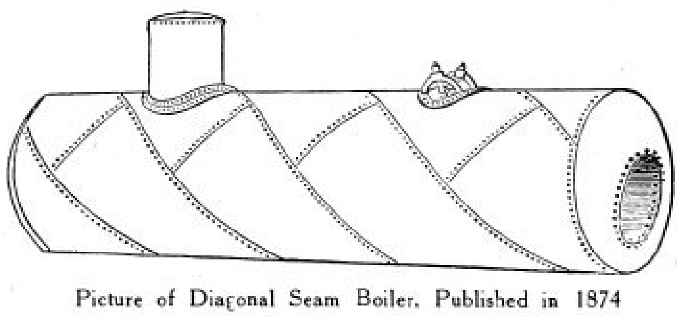
Then, again, another plausible explanation of the bagging and blistering action is offered in the claim that the steel plate of the boiler is subject to embrittlement—loss of its power of elasticity, and hence reduction in strength —because of the peculiar action caused by the high concentration of sodium carbonate in the water under the high temperatures prevailing in the boiler, especially when the sodium carbonate is present with little or no other soluble salts, such as sodium chloride or sodium sulphate.

As stated above, the whole subject is one on which so little actual data and observation have been secured that it is impossible to ascribe the trouble to any one or any combination of the explanations proposed above, but the various theories are presented so that they may be given consideration in any cases where this unusual trouble is encountered.

The Diagonal Seam

While looking through the Dictionary of Engineering, published in London, 1874, I find the picture of a diagonal seam boiler. Thinking that it might be of interest to readers of The Boiler Maker, the cut is furnished with this sketch.

The boiler is described as "Wright's diagonal seam boiler, in which no three corners meet, and, considering the angle of seam, making boiler a great deal stronger."



Picture of Diagonal Seam Boiler, Published in 1874

Formula for diagonal joint

$$= \frac{2}{\sqrt{\text{Cosine}^2 \times 3 + 1}}.$$

Or: assuming the diagonal to be 45 degrees, the cosine of 45 = .707. .707 × .707 = .499. .499 × 3 = 1.497. 1.497 + 1 = 2.497. $\sqrt{2.497}$ = 1.573. 2 ÷ 1.573 = 1.27, or 27 percent stronger than solid.

The principal interest hinging upon the above is the comparatively remote age of same, the original wood cut and the recognition of strength in this unusual form of joint, which must have been thought freakish at that time (1870).

The Vagrant.

Personal.—F. H. Tackaberry, recently associated with the Ordnance Engineering Corporation, New York, has been appointed traveling representative, with the title of general agent, of the American Steel Export Company, New York. Mr. Tackaberry will soon leave for South America.

Are Fire Box Sheets Welded With The Oxwelding Process Efficient?

Answer:

The tensile strength of a single lap riveted seam is approximately 52% to 60% of the strength of the metal itself.

By tests, it has been proven that the tensile strength of a seam welded by the Oxwelding Process is from 80% to 85% of the metal itself.

Why not submit your boiler repair problems to our staff of experts, who are constantly in touch with the application of the Oxwelding Process to the special needs of the steam railroad field?

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Making the Business Earn a Profit—I

Standard Principles Upon Which Business Should Be Conducted —Mechanical Skill Alone Not Sufficient for Business Success

BY EDWIN L. SEABROOK

Business stands on three legs—capital, labor, management—and the greatest of these is management. In the terms of the boiler maker these legs might be termed labor, materials, methods. Whatever may be the terms used to designate the standards upon which successful business conduct rests, the most important is the policy, or that intangible something termed management. Ample capital, the best of labor, will not produce a profitable business without efficient management. Men start with sufficient capital, the best of prospects, and fail of success, while others begin with the most limited means and forge ahead, due entirely to policy or management.

Mechanical skill in the boiler making industry plays an important part in the management of the business as a whole, and from a short-sighted viewpoint may seem to be the greatest factor, but this is by no means the case. The conduct of business is doing work, executing a contract, or disposing of merchandise to produce a profit. In fact, it is a game involving scientific principles—business conduct to-day is the greatest game that is being played. It is a matching of brains and mental resources to produce profitable results. The driving force of our great industrial plants is not within these, but at an office which may be a thousand miles away. Ideas, plans and methods concentrated at the office desk operate the railroads, mines, industrial plants and every other profitable business, no matter what the size of it may be. The fundamental principles of business conduct are the same no matter whether the business be large or small. Those engaged in business must know something of these fundamentals and the scientific principles of the game, if they hope to win success. These cannot be ignored or violated. The word "success" as here used is not meant to imply a failure to meet financial obligations, but the lack of making the business substantial and profitable.

What Business Is

Business to-day is done with the brain and not with the muscle; in fact, it is a mental rather than a physical activity. There are thousands of men in every line of industry that are doing work, performing contracts, but they are not doing business. There is a wide difference between performing contracts, whether in the boiler making business or any other, and doing business. The roller in the mill is doing work, but he is far removed from any business activity in the company; doing business at the office desk makes his employment possible.

The boiler maker who quits the bench and engages in business for himself may get the work to do, but he may not be doing business. A shop, tools, material, mechanics, orders, may mean work executed without the proper application of sound business principles. Thousands of men have done enough business in dollars to have made them fairly well-to-do, yet when their estates were settled there was hardly enough to meet the obligations against them. This condition was not due to losses or reverses. Their shops were generally busy, they thoroughly understood the mechanical part of their trade, yet failed to make the business successful—yield a profit. They did large quantities of work—but very little business. Contracts would be estimated upon, taken and executed. The money would be collected, obligations paid, and beyond this no records of the transactions were kept, no experience tabulated as a guide for future prices and estimates, no comparison made between the estimated cost and completed cost of the work. There was no record of any kind to show whether the business was being transacted at a loss or a gain. This same condition is facing thousands of men in practically every line of trade. They do a large volume of business, handle each year large sums of money, and make but little, if any, progress financially.

Mechanical Ability Alone Not Sufficient

From this it will be seen that mechanical ability alone is not sufficient for successful business conduct. The mechanic qualifies by serving as an apprentice. If he engages in business he must likewise know something of business principles. He is competing not against mechanical skill, but business shrewdness and accurate knowledge of its fundamentals and practices. Mechanical ability and efficient business management do not always go hand in hand. It is just as essential to study and acquire a mastery of the principles of business, how these should be applied, as it is to serve an apprenticeship and learn by practice proficiency in mechanical arts.

There are good business men that would be even poor botches as mechanics. There are highly skilled mechanics that have failed as managers and failed still worse as business men. It is one of the easiest things to lay a brick in a wall, spread some mortar with a trowel and place the brick in position. It is such a simple thing that anyone can do it—how efficiently it is done in comparison with thousands of other bricks in the wall is quite another matter. Mixing the mortar, getting the right proportions of sand and lime, laying the brick so that it will plumb with others surrounding it, require a knowledge and application of certain principles. Making a brick wall is something far different from placing a single brick in position. Everybody can do the latter, but skill is required for the former.

The conduct of business appears so easy, like placing a single brick in position, that many boiler making mechanics decide to start in for themselves. With a thorough knowledge of the mechanical side it seems quite easy to hire other men, work with them, get work, buy the material, make collections, meet the obligations and take the profit if the latter is given any consideration, which in many cases it is not. Success seems so easy that, without counting the cost and without a study or knowledge of the necessary requirements, many make the venture.

Knowledge of Business Practices Essential

Mechanical skill and ability of the boiler maker about to engage in business are by no means to be discounted. These, however, will not in themselves insure success. Performing mechanical work is one thing; transacting business in connection with it is another; the two can and should be joined together. Doing work will be profitable only when doing business is used with it. The mechanic about to engage in business cannot be too strongly impressed with the fact that a knowledge of business practices is just as essential to success as a business man as the knowledge and practices of the mechanical arts is to him as an efficient mechanic. Mechanical efficiency cannot be acquired in a haphazard manner, neither can business efficiency.

Many men without a knowledge of the mechanical part of the business in which they engaged have been eminently successful. Others with a full knowledge of all the mechanical details fail. It is possible in a mechanical trade to make a success of the business without a practical knowledge of the mechanical art required. It is almost impossible for the most efficient mechanic to be successful in business where business qualifications are lacking. It comes down to the third standard of business —proper management. How often will some old-time boiler maker or plumber cast aspersions on his successful competitor because "he never learned the trade," yet is outstripping them in the commercial race, due entirely to the fact that he knows and applies the principles of business, while they adhere entirely to the mechanical.

In business conduct one great principle can be laid down and should be kept constantly in view:

Business gravitates to the one most competent to take care of it.

No matter how efficient the mechanic may be, if he lacks the ability to manage "business," it will drift, in the very nature of things, to the one most competent to do it. A little reasoning will show that business management is the greater necessity than mechanical skill, and the greater always includes the lesser. The man with business ability can hire the mechanical ability, but it is not so easy to hire efficient business management, which is absolutely essential to success.

From the foregoing it will be seen that there is a very sharp distinction between mechanical and business ability as applied to business success, and the absolute need of the latter for even a moderate degree of success, and also leads to the consideration of some of the successful qualifications for the business man.

No Abstract Rules for Success

Success cannot be created out of abstract rules, principles, etc. It is hardly possible to formulate a set of rules which will lead to success. If successful business men could be created according to a certain formula, there would be no such thing as failure, the lack of success would be unknown. Many books have been written on how to succeed, and all of these contain many valuable suggestions as to what to do, what should be avoided, how success came to some, failures to others, etc. None of these things within itself ever made anyone succeed. Reading valuable treatises on the art of boiler making or pattern cutting never made a mechanic. However, this knowledge will stimulate the mental activities and bring out latent qualities which, properly developed, will make for mechanical ability.

Business being largely a mental process, there must be "something" in the man which will take hold of and put into action the elements or things that make for real success. This business activity, being largely mental, varies with different men. All do not possess the same degree of business ability. Some men have this highly developed to a remarkable degree and it comes naturally to some to efficiently manage large industries, just as it does to some to compose music, paint or have the gift of oratory. The products of a machine can be turned out according to a fixed size and form. All machines of the same kind can be operated according to a set rule. The mental processes which govern business activities cannot be subject to any such hard and fast abstract rules. It is very true that certain well-defined policies or principles must be followed, but these must be distinguished from abstract formulas on "how to succeed."

It is given to some men to have great business ability; others have it in a lesser degree until it is entirely lacking. As ability varies in degree, so methods vary even in the same line, by which success is obtained. Each great business man of to-day marked out his own path. Each individual, no matter what the size of the business may be, must, in a very real sense, do the same thing. He must *be himself* and not an imitator of success.

Business Failures Should Be Studied

In studying other business men it is not always wise to look at the successful side only. It is just as important to know why men fail as why they succeed. The ordinary successful business man will probably not be able definitely to state the elements that made him successful. He may lay down the abstract rules or principles that guide him in his conduct. Why men meet reverses, fail of success, is a more important study than why men succeed. Recently several hundred business men were asked this question: "What blunders do you observe men in business make most frequently, and what qualities do they seem to lack?"

In substance the answers were: Inability to think; analyze or exercise judgment; narrowness and unwillingness to see more than one side of a question; feeble thinking; snap decisions; arguing; failure to get to the core of a problem; does not eliminate non-essentials; fails to understand basic conditions; does not make a thorough study of the problem; fails to get a broad view; sees only his own side; does not see the customer's side; inability or weakness to adopt new ideas.

Understanding people and conditions are prime factors of success. Business men too often fail to analyze themselves and to appreciate the all-important viewpoint of their customers; often their rights are neglected and their feelings not considered. Hesitation, putting things off, dodging responsibility, are by no means uncommon. Learning to think, plan, decide and then to act are elements of success and failure to succeed can in many instances be traced to some weakness in the exercise of these essentials.

From an analysis of the above it will be seen that it is quite as important to study the reasons of failure as of success. All men entering business are not imbued with great ability at the start, yet all may acquire in some degree the rudiments of business management by a study of some of the features that make up a successful business.

An Ideal

Every business man should have an ideal as to what his business should be, because the business will never rise higher than the ideal he sets for it. This ideal should include what he thinks, how he acts, how he treats his customers, his competitors, his standing in the community. No doubt many boiler makers start in business with little or no business experience. Going direct from the shop into business, their experience must necessarily be limited. Unfortunately, many who start in this way have a very low conception of what the business ought to produce for them. With many it is no higher than a mere living. A day's wage appears to be the limit of their ambition. The one who ventures into business with no other higher conception than a day's wages would be many times better off in the employ of some one else. One of the tests of business management is profit making, and no one should set a low income from the business. It will never grow any larger, nor produce a bigger income than the ideal set for these by the owner. If he is satisfied with mere wages, that is all the business will ever produce for him.

Volume of business does not always mean profit. The desire for a great amount of business has been the undoing of many. Many small establishments are very profitable in proportion to the total amount of business secured. This is because of proper management, efficiency in economic methods, and seeking the profit rather than the amount of business. Setting the ideal for profit is much safer than seeking the volume. Many start in business with the idea that the only way to secure contracts is to make a lower price than that prevailing among competitors. There is a natural increase of business from year to year in every growing community and there are always new customers. It is much better to create new business than to devote all the energy toward keeping competitors from securing business already in the market. It is a bad policy to begin cheap, because a business habit is created that is hard to break. Unfortunately, a cheap man generally stays in that kind of a rut. He runs along in this unprofitable condition and is unable to get out of it, try as hard as he may. How many firms have been compelled to give up business because they asked a reasonable price? How many have been forced out because they did not ask enough? The first step in securing a good price is to ask it.

TACT

This essential quality should be cultivated by every business man. No one can have too much of it. The dictionary defines tact as:

A touch; sense of touch; nice discrimination of the best course; peculiar ability to deal with others without giving offense; delicate and sympathetic perception or consideration of what is fit under the circumstances.

How essential tact is in its relation to business intercourses with men can be seen at a glance. Mistakes, difficulties, misunderstandings, etc., are bound to occur. Many people offend by their bluntness and throw away an opportunity which, if tactfully used, would accomplish the thing desired. A person with a pleasing personality may have a quick temper or lack the perception of judging between right and wrong. The temptation to "give a piece of your mind" may be great, but if the object desired is worth attaining it is worth suppressing the momentary desire to speak out what may be in the mind.

FIRMNESS

This is another quality essential to success. Tact and firmness must generally be used together. Tact does not imply a lack of firmness. In fact, the *nice discrimination*, or *best course to pursue*, often requires great firmness. Neither is firmness stubbornness or contrariness. Contrariness is simply being against, stubbornness and obstinateness are perversions of the will and judgment, and elements of weakness. Firmness is a clean-cut, well-defined purpose and will win over bluster and bluffing. Firmness will enable one to say *no* when it ought to be said, and prevent him from being influenced or coaxed into doing what his own judgment tells him should not be done.

SENSITIVENESS

Over-sensitiveness is an undesirable trait of character. All should be sensitive as to what other people think and the impressions made by one's conduct. To be otherwise is to harden one's self against the opinion of others. Oversensitive people are easily offended and feel themselves singled out as a target and twist innocent words and actions of others as premeditated against themselves. The business man who permits himself to be easily offended, believing that the look, word or action of others was intended to belittle or injure him, is placing obstacles in the way of his own peace of mind and business success. This class of people nurse these imaginary wrongs, become vindictive and seek retaliation.

PERSEVERANCE

This is really a continuity of purpose. The original word means strict and steady and has the idea of not setting aside. Some men have perseverance for a few minutes, some for a few days, others for a few weeks. It takes years of perseverance to build up a permanent, successful business. One of the largest advertising agencies in the country has won success by "keeping everlastingly at it," which is only another way of persevering. Men in every line of endeavor have persevered in the face of obstacles and gained success.

RESOURCEFULNESS

This is a quality that means: capable of meeting a situation; rising to a situation; means of overcoming a difficulty; expedient; resort; means; contrivance. Emergencies test men's ability. Many can take care of a daily routine, but are seriously handicapped or break down, in the way of management, when something unexpected and serious arises.

With these suggestions as to the mental equipment, some of the methods essential to successful business management, such as the "Cost of conducting business" and its application to estimates and prices, "Estimating methods," "Collection methods," "Advertising," will be treated in the succeeding issues of THE BOILER MAKER.

(To be continued.)

Master Boiler Maker Becomes Assistant Superintendent of Motive Power

Friends of A. N. Lucas, of Milwaukee, Wis., past president of the Master Boiler Makers' Association and a member of the present executive board, will be interested in knowing that his long service with the Chicago, Milwaukee & St. Louis Railway, which has steadily been based upon the motto "Excelsior," has received further and merited recognition in his recent promotion to assistant superintendent of motive power of the Middle district of this railroad, with jurisdiction over that part of the Southern district in Wisconsin and Illinois except the Savannah Terminal, his office being at the company's Milwaukee shops.

The career of Mr. Lucas has always been "forward and onward." It began with his apprenticeship, after education in the public schools, in the boiler works of D. M. Burns and O'Leary Brothers in Green Bay, Wis. In 1881-1882 he was employed in the Escanaba shops of the Chicago & Northwestern. Returning to Green Bay, he entered the shops of the Milwaukee Northern, now a part of the St. Paul system, and soon after was made foreman in charge of boiler work. In January, 1901, he was transferred to the Dubuque shops with charge of the boiler department, and in April, 1904, was retransferred to the Milwaukee shops, where soon after he was advanced to general foreman of boiler work.

He has been one of the most active and valued members of the Master Boiler Makers' Association, and his record there serves to show how his unselfish and devoted efforts for the best interests of the organization have been appreciated. Mr. Lucas enjoys great personal popularity as the result of his radiation of sunshine in every circle that he enters, his considerate handling of men, and the loyalty he gives not only to duty and obligation, but also to a wide circle of friends and a marked capacity for the promotion and maintenance of harmony among the "brethren."

The Boiler Maker

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NOTICE TO ADVERTISERS

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 25th of the month, to insure the carrying out of such instructions in the issue of the month following.

The twenty-ninth annual convention of the American Boiler Manufacturers' Association will be held at the William Penn Hotel, Pittsburg, Pa., on Monday and Tuesday, June 25 and 26. Major General George W. Goethals has been invited to attend and address the convention, and if not prevented by urgent government duties, will be present. It is urged that a very large attendance of the members and their friends attend. An interesting programme has been arranged and the time will be fully occupied.

With this issue THE BOILER MAKER begins a series of articles on "Making the Business Earn a Profit." These will deal with the practical problems of business management. The initial article deals with some of the characteristics of the successful business man, and clearly shows that mechanical ability is not sufficient, but that a knowledge and the application of business principles are essential.

Subsequent articles of the series will deal with the following subjects:

Cost of Conducting Business. How to find this cost and apply it to prices and estimates. This will be illustrated by diagrams.

Estimating. This subject will be dealt with exhaustively in all its phases. Right and wrong methods will be illustrated and analyzed.

Bookkeeping. The forms and system necessary for a successful business, showing not merely the entries but the *result* of the transactions. The compiling of data in bookkeeping form of the different items entering into the cost of conducting business will receive special attention.

Effective Collection Methods. The kind that have been tested and secured results. How to handle the delinquents and slow-pays. The entire range of a collection system, from the making out of the bill until it has been paid, will be clearly outlined.

Advertising. Plans for extending the business by publicity, selling points, buying motives, advertising principles, and other forms of business-getting will be generously treated.

Correspondence. This subject will deal with the writing of business letters and take up the importance of correspondence, what a letter can do, sell, collect, smooth out complaints.

Securing and Retaining Custom. How new customers can be secured and the old ones retained.

Office Management will be the closing number of the series.

All of these subjects will be treated concisely and thoroughly from the standpoint of business practicability. The author, Mr. Edwin L. Seabrook, has had twenty years' business experience. For thirteen years he has been connected with the National Association of Sheet Metal Contractors, either as its president or as its secretary. The information given in his articles is based upon the data and observations gained by a close personal investigation of the business methods in over 2,000 shops located in every section of the United States.

As a result of protests of manufacturers of boiler plate that the requirements of the rules of the Board of Supervising Inspectors, United States Steamboat Inspection Service, governing the manufacture of steel boiler plate for marine boilers are too stringent and unnecessarily increase the cost of making boiler plate to meet the regulations, the executive committee of the Board has adopted amendments relaxing requirements for the physical properties of steel plate and for the drilling of tube and stay holes.

According to the new requirements, the tensile strength of steel plates determined by the tests shall be not less than 58,000 pounds per square inch of section nor more than 73,000 pounds per square inch of section and the elongation measured in a gage length of 8 inches shall be not less than 20 percent.

Instead of requiring all holes for tubes and stays to be drilled and no part punched, the new rules provide that centers or guide holes not to exceed 75 percent of the diameter of the full-sized finished hole for tubes and stays may be punched, the remainder to be cleanly cut, drilled or reamed to full size.

No change is made in the regulations regarding the physical properties of iron plates, the tensile strength of which must be not less than 45,000 pounds per square inch with an elongation of not less than 15 percent.

Engineering Specialties for Boiler Making

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

Plate Planer for Edging Plates 40 Feet Long and 1½ Inches Thick

The Covington Machine Company, Covington, Va., has recently built for the Standard Steel Car Company, Butler, Pa., a plate planing machine for edging plates up to 40 feet long and 1½ inches thick. The machine weighs approximately 75,000 pounds. The frames are built with an open throat, so that plates longer than 40 feet may be planed by moving the plate forward. The machine is so designed that angles up to and including 8 inches by 8 inches of any length may be edged in the same manner as the plates by moving a section forward as soon as the first section is cut.

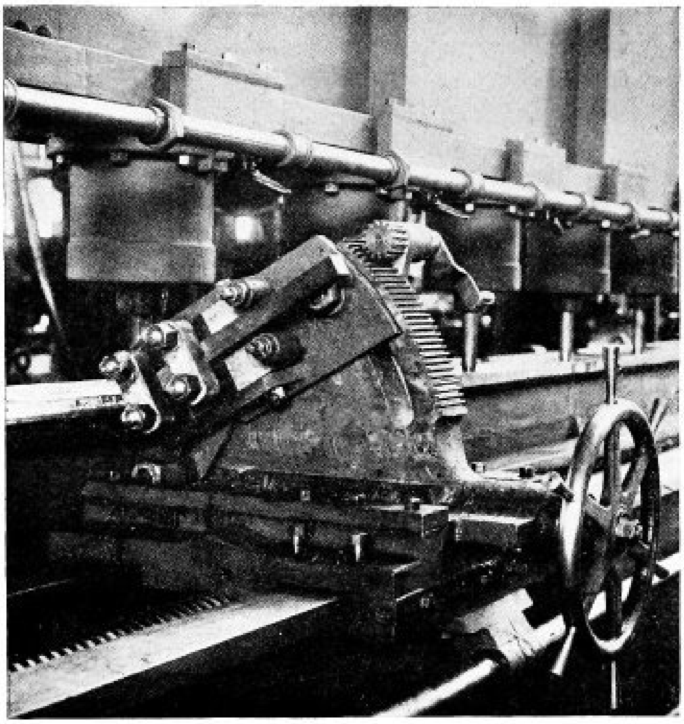

Fig. 1.—Cutting Head

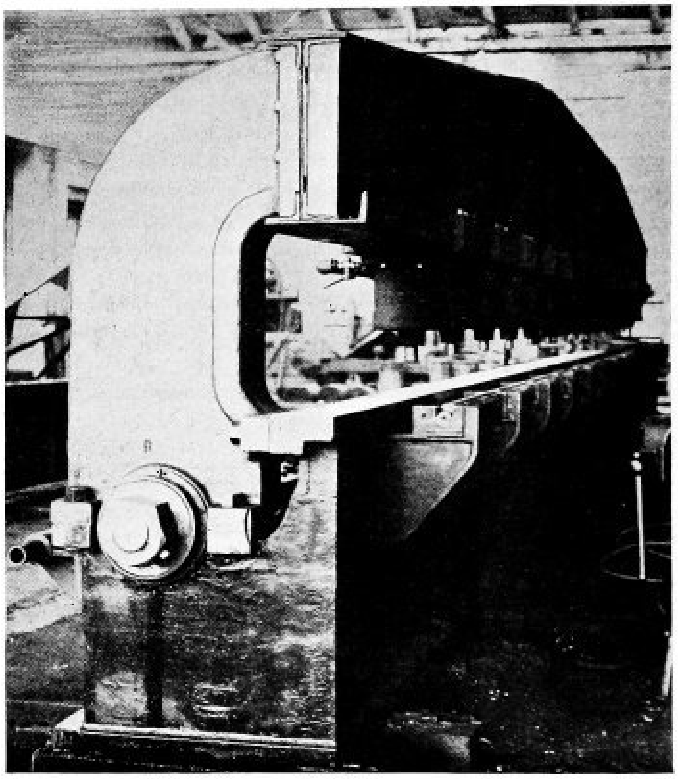

Fig. 3.—End View, Showing Open Throat Frames

The drive screw, transmitting the power to the cutting head, is 48 feet long, 4 9/16 inches diameter, with a double lead Acme thread 1 inch pitch. The end thrust or reaction, due to the tool-cutting pressure, is cared for by two heavy ball bearings, one on each end of this screw, the arrangement of the screw and thrust bearings being such that the screw is always in tension while carrying the cutting head. On the cutting head is mounted a bronze half-

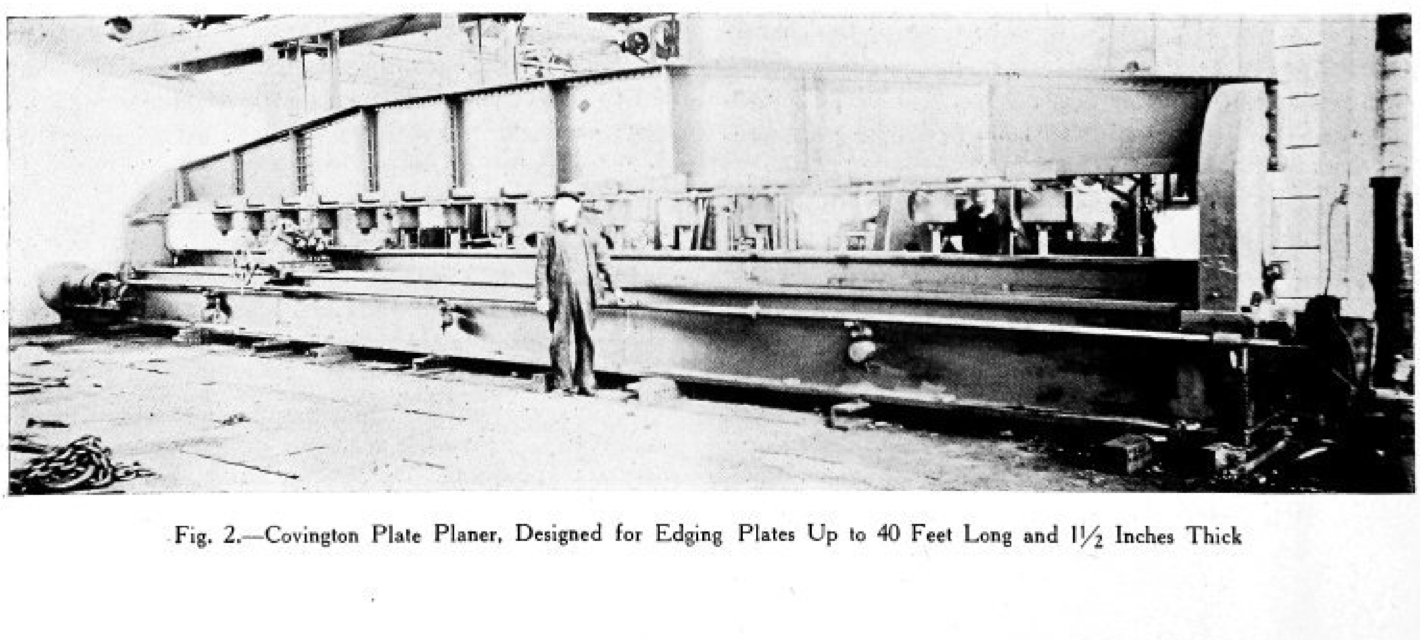

Fig. 2.—Covington Plate Planer, Designed for Edging Plates Up to 40 Feet Long and 1½ Inches Thick

nut, engaging with the drive screw. The drive screw is supported for approximately one-third its circumference on the bottom its entire length. This support has extended flanges, forming a trough for flooding the screw with oil to insure lubrication at all times. At each end of the trough is a pocket for collecting the chips carried forward by the screw in its movement. Chips that are thrown out from the screw-bearing surfaces can be removed from the trough by hand or scraper while the machine is running or stationary. The end pockets are provided with large drain pipes so that the oil may be drained and filtered at any time. This also offers an opportunity for washing the screw and trough with cleansing oil, such as kerosene, at any time.

The cutting head consists of a steel casting mounted in cross feed guides on the carriage with two swivel aprons,

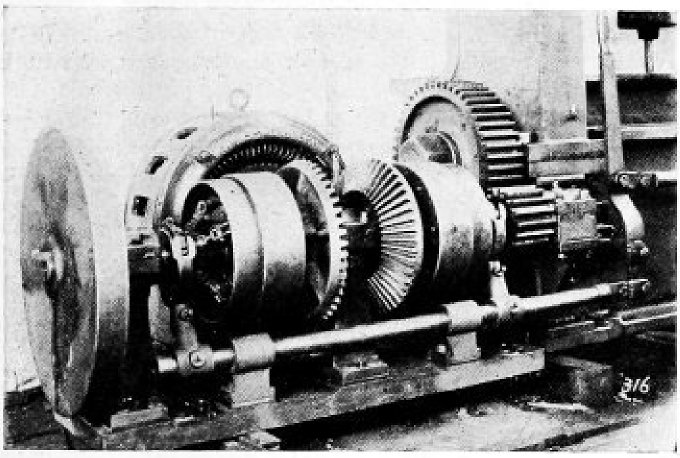

Fig. 2.—Motor Drive

one on each side of the cutting head. These aprons are pivoted upon a large pin bolt, which serves also as a clamp for holding the apron at any desired angle for cutting from 90 to 60 degrees. The tool holders are of the usual clapper box type on machine planers, and are large enough to take a tool 2½ inches wide by 2 inches thick and of any length.

The cutting speed is 20 feet per minute, the maximum cut for a 1¼-inch plate being 1/16-inch feed, although it was tested for 3/32-inch feed.

The machine is motor driven. Reversing the drive of the screw is accomplished by two multiple-plate friction clutches. On the motor shaft is mounted a bevel pinion, which miters into the two bevel gears, running these continuously. The clutches are arranged to grip these gears alternately, to give the motion in either direction, as desired. The motion for reversing the screw through the clutches is taken from the carriage, and a flywheel on the end of the clutch shaft is provided for keeping the carriage in motion when one clutch is thrown out and until the other is thrown in. The flywheel further serves while cutting to maintain a uniform power on the cut.

The side of the plate which is to be edged rests on rollers and a table cast integral with the frame. The plate is clamped in position by fifteen pneumatic jacks, each exerting a pressure of 5,000 pounds on a basis of 80 pounds per square inch air pressure. The air cylinders are piped up so that all may be thrown simultaneously, or any single air jack can be thrown separately.

In designing this machine the parts and clearances were arranged properly to take care of shipyard requirements.

Rivet and Staybolt Cutting Attachment for Oxy-Acetylene Torch

For cutting off rivet heads and staybolts flush with plates by the oxy-acetylene process, it is desirable to have a cutting tip so designed as to permit of the gas jet playing parallel with the plates. To meet this need the Prest-

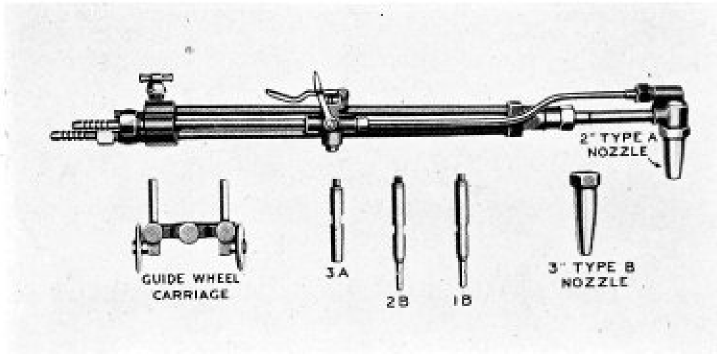

Fig. 1.—Special Rivet and Staybolt Cutting Torch

O-Lite Company, Inc., of Indianapolis, Ind., is manufacturing a special rivet and staybolt cutting attachment. This attachment is used in connection with the Type K cutting blowpipe shown, being screwed into the head in place of the regular cutting nozzles. The copper tip is

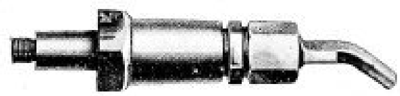

Fig. 2.—Rivet Cutting Attachment

bent at a convenient angle and is adjustable to any position, facilitating operation in close quarters. Much cleaner work in rivet and staybolt cutting is possible with this attachment, it is claimed, than with standard cutting tips, which do not permit of a cut truly parallel with the plates.

Simple Language

Many modern shop executives from universities and colleges, with but limited practical experience, in dealing with their practical, trained subordinates, unconsciously allow themselves to talk in a technical vein when trying to convey their ideas or thoughts to them. This places the practical man in the embarrassing position of having to request the meaning of certain long, technical words. To be able clearly to state your ideas or convey the meaning of your orders to your men is a highly desirable and profitable accomplishment.

Many times an employee or subordinate executive is unjustly considered as being stupid or very slow to comprehend orders or grasp the idea, when in reality the real trouble lies in the lack of judgment of the superior in use of unfamiliar technical terms in his conversation with the practical man.

When it is realized that the successful carrying out of an idea or an order lies in the ability of the superior to intelligently impart his thoughts to his men it would seem that a technical man should put more effort into cultivating this trait. When you find that your men do not readily grasp your ideas in one way you should at once place them before them in another way and always encourage them to tell you when they do not understand the expression of any terms you may use. W.

Questions and Answers for Boiler Makers

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

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

Address your communication to the Editor of the Question and Answer Department of THE BOILER MAKER, 461 *Eighth avenue, New York city.*

Formula for Dimensions of Stack—Material and Thickness of Walls of Locomotive Lubricator—Corner Radius

Q.—(1) I have looked through your index of the contents of Volume XVI to find a formula for figuring the dimensions of round sheet iron smokestacks, but do not find one. The problem placed before me is the height and inside diameter of a round sheet iron smokestack for a firebox tubular boiler with a heating surface of 1,063.6 square feet. At 12 square feet per horsepower we have 87.8 horsepower. By one authority I find it should be 28 inches inside diameter and 40 feet high. Please give a formula for estimating the dimensions stated above and cite the authority.

(2) If I should make a locomotive lubricator out of malleable iron, and, in order to keep it hot, would use live circulating steam from the boiler in addition to condenser steam now used, would this iron answer the purpose and how thick would the walls have to be? Should they be any thicker than our present lubricator? The boiler pressure is 200 pounds.

(3) What is meant by the corner radius? The new State Safety Law says it must not be over 5 inches or less than 1½ inches.

P. F. G.

A.—(1) The first consideration in determining the size of a stack is to select one of sufficient height to produce the required draft for the kind of fuel and the amount that is to be burned per square foot of grate surface.

The second consideration is to determine the cross sectional area of the stack necessary to convey the gases.

The draft required to burn fuel economically depends on the nature of the fuel. Draft is measured by a water gage which indicates the draft in inches of water. For fine anthracite coal, as *pea, buckwheat,* etc., a draft from ⅞ to 1¼ inches as measured on the water gage is needed, whereas, for the larger sizes of such coal, a draft ranging from ¼ to ⅞ inch of water is sufficient. For free burning fuel, as wood and bituminous coal, the draft is less than that needed for hard coal.

Draft is secured by the height of the chimney and by the high temperature of gases escaping from the furnace into the chimney; it increases as the difference in temperature between the escaping inside gases and the outside temperature.

The stack should be made larger than required for the given conditions and dampers used to regulate the flow of gases, and it should be above surrounding buildings to insure a good draft.

There are a number of rules governing the size of stacks for given conditions. "Rankine's Formulas" are as follows:

(a) The pressure of the draft in inches of water is determined by the following formula:

$$P = H\left(\frac{7.64}{T_1} - \frac{7.95}{T_2}\right)$$

in which P = draft in inches of water,
H = height of stack in feet,
T_1 = absolute temperature of outside air,
T_2 = absolute temperature of chimney gases.

The absolute temperature is determined by adding 460 degrees F. to the ordinary temperatures.

(b) If the draft pressure needed for the combustion of the fuel is known, the required height of chimney may be found by transposing formula (a) as follows:

$$H = \frac{P}{\dfrac{7.64}{T_1} - \dfrac{7.95}{T_2}}$$

According to Barr's treatise on "Boilers and Furnaces" the cross sectional area of a chimney should be one-eighth that of the grate surface, and the height for small chimneys is equal to twenty-five times the diameter of the chimney with a gradual decrease in the ratio for larger chimneys; thus a stack 4 feet in diameter may be 100 feet in height, one 5 feet in diameter 120 feet high, etc.

The ratio between the heating surface and the grate area varies with the rate of combustion and type of boiler. The following table gives the averages of heating surface for one square foot of grate area for a few types of boilers:

Type of Boiler	Area of Heating Surface in Square Feet for 1 Square Foot of Grate Area
Tubular	25 to 35
Vertical Tubular	25 to 30
Watertube	35 to 40
Firebox tubular	25 to 35

Using the heating surface value given in the example to find the grate area required for a firebox tubular boiler, we find that 1,053.6 ÷ 30 = 35.12 square feet. The cross-sectional area of stack equals 35.12 × ⅛ = 4.4 square feet.

The diameter of stack 4.4 square feet in area equals

$$\sqrt{\frac{4.4}{.7854}} = 2\tfrac{3}{8} \text{ feet nearly.}$$

Required height of stack equals 2⅜ × 25 = 59⅜ feet, say 60 feet.

To burn anthracite, a higher chimney is needed than for soft or bituminous coal. The foregoing method of proportioning the height and diameter of a stack is an approximation, but is sufficient for most practical purposes.

(2) Malleable iron castings that are made properly are about twice as strong as those made of cast iron. The tensile strength of malleable iron ranges from 37,000 to 45,000 pounds per square inch. A large factor of safety should be employed for cast iron and malleable iron castings subjected to a bursting pressure, say from 12 to 20. Consider a cylindrical vessel 6 inches in diameter to be subjected to a steam pressure of 200 pounds per square inch; find the the required thickness if the object is made of malleable iron.

The rule applied to cylinders in solving for thickness of shell is as follows:

$$t = \frac{D\,P\,F}{2T}$$

in which t = thickness of shell, in inches,
D = diameter of cylinder, in inches,
P = working pressure, in pounds per square inch,
F = factor of safety,
T = tensile strength of metal in pounds per square inch.

Using the values given in the example and solving the formula, we find that

$$t = \frac{6 \times 200 \times 12}{2 \times 37{,}000} = .195 \text{ inch, say } 3/16 \text{ inch.}$$

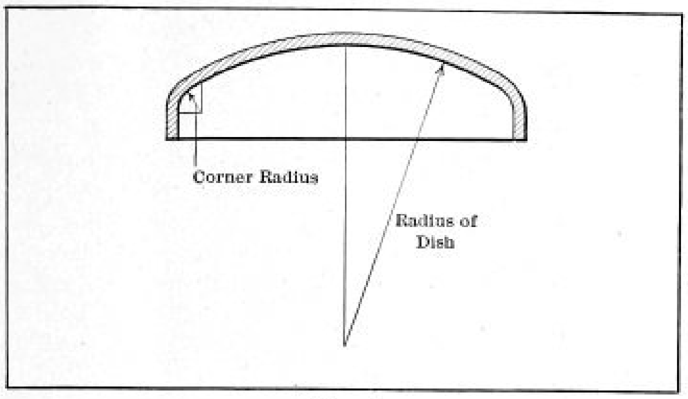

Fig. 1

(3) Fig. 1 illustrates what is meant by the corner radius in a bumped head.

Welding Longitudinal Seams in Smoke-Box of Locomotive Boiler

Q.—I would like to find out through your valued journal where our trouble is in welding longitudinal seams in smoke box of locomotive boiler. We are using oxy-acetylene welder. While applying a bottom section of front end ring to a small dinkey locomotive, I thought it would look better to have the longitudinal seams welded, but in welding we could not make a satisfactory job of it. The weld broke apart in cooling. The weight of front end of boiler was resting on cylinder saddle but not bolted in place. Fig. 2 illustrates the position of smoke box and its arrangement for welding process. H. J. D.

A.—During the process of welding thick boiler plates, the heat from the acetylene torch is conducted to the surrounding metal very rapidly and much of it is lost by radiation. This loss of heat makes it difficult to keep the

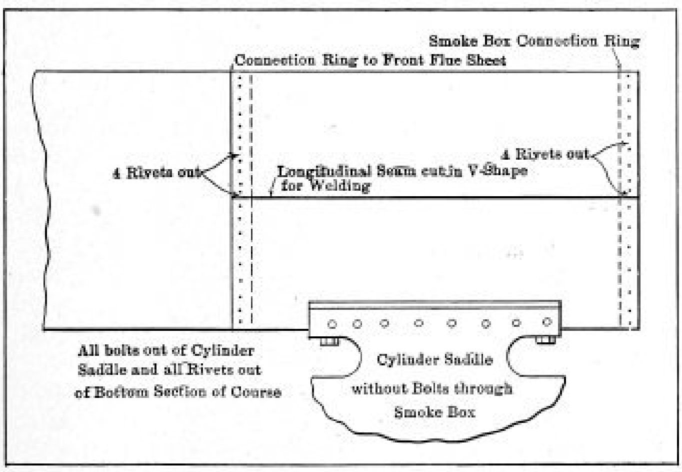

Fig. 2

joint to be welded at the proper temperature for fusing the metal. To overcome this trouble, preheat the adjoining metal around the *V* groove. The heat from the flame may then be directly applied to produce a plastic condition of the metal of the plate with the fresh metal that is filled into the *V* space. During the operation of welding the heat causes the plate to expand, and in cooling it contracts. This action and reaction sets up serious stresses which are liable to strain or break the welded joint. The coefficient of expansion in steel is about .0000066 for 1 degree F.; hence, it will be seen that in all cases where an object is rigidly fixed great stress is produced in the metal. For example, a solid ring 60 inches in diameter is heated to a temperature of 600 degrees F. Its expansion, due to this increased temperature, is $600 \times 60 \times .0000066 = .24$ inch, say 1/4 inch, this making the diameter 60 1/4 inches. By mechanically confining this ring when so heated to resist expansion and contraction, great stresses are set up.

Now, in the case of the welded smoke box shell, it appears from the sketches that this shell course is rigidly fixed to the barrel course and hood. It is reasonable to expect that this rigid connection does not allow the plate to expand and contract to the best advantage, thus placing stresses on the seam that may cause the breaks referred to. We will consider further the condition of the new metal and that of the plate when brought to the fusion state. It is evident that the contraction is very great in the joint, and that the contraction is unequal in extent, thus producing stresses that are harmful. The layer of plastic metal in the weld adjoining the cool plates contracts very rapidly, while that in the center is still in a semi-fluid condition. By doing the welding slowly the bad effects of contraction may be greatly lessened, or if it is required to handle the work rapidly, the surrounding metal about the joint should be heated or the entire work annealed.

Annealing the welded object should be employed wherever practicable, since this process relieves the stresses and restores the metal to its original state. Another method of treating the welded joint is to hammer it, which partially restores the metal. The object of hammering it is to reduce the large grains in the metal mass to a fine condition. It is evident, however, that only a portion of the welded mass can be so restored, as the hammering does not penetrate very far into the weld. Unless the hammering work is properly done and at the right temperature, it may do more harm than good. The foregoing is a general explanation on the matter. It seems to me that if you weld your smoke box course before rigidly attaching it to the adjoining shell, and then if the shell is preheated around the joint, satisfactory results would be had, providing the proper metal filler is used and applied.

Swaging Flues

Q.—Why are the ends of boiler tubes swaged?
(2) What benefit is derived from their use after being swaged?
(3) Is the structure of the material injured in the operation of swaging? S. P.

A.—(1) Boiler tubes are often reduced in size at their ends so that they will fit into holes smaller than the diameter of the tubes. The method of reducing the size of the ends is called *swaging* or *swedging*. Tubes that are safe-ended are swedged at the welded joint to bring their diameter at the weld equal to the diameter of the tubes. After swedging, the tube ends are annealed so as to relieve all stresses due to contraction of the metal.

(2) The preceding answer covers this question.

(3) Before swedging, the tube ends should be annealed to soften them; otherwise, the ends are hard to work, and the metal is liable to crack or be distorted other ways. The method followed in annealing tube ends is to first heat them to a red heat and then allow them to cool slowly in some good annealing mixture. Tubes that are annealed are not injured by swedging, rolling or expanding, and beading processes.

OBITUARY.—L. R. Pomeroy, consulting engineer, with office at 30 Church street, New York, died suddenly on May 6. Mr. Pomeroy had been in the railway and railway supply business for more than thirty-five years, and had a very wide acquaintance. He was born at Port Byron, N. Y., in 1857, and was educated at Irving Institute, Tarrytown, N. Y.

Letters from Practical Boiler Makers

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Pressure on Convex Heads

In the May issue of THE BOILER MAKER, page 137, the answer in regard to pressure allowable on convex head is in error as follows: The formula quoted is taken from an old issue of the United States Rules for Supervising Inspectors. The existing rules give the value as one-fifth the tensile strength, not one-sixth. Another error is that if the head be double riveted to the shell, 20 percent more pressure will be allowed. This also is obsolete per 1916 edition of said rules.

By the latter U. S. G. rules for merchant marine service ter not considered in the U. S. G. rules. This is an important feature when one considers the breathing action that occurs on such heads.

The difference in pressures per above in connection with the U. S. G. rules having recently raised the plate value from one-sixth to one-fifth, point out rather emphatically the importance of being on the safe side for a designer or inspector, especially with the weight of 6,000 engineers of the highest rank being behind the Code. I would therefore advise the inquirer to follow the Code in designing such heads and attach a table herewith (Fig. 1)

Convex Heads. A.S.M.E. Code Rule. 55,000-T.S.

Thickness Blank Head	Const. for Blank Heads	T. of Head with M. hole	C. for Head with M. hole	Thickness Blank Head	Const for Blank Heads	T. for Head with M. Hole	C. for Head with M. hole.
7/16"	6,250	7/16	3,750	23/32	11,875	23/32	9,375
15/32"	6,875	15/32	4,375	3/4	12,500	3/4	10,000
1/2"	7,500	1/2"	5,000	25/32	13,125	25/32	10,625
17/32	8,125	17/32	5,625	13/16	13,750	13/16	11,250
9/16	8,750	9/16	6,250	7/8	15,000	7/8"	12,500
19/32	9,375	19/32	6,875	15/16	16,250	15/16	13,750
5/8"	10,000	5/8"	7,500	1"	17,500	1"	15,000
11/16	11,250	11/16	8,750	1 1/16	18,750	1 1/16	16,250

To find Pressure, divide the constant given in the table by the actual Radius to which the head is dished. For Concave heads, multiply by 0.6

Above calculated from $P = \frac{20{,}000t - 2500}{R}$ for Blank Heads.

$P = \frac{20{,}000(t-\frac{1}{8}) - 2500}{R}$ for Heads with Man-Hole opening.

by. [illegible]

Fig. 1

and using 55,000 T. S., head ½ inch thickness, diameter 120 inches, radius 120 inches and S. 1/5 T. S.,

$$P = \frac{T \times S}{R}$$

where P = steam pressure allowable in pounds,
T = thickness of plate in inches,
S = one-fifth of the tensile strength,
R = one-half of the radius to which the head is bumped.

$$P = \frac{.5 \times 1{,}100}{60} = 91.66 \text{ pounds.}$$

(See pages 18 and 19 of 1916 edition.)

As against the above excessive allowances the A. S. M. E. Code, page 49, convex heads with formula transposed to find pressure using also 55,000 T. S. (the highest allowable under the code) would give the ½-inch head, 120-inch diameter and 120-inch radius 62.5 pounds, a difference of 50 percent. In both cases blank heads are considered, and by the A. S. M. E. Code, if the ½-inch head, contained a manhole it would be required to be at least ⅛ inch heavier, or if kept at ½ inch the pressure would be 41.6 pounds. In addition to the above were the head convex to pressure—i. e., bumped inward—then by the Code the pressure would be 60 percent of above and by the U. S. G. rules 80 percent. I refer the student to the pages quoted by above rules, and point out that the Code wisely limits the value of the corner radius of the flange, a mat- wherein the pressure may easily be found when the radius is determined. The table is based on the Code formula transposed for pressure.

In this connection Massachusetts rules, page 63, use a higher formula for outwardly bumped heads as follows:

$$\frac{8.33 \times R \times P}{T.S.} = T$$

where R = one-half the head radius,
P = pressure,
T = thickness of head,
$T.S.$ = tensile strength head,
8.33 = factor of safety.

This formula was used for years by one of the largest watertube boiler shops after careful investigation of the subject and in spite of existing rules such as the older U. S. G. one. To the above may I add that several explosions wherein convex heads failed just outside the root of the flange proved conclusively that the U. S. G. rules were lamentably weak on such heads. Singularly, the men who made the U. S. G. rules thereupon proceeded to make the heads weaker by taking one-fifth the tensile strength, although it had been shown by the explosions that one-sixth of tensile strength was not strong enough. Fortunately, others, such as Massachusetts Board of Boiler Rules and the A. S. M. E. Code Committee, by their opposite action, have protected society on this detail of boilers and pressure vessel construction. In this connection the Board of Trade do not permit unstayed convex heads above 48 inches diameter. See Stromeyer, "Marine Boiler Management," page 376.

To the above may I add all rules on convex and concave heads are empirical and there exists no scientific data on the subject known to the writer, although we have numerous technical schools with facilities for research work on this subject. However, in view of the situation as respects this subject and other boiler matters, the U. S. G. Supervising Inspectors should line up behind the A. S. M. E. Code, considering the country is now practically solid for the Code.

New York. T. T. PARKER.

Efficiency of Joints and Allowable Working Pressures on Bumped Heads

On page 137 of May's issue appears an article, in answer to an inquiry regarding Efficiency of Joints and Allowable Working Pressures on Bumped Heads. The method used to obtain the result is not in line with practice, and the numerical work, by the formula used, is inaccurate.

The formula used is

$$P = \frac{t \times (1/6 \times T)}{\frac{1}{2} R}$$

substituting the figures given,

$$P = \frac{\frac{1}{2} \times (1/6 \times 55{,}000)}{\frac{1}{2} \times 120} = 76.3$$

the answer shown = 70.6.

This formula is the one used by the Board of Supervising Inspectors of the Steamboat Inspection Service, and for this work the tensile strength would be 60,000 instead of 55,000, and the 20 percent allowance made for a double riveted joint does not apply to the pressure allowed on heads of a given thickness.

By the A. S. M. E. Code,

$$P = \frac{(T - \frac{1}{8})\ 2 \times 55{,}000}{5.5 \times L}$$

substituting the figures given,

$$P = \frac{(\frac{1}{2} - \frac{1}{8})\ 2 \times 55{,}000}{5.5 \times 120} = 62.5 \text{ pounds.}$$

By the explanation given in the article mentioned, if a vessel were designed for a pressure of 84.72 pounds and a head ½ inch in thickness used, the head would need to be stayed as a flat surface, as no allowance is made for the spherical form.

I would suggest that in answering inquiries of this nature the A. S. M. E. rulings be used, as this is the ruling being adopted by most States, and the majority of boilers built to-day are built to conform to these rules.

Brooklyn, N. Y. A. G. REOCH.

Factor of Evaporation Again

It seems to me that A. G. Reoch, in the April number of THE BOILER MAKER, is making the matter of factor of evaporation rather complicated, and I am therefore inclined to enter a protest. It is hard enough to make the average student grasp the idea of factor of evaporation from the standpoint of standard conditions, yet Mr. Reoch states that the factor varies as the barometer varies.

To support my side of the case I quote Prof. R. C. Carpenter from his "Experimental Engineering." He says:

"Factor of evaporation is the ratio that the total heat in one pound of steam at the given pressure and reckoned from the temperature, *t*, of feed water bears to the latent heat of evaporation at 212 degrees."

That being the definition, I believe Mr. Reoch will agree that no matter where the boiler may be—at the sea level or on top of Pike's Peak—the heat required to evaporate one pound of water from and at 212 degrees is a constant quantity. On Pike's Peak it would have to be done in an enclosed vessel, of course, because out in the open atmosphere the temperature of 212 degrees would not be reached. At sea level, on the other hand, no vessel would be needed. In fact, under a high barometric pressure the temperature—or any other temperature, for that matter—is a constant quantity. All one has to do is to consult any steam table in order to assure himself that such must be the case, otherwise all steam tables are wrong. And, what is more, if Mr. Reoch is right, all present factors of evaporation tables are wrong.

It is a fact that the formula is, as given by Mr. Reoch

$$\frac{H - h}{L} = \text{factor of evaporation,}$$

but there is no reason why the L cannot be replaced by 970.4.

In the excellent treatise "Steam," by the Babcock & Wilcox Company, I find this statement:

"Expressed as a formula for use with any set of conditions, the factor is

$$F = \frac{H - h}{970.4}."$$

The word *any* in that statement is clear. Besides, the treatise goes on to show that even where the steam is superheated the same value—970.4—is used.

It is, therefore, a simple matter to determine the factor by merely referring to a steam table, subtract h from H, and divide by 970.4.

New York. N. G. NEAR.

Boiler Inspection

R. C. Sermon's article in the May issue of THE BOILER MAKER was very good and I hope he has started something that will not stop until the question of a boiler maker's being qualified to inspect boilers is settled once and for all.

Boiler makers should sit up and take notice, as boiler inspection laws are getting popular, and there should be more boiler makers acting in the capacity of inspectors than there are now. Engineers claim that where boiler makers are familiar with the construction of boilers they are not familiar with operating conditions, therefore are not as well qualified to inspect boilers as an engineer. When repairs are needed on a boiler the boiler maker goes to the plant where the boiler is operated and makes the repairs and in doing so becomes familiar with the defects that develop in a boiler under operating conditions.

The boiler maker's duties take him to all kinds of plants, big and small, where all types of boilers are being operated under all kinds of conditions, and it stands to reason that he will learn a little about operating conditions. The boiler maker who does this has a much better opportunity to become familiar with operating conditions in general than an engineer who has operated two or three plants and as many types of boilers, therefore the engineer's strongest argument is weak.

The fact that a great many boiler makers have made good when they have taken charge of a steam plant as engineer is a good reason to believe operating conditions are not Greek to boiler makers. There was a time when books containing the rules for computing the strength of boilers were scarce, and anyone having one in his possession took pains to keep it from others, but times have changed and there is no reason now why any boiler maker who wants to become familiar with any rule cannot do so. Come, boiler makers, wake up and let us know what you have on your chest, anyhow!

Olean, N. Y. J. H. FLAHERTY.

I have read and reread the interesting article by R. C. Sermon in the May issue of THE BOILER MAKER, and I am tempted to write a few lines in defense of the boiler inspector appointed from the ranks of the engineers.

Evidently Mr. Sermon feels that an engineer is not qualified for the position of boiler inspector. This I take from his remarks that a steam engineer is a man who by experience has learned to fire a steam boiler so as to raise steam in the boiler to a safe working pressure, and who has additional knowledge gathered regarding the care and maintenance of a steam engine. He makes the statement that at no time during an engineer's apprenticeship is he taught how to repair or construct a steam boiler so that it will be safe to operate under a certain amount of pressure, and in the event of the boiler under his care starting leaking, he at once sends for a boiler maker to make the repairs and put the boiler back in safe working condition.

These statements are rather broad and tend to belittle the present-day engineer of the general power plant field, especially those who aspire and try to obtain the position of boiler inspector.

These men are generally of broad experience and have made many of their own boiler repairs and maintained large batteries of boilers in safe working condition.

Mr. Sermon should read over a few of the engineers' power plant journals, and he would get acquainted with the real, live engineers who express their views in the columns of their papers. Any engineer of worth-while mention with years of training in the power plants is generally qualified to seek the position as boiler inspector.

I fully agree that a man to fill the position should have a thorough knowledge of the construction and repairing of steam boilers, and a wide-awake engineer must have the above qualifications or he is not an engineer in the full sense of the present-day interpretation of the title—chief engineer.

There should be no bar to prevent a reliable boiler maker taking the exam for boiler inspector, and I think he would be better qualified for the job than the average engineer. But he should have to at least spend a certain length of time operating various boilers under service conditions, and it would be well to make an engineer serve a certain length of time in the boiler shop.

It is really a case of fifty-fifty, for a boiler inspector has to study, study, study about all types of boilers and their appliances, and his preliminary training can be gained either in the operating field or in the boiler shops. Very few boiler makers have worked on or constructed more than five percent of all the types of boilers, and the same applies to the engineer. Very few have had to do with more than a few makes. So the aspirant for the position of boiler inspector must prepare himself by the aid of text books on boilers of all makes, by the state laws, the makers' literature, the power plant journals, THE BOILER MAKER, and other papers pertaining to the business of a boiler inspector. In other words, he must assimilate every means to learn about boilers and their appliances. But the writer feels that much of the vital knowledge tending to fit a man for the position of boiler inspector can be best gained by the engineer who while operating different types of steam boilers studies the construction and repair of them.

In the railroad business it is different than in the stationary field. A railroad engineer never makes his own repairs or does anything but operate the engine. The complete care of the boiler as to maintenance is turned over to the boiler maker in the shop. That is why railroad shop boiler makers are better trained for the position as inspector. They not only build all the different types, but they take care of their every ailment.

The attaining of a boiler inspector's position should be made very difficult. A man should have to prove his ability in many ways before he is allowed to fill the position of such high responsibility.

As an engineer, I do not agree with Mr. Sermon that a boiler maker is the most logical man by reason of his experience to fill the position. My explanation is that it is really a case of fifty-fifty.

Concord, N. H. C. H. WILLEY.

"Boiler Inspection," by R. C. Sermon, page 125, May issue of the paper, certainly is significant. It has long been a bone of contention as to which makes the best boiler inspector, a boiler maker or an engineer. But there are boiler makers and boiler makers, and engineers and engineers. While the ranks of boiler inspectors generally are recruited from the body of steam engineers, yet there are some boiler makers who become inspectors. The main reason that so few boiler makers become inspectors is that, as a rule, boiler makers do not study the theory of their trade as engineers must do theirs in order to become engineers. It requires something more than a knowledge of the construction and repairs of steam boilers in order to become a real inspector. A knowledge of the various arithmetic rules and formulas applicable to steam boilers is indispensable to one who aspires to the position of boiler inspector, whether it be in the employ of national, state or city government, or in an insurance company.

In the past, boiler makers have not taken very kindly to figures and figuring. They left that for the "bosses" to do. By the "bosses" I mean the office staff and the foremen. "Bosses" do not want an inspector's job for obvious reasons, and heretofore the rank and file could not qualify in all that is requisite. The engineers did. But there is no reason why boiler makers cannot educate themselves to become anything they desire relating to steam boilers, especially when they have such a trade paper as THE BOILER MAKER to champion their cause.

Boiler inspectors were made from those who had been marine engineers. The marine engineer, by stress of circumstances, was obliged to be an all-round engineer in the true sense of the word. Not only was he (and is, today, just the same as ever) a good mechanic in different branches of the trade as a whole, but he was a thinker, a planner, a reasoner, as well. Conditions by which he was surrounded literally forced him to these. His salvation frequently depended upon those attributes. So in times past he was the kind of man to qualify for the position of boiler inspector. It has been said that most of the big jobs in the big cities throughout the United States, in the power plant engineering lines, are held by ex-marine engineers, and they seldom, if ever, fail to measure up to full requirements. They simply had to study or quit the business. Those who did not study and quit became subordinates in some other relative lines of engineering, and there they stuck. This explains why engineers have predominated in the inspector's field of activity.

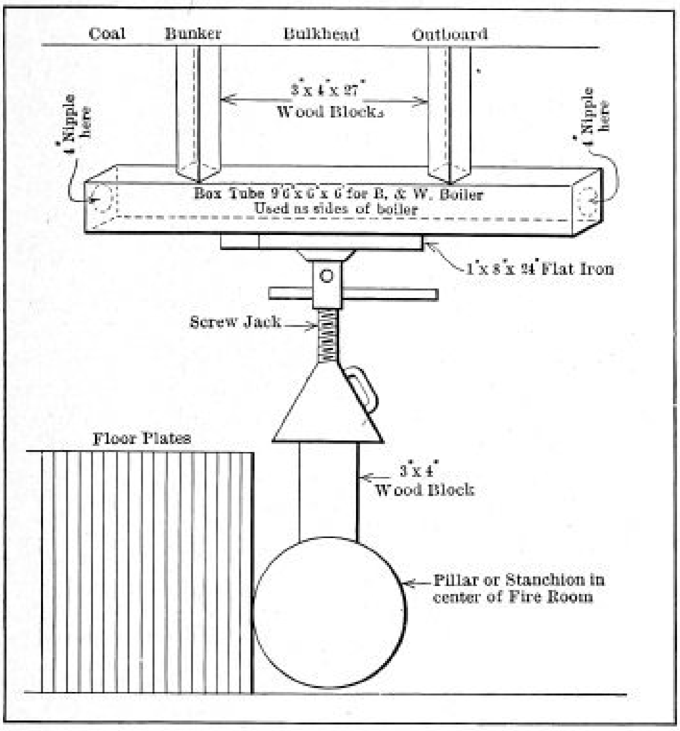
Boiler makers may and can become inspectors if they want to do so, but they must qualify in the same way relatively that engineers do.

Scranton, Pa. CHARLES J. MASON.

Boiler Maker Carries Out Unusual Repair Job on Board Ship

Some time ago, while serving aboard a ship, I had an odd job to do with the handicap of having no repair shop at hand at the time. On inspecting a Babcock & Wilcox boiler of 25 headers I found that the box tubes or side casing had a bend in the center, or, as we say, the tubes had a belly in them. This bend was nearly 7/8 inch out when I used a straight edge on these tubes. Now, if the ship had been in a navy yard at the time it would have been a small matter to take these box tubes, heat them up, lay them on a face plate and bring them to a straight position. Being in Cuba at the time, I got orders to straighten them out as well as I could, with nothing but a blacksmith's forge to heat the tubes with.

I got two pieces of timber 27 inches long. These we commonly call 3 by 4 timbers. By taking these timbers I



Sketch Showing Method of Making Repairs

layed them on the floor plates of the fireroom and placed the box tubes against these braces. I then got a piece of flat iron 1 inch by 8 inches by 24 inches and laid this against the box tube to be straightened out. I then brought an ordinary screw jack, and by placing this screw jack against a stanchion or pillar in the center of the fireroom I heated the tubes at the bend as much as I could with the forge.

When the tube was heated enough I laid the tube against the 3 by 4 timbers, put the piece of flat iron right on the bend of the tube; then, by screwing up on the jack so it would go against the flat iron and the tube, straightened about 8 or 10 inches of the bend. By repeating this I got four of the tubes in a fairly good shape. They were less than 1/8 inch out when I laid a straight edge on them. I then put the bottom tube in the firebox, laid it in position and, lining it up with the water legs, I then put in the 4-inch nipples and rolled them tight in the box tubes at both ends. Then, by shifting the tube forward and aft, I rolled these nipples to the front and back legs of the boiler.

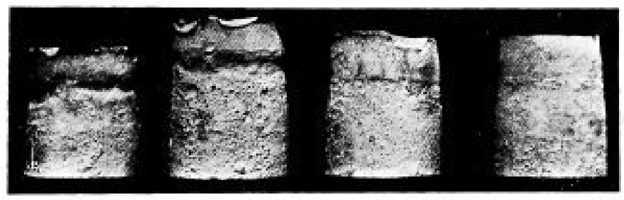
This was an odd job to do aboard a warship, but the boiler gave excellent results. The same work would have been done on all the twelve boilers of the ship, but I am glad to say the work was all done later on in a navy yard. Some men will say that it was poor inspection in not having seen these bends before they got so bad. I had only been transferred to this ship a few weeks previously, and so do not feel responsible for poor inspection. On my part, I think it was a fairly good job, considering the poor help I had.

C. HARRY SCANNELL,
Boiler Maker, U. S. Navy.

Steel vs. Copper Ferrules in Locomotive Boilers

I have for years questioned the use of copper ferrules on locomotive boiler tubes, and having the opportunity three years ago, tried my theory in retubing a locomotive boiler, using double annealed steel ferrules on tubes in one-half of the boiler and copper ferrules on tubes in the other half.

This locomotive has just been retubed and we found that the tubes having the copper ferrules were all very badly



Sample of Tubes Taken from No. 16 Locomotive Boiler after Three Years' Service. This Boiler Was Equipped with Both Steel and Copper Ferrules, the Tubes Shown on the Left with Saw Marks Were Equipped with Copper Ferrules, and the Two without Saw Marks with Double Annealed Steel Ferrules. The Tubes Equipped with Steel Ferrules Showed Practically No Deterioration, While the Tubes Equipped with Copper Ferrules Showed Considerable Deterioration

eaten away at the edge of the ferrule, some of them very nearly through, while the tubes having the soft steel ferrules were in very good condition, most of them not showing any sign of corrosion.

We have used soft steel ferrules in other locomotive boilers with equally good results, but have used this boiler as an illustration because both types of ferrules were used in the same boiler and subjected to the same conditions at the same time.

It is evident that the combination of steel, copper and water, which was treated for use in stationary boilers, formed an acid or chemical condition which attacked the tubes at a point next to the copper where the formation occurred.

We have had very little trouble with tubes leaking, even less than with copper ferrules.

Vandergrift, Pa. CHAS. A. SMITH.

Back Pitch of Rivets

Chas. J. Mason's letter in the May issue of THE BOILER MAKER impels me to write a little more on the subject of back pitch of rivets.

Mr. Mason says the definition of the term given in the April issue is not logical. The term back pitch may not be logical, but it is used to denote the distance between the rows of rivets and may be found in Paragraph 182 A. S. M. E. Boiler Code; also in the Pennsylvania Code.

As to where the term originated, I would not venture an opinion. The fact that the term is used in what will eventually be the standard boiler rules in this country is good evidence that it will come into general use and the up-to-date mechanic should know what it means.

As to its use, it is much easier to say or write "back pitch" than "the distance between rows of rivets."

Olean, N. Y. J. H. FLAHERTY.

Electric Arc Welding

The writer has read with much interest the article by Mr. C. W. Eichhoff on electric arc and oxy-acetylene welding. It is evident from the author's description that he has had more experience with gas welding than with electric arc welding, as the performance shown for the gas-welded containers is very excellent, and shows what can be done when one understands the manipulation of the welding torch. However, the results obtained with arc welding are not up to the standard which the writer is accustomed to, and there must be some explanation of the failure.

Both electric arc welding and gas welding depend primarily upon the welder producing a joint which is thoroughly fused on both sides over the entire surface. With plate as thin as that here used, there should be no trouble whatever in producing complete fusion on both sides of the joint with the arc process, so that this cause of failure can be dismissed at once.

The next important thing for successful arc welding is to use proper welding pencil; that welding pencil which gives the best results with oxy-acetylene flame does not give the best results with the arc.

Using the proper metal, the next requirement which must be complied with in order to get high grade work is the production of the proper amount of heat in the weld.

The heat in the weld is determined by the current and the voltage in the arc. Contrary to the statement contained in the article regarding the arc length, it is the long arc that burns the metal and the short arc that produces the least heat. There is no danger of having an arc too short, because if it becomes too short the metal freezes and interferes with the operation to such an extent that welding is practically impossible. Damage is always done with an arc that is too long.

A skilled welder is able to use practically any kind of current supply for his welding arc and control the length by the manipulation of the pencil with his hand. It is easier to hold an arc a little longer than it ought to be than it is to hold it the right length, and for this reason expert welders sometimes overheat the metal rather than take the trouble to hold a shorter arc. In all electric welding systems which employ constant-potential, there is a rise in voltage as the arc is lengthened, accompanied by a decrease in current. The decrease in current causes a decrease in the flow of the metal from the pencil and a decrease in the total amount of heat produced in the arc. However, the ratio is such that the heat per unit quantity of metal deposited increases very rapidly with a lengthening of the arc.

The author speaks of the desirability of continuing the welding in as long strips as possible without interruption. The reason he has found this necessary is due to the fact that when the arc is broken the voltage rises and all the inductive energy of the circuit is charged into the weld, producing overheating, which makes a hard spot and develops pinholes. On this spot it is difficult, sometimes impossible, to start the arc again and produce a tight joint.

The constant-current, open-circuit welding system has the advantage of maintaining a constant flow of metal, irrespective of the length of the arc. However, in order to obtain this constant current, they usually employ a stabilizer which acts exactly like a flywheel on an engine, in that it absorbs energy, giving it out and taking it up as the current rises and falls in the circuit, and when the arc is broken the total energy stored in this electrical flywheel is suddenly discharged into the weld, greatly exaggerating the natural burning effect produced when an arc is broken.

There is only one arc welding system on the market which operates with a closed circuit, and in this system the arc is never broken. Therefore there is no inductive discharge into the weld, and burning of metal can be prevented absolutely independently of the operator. With this system it makes no difference whether the seam is made with one continuous flow of metal or by starting and stopping a number of times, as far as the quality of the work and the tightness of the seam are concerned, and when experienced operators are employed it is impossible to see where pencils were renewed.

The writer has made hundreds of tests on electrically welded joints and tanks, and has found that on this thickness of metal it is possible to make a flush joint that will be stronger than the plate itself in 90 percent of the cases.

In one factory where tanks are made of metal from 5/32- to 5/16-inch plate and every tank is tested under pressure, welding is carried on by both oxy-acetylene and by closed circuit arc welding. The gas welded tanks are produced by expert welders and the installation has been in operation for a number of years. Leaks are often discovered and repaired.

The electric closed circuit outfit has been in operation for about eighteen months, and in that time not one single leak has been discovered and none of the welding is calked or peaned.

The writer has made a large number of competitive tests on electric and oxy-acetylene welding in plants where electric was being installed to replace well-established oxy-acetylene installations, and these competitive tests have shown that the closed circuit arc welds made with proper metal and properly prepared joints were from 25 to 50 percent stronger than gas welds made under equally favorable conditions.

New York. O. A. KENYON,
Electrical Engineer, Arc Welding Machine Company, Inc.

What Is the Difference?

The above is a question often asked by a prospective purchaser of a boiler, on receiving bids which show a wide variation in price. To the average person, not familiar with details of boiler construction, it is difficult to understand that there can be any legitimate reason for the difference in the cost of a boiler. A boiler which is rated at, say, a hundred horsepower and built to carry a safe working pressure of 100 pounds, appears to many people as being a summing up of all the requirements. Even when boilers are built to specification the latitude often allowed the manufacturer is considerable, and small things count just as much in boiler making as any other industry. Some of the things that account for the difference in price might be of interest:

The flange of manhole opening not reinforced, sometimes not even "toned up," to give a good seating for gasket. Handholes also are often left without reinforcing, where it would be advantageous to have them strengthened. Nozzles and manhole saddles of cast iron, instead of wrought or pressed steel. Braces are sometimes located as to practically prohibit access to parts of a boiler. This is often found in a horizontal tubular boiler below tubes. Calking edges of plates bevel sheared instead of planed. Tube holes left rough and sometimes the edges not even chamfered. Opening for various connections, such as blow-off, not reinforced.

These are all small details in themselves, but the additional labor required to make them right, with consequent increase in cost, is more than offset by the results obtained.

Then, again, in the matter of fittings, the difference between a nickel-seated safety valve and a brass-seated one, brass feed and water column pipes in place of iron, and other details of this nature will show quite a difference on a cost sheet. It is understood, of course, that boilers which are built to conform to the requirement of a code such as the A. S. M. E., or the Massachusetts code of boiler rules, will have these points taken care of.

The points mentioned have had no small part to play in bringing about the adoption of a uniform boiler code, as the reputable and conscientious manufacturer was often underbid by a competitor, this being possible as outlined above. It was an uncommon thing to have two concerns bid on two different propositions, one being a so-called stock boiler, and the other built to, say, Massachusetts standards. In the former case one price would be considerably lower than the other, whereas where they would be bidding on practically equal terms, with regard to requirement, the condition would be reversed. This, to those in close touch with the conditions, would be significant. This is one of the big factors which gained the approval and support of most of the manufacturers in the adoption of the A. S. M. E. code as a uniform boiler code by most of the States.

Brooklyn, N. Y. A. G. R.

Developing a Protégé

It should be the aim of all to develop not only themselves for advancement, but also a protégé, or understudy. You may become proficient in your daily tasks, yet fall short of the qualifications for advancement by neglecting to train a man to fill your place. In most cases, there lies a close relation or connection between your position and two others—the one above, and the one below. While you may have very good or even special ability to handle your work in detail, an excellent stand-in with your men, and very good initiative and progressiveness in putting through successful new ideas for the betterment of the plant, you cannot afford to remain there. You can do so only at the risk of staying there, perhaps indefinitely, or always. Your relation to your superior and your successor are far more important than you may realize.

One of the hardest things for you to experience would be that of seeing someone from the outside brought in and placed in the position you felt by right was yours, and which you were fully equipped with qualifications for.

The true reasons for such a selection of an outsider are, of course, many, and yet most of them are within your own control, for no firm really seeks a new executive from without the plant except when there appears to be no available material in the shop. You should carefully consider this.

Generally very little consideration is given to the development of a protégé by men in responsible positions, and many times it is one of the vital causes for blocking advancement.

The modern methods of organization and business have so changed that it is poor policy for any man to try to corner all the information concerning his department or branch of the business and leave the others to gather what may be allowed to lie loose, as best they can.

If you get the feeling that because of your monopoly on the vital information of the work in your part of the business you are practically indispensable to the firm, and that should you take a vacation, or get sick, they would have to keep in touch with you or the work you had in charge would only get half done, you have allowed yourself to get into a bad fix.

Team work and co-operation with your immediate senior and junior is a real necessity in these days of progress. In the great industrial world of to-day nearly any and every position can be filled in a measure by someone else besides the one who regularly fills it, and any attempt to be so important that no one else in the shop is able to compete for your job is an imitation of real efficiency.

An executive who neglects to train an understudy or to allow any of the men to absorb some of the information and experience that would tend to qualify them to fill in this position, no doubt have some fear that the understudy might capture it.

The above is the kind of shop foreman who, because of this feeling that he alone knows the work so well, will grab a tool out of the hands of one of the men on some difficult part of the work and do it himself, instead of explaining the subordinate's fault and trying to teach him to do the work to better advantage.

The other kind of an executive, who co-operates and feels it his duty to share his knowledge with his men, will only interfere when the task is beyond the scope of the man, and even then he does it only to teach and help out.

Much has been written about studying for the job ahead, and the industrial world is well supplied with ambitious men who are anxious to become understudies of their superiors. You should help them to develop themselves.

Concord, N. H. C. H. WILLEY.

Use of Bessemer Steel Boiler Tubes as a Substitute for Tubes of Open Hearth Steel as Required by the A. S. M. E. Boiler Code

As a result of the unprecedented demand for steel and its present scarcity, efforts have been made to provide for the use of boiler tubes manufactured of bessemer steel in place of the open hearth steel tubes, as required by the A. S. M. E. Boiler Code. The National Tube Company, in a letter addressed to the trade early in March, requested that wherever possible bessemer steel tubes be used in place of those made of open hearth steel, in order to relieve the pressure of demand upon this latter material. It was pointed out in this letter that the present industrial situation has led to a demand for tubes of the open hearth material which had grown to such an extent that the company was nearly two years behind in its orders, and the use of bessemer steel was suggested as a means of relief.

The impression was given that this was an attempt to replace the material required by the Boiler Code with an inferior material. The matter was brought before the Council of the A. S. M. E. at a meeting on March 16, with the result that a committee was appointed to confer with the National Tube Company. This committee consisted of the following members:

Ira N. Hollis, president, American Society of Mechanical Engineers.

Charles S. Blake, Hartford Steam Boiler Inspection & Insurance Company.

J. B. Ennis, American Locomotive Company.

E. R. Fish, Heine Safety Boiler Company.

F. R. Hutton, American Museum of Safety (member of Council).

Julian Kennedy, member of Council.

Frank E. Law, The Fidelity & Casualty Company.

J. W. Lieb, National Electric Light Association.

George A. Orrok, National Electric Light Association.

W. M. McFarland, Babcock & Wilcox Company.

H. deB. Parsons, consulting engineer (member of Council).

James Partington, American Locomotive Company.

H. V. Wille, Baldwin Locomotive Works.

Dr. Hollis appointed Mr. H. deB. Parsons chairman of the committee.

Meetings were held by this Council Committee in conference with officials of the National Tube Company in which the entire situation was thoroughly canvassed and efforts were made to outline a proper solution of the problem. The Council Committee pointed out the unquestionable advantages of open hearth steel as compared with bessemer steel for use in boiler tubes, and urged upon the company the necessity of exerting its greatest effort to cope with the situation. Inasmuch as the National Tube Company had been instrumental in assisting to develop the present boiler tube specifications contained in the Code, and as these specifications had been found to work out satisfactorily, it was felt that to abandon the requirement of open hearth steel would be a retrograde movement. The officials of the National Tube Company explained that this suggestion was merely an effort on their part to point out a means of relief for those cases where it could be taken advantage of without conflicting with rules or requirements based on the A. S. M. E. Code. This statement was supplemented by one to the effect that efforts were being made to rush to completion additional open hearth steel furnaces which would undoubtedly be in operation in the middle of the summer and which would then greatly increase the open hearth tube-producing capacity of their works. It was further stated that the tube-manufacturing capacity of the company was far in excess of the capacity of their sources of material supply.

The result of the conferences was a thorough understanding between the National Tube Company and the Council Committee relative to the situation. Assurances were given that there was no intent to sell tubes of bessemer material with the claim that they conform to the specifications of the A. S. M. E. Boiler Code, and a circular letter was drafted by the National Tube Company to be sent out by its branch offices to counteract any erroneous impression that may have been given. The letter was submitted to the Council Committee and with slight modifications it was agreed to by the committee and was finally approved by the Council in the following form:

NATIONAL TUBE COMPANY
Pittsburgh, Pa.

April 16, 1917.

Circular Letter No. 857

TO MANAGER OF SALES.

Gentlemen: As you are aware, about four years ago we decided to in future manufacture all of our boiler tubes from open hearth steel. This action was taken because our experience had taught us that for locomotive boilers and for watertube boilers the open hearth steel tube was better than the bessemer steel tube. For fire tube boilers we have never had any experience that leads us to believe one is any better than the other, but in order that our output might be satisfactory for all purposes we decided to make all tubes from open hearth steel. Later on a code was prepared by the American Society of Mechanical Engineers covering this whole question both as to material and gage. We gave our hearty co-operation to this Society to bring about the change which they proposed, and we have been co-operating with them in the various states so that this code should be the universal code throughout the United States, it being our firm conviction that boilers with all their appurtenances made under the code of that Society are preferable to those made under any other code heretofore in use. A situation has now arisen, due to the war in Europe, that has made it impossible for us to secure enough open hearth steel for this purpose, and we are pressed as never before for delivery of tubes. Up to the present moment we have endeavored to supply ourselves with enough open hearth steel to fill our orders for locomotive tubes and for tubes for watertube boilers, and have succeeded fairly well. We have been obliged, however, to ask many of our customers, who insisted upon deliveries that we could not make if we depended upon open hearth steel, to accept tubes made from bessemer steel so that we could give the greatest possible service in enlarging the power of the country. The information regarding our desire to supply bessemer steel tubes where the customer would agree to it has not been conveyed generally in the same manner, and an impression has gotten abroad that we are endeavoring to avoid the code of the A. S. M. E. and is causing us some embarrassment as well as the members of that Society. I wish therefore that you would issue this letter verbatim in circular form to your customers, one and all, that each may understand the situation just as it is. If they do, we feel quite sure that, where they are not called upon to supply boilers in accordance with the A. S. M. E. Code, they would readily agree to accept bessemer, and if they do it will enable us, until we can supply ourselves with a full amount of open hearth steel, to run our furnaces full and for the general good. Just when we will be able to go back fully to the use of open hearth in the manufacture of boiler tubes I am unable at this writing to say, but we are rushing the construction of some additional open hearth furnaces, and if nothing unforeseen occurs we expect by July to be able to supply our requirements, and if so we shall do so because we believe it altogether the best practice.

Yours truly,

FIRST VICE-PRESIDENT.

BOOK REVIEW

RIVETED BOILER JOINTS: A TREATISE ON THE DESIGN OF BOILERS AND RIVETED BOILER JOINTS WITH NUMEROUS ORIGINAL DIAGRAMS ENABLING THE DESIGNER TO DESIGN ANY DESIRED JOINT WITHOUT CALCULATIONS. By S. F. Jeter, B. S., M. E. Size, 11 by 8 inches. Pages, 155. Plates, 76. Illustrations, 52. New York, 1917. McGraw-Hill Book Company, Inc. Price, $3 net.

This book gives a new and convenient method of determining by means of diagrams the strength of riveted boiler joints in practically any combination of plate thicknesses and rivet diameters. The diagrams, of which there are seventy-six, represent an entirely new treatment of the subject of calculating the strength of riveted seams. They may be used to find the efficiency of a joint already constructed, as is required in boiler inspection, or they may be used for the purpose of designing joints. They tell at a glance and without calculation what the best possible arrangement for joint strength is. All of the diagrams given are based on a tensile strength of 55,000 pounds per square inch, and a crushing strength of 95,000 pounds per square inch for plate material and 44,000 and 88,000 pounds per square inch for the shearing strength of rivet material when subjected to single and to double shear respectively.

Previous practical attempts to aid the boiler inspector or boiler designer in determining the strength of boiler joints have been by means of tables giving joint efficiencies. Since the methods used in calculating such tables were very laborious, the range covered did not extend beyond the arrangements most commonly required; consequently when the boiler designer was forced by circumstances to consider a combination of riveted diameters and plate thicknesses out of the ordinary, the tables were without value and the designer was forced to figure them out for himself. The original diagrammatic method given in this book enables the designer to handle any style of joint for any particular combinations without being obliged to go through the calculations himself.

The book comprises twelve chapters, as follows: I, Methods of Joint Failure; II, Types of Boiler Joints; III and IV, Efficiencies of Boiler Joints; V, Boiler Plate Material; VI, Strap Thicknesses and Rivet Diameters; VII, Limiting Pitches; VIII, Boiler Joint Diagrams; IX, X and XI, Making Joint Diagrams; XII, Riveted Joints of Maximum Efficiency.

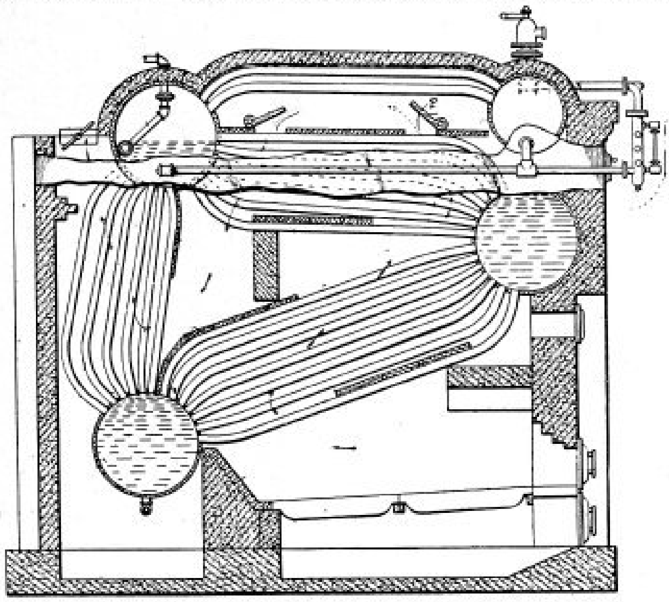
Selected Boiler Patents

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

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

1,214,195. BOILER. WILLIAM J. LINTON, OF JERSEY CITY, N. J.

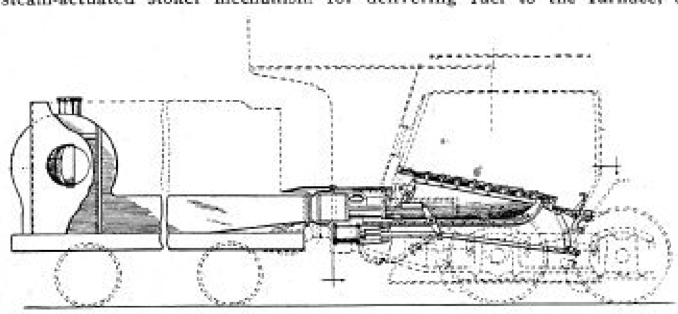
Claim 1.—A watertube boiler comprising in addition to the usual drums and connecting watertubes forming a closed water-circulating system, a steam dome, which is located partly below and partly above the normal level of the water in the water-circulating system, steam superheating tubes which connect the steam dome with the water-circu-



lating system above the normal level of the water therein, and a water pipe which connects the steam dome somewhat above its lower side with the water-circulating system below the normal level of the water and outside the path of the steam therein. Nine claims.

1,211,591. AUTOMATIC STOKING APPARATUS. WILLIAM J. KENNEY, OF WILMETTE, AND HENRY P. GROHN, OF CHICAGO, ILL., ASSIGNORS TO UNDERFEED STOKER COMPANY OF AMERICA, OF CHICAGO, ILL., A CORPORATION OF NEW JERSEY.

Claim 1.—In combination with a locomotive, a furnace, an automatic steam-actuated stoker mechanism for delivering fuel to the furnace, a



steam supply pipe for said stoker mechanism, a valve in said supply pipe, a locomotive throttle valve, a common actuating means for the aforesaid valves, and a valved by-pass around the valve in said supply pipe. Twelve claims.

1,213,820. PULVERIZED FUEL BURNER. LARS H. BERGMAN, OF PHILADELPHIA, PA.

Claim 1.—A pulverized fuel burner comprising an outer pipe and an inner pipe whose discharge ends extend horizontally, an inlet for air under pressure common to both pipes and communicating therewith at their rear ends, a downwardly extending fuel supply chamber provided with an outlet arranged to receive the coal by gravity, said fuel outlet communicating directly with one of said pipes and opening forwardly thereinto in the direction of the flow of air therethrough, whereby the propulsion and combustion of the fuel is effected with the use of but one source of air supply. Three claims.

1,215,529. STOKER MECHANISM. WILLIAM C. A. HENRY, OF COLUMBUS, OHIO.

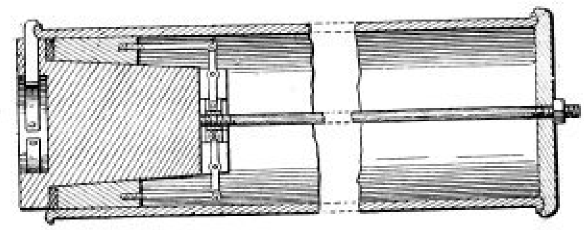
Claim 1.—In combination with a firebox provided with a pair of underfeed troughs, a pair of feed plungers for feeding fuel into the troughs, a crosshead guided for right line movement intermediate the plungers and working longitudinally thereof, an engine intermediate the plungers for reciprocating the crosshead, operating levers for the plungers pivoted at their inner ends to the crosshead, and a fulcrum for the outer end of each lever, the levers being secured intermediate their ends to the plungers. Seven claims.

1,215,288. SPARK ARRESTER. ARCHIBALD LAKE, OF PARKLAND, ALBERTA, CANADA.

Claim 1.—In combination with a stack, a shaft mounted concentrically in the stack, blades rotatably mounted on the shaft, the said blades each having a portion thereof inclined, a groove formed on the blade, and a vertical portion connecting the groove to the inclined portion. Five claims.

1,213,060. BOILER TUBE PLUG. WILMER J. BAKER, OF WAKEFIELD, MASS., ASSIGNOR OF ONE-HALF TO CHARLES H. BAKER, OF PLATTSBURG, N. Y.

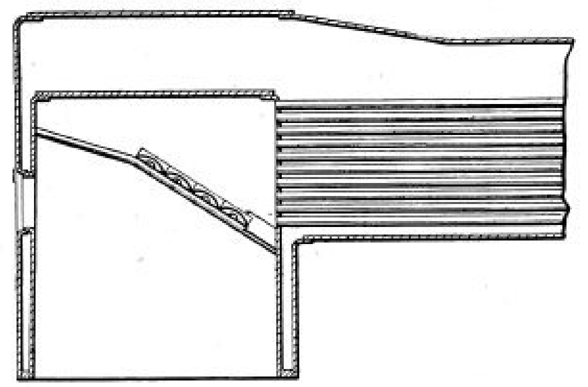
Claim 1.—An apparatus comprising an operating rod adapted to be inserted within a boiler tube, a member carried by one end of the rod and constituting a guide therefor, a closure associated with the rod to be inserted therewith within the tube, and including a plurality of



yieldably supported sections adapted to expand into engagement with one end of the tube when projected therefrom, a second closure adjustably mounted upon the rod for engagement with the opposite end of the tube, and means on the rod for holding said closures in effective engagement with the opposite ends of the tube. Three claims.

1,213,107. ARCH FOR LOCOMOTIVE BOILER FURNACES. LOUIS S. KENNEDY, OF SANDY RIDGE, PA.

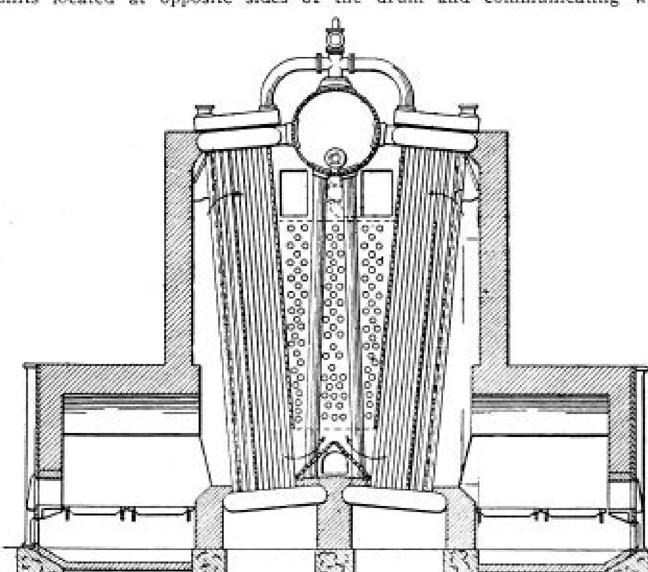
Claim 1.—A locomotive firebox arch comprising spaced supporting elements, and transverse rows of bricks of refractory material resting upon and supported by said elements entirely free and clear of the firebox at the sides of the arch, the bricks of each row having lateral abut-



ment surfaces with interlocking elements, arranged wholly within the plane thereof so that the bricks of each row are held from relative independent vertical displacement and means for retaining the side bricks in spaced relation from the side walls of the firebox. Seven claims.

1,208,812. UPRIGHT BOILER. EDWARD C. MEIER, OF PHOENIXVILLE, PA.

Claim 1.—A boiler, comprising a drum, a plurality of pairs of boiler units located at opposite sides of the drum and communicating with



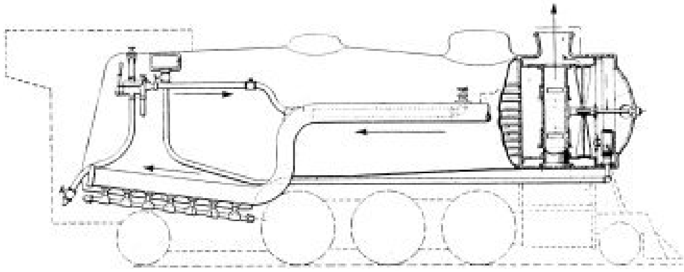
the drum, chambers formed between the pairs of boiler units, superheaters in said chambers, and means for controlling the flow of smoke and gases through said chambers. Five claims.

1,215,165. AUTOMATIC FLUE CLEANER. JOHN R. KARR, OF TRACY, CAL.

Claim 6.—The combination with boiler tubes, of a plurality of loose rings hung on the same in shiftable relation, a portion of said rings being of greater density and a portion of less density than the water in which they are submerged, those of the lesser density on one tube being arranged to touch those of greater density on another tube as the rings shift back and forth on the tubes. Seven claims.

1,208,764. SMOKE CONSUMING DEVICE FOR LOCOMOTIVES. FRANK L. FISHER, OF MILWAUKEE, WIS.

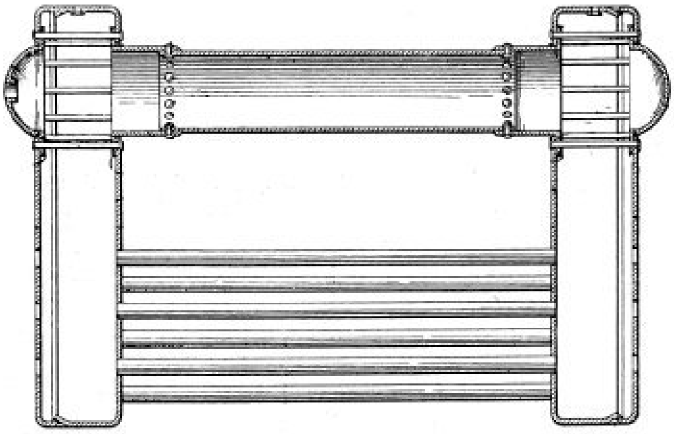
Claim 1.—A smoke consuming device for furnaces including a firebox and a gas chamber, comprising a duct connecting said firebox and gas chamber to form a circuit for the gases, said chamber being provided



with an annular opening, a fan in the chamber, and an annular plate carried by the ends of fan blades and closing said opening and provided with openings at the ends of the fan blades.

1,208,811. BOILER. EDWARD C. MEIER, OF PHOENIXVILLE, PA.

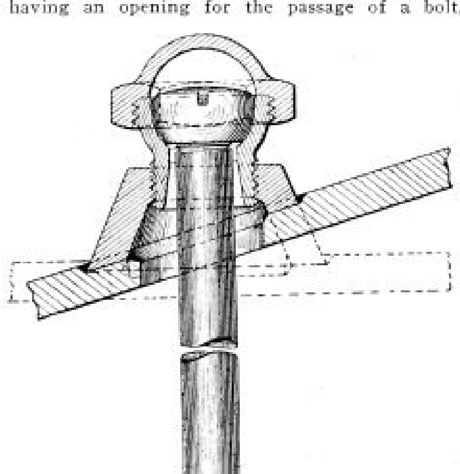
Claim 1.—In a boiler, the combination with two water legs, both water legs having registering openings in their inner and outer sheets, heads projected through the openings in the outer water leg sheets, said heads having outwardly disposed flanges located against the inner faces



of the outer water leg sheets, nipples projecting through the openings in the inner water leg sheets and having flanges at their inner ends, a casing secured at its ends to the respective nipples, a plurality of staybolts projected through both sheets of both water legs, and through the internal flanges of the heads and the nipples. Three claims.

1,210,014. FLEXIBLE STAYBOLT CONNECTION FOR BOILERS. BENJAMIN E. D. STAFFORD, OF PITTSBURGH, PA., ASSIGNOR TO FLANNERY BOLT COMPANY, OF PITTSBURGH, PA.

Claim 1.—In staybolt connection for boilers, the combination of a boiler plate having an opening for the passage of a bolt, a bushing



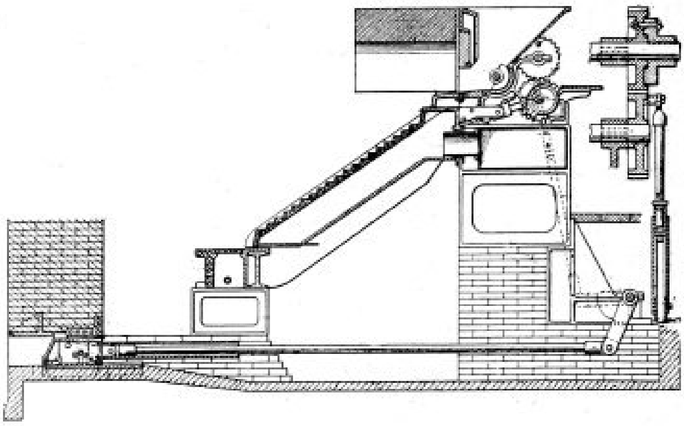
welded to the outer face of the plate around the opening therein, and a sleeve having a threaded connection with the outer end of the bushing, the said sleeve having a seat for the head of the staybolt. Two claims.

1,206,238. FEED-WATER REGULATOR FOR STEAM GENERATORS. ARTHUR GEORGE MUMFORD, OF COLCHESTER, ENGLAND.

Claim.—In a feed-water regulator, the combination of a check or feed delivery valve, a balancing piston coupled to said valve, a cylinder in which said piston works, an outlet in said cylinder beneath said piston, means for permitting a small proportion of the feed water to pass said balancing piston, a float box mounted on the exterior of the generator and in communication with the interior thereof, a balanced float operating in said box, a casing mounted on the float box and having an inlet and an outlet, a pipe connecting the outlet of the cylinder containing the balancing piston of the check or feed delivery valve with the inlet of said casing, a valve co-operating with said seating, a spindle for carrying said valve the diameter of which is smaller than the valve and the length of which is greater than that of its guide, a guide for said spindle mounted directly on the float box, an enlarged extension on lower end of said spindle, and a coupling between said extension and the balanced float. Five claims.

1,210,363. BOILER AND OTHER FURNACE. JAMES REAGAN, OF PHILADELPHIA, PA.

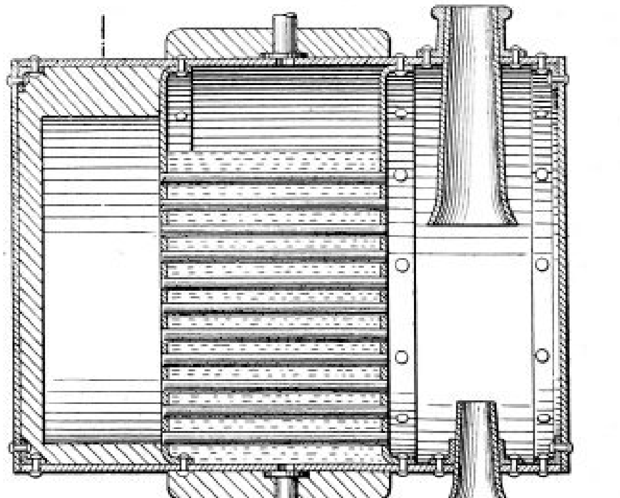
Claim 1.—The combination with an inclined grate adapted to discharge substantially the whole body of ashes from the rear end thereof, a bridge wall separated from said grate so as to leave a space for the



ashes delivered from said grate, and an ash remover consisting of a reciprocating ash drawer adapted to be retracted from and drawn through the lower portion of said body of ashes and a floor for sustaining the ashes over which said ash-drawer reciprocates. Seven claims.

1,210,586. BOILER. HARVEY W. BELL, OF PITTSBURGH, PA.

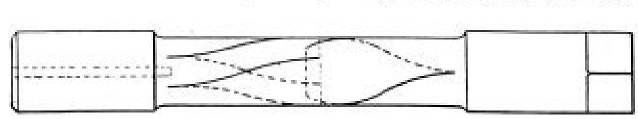
Claim 1.—A steam generator comprising a relatively short cylindrical boiler, end heads positively closing the ends thereof, intermediate transverse heads dividing said boiler into a firebox, a water chamber and a



smoke box, a plurality of fire tubes passing through said intermediate heads and forming a communication between the firebox and the smoke box, and a burner extending tangentially into the firebox and adapted to produce therein a whirling flame in a plane normal to the axes of the fire tubes. Three claims.

1,216,551. STAYBOLT FOR BOILERS. ETHAN I. DODDS, OF PITTSBURGH, PA., ASSIGNOR TO FLANNERY BOLT COMPANY, OF PITTSBURGH, PA.

Claim 1.—As a new article of manufacture, a staybolt, the shank of which is slotted all the way through adjacent one end, and provided



with a plurality of slots extending part way through adjacent the other end. Four claims.

1,216,622. STAYBOLT STRUCTURE. BENJAMIN E. D. STAFFORD AND ETHAN I. DODDS, OF PITTSBURGH, PA., ASSIGNORS TO FLANNERY BOLT COMPANY, OF PITTSBURGH, PA.

Claim 1.—In a staybolt structure, a yielding cap having a member against which the outer portion of the rounded head of a bolt may seat, said cap having a part to be seated against the outer face of the outer boiler sheet and adapted to be secured thereto. Nine claims.

THE BOILER MAKER

JULY, 1917

Patching and Reinforcing Locomotive Boilers

Shape and Dimensions of Patches—Rivet Spacing—Calculations for Strength—Methods of Application—Patch Bolts vs. Rivets

BY WILLIAM N. ALLMAN

The matter of patching boilers, especially locomotive boilers, is one which has apparently not received the attention it deserves. However, since the launching of the boiler inspection rules by the Interstate Commerce Commission it has been necessary to systematize in a great measure the patching and reinforcing of locomotive boilers in order to maintain the proper factor of safety.

In the past this question of patching boilers has been in a large measure left entirely in the hands of the shop man, but this practice is being gradually eliminated and is now generally handled in the drawing room.

The methods involved vary considerably with the various railroads and some practices no doubt can be greatly improved upon. The writer has found that the subject has been approached slowly and very little has been published concerning this very important matter, and for this reason this article is being written, and no doubt it will receive criticism from some sources. However, such criticisms or consensus of opinion would be very acceptable and would be valuable information to those engaged in this important work of construction and repairs of locomotive boilers, and for this reason criticisms are invited.

In the experience of the writer it has been found that the average boiler maker to a large degree lacks the theoretical principles with reference to the stresses and strains set up in a boiler, but it may be expected that with the inauguration of apprentice and industrial schools by so many railroads and other industries that the future boiler makers will have a broader knowledge regarding the stresses which a boiler is subjected to, particularly with reference to strength of parts and the value of tensile and shearing stresses.

I wonder how many practical boiler makers of the present time actually know that the stress in a longitudinal seam of a boiler is just twice that of a circumferential seam, and if they do know this to be a fact, do they understand the theory and the reasoning of same and the principles upon which the efficiency of seams is based?

In the recent report of the committee on design, construction and inspection of locomotive boilers of the American Railway Master Mechanics Association, the following was covered with reference to the patching of boilers:

"Patches when applied to the barrel shall be designed with longitudinal and circumferential seams at least equal in strength to the main longitudinal and circumferential barrel seams. Patches may be applied to flat surfaces (stayed) with properly designed single-riveted seams without impairing the strength of the sheet."

There are various defects which develop in boiler shells, such as pitting, grooving and cracks, which make it necessary to reinforce such parts in order to maintain the boiler in a safe and suitable condition for service.

In observing some applications of patches it will be found that where same has been left entirely to the shop man, that there are some cases of very poor design in the layout, and the strength of the boiler shell has been materially reduced through the application of poor patches. Some boiler makers go on the assumption that if they get enough rivets in the job to make it steam tight, that is all that is necessary, neglecting the fact that they are literally cutting the plate in half; then, very often, a lot of superfluous rivets are used, increasing the cost of repairs considerably.

As an illustration of an unsatisfactory patch, it will be noted from Fig. 1 that the patch plate is just one-half the

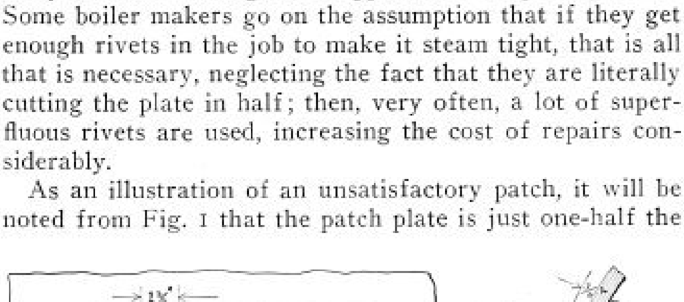


Fig. 1

thickness of the boiler plate, which is ¾ inch. It will also be noted that the rivet spacing is 1¾ inches, running longitudinally with the centerline of the boiler, and which is necessary in order to provide a good calking edge for the thin plate.

A rule which is believed to be good practice is to make the patch plate the same thickness as the boiler shell plate to which it is applied. Referring to the patch in question, it will be found that it is weak along the line *A-B;* this condition would exist in this case even though the patch and the shell were of the same thickness, as the efficiency would be low, based on the tearing of the plate along line of rivets *A-B*. It would also be weak, based on the shearing of rivets. A patch of this character would not, therefore, provide sufficient strength under the rules covering the design and construction of boilers issued by the various State and Federal Commissions, from which will be seen that some other form of patch or reinforcement is necessary, as the factor of safety is reduced to such an extent the boiler pressure would necessarily have to be reduced.

In designing seams and patches it must be borne in mind that a longitudinal and circumferential seam of the same design have equal strength so far as the seam is itself, but the stress set up in the boiler due to the internal pressure is only one-half as great on the circumferential seam as on the longitudinal seam. This fact does not seem clear to a good many boiler men, and the following reasoning may make this point clear, if analyzed and studied carefully:

Let P = pressure in pounds per square inch,
D = the internal diameter of boiler in inches.

From this we find that the stress in a longitudinal seam per unit of length (considering a unit length of 1 inch) is:

$$(a) \quad \frac{D \times P \times 1}{2} = \frac{D \times P}{2}.$$

By referring to Fig. 2 it will be evident why the constant 2 in the denominator is used.

The product of $D \times P \times 1$ equals the total load tending to part the boiler on line A-B, one-half of the load

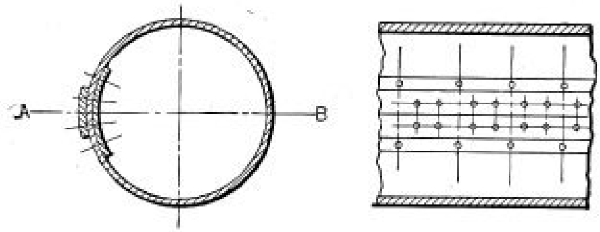


Fig. 2

being carried at "A" and the other half at "B." Therefore the stress at "A" is then represented by the formula (a).

Now referring to the circumferential seam the stress will be equal to the following:

This seam is subjected to the load on the boiler head, and neglecting the tubes and supporting value due to head braces, we have the area of the head in square inches multiplied by the pressure per square inch, which is represented by the following formula:

$$(b) \quad D^2 \times .7854 \times P,$$

in which

D = diameter of boiler in inches,
P = pressure in pounds per square inch.

The length of the circumferential seam is equal to $D \times 3.1416$, therefore the stress per unit of length is then equal to

$$(c) \quad \frac{D^2 \times .7854 \times P}{D \times 3.1416},$$

which by cancellation reduces to

$$\frac{D \times P}{4},$$

and which is just exactly one-half the stress in formula (a) for the longitudinal seam.

Another illustration of a poorly designed patch is represented by Fig. 3. This patch was proposed for application to a boiler to cover a crack 5¼ inches long. When applying cover plates in the initial patch a small plate "A" was used on the outside and a larger plate "B" on the inside of the boiler. This made a weak point in the boiler plate along the line C-D, and in attempting to remedy this weak

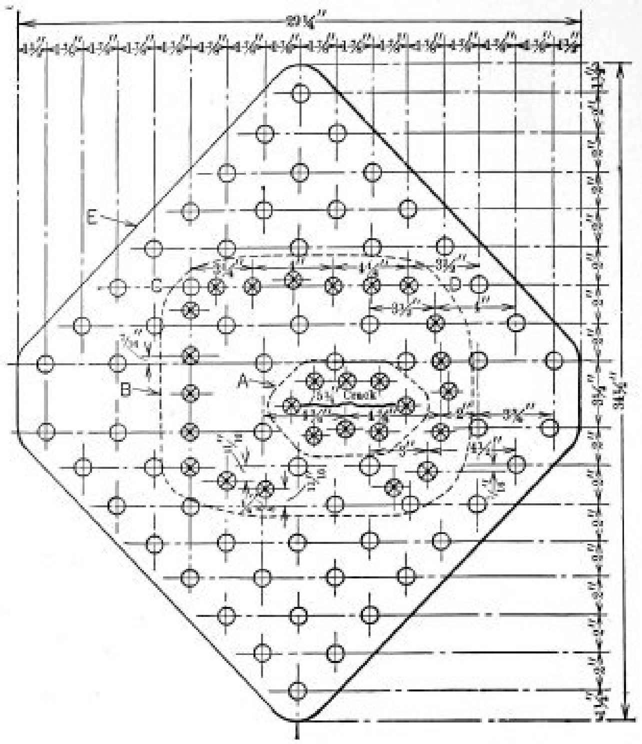


Fig. 3.—Holes Marked X in Old Patch, ¾-Inch Boiler Steel, 15/16-Inch Holes, ⅞-Inch Rivets

point another plate "E" was proposed to be applied by the shop man. While no doubt this would have been amply strong it will be noted that it was proposed to apply 61 rivets.

After this proposition was given consideration by the drawing room a patch as represented by Fig. 4 was substituted and applied. In this case a reduction of 20 rivets was made without affecting the efficiency, as well as reducing the size of the patch and without reducing the strength.

In the opinion of the writer a diamond-shape patch consisting of a single plate is quite satisfactory for small

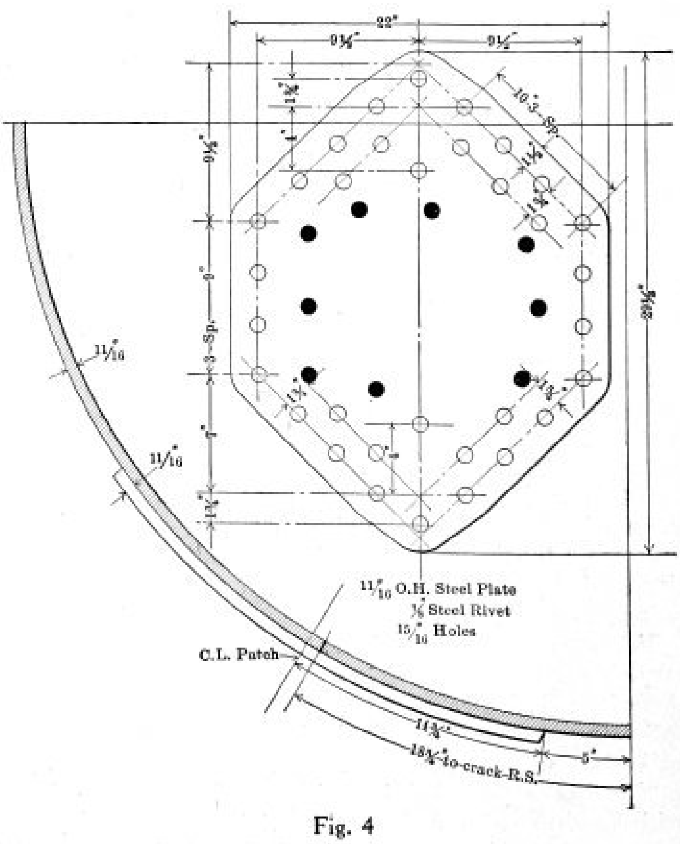


Fig. 4

cracks, and can be employed in reinforcing all cracks up to about 12 inches long. When the defect, however, assumes large proportions, an inside and outside cover plate should be used similar to that shown in Fig. 5, and the proportions of which should correspond to and be of equal strength as the longitudinal seam on the course to which it is applied.

In considering the diamond-shape patch as shown in Fig. 4 it is necessary that care be exercised in the application of same, as, for instance, the efficiency may be greatly reduced if the angle *"X"* of the line *A-B* with the longitudinal centerline of the boiler is less than 45 degrees, as shown in Fig. 6. It is, therefore, evident that the greater the angle *"X"* the more efficient the patch will be.

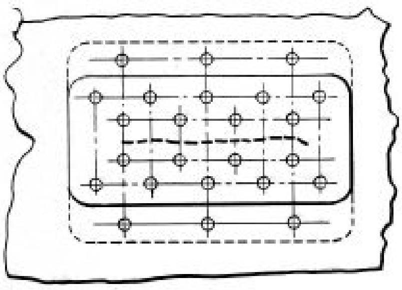


Fig. 5

There have been a great many applications of circular patches, such as represented by Fig. 7. For cases of small reinforcements there seems to be no objection to the use of a circular plate, but there is a limit to this style of patch, as when it reaches a certain diameter the line of rivets as represented by *"C-D"* can be assumed to be a straight line, and on account of the close spacing of the rivets which is required in order to provide a calking edge, the factor of safety would be reduced, which would necessarily mean a reduction in the boiler pressure. It will, therefore, be seen that a large circular patch is not satisfactory and should not be used.

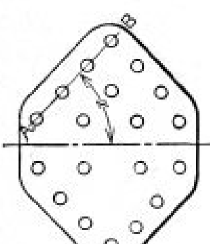


Fig. 6

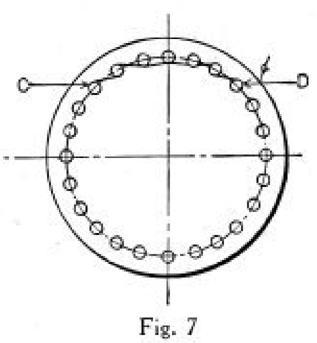


Fig. 7

Very often a plate develops abnormal cracks due to crystallization. In such cases it is not good practice to patch the plates. The proper thing to do in such a case is to renew the whole or part of the plate, as patching under such conditions will not altogether correct matters, as the defective plate is bound to develop defects beyond the limits of the patch and give very unsatisfactory results.

The writer is submitting a series of patches which it is believed will under ordinary conditions serve as a guide in the repairs to defective boilers, when such defects as cracks, pitted places, etc., develop. It will be seen that the patches are graduated for the limits of certain size cracks and the extent of defect due to pitting, grooving and cut-out portions.

In using the single thickness patch particular care must be exercised in keeping the pitch of rivets in the outer row so spaced that the efficiency is not reduced to such an extent that the factor of safety is lowered, which would consequently result in the reduction of the boiler pressure. It is, therefore, evident that a single thickness square or rectangular patch would not be sufficient beyond certain dimensions, as to get a good calking edge it would be necessary to space the rivets too close in order to get a good steam tight job. This, of course, would lower the efficiency so far as the strength of the patch is concerned and result in a factor of safety below four, which is that now worked to on locomotive boiler work in order to meet the requirements of the Interstate Commerce Commission.

From the foregoing analysis it is evident that the only satisfactory single thickness patch would be the diamond shape patch, and the next step to decide is what angle the line *A-B* should make with the longitudinal centerline of the boiler as shown in Fig. 6, as the spacing of the rivets on the line *A-B* must be close enough to produce a good calking edge. This angle will vary with different conditions of service, depending upon the diameter of the boiler, thickness of the shell and the boiler pressure carried.

In the *Locomotive*, published by the Hartford Steam Boiler Inspection and Insurance Company, issues of July, 1907, and July, 1897, the matter of diagonal seams is very thoroughly covered, and for convenience the following table, No. 1, is given for ready reference, from which it

TABLE NO. 1

FACTORS FOR DETERMINING THE STRENGTH OF DIAGONAL SEAMS AND PATCHES ON LOCOMOTIVE BOILERS

Angle.	Sine of Angle.	Sine of Angle Squared.	Cosine of Angle.	Cosine of Angle Squared.	Factor for Strength of Diagonal Seams and Patches. When Angle is Measured with Circumferential Seam.	Factor for Strength of Diagonal Seams and Patches. When Angle is Measured with Longitudinal Seam.
20°	.3420	.1170	.9397	.8830	1.717	1.047
21	.3584	.1284	.9336	.8716	1.700	1.052
22	.3746	.1403	.9272	.8597	1.678	1.057
23	.3907	.1526	.9205	.8743	1.657	1.063
24	.4067	.1654	.9135	.8345	1.635	1.068
25	.4226	.1786	.9063	.8214	1.614	1.074
26	.4384	.1922	.8988	.8078	1.594	1.079
27	.4540	.2061	.8910	.7939	1.572	1.087
28	.4695	.2204	.8829	.7795	1.552	1.094
29	.4848	.2350	.8746	.7649	1.531	1.102
30	.5000	.2500	.8660	.7499	1.510	1.109
31	.5150	.2652	.8572	.7348	1.492	1.117
32	.5299	.2808	.8480	.7191	1.474	1.126
33	.5446	.2966	.8387	.7034	1.455	1.134
34	.5592	.3127	.8290	.6872	1.437	1.141
35	.5736	.3290	.8192	.6711	1.419	1.152
36	.5878	.3455	.8090	.6545	1.401	1.162
37	.6018	.3622	.7986	.6378	1.385	1.171
38	.6157	.3791	.7880	.6209	1.368	1.182
39	.6293	.3960	.7771	.6039	1.353	1.192
40	.6428	.4132	.7660	.5868	1.340	1.204
41	.6561	.4305	.7547	.5696	1.322	1.215
42	.6691	.4477	.7431	.5522	1.306	1.227
43	.6820	.4651	.7314	.5349	1.292	1.239
44	.6947	.4826	.7193	.5174	1.278	1.252
45	.7071	.5000	.7071	.5000	1.264	1.264
46	.7193	.5174	.6947	.4826	1.252	1.278
47	.7314	.5349	.6820	.4651	1.239	1.292
48	.7431	.5522	.6691	.4477	1.227	1.306
49	.7547	.5696	.6561	.4305	1.215	1.322
50	.7660	.5868	.6428	.4132	1.204	1.340
51	.7771	.6039	.6293	.3960	1.192	1.353
52	.7880	.6209	.6157	.3791	1.182	1.368
53	.7986	.6378	.6018	.3622	1.171	1.385
54	.8090	.6545	.5878	.3455	1.162	1.401
55	.8192	.6711	.5736	.3290	1.152	1.419
56	.8290	.6872	.5592	.3127	1.141	1.437
57	.8387	.7034	.5446	.2966	1.134	1.455
58	.8480	.7191	.5299	.2808	1.126	1.474
59	.8572	.7348	.5150	.2652	1.117	1.492
60	.8660	.7499	.5000	.2500	1.109	1.510
61	.8746	.7649	.4848	.2350	1.102	1.531
62	.8829	.7795	.4695	.2204	1.094	1.552
63	.8910	.7939	.4540	.2061	1.087	1.572
64	.8988	.8078	.4384	.1922	1.079	1.594
65	.9063	.8214	.4226	.1786	1.074	1.614
66	.9135	.8345	.4067	.1654	1.068	1.635
67	.9205	.8473	.3907	.1526	1.063	1.657
68	.9272	.8597	.3746	.1403	1.057	1.678
69	.9336	.8716	.3584	.1284	1.052	1.700
70	.9397	.8830	.3420	.1170	1.047	1.717

RULE:—To find strength of joint of patch, when at an angle with the long. or cir. seam multiply strength of corresponding long. seam or patch by factor in table opposite desired angle.

FORMULÆ FOR DETERMINING FACTORS $= 2 \div \sqrt{1 + 3 \sin^2 Y}$ and $2 \div \sqrt{1 + 3 \cos^2 X}$

will be seen that as the angle "X" increases in Fig. 6 the greater will be the efficiency, as the line of rivets "A-B" more nearly approaches the conditions found in the circumferential seam, which is just twice as strong as the longitudinal seam of the same design. Of course the greater the angle "X" the longer will be the patch, from

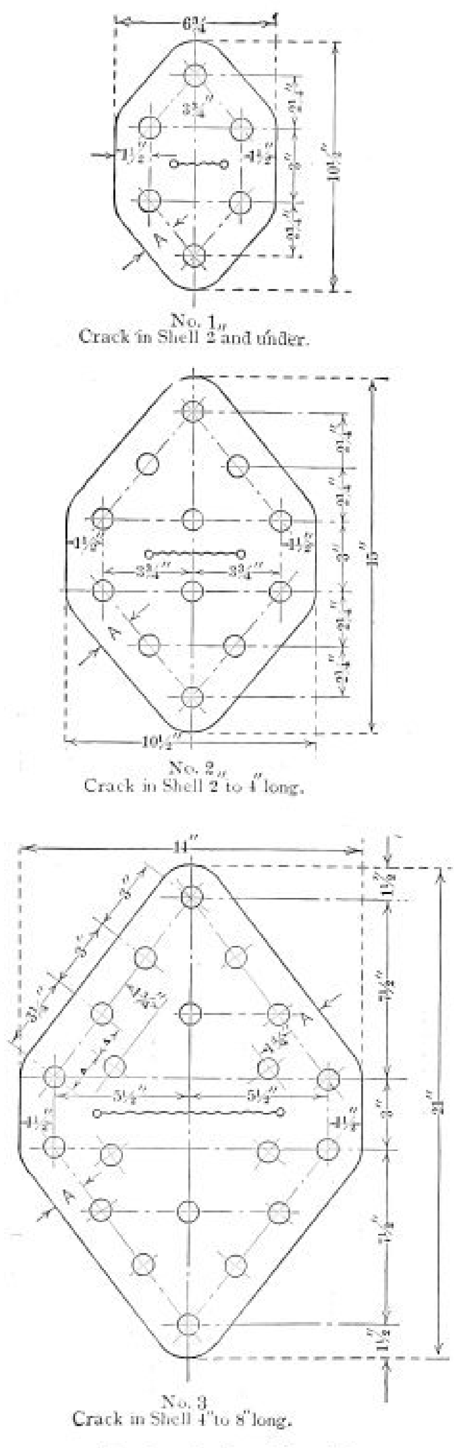
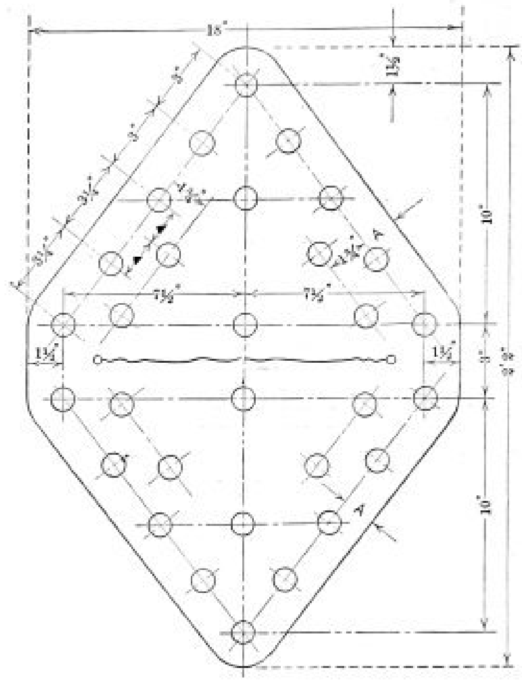


Fig. 8.—Patches Nos. 1-3

which it is evident that there are certain limits that should not be exceeded in order to provide for a good design of patch. The series of patches shown in this article will provide for a factor of safety of four or more if used in conjunction with the data covered in the table of size of rivets.

Objections have been raised in some instances to the use of patch bolts in the application of patches, and it is generally admitted that the best results are obtained from the use of rivets. In applying a patch with patch bolts it is generally the rule that internal examination is not made in connection with the defect and very often the crack assumes larger proportions than at first thought, as the full extent of the crack is not always visible from outside inspection. There may be cases where it is possible and satisfactory to use patch bolts in cases of emergency in order not to remove an engine from service and remove



Patch No. 4. Crack in Shell 8" to 12" Long

flues in order to apply a patch with rivets, but in such cases the patch bolts should be removed at the first opportunity and replaced with rivets. This means that in so doing it is necessary to ream out such holes and apply rivets that are much larger than required.

There seems to be a great diversity of opinion on this subject of boiler patches and one which no doubt has received much study during the past few years. From some of the applications which have been made in the past few

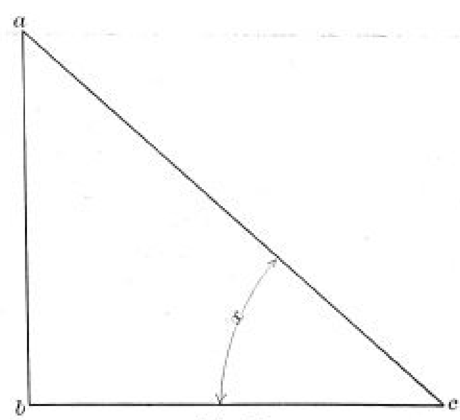
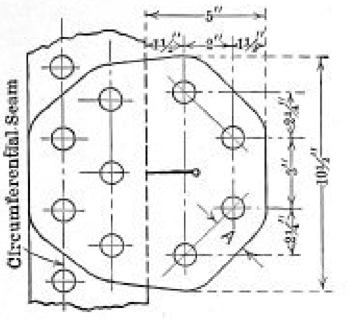


Fig. 9

years it is surprising to know that they have held up under the strains they are subjected to. Of course the margin of safety is about to the limit so far as calculations are concerned, but since the inauguration of the various codes and rules for the government of boilers, a much closer inspection and more rigid examination are given to such matters, and consequently better results are obtained in this regard, and the result is more satisfactory boiler conditions.

As an example for figuring the strength of a patch or a diagonal seam, let us consider a case such as follows:

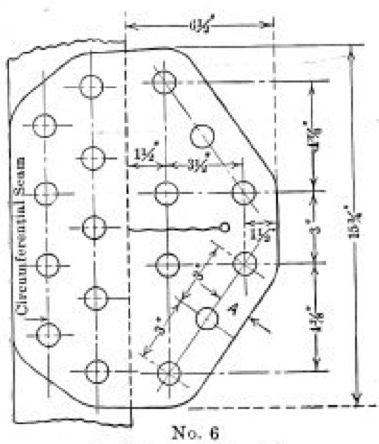


Patch No. 5. Crack in Shell 2" and Under

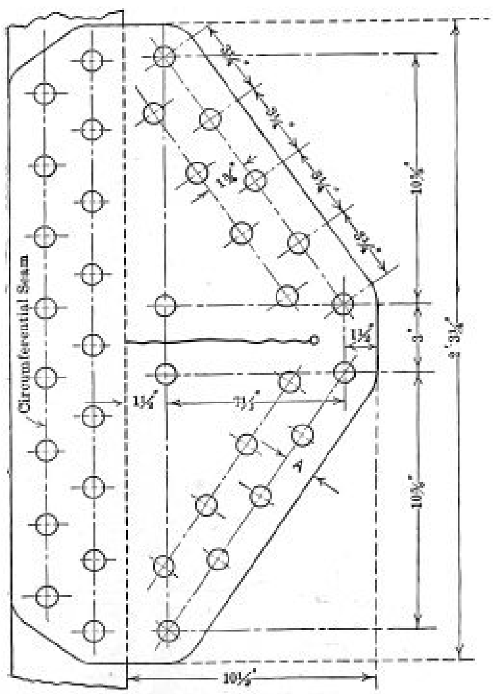
Diameter of boiler..................	70 inches
Boiler pressure.....................	205 pounds
Pitch of rivets.....................	3¼ inches
Diameter of driven rivet............	15/16 inch
Thickness of plate..................	11/16 inch

Patch applied as represented by Patch No. 4. Crack 12 inches long.

The first step is to consider the angle the patch makes with either the circumferential or the longitudinal seam.

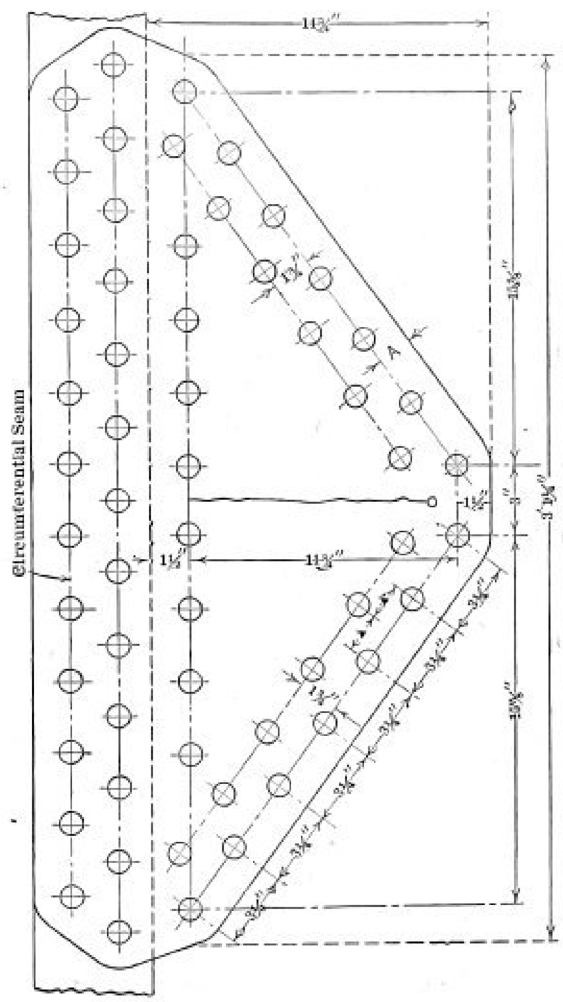


No. 6
Crack in Shell 2" to 4" long



No. 7
Crack in Shell 4" to 8" long

Patches Nos. 6-7



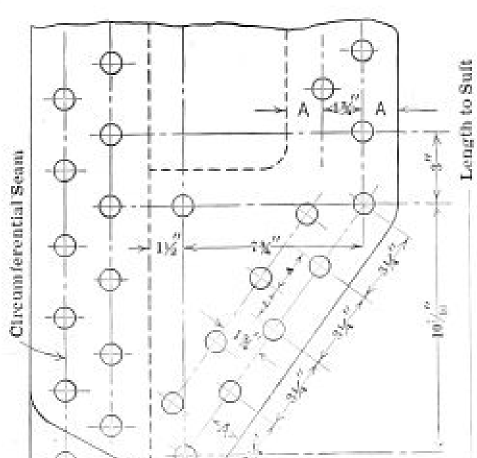
Patch No. 8. Crack in Shell 8" to 12" Long

In this case let us consider the angle with the longitudinal seam.

In the right angle triangle shown in Fig. 9 the sides *a-b*, *b-c*, are known, but it is necessary to determine the length of the hypotenuse *a-c* in order to find the angle "*X*." This is, then, equal to

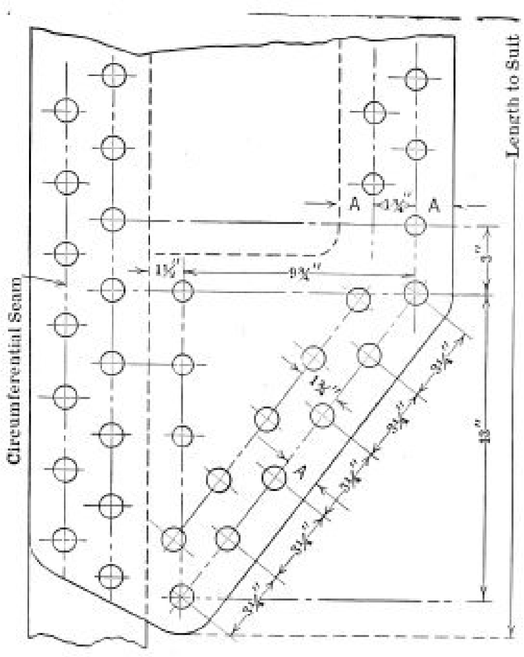
$$\sqrt{10^2 + 7.5^2}, \text{ or } 12.5,$$

and dividing the side opposite the angle "*X*" by the hypotenuse we then obtain the sine of the angle "*X*," or .8000. Upon referring to table No. 1 this very nearly corresponds to an angle of 54 degrees, and the corresponding factor is



Patch No. 9. Opening in Shell 6" and Under then 1.401. In other words, the patch is 1.401 times as strong when making an angle of 54 degrees as when in a longitudinal direction.

$$\text{The efficiency of the plate} = \frac{3 - 15/16}{3} = .6875,$$



Patch No. 10. Opening in Shell 6" to 8" Long

multiplying by the factor 1.401 we obtain $.6875 \times 1.401 =$ 96.3 percent efficiency.

In figuring the shell for the bursting strength:

$$P = \frac{Tt}{r} e$$

where P = bursting pressure,
T = tensile strength of plate,
r = radius of boiler,
e = efficiency of seam or patch,
t = thickness of plate.

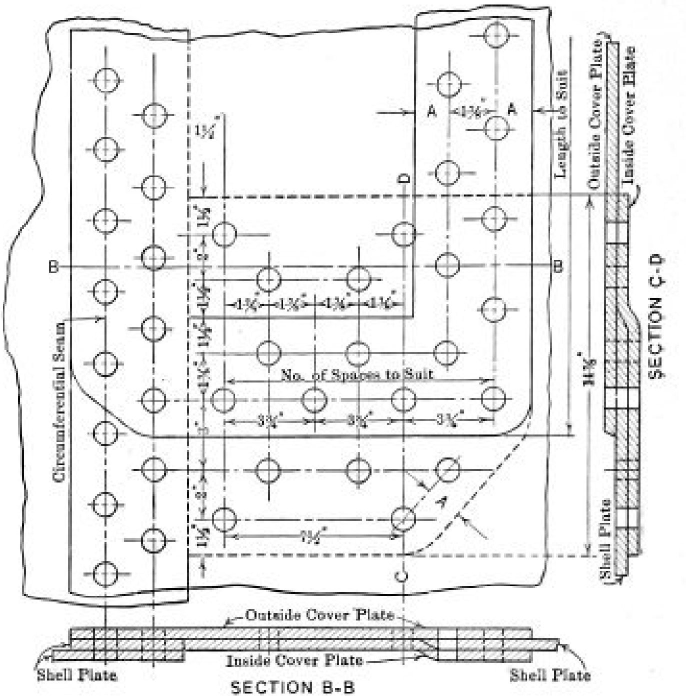
$$P = \frac{50{,}000 \times 11/16}{35} \times .963 = 945.6 \text{ pounds.}$$

Factor of safety

$$= \frac{945.6}{205} = 4.61,$$

so far as tearing plate is concerned.

The next point to consider is the shearing of rivets, or the number of rivets that is necessary to compensate for



Patch No. 11. Opening in Shell 8" to 24" Long. Cover Plates Same Thickness as Shell

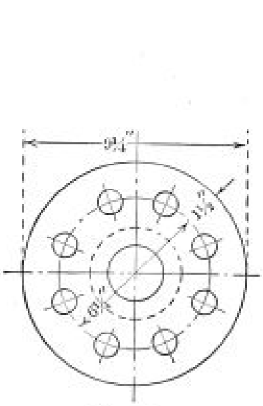
the 12-inch crack. Strength of solid plate then equals $12 \times 11/16 \times 50{,}000$, or 412,500 pounds. Fifteen 15/16-inch rivets (driven size) at a shearing value of 30,373 pounds per square inch, equals

$$15 \times 30{,}373 = 455{,}595 \text{ pounds.}$$

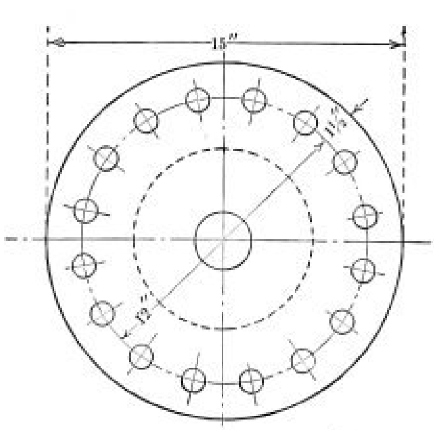
From this it will be seen that the rivets in shear have a value greater than the solid plate removed, or equivalent to an efficiency of

$$\frac{455{,}595}{412{,}500} = 114.04 \text{ percent.}$$

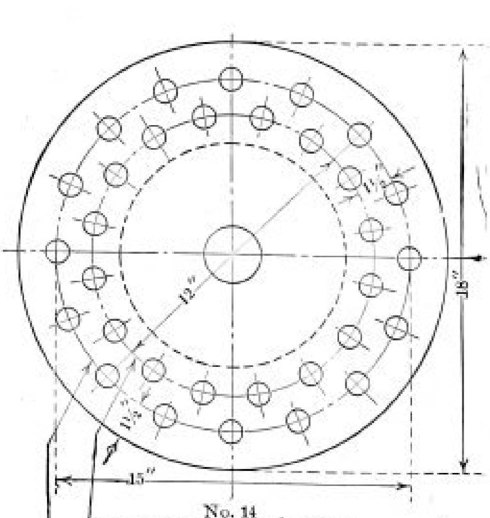
The bursting pressure in this case would then be equal to



No. 12
Holes in Shell from $3\frac{1}{4}''$ to $3\frac{3}{4}''$ dia.
Holes less than $3\frac{1}{4}''$ dia. not required to be reinforced.



No. 13
Holes in Shell from $3\frac{3}{4}''$ to $7\frac{1}{2}''$ dia.



No. 14
Holes in Shell from $7\frac{1}{2}''$ to $9\frac{3}{4}''$ dia.
Inside Row—$\frac{3}{4}''$ Rivets, $\frac{13}{16}''$ Holes
Outside Row—See Table.

Reinforcement for Washout Holes in Boiler

$$\frac{50{,}000 \times 11/16}{35} \times 114.04 = 1119.98.$$

Then the factor of safety at a boiler pressure of 205 pounds is equal to

$$\frac{1119.98}{205} = 5.45.$$

By using patches represented by the examples covered by this article a factor of safety of four or more will be obtained in each case, as the patches are designed to take care of the worst condition for each thickness of plate.

In the formula for figuring the bursting strength, Table No. 2 will be found convenient for finding the value of the product of "Tt" or the strength of the plate multiplied by the thickness.

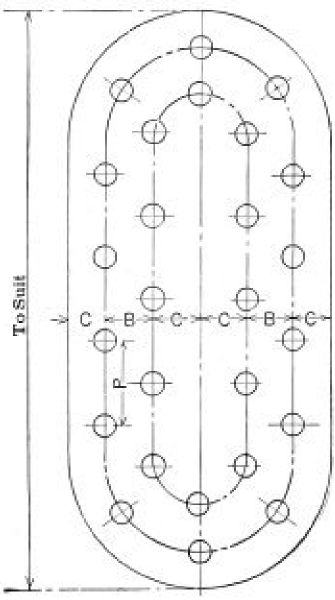
TABLE No. 2
STRENGTH OF STEEL BOILER PLATES, 1" WIDE

Thickness of Plate.	TENSILE STRENGTH.		
	50,000	55,000	60,000
1/4	12,500	13,750	15,000
9/32	14,062	15,469	16,895
5/16	15,625	17,188	18,750
11/32	17,187	18,907	20,625
3/8	18,750	20,625	22,500
13/32	20,312	22,344	24,375
7/16	21,875	24,063	26,250
15/32	23,437	25,782	28,125
1/2	25,000	27,500	30,000
17/32	26,562	29,219	31,875
9/16	28,125	30,938	33,750
19/32	29,687	32,657	35,625
5/8	31,250	34,375	37,500
21/32	32,812	36,094	39,375
11/16	34,375	37,813	41,250
23/32	35,937	39,532	43,125
3/4	37,500	41,250	45,000
25/32	39,062	42,969	46,875
13/16	40,625	44,687	48,750
27/32	42,187	46,406	50,625
7/8	43,750	48,125	52,500
29/32	45,312	49,844	54,375
15/16	46,875	51,562	56,250
31/32	48,437	53,281	58,125
1	50,000	55,000	60,000

In the example given, a tensile strength of 50,000 pounds has been used, as this is the maximum value generally used when authentic record of the plate is not known. The table, however, gives values for 50,000, 55,000 and 60,000 pounds.

Use patch No. 15 for reinforcing cracks running circumferentially around boiler. Also when it is necessary to reinforce shell on account of grooving adjacent the circumferential seams. Dimensions shown at "*A*" must not be less than 1½ times diameter of rivet hole. Dimensions shown at "*B*" and "*C*" to be the same as in the circumferential seam in boiler.

When longitudinal cracks exceed 12 inches in length, single plate patches not to be used. Inside and outside cover plates must be applied with thickness of plates. Size and spacing of rivets the same as in the longitudinal seam of boiler.



Patch No. 15. Pitch *P* Spacing *B* and C, Diameter of Rivets Same as in Circumferential Seam of Boiler

Thickness of all single plate patches to be same as shell on which patch is applied. Steel rivets should always be used in applying patches or reinforcements to boilers.

Thickness of Sheets.	*DIAMETER OF RIVETS.													Outside Row Only.
	PATCH No.													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1/2"	3/4"	3/4"	3/4"	3/4"	3/4"	3/4"	3/4"	3/4"	3/4"	3/4"	7/8"	3/4"	3/4"	3/4"
9/16"	3/4"	3/4"	3/4"	3/4"	7/8"	7/8"	3/4"	3/4"	3/4"	3/4"	7/8"	3/4"	3/4"	7/8"
5/8"	3/4"	3/4"	7/8"	7/8"	7/8"	7/8"	7/8"	3/4"	3/4"	3/4"	7/8"	7/8"	7/8"	7/8"
11/16"	3/4"	3/4"	7/8"	7/8"	15/16"	15/16"	7/8"	3/4"	3/4"	3/4"	15/16"	7/8"	7/8"	15/16"
3/4"	7/8"	7/8"	7/8"	7/8"	15/16"	15/16"	7/8"	7/8"	7/8"	7/8"	1"	15/16"	15/16"	1"
7/8"	7/8"	7/8"	15/16"	15/16"	1"	1"	15/16"	7/8"	7/8"	7/8"	1"	1"	1"	1"

* Diameter of rivet holes to be 1/16 larger than showh in above table.

Thickness of Sheets.		1/2"	9/16"	5/8"	11/16"	3/4"	7/8"
Diameter of Patch Bolts.	Patch No.						
	1	7/8"	7/8"	7/8"	15/16"	15/16"	1"
	2	7/8"	7/8"	7/8"	15/16"	15/16"	1"

INSTRUCTIONS FOR APPLICATION OF PATCHES

Use patches Nos. 1 to 8 for reinforcing cracks running lengthwise on boiler.

Use patches Nos. 9 to 11 for reinforcing openings in boiler or pitted sheets.

Use patches Nos. 12 to 14 for reinforcing washout holes in boiler.

Patch bolts are to be used only in cases of emergency for applying patches Nos. 1 and 2, and when used the material should be mild O. H. steel. Patch bolts should be removed at the first opportunity and replaced with steel rivets.

Small holes should be drilled at the ends of all cracks as indicated on patches, to prevent them from spreading.

When it is necessary to cut out a portion of the shell plate exceeding 24 inches in length, patch No. 11 should not be used. When this limit is exceeded a new course (or half course, according to the condition of the remaining portion of the shell plate) should be applied, using same thickness of plate, diameter and pitch of rivets, and design of seam as in shell of boiler.

The Boiler Inspector and His Relation to the Manufacturer and Purchaser*

Qualifications for Shop Inspector—Purchaser's Interests Primarily Served by Inspector—Approval of Specification Requirements

BY S. F. JETER†

The first question that naturally arises in presenting this subject is, What kind of man should the shop inspector be? I say "shop inspector" since I will attempt to deal only with the problems of shop inspection. The "Hartford's" experience in this class of inspection work leads us to believe that the shop inspector should be the highest type inspector we employ. His duties are constantly becoming more exacting. With the steady increase in legal requirements governing the construction and use of boilers, the burden carried by the shop inspector is continually becoming more irksome. He must be a man of decision, for he is constantly called on to decide matters in regard to the fulfilment of contract or legal requirements that many managers would shrink from deciding. He should be conversant with shop methods and practices and be generally able to suggest a way out of difficult situations that arise in the shop in meeting the requirements of rules of construction or specifications. He should be a man able to gain the respect and good-will of the shop employees so that co-operation is secured in turning out work that will fulfill requirements. There is no inspector so quick of wit and observing that he can always prevent the use of improper construction or indifferent workmanship in the shop where the workmen are bent on putting something over. The shop inspector should be resolute and not easily swayed by argument when he perceives the proper course to take in a given case. If an inspector is of a sympathetic nature very difficult situations often arise in the performance of his duties. A workman will often make a mistake, and for fear that he will be severely censured or even discharged if his error is discovered, pleads with the inspector to overlook the defect and permit it to be covered up in some way to save the workman.

Gaining Confidence of Workmen

I know from experience that in the manner in which some of these pleas are put up to the inspector they are very hard to turn down, and I would plead with you manufacturers to let the inspector in your shop know, in cases of this kind which he reports, that his recommendations for clemency will always be given due consideration in your dealing with the employee. Such action on your part will greatly aid the inspector in gaining the confidence of the men and more certainly insure that improper work does not leave the shop, which, after all is said, is the real reason for shop inspection.

The shop inspector in performing his duties should constantly keep in mind the requirements of the company by whom he is employed. It would be manifestly inconsistent for the boiler manufacturer to lay down the rules for the guidance of the inspector. Therefore, the insurance company by whom he is employed necessarily prescribes certain rules that are to govern him in the acceptance or non-acceptance of the work he is to pass on.

Relation of Inspector to the Manufacturer

The shop inspector serves the boiler manufacturer generally under one of two conditions—he inspects as a representative of the purchaser, either through contract between the purchaser and the boiler manufacturer, or between the purchaser and the insurance company employing the inspector, or the inspection may be a service rendered the manufacturer by the insurance company according to terms of a contract between them. In either case, the manufacturer should thoroughly understand that no matter under which arrangement the inspection service is rendered, the inspector is primarily serving as a representative of the purchaser of the boilers he inspects. Unless this were the case, the inspection service would be without practical benefit to the boiler manufacturer. This is a most important point and should be thoroughly understood by the boiler manufacturer. Too often the securing of the shop inspector's sanction, for workmanship that may be considered slightly off color, is regarded as an aid in securing the final acceptance by the purchaser.

Where the inspection service is governed by a contract or specification agreed on between the purchaser and the manufacturer, the inspector or the insurance company employing him is powerless to change any of the conditions of the contract. This fact seems to be one that the boiler manufacturer has the greatest difficulty in fully appreciating. Our company is being constantly requested to approve changes in specification requirements, particularly where the specifications happen to be drawn by us. After a specification has once left our hands and is made a feature of a contract between the purchaser and the boiler manufacturer, we are just as powerless to change any of its provisions as though it had been drawn by another insurance company or a consulting engineer. Even though the proposed change is one that will not detract from the value or usefulness of the boiler, or even if it would, in our opinion, actually be an improvement, the sanction for the change is necessarily secured from the purchaser. A manufacturer is naturally reluctant to approach a customer in regard to changes after he has bid on a specification, and too often it appears that the boiler manufacturer takes a contract under certain specification requirements without closely examining them to see if he can meet all the conditions specified. Sometimes the manufacturer may know that he is not equipped to perform the work just as specified and relies on obtaining modifications if he is fortunate enough to secure the contract. This procedure is all right if the manufacturer intends to take the responsibility for securing the desired changes himself, but he should not expect the boiler inspector to assume the responsibility of sanctioning such changes. We, of course, know that very often slight changes may be made in the design or construction of a

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* Paper read before the American Boiler Manufacturers Association, Pittsburg, Pa., June 26.

† Chief engineer, Hartford Steam Boiler Inspection and Insurance Company, Hartford, Conn.

boiler without detriment, and if the changes are permitted they may make a considerable difference in the cost of doing the work. In such cases the inspecting company is always pleased to give testimony to the fact that the desired change will not affect the value of the boiler, but further than this it cannot go in securing the consent of the purchaser to the change.

The method that would appear best to pursue where specifications do not secure the most efficient construction, under the shop conditions existing where the boiler is to be manufactured, is for the boiler manufacturer to put in two bids—one to be for construction just as specified and the second depending on the change of certain details in the specifications. Generally the changes required will be few and may be fully explained to the prospective purchaser so that he will be in a position to determine whether he desires the boiler built to the original requirements or changed as proposed by the manufacturer.

FAVORITISM IN COMPETING SHOPS

A point that sometimes comes up and has a bearing on the relation between the inspector and the manufacturer is this: a boiler manufacturer will say to the inspector in his shop, Your requirements for our shop are more severe than those insisted on by the inspector of your company in our competitor's shop. Now it goes without saying that any inspecting company must be trying to give uniform inspection service in all shops where it inspects, and certainly would not as a matter of favoritism be more lenient in one shop in the matter of enforcing rigid compliance with its rules than another. Also, if there was an attempt on the part of the inspecting company to show favor, the result would be to give the most rigid service to the shop it was trying to serve best. The dictionary definition ot the word "inspection" is "careful or critical investigation or scrutiny, especially an official examination by persons appointed therefor." The definition of "inspector" is "one who inspects specifically, an official to ascertain the quality or condition of certain articles of commerce." You will please note that inspection is a careful or critical investigation, and unless the inspection is made in a careful and critical manner it is not an inspection in the true sense of the word.

Another point about the ability of inspectors to have the work turned out by different shops of uniform grades. As you are all perfectly well aware, the mere fact of securing shop inspection service is only one step towards obtaining the desired grade of workmanship in your shops. If the employment of a competent inspector was all that was necessary to secure uniform and high grade workmanship, the complicated task of turning out such boiler work would be very simply solved. As a matter of fact, in order to secure high-grade work it is necessary for you to build up the best manufacturing organization you can and you add shop inspection in order to help keep this organization keyed up to concert pitch. When you see a competitor's product appear to be less critically examined than your own, rejoice that your manufacturing organization and the inspection service furnished in your shop is superior to his. Where your competitor turns out and secures the acceptance of poor work, a complaint regarding inspection service is really due from him.

It is certain that the boiler manufacturer fully appreciates the necessity for securing inspection service from an outside source in order that it will be free from possible contamination by the members of his own organization. Therefore, it seems the height of folly to complain about the thoroughness of the service furnished or that a competitor is securing less critical service.

I feel sure that if you manufacturers should take more interest in the work of the shop inspector and will give him a kind word of commendation when he prevents by watchfulness improper work getting away from the shop, the lot of the shop inspector would be more pleasant and you would be aiding in securing the kind of service that must spell "Efficiency" and "Success" in the long run. In acting on this suggestion regarding the treatment to be accorded the shop inspector, you should go at the matter carefully, because he is accustomed only to receive complaints, either from the field because his work is not rigid enough, or from the manufacturer because he is too exacting. If a sudden change is made and the inspector is commended for doing some of the things that are clearly his duty, the shock may cause serious results.

At this point I would like to give testimony as to the broad-minded manner in which the boiler manufacturing business is conducted in many shops to-day. Our company has recently adopted the plan of having some of its inspectors intended for shop service, but who have not had particular opportunity to gain shop experience, visit plants where we regularly inspect the output. I wrote a number of letters to some of the shops where we conduct shop inspection service, asking permission for making these visits, and without exception the manufacturers approached gave their consent and expressed their entire willingness to help our company for the good of the cause. As long as this spirit is maintained in any line of work it cannot fail to progress.

THE INSPECTOR'S RELATION TO THE PURCHASER

The inspector's relation to the purchaser has been dealt with largely in specifying his relations to the manufacturer. As I have before stated, the inspector always primarily represents the purchaser. Unless this is so the inspector's services would be of very little benefit to the manufacturer. While the manufacturer may complain of the inspector's work in the shop being too critical, he is bound to complain more severely, and with justice, if his product after it reaches the field produces a complaint from the purchaser. The boiler manufacturer should always remember that a stitch in time saves nine, and that every criticism in the shop that prevents a criticism in the field is a real benefit to his business. The shop inspector has learned from hard and sad experience that while his criticism of work in the shop results in harsh words from the shop force, and possibly the management, if criticism comes from the field, in addition to his more severe criticism by the shop management, his company receives most harsh criticism from the purchaser, which, in turn, is reflected on the inspector. On this account, as well as others, the shop inspector has learned that it is best to brave the displeasure of the shop rather than that of the purchaser. As to how well the shop inspector has learned this lesson, I would venture to say that for every complaint we receive from the field that the shop inspector has neglected his duty, there are at least twenty complaints from the manufacturer that he is adhering too strictly to the requirements specified for his guidance in performing his work in the shop.

In connection with the inspector's relation to the purchaser, I may say, it sometimes happens that a boiler passed in the shop will be criticised after reaching its destination. It is needless to say such a situation is as embarrassing to the insurance company as it is to the boiler manufacturer. Every attempt is made to handle such cases without friction. The boiler manufacturer usually gains the impression from what the purchaser reports to him under such circumstances that the inspector in the field has acted in a manner to make a proper adjustment difficult. While such criticism on the part of the manufacturer may in a very few cases be justified, in nearly all instances the inspector's actions would not be at all condemned by the manufacturer if he really knew what had transpired. The purchaser is naturally inclined to exaggerate any statement that may be made indicating that the boiler is not perfect. The way a straightforward statement of facts on the part of the inspector is at times twisted under such circumstances is marvelous.

Goods Damaged in Shipment

Often in the case of criticism by the field inspector the trouble is that the boiler has been damaged in shipment and sometimes a manufacturer will say that the inspector should tell his purchaser that this is the case. If the fact is patent to the inspector that injury has resulted due to improper handling in shipment, he will always so report; but in most cases he can only describe conditions as they exist and it would be entirely illogical for him to surmise as to the causes that might have produced the conditions noted.

I was recently told of a shop incident witnessed by the president of our company, that goes to show that damage may at times occur in the shop to a boiler after it has been tested and passed as O. K. by the shop inspector. While visiting a manufacturer our president was invited to make a trip through the boiler shop, and on reaching the shop he noted that a large H. R. T. boiler, swinging from the traveling crane, was being raised and lowered very rapidly—in fact, it was practically dropped. Closer investigation revealed the fact that the boiler was being raised and dropped on some I-beams for the purpose of straightening them, or, in other words, used as a drop hammer, the blow delivered on the boiler being at the girth seam. Without the subsequent test and tightening of the joint required in this case, there might have been another of those mysterious happenings where a boiler that is tested and pronounced perfectly tight in the shop showed severe leakage when erected.

Disinterested Expert Opinions from Inspectors

The inspector's work in the field frequently results in great benefit to the manufacturer, particularly where a controversy has arisen as to the cause of troubles experienced after operation has commenced. Our inspectors are constantly called on to arbitrate such difficulties or to give disinterested expert opinion as to what is the cause of the trouble experienced.

It would not be proper for me to close this paper without bearing witness to the fact that the boiler manufacturers are almost without exception always open to intelligent criticism from the inspector and welcome all suggestions that appear to afford improvement in either methods or the finished product.

In conclusion, I would ask you to remember that the shop inspector is only human and without doubt has his faults, but do not think he is not trying to serve your best interests because he is finding fault with the work. The chances are that he is serving you most acceptably when he is thought the least of by your shop foreman, and if he happens to become too chummy with that individual, you should then look out and notify the insurance company in order to protect your interests.

PERSONAL.—I. Eads, of Gainesville, Fla., was appointed master mechanic of the Tampa & Jacksonville Railroad in June, vice J. J. Hazel, resigned to accept the position as master mechanic for the Oclowaha Valley Railroad at Palatka, Fla.

The Sequel to the Indifference of Boiler Manufacturers Toward Any Improvement Which Would Result in Their Commercial Advancement*

BY W. H. S. BATEMAN†

Just at the present time, with abnormal business conditions existing due to the great war, the question of business competition is reduced to a minimum. Nearly every manufacturer is now in the position to pick and choose what he can handle most profitably, providing, of course, he can secure the material. I must, therefore, confine my remarks to the boiler business as it exists when conditions are normal.

Being an admirer of Mr. Charles M. Schwab, and having great faith in his optimistic, businesslike ideas and trade opinions, I take pleasure in quoting particularly one statement from his recent address before the World's Salesmanship Congress at Detroit, which was: *"We are entering an era of co-operation, where we are beginning to see that the success of any business does not consist in failure of its competitors."* This is a very true and wholesome statement and can be taken home to the boiler manufacturer as well as any other line of business. In fact, the manufacturer has already learned a lesson during this strenuous war period that will undoubtedly be of great benefit to him in after years.

First and foremost, there must and will be a better understanding and feeling of confidence between boiler manufacturers, which is bound to grow, and which will eventually break down the barriers of bitter competition and result in the general commercial advancement of the industry.

Lack of knowledge and careless business methods, irrespective of shop facilities, in the old days caused many manufacturers to enter into the most ridiculous, and, in fact, cutthroat competition. What for? Simply from a spirit of conquest to beat the other fellow out and put him out of business if possible, and in nine out of ten cases any one of the bidders would hardly break even, and more often would have lost money had they secured the contract.

During the last quarter of a century many changes have taken place in the boiler making line. There has been a steady evolution and betterment of the industry until there are very few of the old ideas and methods in vogue. All this has had a corresponding effect in making competition more sane and equitable. Success does not depend on putting the other fellow out of business. If a concern elects to follow unscrupulous methods in the making and selling of their product, such competition, while manifestly unfair, should be no incentive for others to attempt to meet. Let that kind of a concern go it alone, and in due time they will put themselves out of business. The more work you let them have the sooner the end is reached.

Some years ago the manufacturer built a boiler according to his own ideas and specifications, and figured in some special features which made his boiler a superior type to that of his competitors, and he got away with the business. As the years rolled along and the boiler engineer and mechanical engineer got into the limelight by slipping in between manufacturer and consumer, a new order of conditions is started. The engineer advises the consumer what kind of a boiler he should have, makes up the spe-

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* From an address delivered at the twenty-ninth annual convention of the American Boiler Manufacturers Association, Pittsburg, Pa., June 26.

† Philadelphia representative of Champion Rivet Company, Cleveland, Ohio, and Parkesburg Iron Company, Parkesburg, Pa.

cifications, indicating the quality of the material, etc., invites every concern he ever heard of to bid, and the competition goes merrily on. Quite often the man who quotes the lowest price has not the best facilities, and his competitors wonder if he has left out the plates, tubes or rivets in making his bid, and then forgot to add any profit. As competition continued, and at times became more severe, some concerns were accused of using light weight plates, cutting down the number of tubes, or substituting the quality of material called for, and of resorting to various ulterior methods and means to cut down the cost. Such methods have since been discontinued. The introduction of State inspection laws and the increase and growth of insurance and inspection bureaus have helped to minimize unfair competition and standardize boiler building to-day.

Building Standard Types of Boilers

In building standard types of boilers the competition is based on shop facilities and shop organization to handle the work, and the concern whose officials are shrewd enough to buy right, build right and sell right are the ones whose efforts are crowned with success. Some manufacturers whose facilities and financial responsibility are equal to their competitors instead of criticising their competitor when he underbids them, should turn the searchlight on themselves, and find out if there are any loopholes, leaks or weak spots in their own organization. At the present time there are more concerns to-day who are exchanging ideas and opinions with each other on a friendly basis than ever before in the history of the industry. There is no law—Sherman, Clayton or otherwise —that can prevent boiler manufacturers from getting together locally or generally and endeavoring to regulate their business to make it more profitable and competition more equitable.

A great deal has been said in criticism of the Gary dinners, which, even if they may have affected the digestion of the diners, resulted in a benefit to the steel maker and the boiler manufacturer as well. In the old days when prices of steel commodities were supposed to have been fixed by common consent, boiler manufacturers—in fact, all branches of the iron and steel fabricating line—were able to do business on a more even basis, and the consumer or common public paid less for the finished product.

The Steel Corporation, although severely criticised as a money-grabbing trust, did more to stabilize and keep on an even keel the iron and steel market, and permitted more independents to compete and get rich, than could have ever been accomplished by all the laws ever enacted.

Specializing Business

In boiler manufacturing and bettering of conditions a great many companies have decided that the business must be specialized. The shops that undertake to build every type of boiler used have their troubles, and generally get nowhere. The shops that specialize in one or two types of boiler that are in demand and arrange their facilities and equipment to handle same accordingly are the ones that are naturally the successful bidders and get the business. In some cities there are concerns who do only marine work, others build watertube boilers, and others devote their time entirely to return tubular and special type boilers—such concerns, sticking to their own line, and not interfering with the others, on the contrary, boosting each other's interests. Imagine a condition of that kind twenty or more years ago! I well remember that if I sold one of those concerns and the other fellow found it out, my business relations were severed instanter.

I find also that a great many of the old and reliable boiler building concerns of this country have discontinued the building of boilers entirely. Have they gone out of business? I should say not. They are operating shops five or six times as large with more and heavier machinery than they ever thought of using on boilers, and are devoting their entire attention and efforts to the building of tanks and general plate construction. These people tell me they haven't the time to build boilers, and that if they attempt it other lines of their business will suffer. The same may be said of the large boiler shops. It means a loss of money to them to litter up their plant with a lot of tank work and thereby interfere with their boiler building schedule, which means a consequent loss of money.

What a hue and cry went up from a great many railroads in this country when the subject of compulsory Federal locomotives boiler inspection was broached! Most of these roads felt they were going to meet their financial doom. The law, irrespective of all kinds of obstacles, was finally passed, has been in effect for about five years, and instead of being a detriment has been of great benefit to the railroads and a savior of life and property as well. The records of the Bureau of Locomotive Boiler Inspection speak for themselves without a chance for argument. The same results could, no doubt, be obtained from national uniform boiler inspection laws. No one state with its own special laws can keep the manufacturer of another state from coming in and taking his share in the boiler business if he wants it, and the boiler maker in the State with the fence around it can go after business in any other State or Territory in the Union and get it, providing he meets with the requirements and has the facilities to do the work.

General Discussion Needed of Standards, Methods of Production and Labor Cost

During the past years there has been too much harping on the specifications and quality of material used, and not enough free and frank discussion of standards, methods of production and labor cost involved. Selfishness and jealousy injected into competition should have no place in the boiler business. Such methods prevailed at one time, but the sooner they are completely eradicated the better it will be for all concerned.

The industry has developed to be a tremendous factor in our world economics, and should be elevated to the highest plane of ideas and highest commercial development. This can be brought about if every member of this association will endeavor to secure the confidence, friendship and respect of his competitor and impress him with advantages to be derived from a united effort of all the boiler manufacturing concerns in these great United States to cut out unnecessary red tape, insist on equitable, uniform specifications and inspection laws, and agree to live and let others live.

Campaign for War-Time Economy.—A plan to save lost motion in business during the war and in this way to release men and materials, is advanced in a bulletin issued by the Chamber of Commerce of the United States cooperating with the Council of National Defense. The Commercial Economy Board of the Council believes business cannot continue to render the elaborate service possible in time of peace and asks the voluntary assistance of every business man. In practically every trade there have grown up non-essential services, some of them mere conveniences and others hardly that. In time of peace they may be permissible. In time of war they are a serious waste and should be stopped.

Making the Business Earn a Profit—II

**Overhead and Expenses That Must Be Allowed For It—
Elements of Cost That Go Into the Overhead Charges**

BY EDWIN L. SEABROOK

How much does it cost to conduct business, what are the component parts of this cost, and how do these originate? are vital questions to every boiler maker. Vital as these are, they are applied by some, understood by others, misunderstood, misapplied and unheeded by many more. These questions are more than vital—they go to the very root of profitable business conduct. Ignorance of the cost of conducting business and its proper application are probably responsible for seventy-five percent of the evils growing out of estimating and price-making. The lack of a proper knowledge of this subject and its application to selling prices spells disaster. The matter as presented in this article will be from the standpoint of a shop doing a general, rather than a special, line of business. The profits derived from the boiler making business depend upon a knowledge of this cost, its origin and its proper application to estimates given and prices charged.

Every price for a boiler contract or repair work is composed of four parts, i. e., cost of material, cost of labor, expense of conducting business, and profit.

Probably this statement ought to be changed to: should be composed of four parts, because experience demonstrates very clearly that prices are offered and many contracts made without consideration given to the third and sometimes the last-named element. No intelligent estimate or price can be given unless each of these four elements is definitely known.

What would be thought of a supply house that received a carload of merchandise, tore up the invoice prices and told a subordinate to mark the selling price on each article? Would this concern be naming its price in any more haphazard way than the boiler maker who has no definite idea as to what it is costing him to conduct his business or the proportionate amount of such cost that should form a part of every estimate or piece of work performed? What would be thought of the boiler maker who offered to do a certain piece of work for a fixed sum without knowing the amount of material required? Would such an offer be any less accurate than one in which the cost of conducting business is not known or considered?

The cost of conducting business exacts a certain charge from every contract or piece of work performed. The amount of this charge can be just as definitely determined as the material and labor required. Naturally, material, labor and profit are included by every one; many, however, unwittingly delude themselves as to the true nature of the transaction, because the third item—overhead charges—is not taken into account.

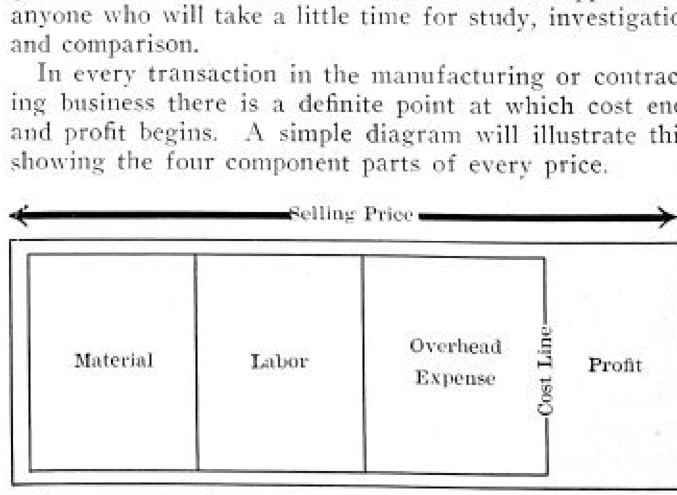
Cost accounting and proper bookkeeping methods must go together. Many have the impression when the subject of cost accounting is broached that they must necessarily go into complicated, technical and elaborate bookkeeping requiring expert accounting. For the ordinary business nothing is further from the facts. A bookkeeping system, quite simple, which can be installed and kept by anyone who has some knowledge of its first principles and making proper entries, will answer all purposes. It is possible to have bookkeeping without any cost accounting in it, but it is not possible to ascertain the cost of conducting business without a proper set of books. The great defect in the bookkeeping of many establishments is that it shows only one thing—how much is due to others. A proper bookkeeping system will not only show how much is due the firm and owing by it, but the operating results of the business. It will show how much was disbursed and the identical items for which these were made. It will show how much was disbursed for the various items necessary in the cost of carrying on the business.

No doubt someone asks: "Why all this agitation about overhead charges or the cost of conducting business? Years ago manufacturing firms knew little or nothing about this expense, yet made money." In a certain restricted sense this may be true, but there never was a time when any business could be managed without expense. Competition among well-conducted manufacturing establishments has always necessitated a cost system—the keener the competition, the more efficient the system.

Business is managed to-day on more exact knowledge of the details of each transaction, or, in other words, on more scientific lines. There was more leeway years ago between cost and selling prices; estimates were given and contracts made in a more or less haphazard manner, and conditions allowed a much wider margin of the so-called profit that went with these methods. It is a wellknown fact that all lines of business are to-day transacted on smaller margins than ever before. The greater the volume, the smaller the profit on each unit. The profit on such unit narrows as production increases. If a boiler maker has a contract for making one special boiler, he will ask a certain profit. If he has ten of these to make, he will be satisfied with a smaller profit on each one. If he has a hundred to make, he will be satisfied with a still smaller profit on each unit.

From this it will be seen that as demand and production increase, competition becomes a little keener and the margin between cost and selling price narrows, the profit on the unit is small. Economic agencies are forcing a narrower margin between cost and selling price; the unit profit gets just a little smaller as the volume of business grows larger. These are facts that must be apparent to anyone who will take a little time for study, investigation and comparison.

In every transaction in the manufacturing or contracting business there is a definite point at which cost ends and profit begins. A simple diagram will illustrate this, showing the four component parts of every price.



There Can Be No Profit for the Boiler Maker Until the Selling Price Passes the "Cost Line." This is Definitely Fixed by the Amounts Expended for Material, Labor and the Cost of Conducting Business on Each Contract or Piece of Work.

There can be no profit for the boiler maker until the selling price passes the "cost line." This is definitely fixed by the amounts expended for material, labor and the cost of conducting business on each contract or piece of work.

The first three—material, labor, expense—are linked together and form the first cost. The fourth, profit, is joined to these and the four compose the completed transaction or selling price. It should be noted that the first three of these items are fixed—that is, in every contract completed or piece of work performed the total of these comes to an unyielding, inflexible amount represented by a *cost line*. No matter what the selling price may be, this amount is exacted from it before there is any profit. Between this line and that of the completed transaction, or selling price, there is a margin of safety or profit. This statement must not be construed to mean that there can be no variation between the estimated amount of these three parts and those actually used in the performance of the transaction, but that in the very nature of the transaction, when these parts of it are completed, there is an inflexible amount demanded from the selling price.

Is it not, therefore, absolutely essential to the safety of the business to know where cost ends and profit begins? The boiler maker who knows this is able intelligently to name his selling price. This axiom may be deduced from the foregoing:

To name an intelligent and adequate selling price an approximate certainty of the cost of conducting business is an absolute necessity.

The Dollar as a Messenger

The boiler maker is sending out his dollars every day. Some of these go for material, labor, his own salary; others for a hundred different items, and the process goes on every business day in the year. These dollars that are sent out in the many different directions come back in the form of a price that is set upon a combination of material, labor, expense—the latter invisible, but very real—and profit, if there be any. In this process of coming and going, these messengers may increase or decrease, lose part of themselves, or come back with a companion, depending entirely upon the amount of work given them to do. They will come back just in proportion to the number of them that it takes to perform the completed transaction to the price asked for it. If more are asked to come back than were sent out, there will be an increase. If the task imposed has been too difficult, if less were put into the price than must be sent out, there will necessarily be a decrease in the returns.

It becomes essential, therefore, to show where and how many of these dollar messengers were sent out and to check the number returning from each transaction. A messenger once lost can never be found; it can only be replaced by increasing the number of those sent after it. Business intricacies prevent the following of each dollar as it plays its individual part in the transaction. Combinations of dollars are, therefore, sought, comparing the number of dollars going into any one transaction, and the number that must be returned in order to find the basis to ascertain the profit. The necessity for tracing the dollars from the time they are spent until they come back is self-evident. The outgo will be for the first three parts of the price—material, labor and cost of conducting business. The latter outgo is variously termed overhead, expense, cost of doing business, etc. It will serve all purposes if it is designated *cost.*

The Elements of Cost

The question naturally arises: What are the elements that make up or enter into cost? These are clean-cut and can be determined very easily. The great difficulty is that most men in contracting lines deceive themselves as to the real nature and amounts of these cost items. Many juggle themselves into believing that they are quite small and do not amount to a great deal. This is largely the case, because they have never taken the trouble to make a complete list and amount of these expense items. A contractor in one of the building lines in a Western city told the writer that he had found forty-nine items of cost, and was not sure that he had discovered all of them. No doubt the experience of boiler makers who have dug deep enough into this cost will tally with this contracting firm. No business can be conducted without this cost. The moment business is started cost begins and goes on day and night, every day in the year, increasing as the volume of business grows larger.

There are certain costs inherent to every business. In preparing a list of items which compose the cost of the boiler it is not possible to fit the exact conditions to the individual business. There will be some variations, but these will be slight and not affect the principle or general proposition. In point of accuracy each individual business must prepare its own lists of cost items and amounts from its records and experience. For all practical purposes in the boiler making business, a fairly accurate list of these cost items can be prepared, and with slight variations to fit the individual business, these can be used in determining the cost.

Every boiler making business has, without regard to size and practically few exceptions, the following items of cost:

Rent	$——
Innsurance (fire, liability, accident, etc.)	——
Taxes (city, county, State, Federal)	——
Advertising	——
Telephone and telegraph	——
Printing, stationery (including trade and daily papers)	——
Postage	——
Carfare (where not charged on work)	——
Shop supplies (lubricating oil, rags, waste, etc)	——
Lost time of workmen (time paid for but not chargeable to any work	——
Freight (where not added to cost of material)	——
Light (gas, electricity, etc.)	——
Heat (gas, coal, etc.)	——
Power (gas, electricity, steam, etc.)	——
Depreciation and repair of tools and equipment	——
Allowance (where a reduction must be made to get settlement)	——
Hauling (where a wagon or truck is owned by the establish ment. This would include all the cost of operation, such as drivers' wages, feed, repairs, shoeing, license, depreciation, etc.)	——
Bad debts	——
Collections	——
Legal expenses (attorney's fees, etc.)	——
Mercantile reports	——
Charities, donations, etc.	——
Dues (trade organizations, etc)	——
Interest on investment	——
Salaries (money paid to those for whose services a charge is not made; for instauce, bookkeepers, stenographers, porters, errand boys, managers, and owners where the latter do not work on a job; where they work part time, the *money they get for the time they do not work should be included in this item.* Where a driver is employed his wages should go in the *hauling* item of this list)	——
Total	$——

The next installment of this article, in the August issue, will deal with a discussion of these cost elements, the analysis of a business and getting the cost of conducting business into the price.

(To be continued.)

The Boiler Inspector's Job.—In concluding an address delivered at the Ohio Boiler Inspectors' Convention, Mr. John F. Whitely, inspector for the Fidelity & Casualty Company of New York, endorsed boiler inspecting as a worthy occupation, stating that the longer you worked at it the more you enjoyed it. It has its little dangers and discouragements, but they act as an appetizer, and, if you do your duty, you will find the work pleasant enough. If you do not do your duty, it may be decidedly unpleasant for you.

Boiler Manufacturers' Convention

Report on Nation-Wide Adoption of Uniform Boiler Laws — Boiler Manufacturers' Part in the War

Progress in the adoption of the A. S. M. E. Boiler Code and the boiler manufacturers' part in the war were the predominating subjects discussed at the twenty-ninth annual convention of the American Boiler Manufacturers' Association, held in the William Penn Hotel, Pittsburg, Pa., on June 25 and 26.

The first session of the convention was called to order by Mr. M. H. Broderick, president of the association, at 10 o'clock on the morning of June 25. In outlining the war problems that confront the boiler manufacturers, Mr. Broderick pointed out that whereas at previous conventions a great deal of time was devoted to discussion of boiler plates, bars, rivets, etc., the great problem this year is the war problem. In the near future boiler manufacturers will be called upon to assist the Government in the building of boilers and other parts for ships. Many of the boiler shops in the interior as well as many on the coast are equipped so that they can handle the type of watertube boiler that will be required for the vessels of an emergency cargo fleet, and one of the principal problems that must be solved is that of transportation of the finished product to the sea coast.

The first thing on the programme was an address by Mr. Thomas E. Durban, chairman of the Uniform Boiler Law Society.

Progress of the A. S. M. E. Boiler Code

Extract from Mr. Durban's Address

A number of you have undoubtedly received Bulletin No. 9, which is the last report of the efforts of the society which have honored me with their chairmanship. A great many of the legislatures in the various States convened in January, and while we met with some keen disappointments we feel that the work accomplished is very far-reaching in its results. Our effort has been very largely an educational campaign. All parts of the country—East, West, North and South—have had attention, and public opinion has been directed toward the effort we are making, and we are quite confident that in States where we failed to get the legislation through this time that at the next meeting of the legislature we will have no trouble in putting the legislation through.

In harmony with our experience, we have in all cases limited our effort to get an enabling act through the legislature to create a board to draw rules. We have met with a great deal of opposition in several States because of the fact that we refused to participate in legislation concerning the detail of inspection of boilers. The Boiler Makers' Union, under the leadership of Mr. James J. Casey, has been very insistent that only boiler makers be appointed as inspectors, and in many states had this rider attached to our Enabling Act, which defeated it. We have steadfastly adhered to our cause, and not participated in any legislative matters pertaining to the manner in which the code should be applied or who should have jurisdiction over it. These are matters which must be settled in the various States according to the existing conditions and the desires of the people in power.

We would report to you in detail the following progress:

New York.—The Code Committee of New York has formally adopted the A. S. M. E. Code and reported it favorably to the Industrial Commission. For boilers in the factories in the State of New York the Code will be effective July 1, 1917, and for new construction it will be effective January 1, 1918.

Michigan.—Our Enabling Act was passed unanimously by the House and Senate, and has been signed by the Governor, and the Committee will be appointed to proceed with the adoption of the Code.

New Jersey.—An Enabling Act was passed by the Legislature and signed by the Governor, the same as in Michigan, and we understand that the Committee has been appointed and in due time New Jersey will issue the Code and the date of its going into effect.

Minnesota.—Minnesota has issued a notice through the duly appointed representatives of the Inspection Board of the State, and on and after January 1, 1918, all boilers must be made according to the boiler code of the American Society of Mechanical Engineers. This has been approved by the Governor and renders the Code absolutely effective after the date mentioned.

Missouri.—Our bill failed in Missouri, due to political reasons, but the city of St. Louis has passed the Code to put it in operation, as has also the city of Kansas City. With the example set by these two great cities of the Sate, we believe that at the next meeting of the Legislature we will have no trouble in having the Code adopted by the State of Missouri.

Colorado.—In Colorado we did not succeed in getting the bill introduced to the Legislature, due to the fact that there was political turmoil during most of the session of the Legislature, and, as a matter of fact, it is our belief, based on the advice of competent attorneys, that it is not necessary to get a bill passed in Colorado in order to have the Code adopted, as the new Industrial Commission of the State will have the power to adopt the Code.

We had our bill introduced in the following States, where it failed of passage, due to various reasons: Washington, Oregon, Texas, Tennessee, Rhode Island, New Hampshire, South Dakota, Iowa, Utah and Kansas.

While we are disappointed at not getting more net results, yet on the whole we are inclined to the belief that the Code has made such progress that its momentum will be irresistible at next meeting of the Legislature, which will be, in most States, two years hence. In no State was the Code defeated on its merits. The arguments in favor of the Code have not been successfully met in any State. All agree on the necessity for a code, and in no State has the A. S. M. E. Code been successfully attacked.

Canada.—The Province of Manitoba is revising its boiler code, and expects to call a meeting in the near future with the idea of getting the co-operation of the other provinces in Canada, with the hope that a universal rule can be made for Canada. We are in correspondence with the various provinces, and there has been expressed a desire to make the A. S. M. E. Code operative in Canada. In this we have the strong support of the Province of Ontario, which is one of the leading provinces in Canada, and also the support of the leading boiler manufacturers throughout the entire Dominion.

Massachusetts.—Our situation in Massachusetts has not been materially changed. We had hoped from the earnest effort that Mr. Luck put forth in attending the meeting in Washington, and also the public meetings of the Code

Are Fire Box Sheets Welded With The Oxwelding Process Efficient?

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Committee of the American Society of Mechanical Engineers, that by this time we could report some progress in Massachusetts, but, unfortunately, we cannot do so.

The States and cities in which the Code has been adopted, or is in process of adoption, are as follows: New York, New Jersey, Pennsylvania, Ohio, Indiana, Michigan, Wisconsin, Minnesota, California, Kansas City and St. Louis, Mo.

With the progress that we have now made, we predict that the Code will be practically universal within a period of four years more.

You will be interested in knowing where our money comes from and how it has been spent. The receipts for conducting this campaign are as follows:

Contributor	Amount Contributed	Amount Asked
Material manufacturers	$3,635.00	$3,000
Insurance companies	608.43	500
Boiler manufacturers	660.00	1,000
Locomotive manufacturers	1,000.00	1,000
Steam shovel manufacturers	460.00	500
Steel tank manufacturers	200.00	...
Tubular boiler manufacturers	894.66	1,000
Hoisting engine manufacturers	382.15	500
Low pressure heating boiler manufacturers	500.00	500
National Electric Light Association	1,000.00	...
Traction engine manufacturers	1,000.00	1,000
Watertube boiler manufacturers	2,000.00	3,000

The total receipts from all sources have been $11,890.54 out of a request for $13,500.

Recognition of the A. S. M. E. Code has also obtained from the Government the specifications for power plant equipment for the naval training station at Newport, R. I., calling for boilers and accessories to comply with the Code. In a conference at Washington on marine work it was decided in regard to the boilers for the emergency fleet that those boilers should be built according to the A. S. M. E. Code, and at that meeting the fact developed that the Navy Department, while it had not come out and accepted the Code, had come out and accepted the Code in so far, very largely, as workmanship was concerned.

In regard to the remarks of the President concerning the attitude of this organization towards marine work, I would say that a number of gentlemen met in an advisory capacity with the U. S. Government and I am not betraying any secrets when I tell you that within a very short time specifications will be issued that will put every boiler maker in the United States in position to bid on the marine type of boilers; any shop that is equipped, as our shops are all equipped, to do the work under the A. S. M. E. Code, will be equipped to manufacture a marine type of boiler of the watertube type which will have the endorsement of at least the Emergency Fleet Corporation. The specification will be such that the boilers can be readily shipped anywhere. Of course the difficulty that confronts us all now is the difficulty of getting material and labor.

The subject that is very close to my mind, however, is the fact that this organization is not as concretely organized as it should be, and this has been brought out by the war. When the Government wanted to know what could be done on boilers for the emergency fleet, there was nothing on record to show what the boiler manufacturing capacity of this country was. It is quite possible for the Government to get the production in almost all other lines—and they have got it. I have found out that all trades had some organization which could render service to the Government in the way of telling them what could be done. Our trade, unfortunately, is not in that position.

Years ago, at my own initiative, I took up the matter of getting a universal specification, in order that we might have at least a foundation or a common ground. I think that the thing should be carried further. I think that we should have, for our own enlightenment, a universal cost sheet.

Another thing that I think we could agree on if we could get together on it is a sale condition, relative to the receipt of the money and when the money shall be paid. It is not infrequent to make your contracts 50 percent on the shipment and the balance scattered along through the life of the contract. As a matter of fact, you have no control over the shipment. The contract should be made 50 percent when ready to ship, and if the building is not ready, or if the sidetrack is not built, or if the location has not been definitely decided upon, it is not incumbent upon the boiler manufacturer to carry that material and investment in stock, awaiting the pleasure of somebody else, perhaps not the pleasure but the necessity. If we take a contract for a large number of boilers and have them ready to ship, when they are ready to ship our money is invested. Now if, beyond the control of anybody, the shipment cannot be made, we ought to embrace in a general form of contract that we get at least half of our money and let the fellow who is back of the enterprise bear his share of the burden.

Again, there is loaded on the boiler manufacturer, many times, auxiliaries. A man is compelled to bid upon not only brick work and installation; he is compelled frequently to take the chance on foundation work, superheaters, stokers, soot blowers, and other auxiliaries which he does not build himself, but which he is responsible for in his contract.

This organization should take its place, together with other great organizations in this country, and assume a more active, definite line of action in recommending to its members the conduct of its business. I think that this organization ought to take on a definite form and have a paid representative who does nothing else but look after the interests of the boiler manufacturing art.

Discussion

Secretary Covell: I fully appreciate all that Mr. Durban has said, but I can assure you that there are many difficulties in the way of accomplishing all that he idealizes. I presume that every man in the room representing a manufacturing establishment received from Washington a long list of questions to be answered for a national inventory of our national manufacturing resources. I was asked, as secretary of this organization, to present a list of the names of the members of this association, which I promptly did. I therefore conclude that everyone received a notice, and that the authorities in Washington must have the information which Mr. Durban says it is essential that they should have; if they have not, it is their own fault. Now it would seem ridiculous to duplicate work. This board have taken it upon themselves to get the information; why should we, as an organization, duplicate that same work?

The Chairman: Next on the programme is an address by Mr. George A. Luck, representing the Massachusetts Board of Boiler Rules, on the subject of Steam Boiler Regulation in Massachusetts.

Steam Boiler Regulation in Massachusetts

(An abstract of this address will be published in a later issue of THE BOILER MAKER.)

Discussion

Mr. Covell: Do I understand that without any further qualification the State of Massachusetts will accept a boiler stamped A. S. M. E.?

Mr. Luck: Boilers so manufactured comply with the Massachusetts rules as well as the A. S. M. E. I have never asked a State, a city, a town or an individual to adopt the Massachusetts standard rule. Any rules you might adopt, I don't care which one of them, are good.

The Chairman: Inasmuch as the Massachusetts standard and the A. S. M. E. Code are practically the same, has the Commonwealth of Massachusetts given the A. S. M. E. Code any consideration as to its adoption instead of the Massachusetts standard?

Mr. Luck: In Massachusetts we have a law so worded that we could make changes in our rules any time the board sees fit, and by law they must hold two public hearings per year, one hearing in May and one hearing in November. Now, they can go to work and hold any other meetings they wish. Now, the board has not received any petition from the Uniform Boiler Committee or from the A. S. M. E. to change their rules. Our law strictly provides how our changes shall be made.

Mr. Pease: I would like to ask a question in reference to the stamping of a head. The Massachusetts law, article 20, I think, says that heads shall be stamped in three places on each side.

Mr. Luck: The head should be stamped in two places; there is no requirement for three places for stamping on a head. Those two places can be on one face, on the outside, right and left side.

Mr. Connelly: I wish to offer a resolution to read that we petition the State of Massachusetts to revise their rules so as to bring them in harmony with the A. S. M. E. boiler code.

Mr. Covell: I move a vote of thanks to Mr. Luck for coming all the way from Boston to make this very interesting and instructive address, and to the State of Massachusetts for allowing him to come.

Mr Connelly: I wish to second that motion and to add to it that the secretary write a letter to the Governor of the State, thanking him for his courtesy in permitting Mr. Luck to come.

The motion was seconded and adopted.

The Chairman: The next business in order is the reading of the minutes of the last meeting.

On motion, the reading of the minutes was dispensed with.

The secretary next presented invitations from Buffalo and Philadelphia to hold the next meeting of the Association in those cities.

Monday Afternoon Session

The chairman appointed Mr. Shaff, Mr. Ashley and Mr. Coggswell as a nominating committee and on the auditing committee appointed Mr. J. Don Smith as chairman, with power to select two more members.

By-Products of the War

BY C. V. KELLOGG,* VICE-PRESIDENT

ABSTRACT

The people of America do not realize the conditions existing at the present time, but before long they are going to realize, if they never did before, the duty and responsibility that they owe to the Government and the burden that the Government imposes upon the people. There is a reason why the world is in its present state of destruction with its desire to destroy. The thought of Russia, France, Germany, the thought of America, expressed through their great thinkers and writers, has been that they have done their great share in bringing the remainder of the world to the high level that they and each of them have already attained. With this self-created superiority there comes another thought, and that is the thought of the inferiority of the neighbor, the inferior character of the man whose skin happens to be of a slightly different color, or who happens to be of a different nationality, that people of the different nations are referring to the other nations of an inferior standard. You will find, doubtless, expressions of contempt, wherein, through these original expressions, they speak insultingly of their neighbor upon every hand. This has bred hatred, contempt and discord, and as consequence of these differences and these hatreds the world to-day is shooting each other and America finds herself on a certain day, the most fitting day of the year, Good Friday, involved in this war.

To-day, four-fifths of the people of the civilized world, of the one billion six hundred and fifty million human beings, four-fifths of the area of the globe, exclusive of the polar regions, are mowing each other down in battle fields and upon the seas. This is the beginning of a new chapter. How many of us realize the responsibilities before us?

But business men of the United States will awaken. We never realized that we needed a government as we need it to-day. We never realized how impotent and helpless we would be without a government. This Government, in order to maintain its standard, is dependent upon the business man not only in time of peace but in time of war. It must depend upon its railroads, its industries, its banking resources and upon the great captains of industry and commerce that are directing these great forces of development.

We did not enter this war for the purpose of aggrandizement or for extension; we entered the war for the purpose of maintaining that which this country was established for, freedom and liberty to mankind, and there will be left nothing undone, there will be no faltering on our part that will leave uncertain the courage of the American people or the purpose of the American Government. This Government has authorized the issue, either in bonds or certificates, of seven billion dollars, all of which must be borne by the industries of this country; and yet, before this war is over, it is my opinion that we will be called upon to support this Government to the extent of at least twenty-five billion dollars. It will be up to the cool, calculating, shrewd American business man, not as such, but as a patriot, to see to it that every step is taken that will make this investment a sound one, so that our bonds will always be at a premium.

There is another duty thrown upon you. Many thousands of men and women all over this country will say, "I want to help my country, I want to help in this war." To do this they will have to sell their securities and they will be dumped upon the market. The business man must meet this condition. Not only must you protect your own business, but you must assist to protect others, and this will bring about a different feeling between the Government and business. It will create a different public sentiment in favor of business. It is up to the business men of this country to see that their securities are not depreciating to the extent of bringing about destruction on the one hand and that investment in Government securities is not impeded in any way to such an extent as to prevent the Government from carrying out its purpose.

Now, with all this, what are some of the by-products of this war? First, our national vision has been turned away from our shortcomings. Introspection has been our occupation. It found the rewards of labor unequally divided. It brooded over internal problems until our vision was blinded and distrust of each other existed. To-day,

* Kellogg & McKay, Chicago, Ill.

as between the public and the Government, there is more of consideration and confidence. It will teach business men to have more confidence in and good will toward his neighbor and competitor.

Second, we have obtained financial independence. We have changed from a debtor nation to a creditor. The inflow of money will create a prosperity such as we have never seen before, and if you do not accept the opportunity the responsibility lies at your door.

Third, we have and are gaining a broader industrial development, a preparedness that we never thought possible, the better able to supply our own needs. We are self-reliant, able to produce that which we depended upon other nations for, raw material for which we were dependent upon other countries, to-day we are producing ourselves.

Fourth, it is creating a change in public sentiment as to tariff. Repeatedly have bills been introduced into Congress to create a tariff so that protection should be given to our industries and our labor. Congress realizes that tariff is a necessity and that it is a safeguard to American business and American labor, and at last a necessity to finance the needs of this country.

Fifth, another product is our merchant marine. This has been almost talked to death and is still sick. We have to-day only one vessel sailing from the Pacific coast. Japan awoke to the opportunities, furnished that which we neglected and all our commerce from the West is carried in Japanese bottoms. To-day, not only Congress but the entire nation is exerting every force to build ships, not only to transport our soldiers, but to feed the starving nations.

Sixth, it is giving us a greater export trade, a foreign market for our surplus, especially when we will be overproduced at home. Never have we been able to compete with Germany and other nations. To-day, if we are alive to the opportunities, our industrial life will look beyond our own borders and recognize the advantages thus derived.

Seventh, the most important is a new relation of confidence and co-operation as between the Government and the business interests and the general public, and between business man and business man.

Belgium to-day lies prostrate, the pity of the world; Russia, with 170,000,000 of scattered population, suffering the throes of the struggle of a new democracy; England within three weeks of starvation the moment the submarine destroys the last ship that can take food to her borders; France drenched in blood, presenting a picture of pity to the world—this combined picture of adversity called for co-operation, not only between all the nations that are now struggling for their existence, but for America to co-operate and join with them. And do not for a moment underestimate the present conditions. Germany, with her 70,000,000 of inhabitants; Austria, with her 60,000,000 of people; with the great railroad facilities which Germany has, one of the greatest governments in the world as to its efficiency, everything within its own borders sufficient to maintain not only its government but its people, her railroads developed to the extent that she can transport her troops from one border to another in a night's time, while the Allies are bringing their forces from the four quarters of the globe—don't forget that this war will not end within one day or one year or years.

The burden of the entire war necessarily must fall upon America, the credit nation, who is able to mobilize her money to finance the world. She must produce the ships to transport the food to the starving nations, and the question necessarily arises as to the problems that confront us and what are and what will be the conditions at the close of the war. It may seem to you that the nations at war, owing to the immense destruction, will create a greater market for you, but remember that Great Britain, France, Italy and all of the Allied nations have become more efficient, more self-reliant, and within the last thirty-six months have created a greater efficiency than they have in the last thirty-six years. At the end of the war, when it does come, the men who have been hard trained, the women who have been obliged to take the places of the men, will be capable of producing for those countries in a way such as we have never dreamed of.

And still there is another proposition, and that is the financial ability of those countries. Some of you may remember the conditions that existed after the Civil War, and when the manufacturers and industries from the North went to the South to sell their products the people in the South were unable to buy because they had no money to pay for them. This will be largely true of the countries now at war, and it will be a long period before these countries will be able to build and replace any improvements except so far as it may be necessary to upbuild their manufacturing industries, and they will be seeking to market their products in this country and other countries that are able to finance them.

This brings us to the personal consideration that we at this time should consider, and that is, where are we at? This line of industry seems to me entirely different from any other industry. The industry has no organization. There is nobody to present facts to the Government as to the ability or capacity of this industry. Prices and market conditions are advancing with you so rapidly that you are unable to keep pace with them. And yet what will be the future? No one can tell the market conditions that you have to face, and yet it has been said that the officers of your body have been criticised because they have been unable to obtain the necessary information or to place this vast industry, which runs into millions of dollars, upon such a plane that it can meet the conditions which are necessary for your business.

What will you do when the war closes? While I agree that it is a long time off, you who are necessarily obliged to make contracts as to your materials, as to labor conditions, how are you going to meet the conditions when the markets go down? It would seem to me that there is no other word or question than to adopt that which the nations have had to adopt, and that is co-operation, a closer co-operation between yourselves. Bring yourself into such a position that you are willing to lay upon the table the cost, not only the manufacturing cost but the cost under market conditions, and place yourself in such position that you are able to aid the Government in financing the great problems that we must meet, but also to aid yourself in being able to protect yourself when the time comes that you need protection.

Let us remember that America must finance the world and the business men of America must finance America. America must produce the men that will face the struggles which are necessary to bring about a lasting peace, a peace which shall herald to the world at large freedom and liberty to mankind.

We never can forget the duty that we owe to Russia or the duty which this Republic owes to France. When the people who had adopted this country as their native soil were stuggling to make it a country of freedom and liberty, they appealed to France, and when our forefathers, in the last struggles, were unable to further throw off the burdens, they asked for relief and she came to us and furnished this country not only fifty million dollars of money, being two dollars for every man, woman and child in France—her population at that time was only twenty-five million—but in addition to that she spent from three hundred and fifty to seven hundred million to bring about victory to this Republic. Not only did she furnish her soldiers to fight alongside of ours so that at the time of the surrender of Cornwallis there were 5,500 American regulars by the side of 7,000 French troops.

Can we forget her? Were we not right in listening to the appeals of this country? Were we not right in enforcing the law that every American citizen's life should be of some value, whether within the borders of America or upon the seas? And when to-day we behold France invaded, her skies red with the fires of warfare, her soil with the blood of men, and not only her liberty but the liberty of the Allied nations in danger, is it not right that America should answer and let the answer be one that will ennoble and inspire humanity the world over? Let it be one that will teach the world before we are through, every man in the world will take his hat off, and every emperor, king and czar take his crown off in the presence of the starry banner of the Republic.

Let us teach not only by our efforts, but by our industries, by our finance and by our co-operation, and every effort that is possible within our power, so that the world will realize that America has entered the war and will perform its duty and will be the foremost champion of human rights and human liberty, and when the last chapter is written, that our boys will come sailing home with wreaths of gratitude and victory woven from the roses of England and the lilies of France.

Manufacture of Seamless Tubes

Mr. Mason, of the National Tube Company, Pittsburg, Pa., showed on a screen several reels of moving pictures showing the various processes of manufacturing seamless tubes, and fully explained these manufacturing operations. At the end of the address an invitation was extended to the association to visit the company's works at McKeesport on Wednesday.

Committees on Uniform Cost and Uniform Contract Sheets

Motions were carried providing for the appointment of committees to work out a uniform cost sheet and also a uniform contract sheet for boiler makers, the committee reports to be presented at the next annual convention of the association.

Standard Flanges for Safety Valves

Owing to the absence of Mr. E. R. Fish, of the Heine Safety Boiler Company, St. Louis, Mo., a paper which he had prepared on the subject of "Standard Flanges for Safety Valves" was read by the secretary.

Requirements for Marine Boilers

In a communication, Mr. E. R. Fish, of the Heine Safety Boiler Company, called attention to needed changes in the requirements of the Steamboat Inspection Service for plates and details of marine boilers. While the U. S. Shipping Board seems perfectly willing to accept the A. S. M. E. Code for boiler construction, nevertheless the boilers so built will eventually after the war pass under the jurisdiction of the Steamboat Inspection Service, and in anticipation of this the Board of Supervising Inspectors has amended its rules, bringing their requirements in harmony with the A. S. M. E. Code. The main difference now existing, however, is the requirement of the Steamboat Inspection Service making 58,000 pounds per square inch the minimum tensile strength, which, in Mr. Fish's opinion, is unjustified. According to present requirements the manufacture of marine boilers is unnecessarily expensive and difficult.

Mr. Ashley: Do you know the difference in price between that fixed by the Government for plate and that which we have to pay, and also our difficulty in getting the material? It would seem to me that, inasmuch as boilers are absolutely necessary to manufacturers taking contracts that pertain to the war, we ought to get some action whereby demands for boiler material will receive some recognition at the mills through the Government and we can get action.

Mr. Kellogg: Wherever material is needed for boilers to be used in producing material for the Government, if the Government is advised of it the material for the boiler will be forthcoming.

Annual Banquet

The usual banquet, which was scheduled for Monday evening, was dispensed with, and in its place an informal round-table dinner was held, the difference in cost, amounting to $325, going to the Red Cross Corps.

Tuesday Morning Session

The Tuesday morning session of the convention was called to order at 10 o'clock by President Broderick, who introduced the Hon. E. S. Sweet, Assistant Secretary of Commerce, Washington, D. C.

Industrial Co-Operation in the War

Abstract of Mr. Sweet's Address

The Department of Commerce is the business man's department of the Government. We have in the Department of Commerce about 9,500 regular employes, and our expenses are a trifle over a million dollars a month. It comprises eight bureaus, including the Lighthouse Bureau, employing in the neighborhood of 6,000 employes, and the Bureau of Standards. I regard the Bureau of Standards as one of the most interesting and useful bureaus connected with any department of the United States Government. That bureau is conducting a great many wonderful investigations. One of the pieces of work that it has done recently that is now proving of great service to the country, is work in connection with the making of optical glass. Were it not for the work that the Bureau of Standards has done, we would be up against it, as the boys say, at the present time for glass for telescopes for numerous heavy guns that are being made for the navy, but the navy is realizing the value of what our Bureau of Standards has done and is doing, and is making every possible use of its experiments.

In addition to those bureaus that I have mentioned, we have the Bureau of Fisheries, which is doing an immense amount of good at the present time in reducing the high cost of living. I could talk to you gentlemen for an hour or more in connection with every one of these bureaus, and I have no doubt I would find some interested listeners, but I don't want to bore you, and my subject is Industrial Co-operation in the War, and I want to talk a little about that.

To win the war upon which we have entered it is not merely a question of soldiers, but a question of science: it is a question of chemistry, it is a question of physics, it is a question of ships, it is a question of industry, and I think I may safely say that we are going to win this war in the United States, that right here on our own territory we are putting into motion the elements, the industries that mean success to the American flag. Men engaged in employments like yours are playing a most important part in this war. We are building more ships to-day than we ever built at any one time in the history of the United States. Many of these ships will go to the bottom of the ocean, but we have wood and steel and labor and capital, and we are going to keep on building ships. At the end of this war we are going to have more ships under the American flag ready to enter into the great commerce of the world than ever before in our history. We are going to have a merchant marine, a thing which we have not had for more than fifty years, and that, perhaps, will be one of the compensations of this horrible war.

Our Department of Commerce has one bureau that is playing a most important part in the matter of foreign commerce, and that is the Bureau of Foreign and Domestic Commerce. Our exports have considerably more than doubled since the war began. In 1913 our total exports amounted to about two billion seven hundred million; in 1916 the exports amounted to about five billions seven hundred millions. I would be disloyal to the Department of Commerce with which I have been connected for the past four years if I were not to tell you that a great deal of the increasing export trade was due to the efforts of the Government during this period. In the early part of 1913 the Department of Commerce asked Congress for an appropriation of $150,000 with which to send commercial attaches abroad. Congress gave us $100,000, and with that we sent out ten commercial attaches and a good many commercial agents to foreign lands. It was the first time in the history of our country that any commercial attaches had been sent abroad. They were business men, men of large experience, big men; they were to receive large salaries and they have given us results, and quite a good deal of the increase in our exports, as well as the import business, is due to the efforts of these commercial attaches. We should remember that it is not merely exports that ought to interest us, but imports.

So it is necessary for us to have foreign trade, and it is proper that we should have an important department of the Government of the United States busying itself all of the time in getting foreign trade, finding out what the people of these other countries want, and trying to meet their wants.

As to what is going to happen when the war is over, I think that the United States, and I might say all other countries, are likely to try to be more self-sustaining than they were before the war. The United States Government must, and I hope and pray will, when it takes its seat in the council that will settle things at the end of this war, create or be the means of creating a sort of international trade commission that will stand with its semaphore saying go and stop, and will say stop to that rancorous kind of competition that used to make enemies of individuals and is now and has in the immediate past been making enemies of nations—say stop to that kind of trade and that spirit of conducting trade and will pass forward the spirit which means good will, friendly rivalry, and which is conducive to the peace of the world and the upbuilding of civilization.

Election of Officers

At the close of Mr. Sweet's address, reports were presented and accepted from the treasurer and from the nominating committee. With the exception of one member of the executive committee, all of the officers of the association were re-elected for another year, as follows:

President—M. H. Broderick, Broderick Mfg. Co., Muncie, Ind.

Vice-President—C. V. Kellogg, Kellogg & McKay, Chicago, Ill.

Secretary and Treasurer—H. N. Covell, Lidgerwood Mfg. Co., Brooklyn, N. Y.

Executive Committee—W. C. Connelly, D. Connelly Boiler Co., Cleveland, Ohio; G. S. Barnum, The Bigelow Co., New Haven, Conn.; E. C. Fisher, Wickes Boiler Co., Saginaw, Mich.; E. R. Fish, Heine Safety Boiler Co., St. Louis, Mo.; Louis Mohr, John Mohr & Sons Co., Chicago, Ill.

The Boiler Inspector and his Relations to the Purchaser and Manufacturer

BY S. F. JETER, CHIEF ENGINEER, HARTFORD STEAM BOILER INSPECTION AND INSURANCE COMPANY

(This paper is printed on page 182.)

A Historical Narrative of the Boiler Making Industry in Canada and the Effects of the War upon the Same

BY D. M. MEDCALF, CHIEF BOILER INSPECTOR, TORONTO, ONT., CANADA

(An abstract of this paper will be published in a later issue of THE BOILER MAKER.)

The Sequel to the Indifference of Boiler Manufacturers Toward any Inprovement which would Result in their Commercial Advancement

BY W. H. S. BATEMAN, PHILADELPHIA REPRESENTATIVE OF CHAMPION RIVET CO. AND PARKESBURG IRON CO.

(This paper is printed on page 184.)

Resolutions

Resolutions regarding the death of Mr. Frank Bigelow, of the Bigelow Company, New Haven, Conn., were passed, as also were resolutions in regard to boiler plate for the United States Steamboat Inspection Service, as follows:

"*Whereas,* Boilers for marine purposes, and especially for the Emergency Cargo Ships, are now one of the urgent necessities of the country; and

"*Whereas,* Such boilers will now or ultimately come under the jurisdiction of the U. S. Steamboat Inspection Service; and

"*Whereas,* The Boiler Code of the American Society of Mechanical Engineers is applicable to marine as well as stationary boilers;

"*Therefore, be it resolved,* That the Board of Supervising Inspectors of the U. S. Steamboat Inspection Service be requested to so modify their rules and regulations as to agree and to be in harmony with the A. S. M. E. Boiler Code."

It was voted that the president appoint a representative from this association for the American Uniform Laws Society, and that the society make a contribution for this year of $1,000, the same as last year, for this purpose.

It was also voted that the executive committee of the association be instructed to make application to the Governor, or the Board of Massachusetts, to amend their rules so that they will conform to the American Society of Mechanical Engineers' Code.

New Tank Shop Planned

The McNamara Brothers Company, Inc., Ranstead's Wharf, Baltimore, Md., manufacturer of tanks and boilers, has commissioned Herman F. Doehlman, 1101 American Building, to prepare plans for a steel plate tank factory, a boiler plant, and an office building to be erected at Bush street and the Baltimore & Ohio Railroad.

The Boiler Maker

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NOTICE TO ADVERTISERS

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 25th of the month, to insure the carrying out of such instructions in the issue of the month following.

In consequence of a report of the Bureau of Standards, Department of Commerce, Washington, D. C., that the requirements for steel plate for marine boilers may be somewhat modified and that production may be increased thereby without lessening the safety of this material, the executive committee of the Board of Supervising Inspectors, Steamboat Inspection Service, has recently adopted amendments in the general rules and regulations for steam boilers regarding the amount of sulphur in open hearth steel, the test specimens for tensile and quench bend tests and also regarding the allowable working pressure on flat surfaces.

The percentage requirements as a limit for sulphur in open hearth steel was raised from .04 to .05 percent. The amended rule reads as follows: "Open hearth steel shall contain not more than .04 percent of phosphorus nor more than .05 percent of sulphur."

The following amended rule relating to tensile test specimens and quench bend specimens was adopted:

"Two tension tests and one quench bend test shall be made from each plate as first rolled from the billet, slab or ingot, the tensile test specimens to be taken from the diagonal corners of the plate and the quench bend specimen to be taken from that part of the plate which represents the top of the billet, slab or ingot.

"The quench bend specimen shall withstand, without fracture, being bent over until the ends are parallel and the inner radius equal to one and a half times the thickness of the test specimen."

Section 18, Rule II, all classes, General Rules and Regulations, was struck out, and a modified rule for determining the working pressure on flat surfaces of boilers was adopted.

All of these amendments will be contained in full in a circular letter entitled "Sixth Supplement to General Rules and Regulations," which has been issued by the Steamboat Inspection Service to boiler manufacturers, manufacturers of boiler plate, steamboat companies and others. The circular letter may be obtained on application at an early date from the United States local inspectors, Steamboat Inspection Service.

An incomplete answer, published in our June issue in reply to an inquiry as to why boiler tube ends are swaged and the benefit derived from this operation, has brought out the following communication from Mr. P. J. Conrath, of the National Tube Company, a former president of the Master Boiler Makers' Association, which we take pleasure in printing:

"Tubes when being welded are opened up to receive the safe end and not reduced or swaged, as was stated in the June issue. The tube is then brought down to size while being welded under the hammer with a top and bottom swage or roller, which is set to the outside diameter of the tube with a mandrel to fit the inside diameter of the tube.

"The reasons for swaging the tubes are:

"First. To bring about greater strength at the back end, as any tube which is opened up beyond its original diameter is weakened.

"Second. To give more water space at the back end where the heat is most intense, as the greater body of water will more readily adhere to the hot sheet.

"Third. The reducing of tubes at the back end will assist in keeping them clean internally, as any pieces of cinder or coal which enter the smaller diameter will pass through the larger opening in the body of the tube. It is very essential to have clean and open tubes, thereby allowing the heat and fire to travel freely through them.

"As to the annealing of the tubes, the setting of the tubes into some annealing mixture is not necessary in the modern steel boiler tube. All that is required when swaging is to bring the heat to a degree high enough to have not less than 1,700 to 1,800 degrees Fahrenheit when the tube is finished. This would be about a bright orange color by a shop light. The cherry red, as stated in the June number, is entirely wrong in the annealing of steel tubes, and will tend rather to harden instead of anneal the tubes. Most of the large railroad shops swage the tubes with the same heat with which they are welded, making practically one operation.

"The different size holes in the back tube sheet, caused by working of the tubes, are taken care of by different thicknesses of copper ferrules. In this way one size swage will meet all requirements."

Questions and Answers for Boiler Makers

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

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

Address your communication to the Editor of the Question and Answer Department of The Boiler Maker, 461 *Eighth avenue, New York city.*

Circular Patch

Q.—A patch 14 inches in diameter is placed inside the shell of a tubular boiler. Working pressure on boiler equals 120 pounds per square inch. Plate thickness of boiler shell equals ½ inch. Thickness of patch plate equals ½ inch. Inside diameter of boiler equals 49¼ inches. Patch is held by twenty-eight ¾-inch rivets driven size. Find factor of safety for plate and rivets and state which factor would be used in basing the allowable working pressure on the patch.

A.—To determine the factor of safety at the weakest part of the patch, we will consider first the different ways the patch may fail.

The steam pressure acting in the direction of the arrows, Fig. 1, tend to break the shell apart at *a* and *b*. The resistance to the load is equal to the plate thickness at *a* and *b* times the length of the shell times the shearing strength of the metal. The inside diameter of shell multiplied by the steam pressure times the plate length *A-B*, and the product divided by 2, equals the load on *A-B* of the patch. In this case the load equals

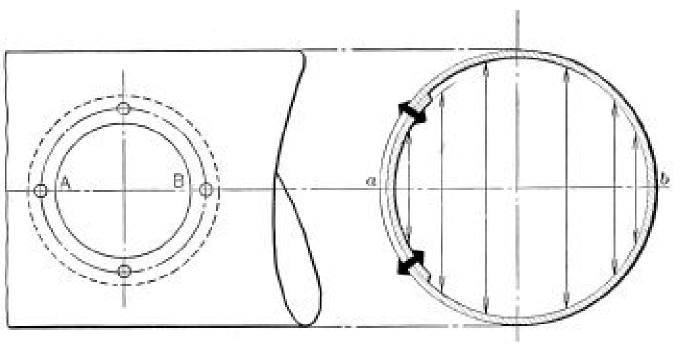


Fig. 1

$$\frac{49\frac{1}{4} \times 120 \times 14}{2} = 41{,}370 \text{ pounds.}$$

The resistance of the plate on *A-B* to this load equals $14 \times \frac{1}{2} \times 55{,}000 = 385{,}000$. Factor of safety of plate equals $385{,}000 \div 41{,}370 = 9.3$. The resistance of the rivets to this load equals $.4418 \times 13 \times 38{,}000 = 218{,}249$ pounds. Factor of safety of rivets equals $218{,}249 \div 41{,}370 = 5.27$. So far only the strength of the strongest parts of the patch has been considered, as will be understood from Fig. 2. In this drawing the pitch of the rivets was laid off to scale and it was found that three rivets lie in a plate length of 3½ inches. The conditions affecting the rivets and plate at the top and bottom of the patch are practically the same as in a longitudinal joint. The three rivets lie practically in the same straight line, and the factor of safety found for this arrangement would be close enough in large circular patches for practical purposes.

Then in this example, to find the factor of safety for the plate we find first

$$\frac{3.5 \times 49\frac{1}{4} \times 120}{2} = 10{,}342\tfrac{1}{2} \text{ pounds,}$$

the load on a plate length of 3½ inches.

The net section of metal within the 3½-inch pitch equals $3.5 - (2 \times .75) \times \frac{1}{2} = 1$ square inch.

$55{,}000 \times 1 = 55{,}000$ pounds, tensile strength of net section of plate.

$55{,}000 \div 10{,}342\frac{1}{2} = 5.3$ factor of safety of plate.

The factor of safety for the rivets is found as follows:

Area of ¾-inch rivet driven size equals .4418 square inch.

$2 \times .4418 \times 38{,}000 = 33{,}576.8$ pounds, shearing strength of rivets.

$33{,}576.8 \div 10{,}342\frac{1}{2} = 3.24$ factor of safety.

Owing to the fact that the rivets and plate are inclined about 9 degrees to the horizontal, as shown in Fig. 2, the joint efficiency is a trifle higher; therefore an increased

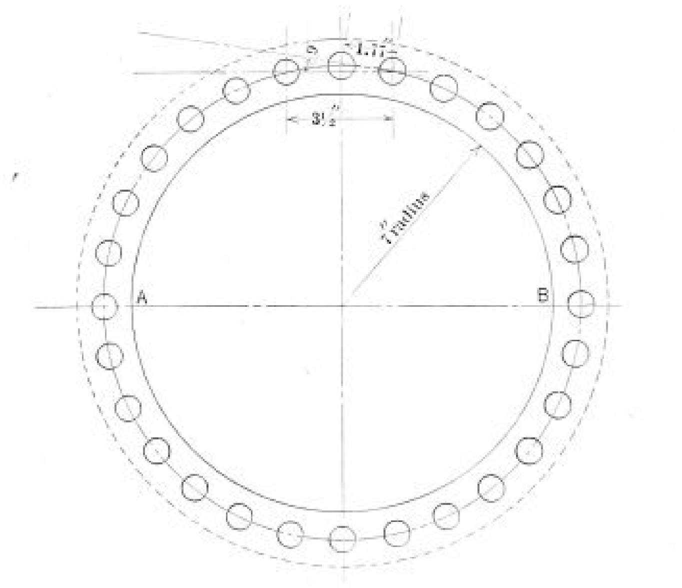


Fig. 2

factor of safety would also be found. The calculations of the strength of diagonal joints were fully treated in the October, 1915, issue of The Boiler Maker. The multiplier for finding the increased efficiency of joint or factor of safety of diagonal joints may be found according to the following formula:

$$\frac{2}{\sqrt{\text{cosine of angle of inclination}^2 \times 3 + 1}}$$

Cosine 9 degrees $= .9877$.

Substituting this value in the formula, we have

$$\frac{2}{\sqrt{.9877^2 \times 3 + 1}} = 1.01,$$

the required multiplier.

The factor of safety for the rivets then equals $3.24 \times 1.01 = 3.27$. The factor of safety for the plate equals $5.3 \times 1.01 = 5.35$. The rivets in the 3½-inch pitch are the weakest; hence the factor of safety of 3.27 is the one at which the boiler would be operated when the patch is applied. This factor of safety is too small; either reduce the pressure or make the patch stronger by double riveting it.

Lining up Locomotive Boiler

Q.—(1) I would like to have some one bring out in your magazine a good method of lining up a new locomotive boiler.

(2) What is the idea of inserting a taper course in a locomotive type boiler, and is there any formula for finding its taper?

A.—Fig. 3 shows one way to line up a locomotive boiler. The first step is to fit the shell courses *B* and *C* together and line them up as explained in the March issue of THE BOILER MAKER. Place the firebox *A* on wooden blocks, *D*, so that it sets level; then bolt course *B* to the firebox and line up the shell courses so that they are level with *A*. Over the course *C* and the outside wrapper sheet arrange the plumb lines *b*, care being taken so that they are equal to all points from the seam lines. Arrange the horizontal plumb lines *a* over the wooden horses so that they touch the lines *b*. The boiler should now be adjusted so that the distances *x* on both sides of the firebox are the same. The distances between the plumb lines *a* at *m* and *n* should be equal. If they are and the distances *x* are the same, the boiler is in line its entire length. If the firebox is wider than the shell courses, the plumb lines *a* should be moved out a convenient distance, but the distance of each line from the plumb lines *b* should measure the same on opposite sides of the boiler. Should the distance *x* be out a fractional part of an inch on one side of the boiler, the shell courses must be readjusted. In such a case several bolts in the girth seams are loosened so that the boiler sections may be shifted to bring them in line.

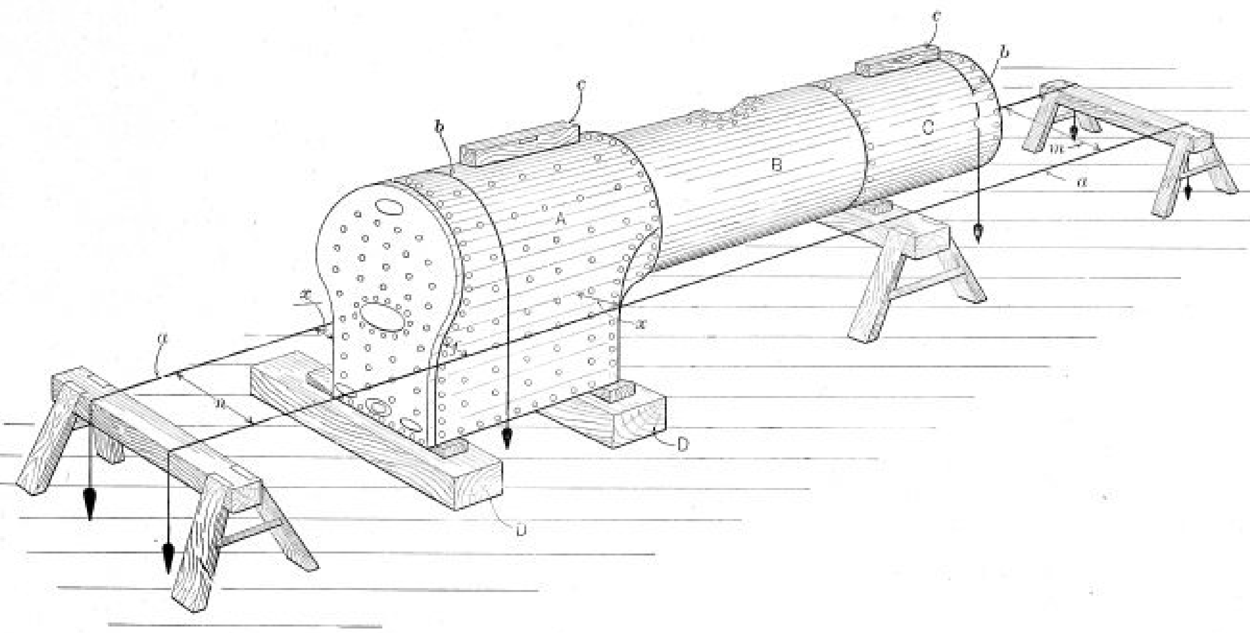


Fig. 3.—Method of Lining Up Locomotive Boiler

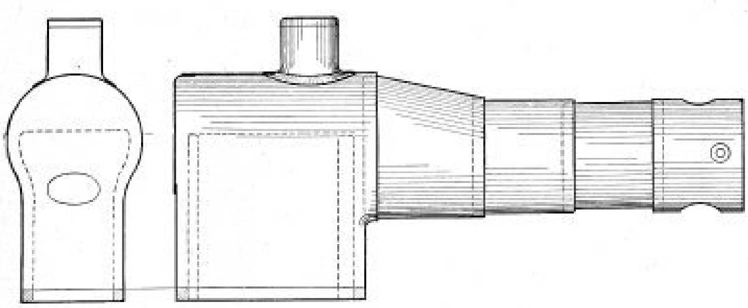


Fig. 4.—Sketch of Wagon-Top Locomotive Boiler

(2) Large fireboxes of different shapes are made to increase the water and steam space in locomotive boilers. In the *wagon-top* type of boiler the outside firebox wrapper extends much higher over the crown sheet than the cylindrical sections. Fig. 4 shows a sketch of wagon-top type with the dome located over the firebox. The taper course *A* joins the cylindrical courses and the firebox. In the *extended wagon-top* type a circular shell course joints the firebox instead of a taper course, and upon it is located the dome, and a taper course joins it with the smaller shells. By the use of taper courses in this manner a large steam space is secured over the crown sheet. The rate of combustion, area of heating surface, and water and steam space needed for the generation of the quantity of steam required are the factors that must be considered in proportioning the dimensions of the firebox, shell courses, etc.

Smokeless Combustion

Q.—I have a 36-inch by 11-foot horizontal return tubular boiler. I would like to have a smoke burner fitted to same. Could you advise me through THE BOILER MAKER, or otherwise, of a good make for this class of boiler? I would also like to get a book dealing with this subject in general. H. S.

A.—The patented devices of this kind for obtaining smokeless combustion of fuel have in most cases proved failures. The best means to produce combustion without any great amount of smoke is to provide a proper designed furnace and boiler setting, and then employ methods of firing that are conducive to good combustion. A steam jet is often employed in furnaces of improper design or when the supply of air into the furnace is insufficient. Its purpose is to mix the air and gases, thus increasing more quickly the ignition of the gases. After smoke is produced, it is practically impossible to burn it under any condition in the furnace. Write to the Department Bureau of Mines, Washington, D. C., for Bulletin 40, entitled "The Smokeless Combustion of Coal in Boiler Furnaces." It contains 186 pages of interesting data on boiler firing and furnaces.

LARGE BOILER PLANT.—In order to get the greatest economy of space and in use of fuel a boiler plant for supplying steam for a 60,000 kilowatt turbine has been designed by the Babcock & Wilcox Company, consisting of a single unit with a total heating surface of 108,752 square feet and a grate area of 936 square feet.

Letters from Practical Boiler Makers

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

Back Pitch of Rivets

There appears to be considerable misunderstanding about the term "back pitch." For the benefit of Mr. Chas. J. Mason and other readers that may be interested, I will endeavor to explain this point and, to arrive at a better understanding, will quote the rule, as follows:

The distance between the center lines of any two adjacent rows of rivets, or the "back pitch" measured at right angles to the direction of joint, shall be at least twice the diameter of the rivet and shall also meet the following

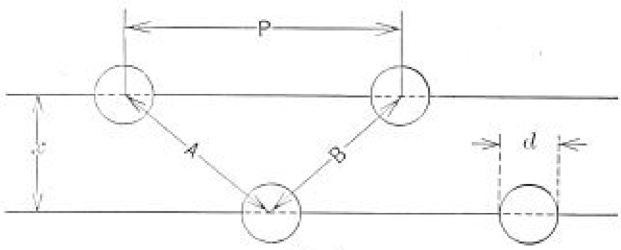


Fig. 1

requirements: (a) Where each rivet in the inner row comes midway between two rivets in the outer row, the sum of the two diagonal sections of the plate, between the inner rivet and the two outer rivets, shall be at least 20 percent greater than the section of plate between the two rivets in the outer row. (b) Where two rivets in the inner row come between two rivets in the outer row, the sum of the two diagonal sections of the plate between the two inner rivets and the two rivets in the outer row shall

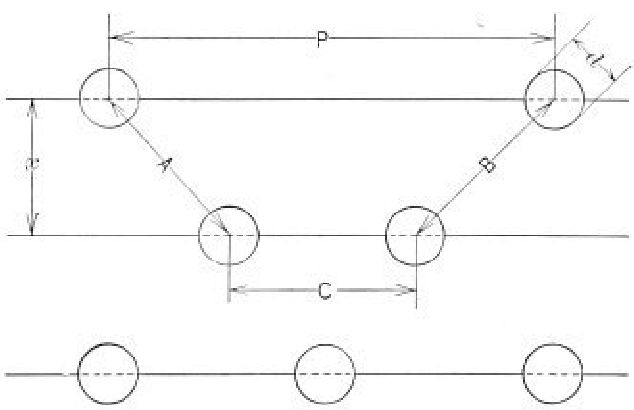


Fig. 2

be at least 20 percent greater than the difference in the section of plate between the two rivets in the outer row and the two rivets in the inner row.

The first, obviously, is intended to apply to double riveted joints, either lap or butt form of construction, and is made clear in the sketch, Fig. 1:

$$x = 2d \text{ or } (A + B) = P \times 1.2.$$

The formula for predetermining this distance x is

$$x = \sqrt{.11 P^2 + .48 Pd + .16d}$$
$$x = 2d \text{ or } A + B = 1.2 (P - C)$$

The latter applies to triple riveted joints and the formula for predetermining this back "pitch" is

$$x = \sqrt{.0275 P^2 + .6 Pd + d^2}$$

Mr. Chas. J. Mason states that someone casually referred to this distance between two rivets as "back pitch" and so set a precedent, also that the term is new. It is apparent from this that Mr. Mason is not keeping up with the times, for that term has been used in print for at least three years.

If it is necessary to have some rule governing the "lap" on the joint, it is just as necessary to have some rule governing the "back pitch," or "back lap," as it might be termed, and is done to equalize the strength of joint by taking care of the crushing strength of the plate in the inner row or rows of rivets. The need for rules of this kind will be better appreciated when we hear statements made by men in the trade that the more rivets in joint the stronger the boiler.

Brooklyn, N. Y. A. G. Reoch.

Hand vs. Power Riveting

We have read with great pleasure and profit the letters appearing in The Boiler Maker written by Mr. James Francis, and especially the one in the May issue, wherein he says, regarding hand vs. pneumatic riveting: "Not much like hand work is good pneumatic riveting. The writer [Mr. Francis] has many a time cut off hand-driven rivets, and the body of the rivets fell out of the holes as soon as the head was removed, but not so much with pneumatic or hydraulic rivet driving, etc."

After many years' experience in hand riveting with American top and side hammer, the English long hammer and a working acquaintance with the Cornish hammer, and hand snaps of all kinds, steam, hydraulic, hydro-pneumatic riveting machines and the pneumatic long-stroke hammer of various makes, and with some years as foreman boiler maker and qualified boiler inspector, we have yet to see the *first boiler under test* and driven by any of the above-mentioned modern riveting machines that had only a few rivets around the lap that required calking. Our experience in the trade, boy and man, during the last forty-seven years has taught us that there is no work done to-day by any of our modern riveting machines that can stand up to the test, not only of the various kinds of pressures used for that purpose, but to the test of time, the searcher of all defective work.

During eleven years' service in one shop equipped with the most modern machinery for the making of boilers, and turning out some hundreds of boilers per year, to our certain knowledge there was *never* passed a single boiler driven by steam or hydraulic pressure that did not require calking all over, and that for many hours at a time, and so bad did some of the fireboxes leak that the men entering them had to wear oilskin suits. Now, in the case of each boiler tested, there were at least four rivets in the corners of foundation bar, or mudring, that were driven by hand and finished with the clinch patent hand snap, and which gave the least trouble of all the rivets and many times did not leak at all.

In the case of the hydro-pneumatic riveter before mentioned, which was installed for the express purpose of driving 1¼-inch rivets in air tanks 13/16-inch thick with dished heads 1¼-inch thick, and a test pressure (hydraulic) of 1,150 pounds to the square inch, and a working pressure of 850 pounds, this massive machine proved to be an utter failure and was discarded.

The hydraulic riveter with a pressure of 150 tons on the rivet, before which the rivet flowed in the best manner possible and doing fine work, could not drive a rivet that did not leak under pressure and gangs of calkers were employed for days at a time calking rivets by hand and with the air hammer, so that the tanks would pass the required test, which was that they be absolutely dry under the test pressure of 1,150 pounds. If it were possible to drive rivets that would not leak, we are persuaded that all boiler manufacturers would be glad to replace their old with the new, which would be so much better and save so much labor.

Let us compare both methods of riveting on the same boilers, that of a batch of marine boilers (Scotch type). The shells, 12 feet in diameter, were riveted by hydraulics and the furnaces and combustion chamber by hand. In driving the hand rivets, light mauls were used to plug the rivet well into the hole, and light finishing hammers with the sharp edge ground off to finish the rivets, leaving the edge of the rivets about the thickness of a penny. In preparing these boilers for test, the shell seams were first swabbed with a solution of sal-ammoniac and allowed to dry; they were then connected with shop boilers and steam turned on slowly and allowed to condense for three days and pressure finally applied. Under this test it was found that all hand-driven rivets were perfectly dry and required no attention, while shell rivets were calked, notwithstanding the swabbing they got from the rusting solution.

While discussing this subject with an old friend of ours, and a foreman of high standing, the above facts were mentioned, and he recalled a case very similar to this. He had built some stationary boilers for foreign shipment which, when completed, would be cut in half. There very little attention was paid to the way the center seams were driven, other than that the rivets were well plugged into the holes without finish. When the test took place, it was found that these rivets that were given the least attention were the ones that did not leak, proving again that the hand-driven rivets are superior to machine-driven rivets for perfect work.

Mr. Francis mentions ⅜-inch that were driven cold with air hammer. We have not had any experience with rivets driven in that manner, but we recall the time that the flues on two flue boilers for steamboats plying the three rivers here in Pittsburgh were driven cold and good work was done, an iron rivet of good quality being used. The object of this was the flues were so small that it would be impossible to calk leaking rivets, and it was absolutely necessary that all rivets be driven tight. This was accomplished by cold riveting on the stake with heavy mauls. We have driven 335 ⅝-inch rivets (in nine hours) hot on the stake, cutting the edges into the sheet, for the same purpose that the rivet could not be calked once the flue was fast in the shell.

We could mention many more cases of actual test wherein the hand-driven rivet has proved its superiority over that of all other forms of riveting. We do not contend that modern machine riveting is not good, and that larger *quantities* of work can be turned out by their use than can be done by any form of hand work; also that cheaper labor can be employed in doing it. But if we were giving an order for steam boilers of any kind, we would specify hand-driven (hammered) rivets.

Pittsburgh, Pa. GEORGE H. HARRISON.

Closing Rivets at the Wrong End

It is scarcely necessary to point out that tank making differs greatly from the related industry of boiler making, the difference being not merely one of degree, but virtually one of kind. The boiler shop making an occasional tank cannot compete with those firms who specialize in tank making.

Yet while modern labor-saving devices are now common enough in boiler shops, you look in vain for similar appliances in tank making. In the latter industry all work is done on a piece basis; the cost of the finished product is extremely low in spite of what seems old-fashioned methods. As a consequence, employers are not overhasty in the introduction of devices costing capital outlay even where these are general and successful elsewhere. Indeed, for various reasons modern labor-saving devices have not as yet penetrated to any depth in tank making.

Yet here and there a pointer is noticed showing that more modern methods will eventually oust those now in vogue. The trade is very hard on the man and does not appeal to present-day youth, so that skilled labor is becoming more rare; to offset this there is only one means open and that is revision of process to utilize labor of a less skilled type.

Multiple punching machines are, of course, the rule, and in this particular the advantage is so obvious that they are universal and serve to explain why the boiler shop cannot compete for regular stock articles. These machines care for the holing of the plates, which are themselves invariably less than 5/16 inch. Riveting up is hand labor, as is calking—that is, with very few exceptions. It is one of the exceptions which the writer desires to bring under notice.

Speed is essential and the number of rivets closed down for a normal day's work would startle most boiler makers. By comparison these are excessive in size and too close in pitch, but the thin nature of the sheets handled renders these conditions essential.

The usual procedure is a holder up with dolly-bar inside tank, riveter outside and a boy heater from the gang. The hot rivet is thrown to holder up, who places it, the riveter knocking down and snapping *tail* of rivet in the usual way to form *head on outside*.

The exception to which attention is directed uses the smallest size pneumatic hammer (fitted with snap) made. The procedure is as follows: Rivet is placed from outside tank by boy heater—that is, tail is inside; holder up applies dolly-bar and riveter uses hammer on *head* of rivet. The jar of the hammer as it is absorbed by the dolly-bar forms *head inside tank*.

Such inversion of normal practice adds at least 50 percent to the daily total of rivets closed, with a corresponding decrease in piecework price. The advantage gained is sufficient to justify the installation of pneumatic plant and tools. This, of course, leaves out of the question the lessened fatigue of the men and the superior workmanship of the seam. The rivet is placed hotter, there is no picking up and the speeding up is very noticeable. Obviously the practice cannot be applied to heavy work. In tank making where the work is to be subsequently galvanized, the formation of heads rather than the filling of holes is the end sought. Yet in thin gage work the holes are duly filled by the method and black fluid tight work is better done by the new method than by the old.

Since the practice outlined is in daily use in at least one progressive tank shop, it is worth imitation. The inversion of ordinary method involved by closing the rivet at the wrong end may be startling to many, but the writer has evidence of his own eyes and can vouch for the facts. To prove the matter simply means an experiment, open to anyone interested. It is one case among many where the wrong method is right in practice and proves that the obvoious is usually wrong, or at least that circumstances alter cases. A. L. HAAS.

The Safest Boiler for Warships

I respectfully ask you once more to allow me to answer my latest antagonist, on the subject of "The Safest Boiler for a Warship."

I am sure that the gentlemen who publish THE BOILER MAKER, or the people who read it, care nothing for personalities. What we want is information. Therefore, I will indulge only sufficiently to say that I am glad to be reprimanded by a man from the "Good Old Granite State," in whose banner county (that protects the rest of the State from the ocean) I was reared and educated.

Now, I will assume that the man who signs himself C. H. W. has read more or less about New Hampshire's most famous statesman—Daniel Webster. If so, he must know that one of Webster's maxims was "Be sure you are right and then go ahead." That is the advice I followed in answering Mr. Roberts. I used his own words and told where they could be found, and I do not know a fairer way to treat it. Surely, C. H. W. would not have me make a mouthful of it by telling Mr. Roberts that he was no George Washington.

I dare say that C. H. W. is either an engineer, machinist, boiler maker or chief water tender, and I can conscientiously say that I am a thousand times more interested in their future welfare—and all others below deck—than for any notoriety.

I was never in the navy. I tried to enlist in 1873 (when we were near war with Spain over the Virginious affair) at Charlestown, but was rejected for lack of my parent's consent. I know hundreds of the navy men (as I do their repair work), and I am sure that any one of them would do me a favor. I agree with Mr. Roberts' ideal boiler; i. e., a 54-inch steam drum, no tube to be less than 3¼ inches diameter, able to steam for thirty minutes with the pump broken down; but where is there such a boiler? To prevent wearing out the patience of the generous publishers of THE BOILER MAKER, and also to spare the feelings of my friend from Concord, I must confine the most of this article to asking questions.

Where has the watertube boiler (of any type) made good in war? When you say made good in war craft, do you mean when the ships are out on a practice picnic or out looking for fight? I am sure you know there is vast difference between the two conditions.

In reference to the number of men that each type of boiler kills, I surely stand by "safety first." As to the watertube boiler having a wider field than the Scotch—well, there is that bad taste coming back again. In the name of Rockingham County, that built the good, old *Kearsarge* and bred the most of the brave men who manned her, where is the wide range, or field? How many watertube boilers are in the P. and O. boats running from London to Melbourne, Sydney or Hongkong? How many are in the ships running between San Francisco and China? How many of them cross the Atlantic Ocean? How many of them run from New York to Panama? How many of them—I was going to say—run between Cohoose and Yonkers, in the good ship *Cap't. Dollinger?*—but, I dare say, the reader is tired of it.

For the information of THE BOILER MAKER's readers, I will say that the British (and other nations, too) send ships equipped with the "Good Old Scot," loaded with the best Welch coal, for the use of the ships equipped with watertube boilers on the China station, and even skin the poor old Scot of her bunker coal, as a little tar, bitumen, clinker and a dozen other minerals mixed is considered good enough for the Old Scot to find her way home—in other words, Japanese coal. Let anyone who doubts this statement ask the men who informed me; i. e., the men who man the British cargo ships.

I am so well acquainted with the brave boys who man our ships (below deck) that I know they are more apt to belittle terrible accidents than to magnify them. Yet, I must admit that this is the first time in my life that I have heard of a 14-inch steam line exploding and have anyone live through it to tell the tale. However, I heartily congratulate my neighbor from Concord and his brave companions on their miraculous escape.

With regards to Scotch boilers using salt water, I have seen boilers that ran to Hongkong from San Francisco come back with hundreds of pounds of salt in the bottom of the boilers and the spaces between the tubes filled solidly with mud and salt. This was thirty years ago when evaporators were not much in use. Of course, the tubes leaked in the combustion ends; but what chance would a watertube boiler have under such conditions to make port?

Let us cut out this talk about quick steam and high-horsepower units and give some real facts. Show me a ship equipped with the best type of watertube boilers making regular runs of a month's duration—say from 5 to 7 thousand miles out and back—without a breakdown every other trip? If these so-called accidents happen in time of peace, what will prevent them in time of war? Will you say that our ships will not be called on to make such long runs in time of war? How many miles did our good old *Kearsarge* reel off in chasing the *Alabama?* What about the *Oregon's* run from San Francisco to Santiago? Compare the *Olympia, San Francisco, Oregon* and *Wisconsin* with four of their class equipped with water-backs, and where do you land? Ah! I see you reaching for your note-book—horsepower? Sure! Loads of it until you get outside the heads; then you can blame the coal or a few more grains of salt to the gallon of water. But I prefer Webster's advice, and will take the salt with the statements of those who are boosting watertube boilers for a warship.

When a man says deck space, am I to understand that he means the bilge or tank top? For instance—C. H. W. asks me if I have seen evaporater coils scaled? I say yes—hundreds of times—but, does he really mean what he says; that the evaporator was distilling fresh water? And also, please show me this large combustion chamber in a watertube boiler. A combustion chamber, as I understand it, is between the furnace and the tubes.

I admit that watertube boilers are O. K. for small craft because they are in port most of the time and are intended only to make a quick dash out and back, and contain a much greater heating surface in proportion to their size and weight than a shell boiler. My main objection to them is that they will not stand long runs and keep fit for a fight at the end of it. Do you know that the crack 21-knot Russian battleships, after being three months at sea, could not make more than 10 knots when they most needed speed? Was that the condition of our Old Bulldog at Santiago, or the *Olympia* at Manila Bay?

Now, please come out with some real war test of the watertube boiler, without classing me with the fools who could ask more questions than a dozen men could answer, as I assure you that I can answer everyone I have asked you. J. S. GRANT.

Vallejo, Cal.

Some More Facts About Battleship Boilers

The discussion of the most suitable type of boiler for battleships brought forward many interesting points. The most outstanding, in the writer's estimation, assuredly the most vital point, is dependability. The success or failure of a naval engagement depends primarily on the mobility of the units engaged, and this in turn is dependent on the motive power.

Why are not internal combustion engines used on battleships? Apparently they have everything to recommend them for this purpose. They occupy less space, weigh less, require less attendants, cost of operation is less, the cruising radius of the ship would be greater, and in many ways are better suited for this work than the steam plant. The answer is lack of dependability; this, then, should be the deciding factor in governing the choice of boilers.

The writer has watched the change, with regret, from the former types used to the present, to borrow from J. S. Grant, "pipe boilers." A scrutiny of the records of the accidents to boilers in the United States for a period of three months discloses some facts which have a bearing on this discussion.

The total number of accidents to boilers recorded is 112. Of these 35 were to cast iron boilers operating at low pressure and used for heating purposes. Of the 77 remaining cases, 46 were accidents to watertube boilers, leaving 31 accidents to all other types, which includes locomotives, threshing machines, kitchen boilers, etc. Expressed in percentages these figures do not put the watertube boiler in a very favorable light.

Type of Boiler	Number	Percent. Based on all Types of Boilers	Percent. Based on Power Boilers
Watertube	46	41	59
Cast Iron Sectional	35	31	..
All other types	31	28	41
Total	112	100	100

These figures are the records of stationary boilers with the exception of two boilers, and they were of the firetube type.

A comparison of the cost and time required for repairs to battleships equipped with both types of boilers would also throw some interesting light on this subject.

What type of boilers are used on the majority of modern ocean liners, which run to schedule and often receive hard service? The writer, in common with many more practical men who have had any experience with ships equipped with types of boilers, feels that for plain, downright dependability, the "Auld Scot" has yet to meet its equal.

New York. A. G. R.

What Counts the Most

It is not so much what you know that counts,
But it's what you practice will tell;
Of course, all your knowledge to lots amounts
If you use it doing things well.

There's a great big difference between these two—
The walking text book and the doer;
Let's hope that the first one is not like you,
'Tis better for us when there's fewer.

A man may acquire vast knowledge great,
But tell me what it will avail
If he can't to his work make it relate?
In spite of it all he will fail.

Concord, N. H. C. H. Willey.

Boiler Corrosion *

If it weren't for corrosion boilers would last almost indefinitely. Corrosion is the thing that thins the shell and plates, rendering the boiler so weak after a number of years of operation that either it must be scrapped or the pressure must be reduced.

It is impossible to eliminate corrosion altogether; at least I have never heard of its being accomplished in steam boilers. You can't paint a boiler as though it were a bridge or steel building, and thus ward off corrosion for an indefinite period. A boiler needs the best of care in another way: it must be kept dry on the outside.

The inside of a boiler won't corrode excessively if good, pure water is used, free from acid, and if the boiler is kept full of water or absolutely dry while not being used. While in use the inside "hasn't time" to corrode, save for the part that corrodes electrically, or, as it is generally called, through "galvanic action."

It is therefore plain that boiler leaks are a source of loss in other ways, not counting the heat loss. Boiler leaks permit the outside of the boiler to get wet, and wetness fosters corrosion. There are almost innumerable places on a boiler where leaks can occur. There should be no such leaks. Tubes, pipe connections, rivet holes, seams, stay holes, etc., should all be maintained in a tight, leakless condition. Some day, perhaps, we will have seamless, rivetless boilers. We are getting there rapidly through our knowledge of electric and flame methods of welding. When the day of perfection arrives no more corrosion troubles should be experienced on the "outside" of a boiler. W. F. Schaphorst.

Too Much Metal in Boiler Shells

If a given boiler joint has an efficiency of 80 percent, it means that the shell is 20 percent stronger than the joint. It means that if there is going to be any bursting at all the joints are going to give way and the shell will remain intact.

This efficiency proposition reminds me of an architect who has quit this "efficiency monkey business," as he calls it, and who is making everything 100 percent efficient as far as possible. To do this is probably an easier matter with girders and columns than with boilers, but inasmuch as I have never seen the subject discussed in print the thought occurred to me that it may be new in the boiler field, and some designers may profit from a discussion on the point.

My friend the architect reasoned thusly: "Why should I allow such a thing as a joint efficiency of 90 percent? Such talk means that I have 10 percent too much steel in my girders, for no girder is stronger than its weakest part, and that part is generally the joint. Steel costs too much to waste these days. I shall therefore increase my joint efficiency and reduce my steel sections."

He did it, contrary to the wishes and advices of engineers and contractors, but he found nobody who could answer his arguments satisfactorily, and so the first building went up with "100 percent efficient" joints. To-day the building is completed and it is giving eminently satisfactory service.

In the boiler field we would have greater difficulty in reducing the amount of steel in a shell so that the shell strength would just equal the joint strength. Before rolling, the dimensions of the shell would have to be known in order that it would be "thinned down" within the proper limits. Or the shell would have to be reheated

* Copyright, 1917, by W. F. Schaphorst.

and rerolled for the express purpose of reducing the strength of the shell proper.

Treatment of this kind would very likely improve a boiler in many respects, for the same reason that a through staybolt is improved by reducing the diameter down to the diameter of the root of the threads. It is well known that in such a bolt the stretch occurs uniformly throughout the full length, whereas otherwise the entire punishment would fall on the threads between the boiler and the nut. I believe the theory of this bolt is so well known that I need say nothing further on the subject.

Does it not seem, then, that in a boiler shell of the same strength as the joint the torture would be uniformly distributed all over the boiler? As it is now the joint is weakest, and my logic tells me that that is the reason why we have so much trouble with joints.

The same is true with railroad rails—the joints are weakest. If a railroad joint of 100 percent efficiency could be made, railroading would be *lovely*. If a boiler joint of 100 percent efficiency could be made, boiler troubles would largely cease.

Anyway, I believe readers will all agree with me when I say that the average boiler contains about 25 percent too much metal. About the only thing the thick metal is good for is to make the boiler more durable because of the longer time required for corrosion to thin the shell to the lower limit.

New York. N. G. NEAR.

Non-Ferrous Materials in Boiler Construction

An Englishman writing not long since on the divergence in locomotive firebox construction as between British and American practice, expressed himself rather sarcastically to the effect that some day, in American locomotive engineering, it would be discovered that the copper firebox is a good thing, whereupon Americans will claim to have invented it! By "discovering that it is a good thing" he must have meant to anticipate that sooner or later the use of the copper firebox will be ventured by us with sufficiently satisfactory results to prompt its more or less general adoption. As for actual "discovery," almost anyone can refer to a handbook of engineering data and draw a comparison as to weight, conductivity, etc., which, together with considerations of costs and scrap values, should give a pretty good index as to the desirability of copper over steel as a material from which to construct fireboxes under conditions of American practice.

It is just possible that this already has been done—if not, we recommend it merely for the sake of the mental practice it should afford, if nothing more. And as for plagiarism in invention, "cousin" takes a mean advantage of us—the popular thing these days is to ascribe this trait to the "Teuts."

One might properly be ruled out of order, during these days of abnormally high prices, for suggesting such a thing, nevertheless it *is* unfortunate that the copper firebox has not been tried out on a modern American locomotive, irrespective of the "index" above referred to. Unless we are misinformed, British locomotive builders (likewise Swedish and very probably the German) are resorting to steel in firebox construction, doubtless with an even chance that it will be perpetuated after the war, by which time they will have discovered that the steel firebox is a good thing and, for all we know or care, may lay claim to its invention. Whether or not, the copper firebox ought to be tried out without prejudice at the first opportunity. The information to be derived from a series of tests on a locomotive so equipped and operated on any one of our several elaborate locomotive testing plants should be made in the face of reasonable expectations of negative results.

One circumstance that prompts this opinion is the outcome of certain tests made during recent months whereby to determine the design of an exhaust feed-water heater suitable to the peculiarities of American locomotive practice. During the course of these tests it became expedient to draw a comparison between brass and steel in the tubes of the heater, conditions otherwise remaining practically identical. The net result was a difference in favor of the brass tubes of 15 degrees in the temperature of the water delivered to the boiler, which certainly, since "each 10 degrees rise in temperature of the feedwater, above an initial temperature of 160 degrees, represents one percent increase in the efficiency of the locomotive," is a result well worth securing. If the difference in the behavior of brass and steel on a mere 120 square feet of feed water heating surface, at a given rate of fuel consumption will account for as much as 25 horsepower at the draw bar, what quantities of fuel might we not save through the use of copper and brass in fireboxes, flues, and superheater elements throughout? Yes, in all probability, we will some day learn something as to the value of these materials in locomotive boiler construction, and when we do, let us hope we will be able to reflect on our perspicacity with becoming grace!—*Railway Review.*

Gathering Thoughts

In any shop, large or small, it will be found profitable to adopt some provision for getting a grip on the suggestions of employees, customers and visitors. Many of these could be made use of—at any rate, to ignore suggestions or comments of people interested in the shop's business is to lose a bit of ground every day in the battle for progress.

Many employees invent ways for lightening their labors or increasing their production when working on piecework basis. They do this to increase their earning capacity, and when the manager or firm finds that the employee has found a way to increase the production from, say, 100 pieces to 159 pieces, they generally cut the piece rate. This is wrong, for it discourages the man, and you can be sure he will not again rack his brain on the problem of increasing the production.

Employees should be encouraged to use their thinkers and to place their ideas, suggestions and comments before their executives and be rewarded commensurate with their abilities. C. H. W.

A Word of Appreciation

Men of authority in all lines of business should realize (and more and more do each day) that a word of appreciation to their men in recognition of an especially well-performed task is a stimulus to continued energy and interest of the employee so commended.

An encouraging word once in a while is really needed by some men. It acts as a mental stimulant, just as much as food does to the body. It should be given at the proper time and in the right spirit.

While there is a chance that an executive could be too generous in his praise, and cause an employee to become over-elated, and assume a sort of swelled head, it does seem that the average tendency is that the employee does not receive encouragement enough.

Concord, N. H. C. H. WILLEY.

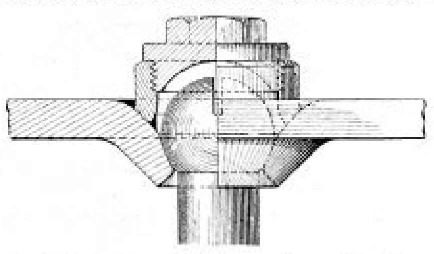
Selected Boiler Patents

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

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

1,210,013. STAYBOLT CONNECTION FOR BOILERS. BENJAMIN E. D. STAFFORD AND FREDERICK K. LANDGRAF, OF PITTSBURGH, PA., ASSIGNORS TO FLANNERY BOLT COMPANY, OF PITTSBURGH, PA.

Claim 1.—In staybolt connection for a boiler, the combination of a boiler plate having a depressed seat for the head of the staybolt and a



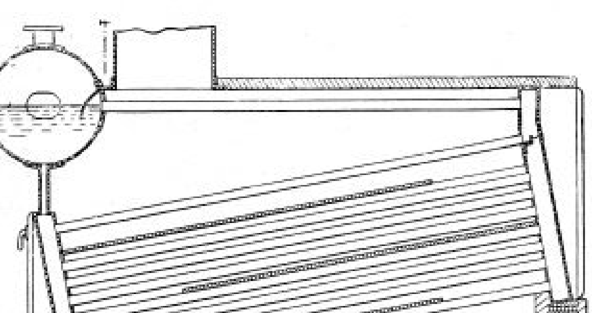
bolt opening at the bottom of the depression, a housing welded to the plate around the depression, and a screw cap for closing said housing. Three claims.

1,207,635. WATER GAGE. KENNETH RUSHTON, OF PHILADELPHIA, PA., ASSIGNOR TO THE BALDWIN LOCOMOTIVE WORKS, OF PHILADELPHIA, PA., A CORPORATION OF PENNSYLVANIA.

Claim 3.—The combination in a water gage, of two cap plates; a gage glass extending from one cap plate to the other; a series of cylindrical glass rods extending from one cap plate to the other; spacing members located between the rods, each spacing member having a longitudinal groove therein; packing in each groove bearing against the surface of the glass rods; clamps on the cap plates for holding the rods and spacing members in close contact, said rods and spacing members forming a guard for the gage glass. Six claims.

1,219,855. WATERTUBE BOILER. THOMAS T. PARKER, NEW YORK, N. Y.

Claim 1.—A watertube boiler, comprising horizontally inclined tubes constituting the main bank, the front ends of which are lower than the rear ends, the tubes at each end being connected by a header and a



series of downcomer watertubes extending from the front to the rear header, a baffle plate extending over the top of the main bank of tubes and beneath said downcomer tubes, whereby to prevent direct impingements of the products of combustion on said downcomer tubes throughout the major portion of their lengths, and a baffle in the upper header extending across the same below the entrance to said downcomer tubes. Four claims.

1,211,755. BOILER AND OTHER FURNACE. JAMES REAGAN, OF PHILADELPHIA, PA.

Claim 1.—A furnace having in combination a fuel feeder delivering to a coking zone and a movable grate of a different declination, including means for supplying air to the fuel, the fuel feeding means being so related to the grate as to admit of a disruption of the body of the fuel as it passes to the grate and stationary means for supporting the fuel moving through the coking zone and delivering directly to the grate, whereby disruption of the body of fuel will be localized and destructive distillation thereof, controlled. Ten claims.

1,212,339. WATER-SOFTENING APPARATUS FOR LOCOMOTIVES. FRANK C. FOSDICK, OF CHICAGO, ILL.

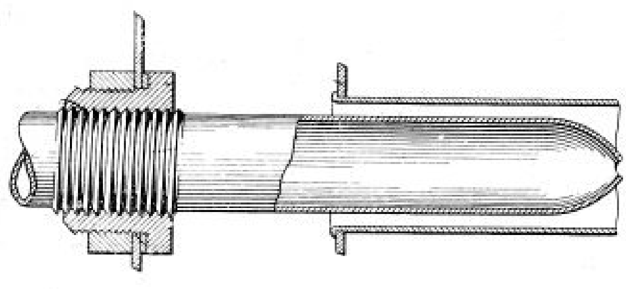
Claim 1.—The combination of a locomotive tender having a water tank, a chemical hopper mounted on the tank and communicating therewith, a rotary device to control the feed of chemicals from the hopper to the tank, a sprocket wheel having a one-way driving connection with said device, a sprocket wheel within the tank, a chain extending around said sprocket wheels, a float attached to the chain, and a tube inclosing a portion of said chain, said tube extending above the tank. Nine claims.

1,212,556. STEAM GENERATOR. CHARLES RADIGUER, OF ST. DENIS, FRANCE, ASSIGNOR TO THE SOCIETE ANONYME DES ETABLISSEMENTS DELAUNEY-BELLEVILLE, OF ST. DENIS, FRANCE, A CORPORATION OF FRANCE.

Claim 1.—In steam generators composed of elements having two coils, the combination of a purifier and steam outlet pipes for the upper tubes of each element, said outlet pipes projecting into the purifier and having oblique extremities inclined from front to rear and ending flush at the front of the bottom of the purifier. Two claims.

1,220,254. COUPLING. EDWARD C. MEIER, OF PHOENIXVILLE, PA.

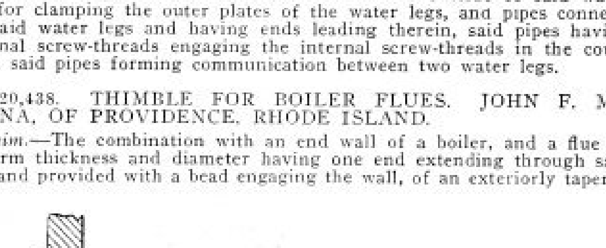
Claim.—The combination with two water legs having hand holes in their outer plates, of couplings secured in the hand holes of the water legs, said couplings having hollow extensions externally and internally



screw-threaded, said extensions also having plates of larger area than the area of the holes and at their inner ends engaging the inner surfaces of said legs, nuts on said external threads outside of said water legs for clamping the outer plates of the water legs, and pipes connecting said water legs and having ends leading therein, said pipes having external screw-threads engaging the internal screw-threads in the couplings, said pipes forming communication between two water legs.

1,220,438. THIMBLE FOR BOILER FLUES. JOHN F. McKENNA, OF PROVIDENCE, RHODE ISLAND.

Claim.—The combination with an end wall of a boiler, and a flue of uniform thickness and diameter having one end extending through said wall and provided with a bead engaging the wall, of an exteriorly tapered



tubular thimble driven into the tube to expand the same, the inner end of said thimble having a thin edge, the outer end of the thimble having an annular flange of substantially the same thickness as the thicker portion of the body of the thimble, said flange being free of substantial projections, and engaging and covering said bead, whereby burning off of the bead is prevented.

1,216,622. STAYBOLT STRUCTURE. BENJAMIN E. D. STAFFORD AND ETHAN I. DODDS, OF PITTSBURGH, PA., ASSIGNORS TO FLANNERY BOLT COMPANY, OF PITTSBURGH, PA.

Claim 1.—In a staybolt structure, the combination with a bearing sleeve and a cap removably attached to the exterior thereof and extending over the end of the sleeve, of a yielding member carried by one of said parts and engaging the other part. Six claims.

1,209,946. STAYBOLT FOR BOILERS. ETHAN I. DODDS, OF PITTSBURGH, PA., ASSIGNOR TO FLANNERY BOLT COMPANY, OF PITTSBURGH, PA.

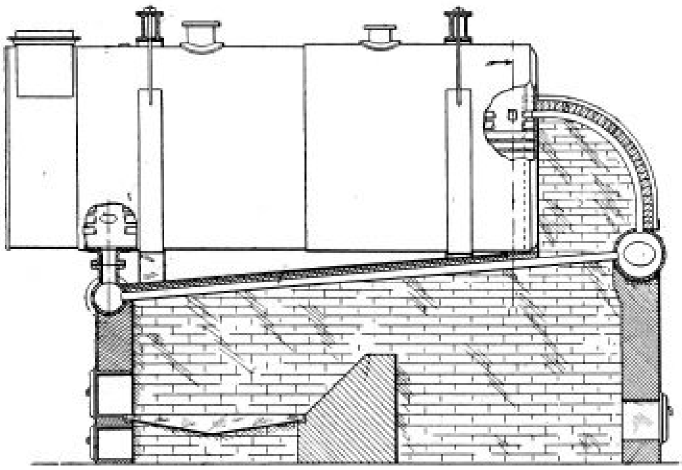
Claim 1.—A staybolt having a series of slots, said slots extending longitudinally and said series arranged spirally around the bolt, the said slots extending only part way through the bolt. Two claims.

1,220,161. FURNACE. OSCAR PATRIC OSTERGREN AND EDWIN LUNDGREN, OF BROOKLYN, NEW YORK, ASSIGNORS, BY DIRECT AND MESNE ASSIGNMENTS, TO THE WESTINGHOUSE MACHINE COMPANY, A CORPORATION OF PENNSYLVANIA.

Claim 1.—In an underfeed, forced draft furnace, the combination of a fuel support comprising an inclined, elongated fuel retort, twyers adjacent thereto, an air chamber underlying said fuel support and twyers, a partition wall dividing said chamber into a plurality of compartments, means provided in said partition wall for regulating the admission of air from one into the other of said compartments, a conduit in communication with one of said compartments, said conduit extending longitudinally beneath the fuel support, and terminating at a point above the fuel bed to deliver the heated air from said compartment above the fuel bed. Ten claims.

1,221,028. STEAM BOILER. MARK R. COLBY, OF PORTLAND, ORE.

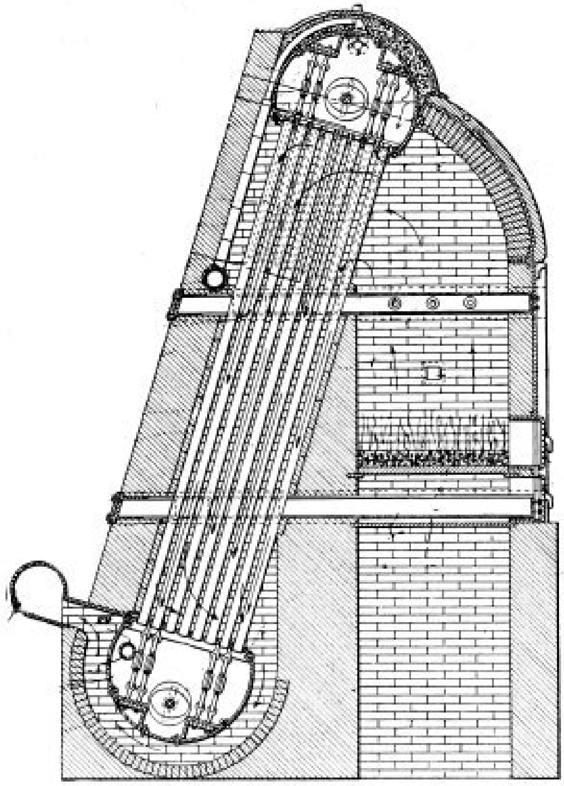
Claim 1.—In a boiler having an upper fire-tube section, the combination with said fire-tube section of a lower watertube section comprising a transversely disposed drum located beneath the front end of said fire-tube section and spaced therefrom, a drum located at the rear end of the fire-tube section, said drums having greater length than the diameter of said fire-tube section, said lower watertube section connect-



ing said drums along their full length and extending longitudinally beneath said fire-tube section, a connection between the lower portion of said fire-tube section and the forward drum, extension headers projecting laterally from the rear end of the fire-tube section and being in direct communication therewith, and arched watertubes connecting said rear drum with the fire-tube section approximately at the plane of the upper row of the fire tubes, the outer of said arched watertubes connecting with said extension headers. Two claims.

1,221,431. STEAM BOILER. ROBERT FARIES, OF DECATUR, ILL.

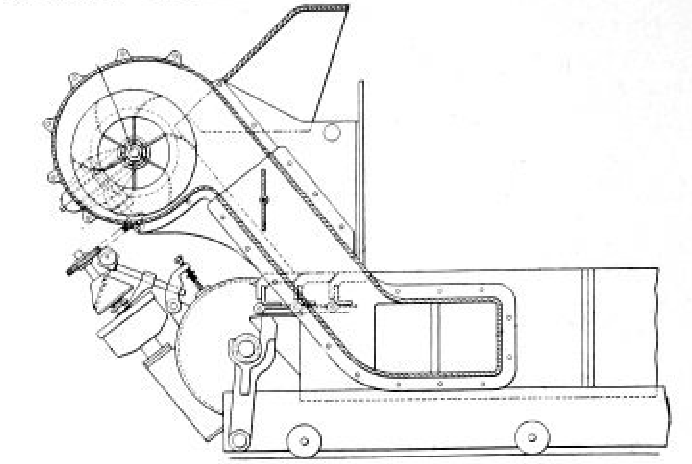
Claim 1.—An apparatus including in combination a combustion chamber and a boiler chamber or compartment communicating at their upper ends so that the hot gases and products of combustion enter the boiler



chamber or compartment at the top thereof, drums mounted at the opposite ends of the boiler chamber or compartment, watertubes connecting said drums, circulating tubes positioned within the upper portions of said water tubes and communicating with the upper drum, said circulating tubes being considerably shorter than said watertubes so that the circulation occurs in the portion of the watertubes subjected to the hottest gases and products of combustion. Seven claims.

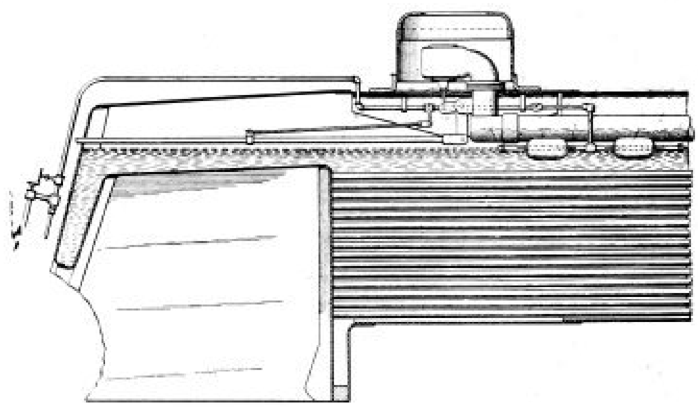
1,221,125. AIR SUPPLY TO MECHANICAL STOKERS. WILFRED ROTHERY WOOD, OF LONDON, ENGLAND.

Claim 1.—In a furnace, the combination of a mechanical stoker, including a fuel support and a hopper, a fan or blower mounted adjacent the hopper whereby it is adapted to collect dust therefrom and withdraw heated air from adjacent the front of the furnace, and an air duct connecting the fan casing with a chamber below the fuel supporting surface of the stoker, all of said parts being bodily movable together from the furnace. Five claims.



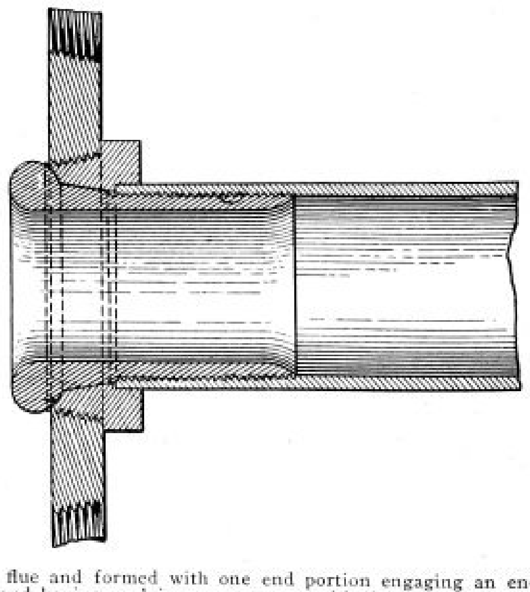
1,222,564. BOILER SKIMMER. NORBERT SCHREIBER AND RAPHAEL ROSENTHAL, OF LINCOLN, ILL.

Claim 1.—A boiler skimmer comprising side members provided with intake openings and a cross member connecting said side members between the ends thereof, floats for supporting said side and cross members, an outlet pipe pivotally connected with said cross member, and a drain pipe to which said outlet pipe is pivotally connected. Ten claims.



1,222,806. BOILER FLUE SETTING DEVICE. FREDERICK SCHMITT, OF POCATELLO, IDAHO.

Claim 1.—In combination, a flue sheet provided with a flue opening, a bushing disposed in said opening, a flue having an end thereof seated against said bushing, and a clamping and securing member connected



with the flue and formed with one end portion engaging an end of the bushing and having wedging engagement with the bushing for some distance from the said abutting end portions to establish connection between the flue and flue sheet. Seven claims.

1,229,887. FURNACE FIRE BRIDGE. JAMES HOLLINGSWORTH CLEGG, OF WALLASEY, ENGLAND.

Claim 1.—In combination, a fire bridge plate, a plurality of bars supported on the fire bridge plate, and a pivoted weighted latch engaging the lower ends of the bars, the weight serving to hold the end of the latch in engagement with the bars to prevent displacement of the latter on the fire bridge plate. Three claims.

THE BOILER MAKER

AUGUST, 1917

History of the Boiler Making Industry in Canada and Effect of the War Upon the Trade*

Canadian Boiler Manufacturing Begun by Advent of Steam Navigation—Present War Now Makes Demand for Marine Boilers Urgent

BY D. M. MEDCALF †

Doubtless the first boiler makers in Canada were located around the eastern seaboard. In the early part of the eighteenth century settlements clung close to river, lake and sea, and the St. Lawrence, the St. John and all their tributaries, besides other lesser rivers, provided inevitably the points of settlement and the lines of travel.

The development of water transportation in Canada is interesting and furnishes a record of need and invention and enterprise, and not the least among these is the advent of steam navigation proving commercially successful in Canada. First came the bark canoe, large enough to hold a few voyagers and peltry, and for a long time it held its place for the far journeys. For shorter travels the canoe was superseded by the larger but clumsier bateau. In later years the increase in river freight led to the introduction of the still larger Durham boats, while along the coast and on the Great Lakes the sailing schooner long filled a notable place. Finally the steamboat came in 1839. Only one year after the *Clermont* had begun its regular trips on the Hudson there was built at Montreal the 40-ton steamer *Accommodation*, and seven years later the *Frontenac*, of about 740 tons displacement, was launched.

Transatlantic Steamship Built in Montreal in 1833

It is also noteworthy that the first steamship to cross the Atlantic without any auxiliary aid was built in Montreal. This ship was called the *Royal William* and left Canada on August 5, 1833, for London, and arrived there about one month later, so that our early Canadian boiler makers were among those pioneers who not only developed water transportation in Canada, but inaugurated ocean steam navigation.

Marine boilers at that period were built rectangular in form of the marine flue type, carrying from 10 to 20 pounds pressure. Boilers of this type, with certain modifications in design, were in vogue for a considerable time, and gradually developed into the Scotch marine type. The development of these boilers was, of course, due to the efforts of Scotch engineers on the Clyde.

In regard to the manufacture of boilers in Canada, in the early days around 1850, there were quite a few of the old pioneers engaged in this work. A list of their names would be of little interest, but I might mention the following firms still extant:

E. Leonard & Sons, Ltd., London, Ont., established 1839.

Waterous Engine Works Company, Ltd., Brantford, Ont., established 1840.

Mair & Eveit, now the John Inglis Company, Ltd., Toronto, Ont., established 1859.

John McDougall Caledonian Iron Works Company, Ltd., Province of Quebec, established 1858.

Goldie & McCulloch Company, Ltd., under the name of James Cromby, Galt, Ont., established 1844.

Besides these there was a large number of thriving little boiler businesses long since petered out, like the Dickie Neal and John Perkins Boiler Works of Toronto, Joseph Hall, Oshawa, etc.

Early Types of Boilers

Sixty or seventy years ago the types of boilers generally in use were externally fired with three to five flues, 8 inches to 10 inches in diameter. There has been little development in this type of boiler, and the horizontal return tubular in use to-day is typical of the boiler used then. The diameter of these boilers seldom exceeded 54 inches, but what they lacked in girth they made up in length, as 20 to 25 feet was no uncommon stretch for those old stagers. The seams were all of single riveted lap construction and the plates ranged in thickness from 1/4 to 3/8 inch. The shell rings and also the tube rings were telescoped one into the other like stove piping. They were very strong on domes at that time and I believe a boiler maker then did not think he was building a boiler at all unless he had a huge dome on the outfit. Most of those early domes were cast iron, and some of our manufacturers adhered to this style of dome until as late as 1890, and I venture to say a good many explosions have resulted from these castings fracturing, two accidents of recent date coming under my own personal notice.

With the exception of the domes of some of these boilers, wrought iron was the material almost exclusively used in their construction. The brands of iron were Lowmoor, Yorkshire, Bowling, Thornycroft, etc., all imported

* Paper read before the American Boiler Manufacturers' Association, Pittsburg, Pa., June 26.

† Chief Boiler Inspector, Toronto, Ontario, Canada.

from the British Isles. As a rule, the plates were short and measured about 4 feet 6 inches square. These sheets were soft and ductile, but blisters or laminations were not unfrequently met with, which caused considerable loss and inconvenience. Another imperfection was spongy parts, generally due to imperfect puddling, but notwithstanding these defects the old iron boilers gave good service, and we have many still in use after thirty or forty years of general wear and tear. The majority of the boilers then were used in sawmills and flour mills, and were often used to augment the power of a water wheel. The steam pressures carried were low and forty to fifty pounds was looked upon as a very high pressure indeed. Fuel was cheap, as wood was plentiful, but coal was very scarce and seldom used except by the blacksmith in the smithy fire and the moulder in his cupola.

Original Plate Rolls Made of Wood

I presume that our method of manufacture was very similar to yours in those days, although our boiler shops were much less numerous. Our plate rolls originally were made of wood and were operated by hand. This, of course, was only made possible by the size and thickness of the sheets used at that time.

Punching was done by hand with a screw or bear punch, and sometimes as many as four men were employed at a time to pull on the punch lever. All holes were punched full size, and those that did not come fair enough were usually persuaded into alinement by the gentle assistance of drifts and sledges. Sometimes a taper reamer was used, but this was the exception rather than the rule, and any holes which could not be reached with the punch were cut with a round nosed chisel.

The head plates were flanged with large wooden mauls over cast iron flange blocks of the required size. It was customary to make the heads a little undersize so that they could be drawn out gradually to the exact diameter. Heads were dished in a very crude manner by digging a hole in the ground somewhat resembling the desired curvature of the head. The circular plate was then heated and beaten down into this hole with wooden mallets, the finishing process being accomplished by flatteners and sledge hammers. It sometimes happened in the case of heads dished to a deep camber that the work could not be done in this way, and a large cast iron ball was often used to advantage. This ball was hoisted a certain distance, then dropped on the red hot plate in much the same way as a pile driver.

Half-Century Change in Manufacturing Methods

These—what now appear to us—crude methods of the early boiler makers have undergone a vast change in the last fifty years. The up-to-date machinery now in use for every branch of this industry has almost entirely superseded hand work, and there is just reason to be proud of the modern steam boiler which our manufacturers are turning out to-day in large quantities. We must not, however, despise the useful work of our predecessors, for they built many good boilers in those good old days.

We have a large number of boilers in Ontario that were constructed before the present law governing the construction of boilers came into force and took effect, which were built in a thorough workmanlike manner. We also have some that are not so good, and they were not all built in Canada, but since the enactment of the present law we are quite satisfied that better boilers are now being turned out and the purchaser is safeguarded as far as workmanship and material are concerned.

No matter how rigid the inspection, it is not a guarantee that the boiler will not explode, because how long it will remain in useful service largely depends upon the care and attention the boiler receives when in operation. Quite recently I was requested to make a personal examination of two 66-inch by 16-foot horizontal tubular boilers that had been seriously damaged. The boilers referred to were built from an approved design and inspected during construction; the shell plates were fabricated by one of the largest plate manufacturers in the United States, and were carefully examined before any work had commenced, the heat numbers and tensile strength recorded and passed as being suitable for a steam boiler. The workmanship was also examined during the entire construction, and upon completion it was passed and certificates issued in the regular way. After these boilers had been in service six months they each developed bags on the sheets directly over the fire, extending 4 inches down, 3 feet wide and five feet long, and on account of their being practically new the owner claimed that the cause was poor material and workmanship, and I personally acted as a referee in the settlement.

When I visited the plant, and when trying to squeeze into the regulation inspector's outfit, which is now too small for me, I requested the owners to have the manhead under the tubes removed. The manhole in the top of the shell was open and ready for the inspector. Immediately the light was flashed on the interior of the boiler it was quite apparent what caused the trouble. The water that lay in the depression was covered with black spots and the tubes and shell as far as could be seen were coated with oil.

Importance of Care and Attention for Safe Operation of Boilers

It was at first a difficult matter to convince the owners that oil had caused the trouble; it was a new plant and oil, they claimed, could not get into the boiler because they had installed an expensive oil separator in the exhaust line from the feed pump, which was the only steam line returning its condensation to the boilers. A further examination was made by disconnecting the oil separator, which was found quite clean, but beyond the outlet a full handful of grease was collected and shown to them, with the result that they were quite satisfied that they themselves were to blame, and not the poor manufacturer who made the boilers to comply fully with the requirements of the Province of Ontario. The necessary repairs cost about $2,500 and considerable inconvenience to the operation of the plant.

I could cite a number of cases very similar to this one, but believe there is "nuf sed," and my object in mentioning this fact is because frequently when trouble develops, and the cause of same is not known, it is blamed on the rotten old boiler made by so and so, who is really blameless.

Effect of War on Boiler Making in Canada

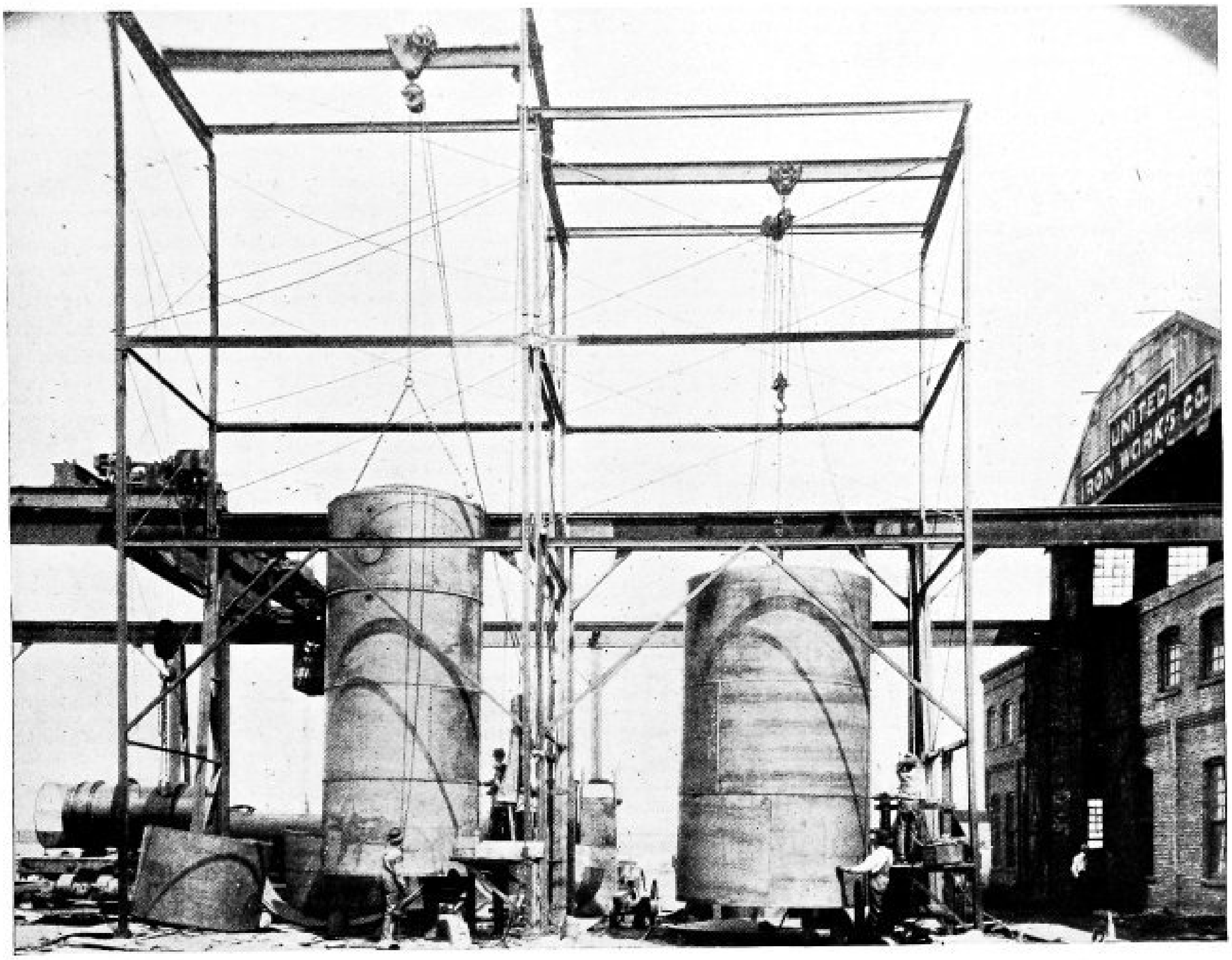
In regard to the effect of the war on the boiler-making industry in Canada, I might say that its penetrating influence has affected almost every industry we possess, either directly or indirectly, and the most seriously swayed of these have been engineering and allied trades. This condition of affairs, I suppose, prevails in the United States, although perhaps not to the same extent, as we have been longer at war than you.

Almost since the beginning of the war, or, to be correct, since the governments of the Allies began to place orders abroad for the supply of munitions, most of our boiler shops have been partly converted into munitions factories, while our machine shops are similarly engaged, running night and day. But besides making shells our boiler shops are turning out boilers in fairly large numbers, not only for domestic use, but for export trade, chiefly to the Allies, and we have orders for many more which cannot be supplied by reason of our inability to obtain the necessary material. It is true, therefore, that the war has increased the output of our boiler works, and it is also true that the war is retarding that output owing to the scarcity of steel, or, to be correct, owing to this merchandise finding a more ready outlet in another channel. A large number of the mills, I believe, who are working on metals, have sold their full production one year in advance for war purposes.

The dearth of steel, however, is not the only obstacle. The price of steel, as you all know, has been going up with leaps and bounds since the war began. Labor conditions are also very bad and good boiler makers to-day cannot be had in anything like sufficient numbers to cope with the increase in business. From the beginning of 1915 to the present time, but more especially in 1915 and 1916, a large number of munition factories and like industries, which were urgently required to meet the existing crisis, suddenly sprung into being, and consequently more boilers were required. Our manufacturers having only their usual stock of plates and tubes on hand, were very soon unable to supply the goods until more material was forthcoming, and this occasioned much delay. Those factories, therefore, which urgently required boilers turned their attention to the second-hand market and used-boilers were largely sought after.

Old boilers of all descriptions were painted up and offered for sale as good boilers, and, needless to say, many were condemned by our department. These scrap boilers have in turn found their way to the blast furnaces to be melted into shell billets, and latterly shipped to Germany via France. Perhaps a part of one of our old boilers, after undergoing this transformation, may yet find a resting-place in the Kaiser or the Crown Prince.

The demand of late has not been so much for stationary boilers as for marine boilers, and our manufacturers are harder pressed now than ever for steel plates and tubes, and although they are turning out a lot of work, the demand far exceeds the supply. If we only had steel plate mills of our own in Ontario, it would have been of great assistance at this period, but, unfortunately, we are not sufficiently advanced along those lines, and have to depend entirely on imported material. This has been a lesson, of course, which will not require to be taught again, and there are now several plate mills being established throughout the Dominion which will in future supply our boiler shops and shipyards with all the plate steel they require.



Large Tanks Being Riveted by Pneumatic Riveters

Portable Pneumatic Riveters Building Large Tanks

Modern portable pneumatic riveters are used in building large tanks at Ottumwa, Iowa, the tanks and tools being handled by electrically operated hoists and cranes. It may be stated that the gap riveters have clearances of 6 feet, 8 feet, 10 feet and 12 feet. The 6-foot and 8-foot machines have single bands holding the two arms, while the 10-foot and 12-foot machines carry double bands. A valveless automatic hammer is attached to the upper arm and a pneumatic holder-on or "bucker-up" to the lower arm. Air connection to the holder-on is made by a small pipe from a hose connection running through the upper arm, dropped at the rear end and thence through the lower arm.

The pneumatic hammer holds a rivet set by means of the usual spring clip, and the machine being overbalanced on hammer end causes the rivet set to rest firmly on the head of rivet, while the holder-on carrying another rivet set rises from below and forms the head on that side.

The hammering is all done on the head of the rivet, yet the holder-on set forms a perfect head from the shank. The head clamp is so arranged that the hammer may be raised or lowered to suit the work. Where a machine is used for small pipe work (12 inches and larger) it is fitted with the short holder-on. If desired to rivet close to tank head, a special holder-on piston and extension block is utilized. The heated rivet is always dropped into place from the outside—just the reverse of hand riveting. The smaller tool is said to be strictly a one-man machine. It will drive ⅞-inch and smaller hot rivets, or ⅜-inch and smaller cold rivets, and do as perfect and tight work, it is claimed, as any gun. It drives rivets in one-half the time required by an ordinary gun and reduces the cost of riveting 50 percent.

It is held that it makes a perfect head on both sides and for general boiler shops making boilers, compression tanks, stacks, storage tanks and structural work, it is indispensable to low manufacturing costs, and necessary to produce profitable returns. It enables the medium-size shop to compete in workmanship and selling price with the completely equipped shop.

One of these portable riveters is a 6-foot gap machine, fitted with a sheave for running on edge of sheets, and used in building large diameter tanks. The machine is so balanced that the hammer set will press firmly upon the head of the rivet, thus insuring good work. It is carried forward for each rivet by a simple sprocket chain device. The vertical rows of rivets are driven by tilting the machine as required and the rivets are inserted on the operator's side of the tank.

It is of interest to note that four very large tanks were built at one time by Henry Goldner Boiler & Tank Works, Philadelphia, Pa. They are 42 feet diameter and 32 feet high. When completed the tanks were tested and found to be in perfect condition. The bottom course consisted of ⅞-inch rivets; all others are ¾-inch. Compressed air seems to be ideal for riveting work, but electric power is utilized to advantage in hoisting and crane service for handling the tools and tanks.

John "Squares Off" Again

Quick Method of Spacing Off Rivets—Laying Out Polygons with the Square

BY JAMES F. HOBART, M. E.

"John! Oh, John! What are you making? Doing a cake walk along that sheet with the dividers? That's three times you have stepped off the side of that sheet. What's the great idea of all that divider work?"

"Why, hello, Mr. Hobart, I didn't know you were here! When did you come in?"

"Just as you started to space that sheet, John. And I watched you walk the dividers across it three times, and you seem about starting them off on a fourth trip. What's it for, anyway?"

"Why, the 'Old Man' was mighty busy and he told me to lay off the punching on this sheet. It's 78 inches between the rivet lines and he wants me to lay out thirty-two spaces, which would make each space 2.47 inches long. I set the dividers 2.5, then closed them up a bit with the spring, and stepped across the sheet, but couldn't make the spaces come out even. I've got it almost right now, and one or two more steppings across the sheet will bring the dividers just right."

"Oh, John! John!! John!!! You surely have got all the time there is, and propose to use it all, too, don't you? Why, you never ought to have to step a line more than three times at the most, and that's one time too many. The second time across ought to bring the dividers adjustment O. K."

"It might, if I could set the dividers close enough to 2.47 inches the first time, but it's largely guesswork below 2½ inches."

"Don't see why it is, John. You have got the exact dimensions right there on that brand new square of yours, and now that you have got a thing, why in all creation don't you use it and save a lot of time?"

"Where have I got 2.47 on this square? I don't seem to savey it yet."

"Right there on the blade; don't you see that little bunch of diagonal lines which looks like this sketch (Fig. 1)? Well, you will find 2.47 there, or any other fraction from 0.01 inch to 11.99 inches, and perhaps then some."

"Say, just 'show me,' please. If that is on my square I want to use it right away without stopping to hunt for it. Where is it, please?"

"Here, John, we will look at Fig. 1 a bit, then you will see how the fraction business works. You can understand the whole inch business easy enough, for the bunch of horizontal lines are laid off in even inches, and from *B* to *C* is two inches. Now to determine the fractional part of the measurement. Another inch on the scale from *C* or 0 to 10, is divided into ten equal spaces and are therefore each 0.1 inch long. See?"

"Yes, I see that, all right, but what are those diagonals for?"

"The diagonals, John, are where you get the hundreths of an inch. Just take notice of the first diagonal, from 0 to *D*. This diagonal, at 0, you will see, is 0.0 inch from the line 0 *C*. In fact, is exactly on that line."

"Yes, I see that."

"Well, then, at *D* the diagonal is exactly 0.1 inch from line 0 *C*, isn't it?"

"I believe it is. Yes, I'm sure of it, for the diagonal is right on top of the 0.1-inch division to the left of *C*."

"Correct, John. Now, if we divide the distance 0 *C* into ten equal spaces, as has been done by the horizontal lines you find ruled all over Fig. 1, and as marked, 2, 4, 6 etc., at the left of the engraving, then can't you see that the diagonal line o D inclines 0.1 inch from o to D, or 10 by the left-hand vertical scale; therefore the line o D must incline exactly one-tenth as much between each of the horizontal lines? Therefore, from line o C to diagonal o D on the first horizontal line from the bottom must be .01 inch, must it not?"

"It sure looks that way, by crackee, and if that is so, then on line 2 the diagonal will be 0.02 inch from line o C. Say, I have just got the whole thing now. Pshaw, it's easier than for a green cub to mash his thumb with a calking hammer. Gee whiz! Anybody can take inches and fractions from that bunch of diagonals! Why in all

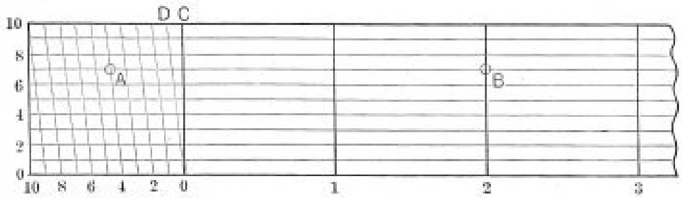


Fig. 1.—John Finds 2.47 Inches on a Steel Square

creation didn't I see it before? Here I have been, as usual, working in one direction while the dope I wanted was burning my fingers and I didn't know what was the matter with them. Say! Just drop a keg of rivets on me, will you? It might make me feel better and I know it wouldn't damage my 'ivory dome' a bit! Why, to take off 2.47 on that bunch of diagonals is to start at the bottom on the fourth diagonal and run up to the seventh horizontal line. That point is at A, and it sure is exactly .47 inch from line o C. Then, all I have to do is to place one leg of the dividers at A and carry the other leg to the right, keeping it upon the seventh horizontal line all the time until it arrives at the 2-inch vertical line. This point is at B. Then, with the dividers set accurately from A to B, they must be open as near 2.47 inches as a man can set them. O! I can do that in half a minute, and here I have been fooling around for fifteen minutes, stepping along that 78-inch line of rivet-spacing. Say! I just believe I will write a book about the "Things I Didn't Know and How I Found Them Out!"

"Never mind, John; you have got one more thing out of the 'Don't Know Column.' Keep at it and you will have a lot of items on the right side of the ledger by and by. But, look here, do you ever use the 'Brace Run' on your square?"

"Brace Run; what's that?"

"Well, guess you don't use it much if you don't know what it is. You will find a whole lot of figures, whole numbers and decimals, scattered along on one side of your square, probably on the tongue. Away down next to the blade you may look for

18
30
24

This means that the length of a brace which has a run of 18 inches on one end and a rise of 24 inches on the other will be 30 inches in length from toe to toe. It really means that with a right angle triangle having a base of 18 and a perpendicular of 24, the hypotenuse will be 30. That's exactly what the 'brace run' figures mean, and you will find a lot of them:

60 57 54 51 48 45 42 39
84.85 80.61 76.37 72.12 67.90 63.84 59.40 55.16, etc.
60 57 54 51 48 45 42 39

"Well, Mr. Hobart, what good are those figures to me? How am I going to use them?"

"John, like every other bit of knowledge you may possess, you will find a situation somewhere in which that bit of knowledge will come in mighty handy. If you don't know a thing, then certainly you never will have any use for that thing. But I never yet acquired a bit of knowledge which was not of use to me, or to others, sooner or later. Suppose, for instance, that you are wanting to get out a sort of gusset sheet to tie a corner in some steel shape work. You want the three-cornered piece to have a rise and run of 36 inches, plus the necessary length for riveting. Instead of multiplying 36 by itself, doubling the product, and then extracting the square root, you simply look at the brace run on your square, find

36
50.9
36

and you are pretty safe in seeking for a piece of plate 51 inches long, plus the amount necessary for riveting. Also, the 'brace run' is sometimes mighty handy for finding the diagonal distances inside of tanks, where braces or partitions are necessary. Also, you can figure out a special table and stamp it on your square, if you wish, showing the lengths of boiler braces with various lengths of run and rise. But, John, if you do this, be very careful when stamping the figures upon your square, that you don't stretch the metal enough to throw the square out of truth."

"I'll do that. A bunch of diagonals sure will come in handy more times than one. But, just a minute, Mr. Hobart. A few days ago I was over in Smith's shop and saw their layerout marking some heads for screens or reels. Some of the heads had five sides, some six. The layerout didn't use the dividers in laying out these heads. He did it all with the square. Began with one side and went right around. I didn't have any chance to see how he did the trick. Can you tell me how it was done?"

"Sure, John. I can tell you one method—a good one, too—but I am not sure that it was the same one that was used by the man you saw laying out the heads."

"I don't care whether it is his way or not, as long as it is done with a steel square!"

"Well, then, just take a look at Fig. 2. Lay down the length of one side from E to F and extend the line some

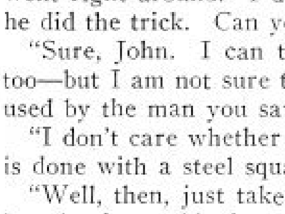


Fig. 2.—Laying Out a Pentagon

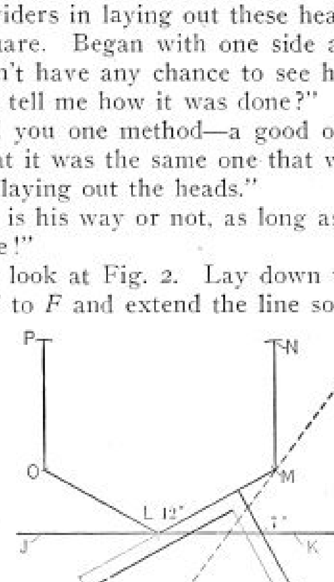


Fig. 3.—Laying Out a Hexagon

distance past these points in either direction, as shown in one, at G. Place the square as shown, with the 6-inch point on the tongue fair with point E, and the 21-inch point on the blade fair with line G, no matter where upon that line the 21-inch mark may fall. Hold the square rigidly in that position and mark along the tongue, producing the line to some distance. Afterwards, measure along the line thus found and make $E H$ equal to $E F$.

"This will give two of the sides. Then reverse the square and work with point F on the tongue 6-inch mark. Proceed as before and you will find line $F I$, which, being also made equal to $E F$, will form the third of the five sides required. Next, proceed to repeat the work from points N and P in turn, which will determine the two remaining sides. And, John, if you are sure of yourself, you may, after working from either N or P, connect the new point thus found with the remaining point which you have not worked from. But you had better not try this at first. Work out both sides from *N* and from *P*, then if they both end off at the same point, you may be sure that the work has been accurately done and is right. But if the two remaining lines do not fall together at the same point —do not close, as the land surveyor puts it—then you will know that something is wrong and you must go over the work again until you find and remedy the error."

"And is that all there is to it? Just put 6 and 21 on a line and draw the second and third sides, and then all the rest of the sides?"

"That'll do the trick, John. If you want the practice, you can work around through a lot of geometry and prove just how and why the points named will give the angles of a five-sided figure. That will be a good job for you, John, some time when you are tired and want to rest?"

"Yes, and when I do, you watch me! When I'm tired and want rest I'll just wander into a movie show. That's a whole lot more restful to me than taking a fall out of geometry. I'll tackle that bunch of lines and angles when I feel fighting mad, not when I'm tired, if you please. But how about the six-sided figure, the 'hex' reel-head? Is that laid out in the same way?"

"It is laid out according to the same principle, John, by means of certain distances on blade and tongue of square, but the method I will show you is handled a bit differently from that for finding the five-sided figure. Draw the base line *J K* and make a mark somewhere near the middle from which to start the first side of the 'hex' figure. This time, take 7 inches and 12 inches on the square and place the heel of the square above the base line instead of below it, as in the former example. Draw the line *L M* and make its length equal to the side of the required hexagon. Then reverse the square and proceed in the same way to lay off the line *L O*, which will be the second side of the required figure. At this stage of the work two courses are open to you, John. You may place the square fair with base line *J K* and square up a line through point *M* and another line through point *O*; make each of these line *E* in length equal to *L M* or *L O*, and you will have four of the six sides required.

"By the other method, which is a whole lot more work and not as good, you can reverse the square from the position shown in Fig. 3, placing the 12-inch mark fair with point *M*, the blade of the square lying along line *L M*, same as it does now. Then draw a line through point *M* and mark 7 on the tongue. This will give another base, as shown by the dotted line *Q R*. From this new base you may lay off the side *M N* as described for side *L M*. But this method is not to be recommended. It is far too much work. In fact, for this particular figure, the hexagon, there is no way of laying it out so good as with the dividers. Simply take the required length of side between the divider legs, strike arcs intersecting each other from the ends of the first side, then place the divider leg upon the arc intersection, describe a circle and space around it with the radius for the intersections of the six sides. Connect these with lines and the figure is complete."

"But, say, I wanted to do it with the square, not with the dividers."

"That's all right, John. You may do it that way for practice, but don't lose time in using the square method for hexagons in the shop. The square is O K for five-sided and some other figures, but it don't pay to use on either a hexagon or an octagon, although the latter may often be laid out with the square to advantage in certain cases, although usually the dividers will prove the quicker way."

"Why not use the square and get practice enough so I can do the work as quickly as with the dividers?"

"Because it is not possible, John. Now, just look a-here, you never would think of practicing with the riveting hammer in hopes that you could learn to drive rivets faster than with the air-gun, would you?"

"No, I wouldn't try that, for it can't be done."

"Well, John, it's just the same with the hexagon laying out. It can't be done with the square as quickly as with the dividers, no matter how much you practice the work. See?"

"Suppose I'll have to take your word for it; you haven't fooled me yet, but I'm just going to try it out the first chance I get."

"That's right, John; 'seeing is believing'—sometimes, and you'll see that I am right in this matter."

"Say, Mr. Hobart, can you lay out seven-, nine- or eleven-sided figures with the square?"

"To be sure you can, John. Any number of sides, for that matter, but it won't pay you, John, to bother much with laying out those figures with the square or in any other manner, for you will have very little use for them in boiler making. You may, however, mark down in your notebook the following figures, then if you ever have use for them, you will be able to lay hands upon them at once—provided you can find the particular notebook which has the figures in it!

"But here is the 'dope':

FOR LAYING OUT POLYGONS WITH THE SQUARE

Sides	Points
5	6 : 21
6	7 : 12
7	7 : 14
8	7 : 17
9	5 : 13

"There you are, John. You can use 'em, if you want to, but watch out how you apply the square to the base line. It must be laid on in different ways for different problems and you can puzzle them out at your leisure. Now, I am going to show you one more stunt with the steel square, and then I'll be off. But this one will come in handy many a time. Supposing you want a band or collar to just lap around a 4-inch boiler tube. You can get this on the square quicker than you can figure it, and get it right on the strip of band iron without any measuring upon the strip. Want it?"

"You bet I do. That listens mighty good to me."

"Well, then, select the strip of iron or steel from which the collar is to be cut. Lay it down as shown at *S T*, Fig. 4, then place the square on the strip with the 24-inch end of the blade flush with one edge of the strip *S T* and

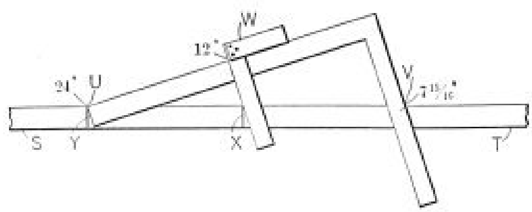


Fig. 4.—Finding the Circumference with a Square

the 7 15/32 inch mark on the tongue, flush with the same side of strip as shown at *V*, the end of the square being placed as at *U*. Now take three times the diameter whose circumference is to be found—in this case 4 inches, and three times that amount will be 12 inches. Lay off this distance from end of square blade *U*. In this case it will be 12 inches from the heel of the square. Place a try square on the 12-inch mark, as shown at *W*, and make a mark on strip *S T*, upon the edge flush with the points on the square. Then strike square lines across the strip at *X* and *Y*, and the distance between these marks will be the circumference of a 4-inch circle. If the strip is to go on the outside of a boiler tube, then add the necessary length to make up for the loss in bending, viz., three times the thickness of strip; or, if the collar is to go inside of a 4-inch hole, then deduct three thicknesses. Do you get this stunt, John?"

"You're just right. I got it, Mr. Hobart, and that's a dandy, isn't it? One of those little handy things which stay with a fellow and come to mind without being thought of just when they are needed. Say, I reckon I have got to get busy to stow away all these square things under my hat in such shape that I can get them when they are needed. But I'll do it, you know."

The Steam Locomotive as a Power Plant

The following shows how 30 to 50 percent of the coal now burned by steam locomotives can be saved. The present-day locomotive has about reached the limitations imposed by allowable wheel loads and clearances, but the changes suggested would also make possible an increase of 30 to 40 percent in hauling capacity without increase of weight or size.

Locomotives are run for long periods at reduced speeds, at the same time frequently being compelled to exert their maximum tractive effort. Such conditions are not favorable to the steam turbine, unless, indeed, speed-changing gears are to be used, which does not seem practicable.

The trouble with the locomotive is not in the engine. Under favorable conditions it shows good steam economy. Published results equal those obtained in stationary plants using either turbine or reciprocating prime movers, operating with the same steam pressure, superheat and back pressure. The boiler and furnace end of a locomotive, however, might well be described as a crime against civilization, considering our diminishing coal reserves and the large portion of the annual coal production consumed by locomotives.

Not only is the locomotive most wasteful, but it further fails to meet the requirements of business. The question troubling railroad men most of all is that of capacity. They want to haul longer trains up limiting grades and at greater speeds, to handle more business with present equipment and labor charges. Some roads have even gone to the length of putting two boilers on a locomotive, in spite of the complication and unhandiness of such a unit, and others are experimenting with mechanical stokers as an alternative to placing two firemen on a locomotive and with the object of increasing hauling capacity, which at present is limited by the amount of coal that can be burned in a firebox as wide as can be carried on the present gage and as long as can be stoked by a human fireman.

The high rate of combustion per square foot of grate now used implies a high draft, amounting at times to a suction of as much as 10 inches water column in the firebox. This draft is maintained in about the most inefficient way that could be imagined: namely, by using the exhaust from the engine in a steam ejector formed by the exhaust nozzle and the stack. To obtain the blast required, a back pressure is put on the engine cylinders that at high speed and heavy pulling reaches 20 or 30 pounds per square inch, thus reducing materially both the hauling capacity and the efficiency of the engine. It has repeatedly been shown that the back pressure horsepower at times equals the useful horsepower.

Without going into details and figures, it can safely be assumed that:

1. By using mechanical draft fans instead of the engine exhaust to produce the draft, the steam consumption of the engine can be reduced 10 to 15 percent or more, with an expenditure of steam for driving the fans of only 2 or 3 percent.

2. By utilizing some of the exhaust steam from the engine for heating the feed water, the steaming capacity of the boiler can be increased 15 percent while using the same amount of fuel, or the fuel consumption can be reduced by a like amount while maintaining the same rate of steaming.

In other words, the tractive effort under maximum speed and load conditions can be increased at least 10 or 15 percent, while the power that can be developed from a given size of boiler and weight of fuel can be increased 25 or 30 percent by the simple introduction of a mechanical draft fan and a feed water heater.

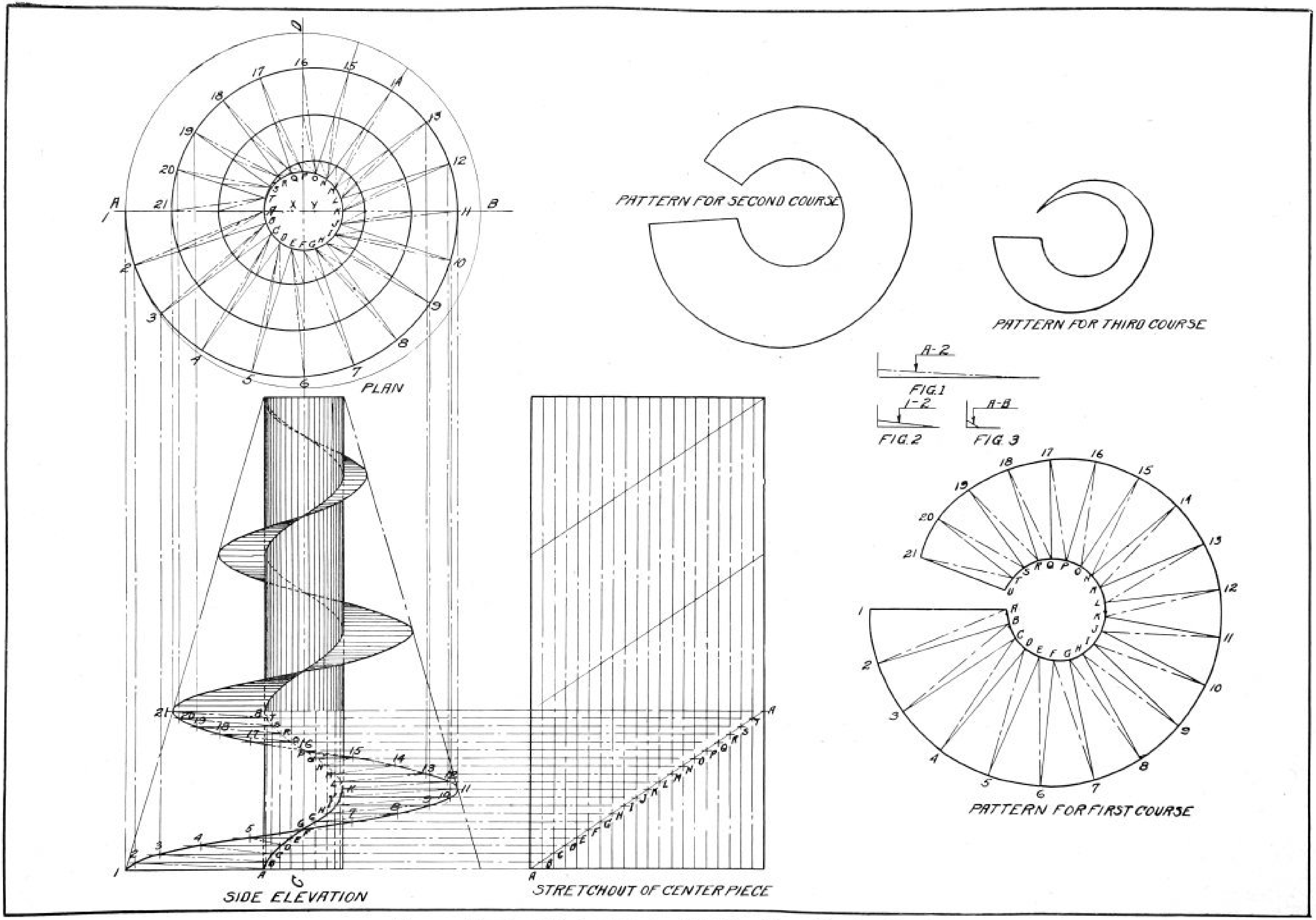
3 and 4. The ample draft obtainable with a turbine-driven fan, however, makes possible still further economies, since it permits the use of ample superheater and economizer surface and of high gas velocities, which would give high rates of heat transmission through such surface. The superheater and economizer would not entail further loss of power from back pressure on the cylinders, as at present. By means of a good superheat 15 to 20 percent more power can be obtained from a given weight of boiler and fuel, while an economizer receiving water from the exhaust heater at 210 degrees F. could easily deliver it to the boiler at 300 or 350 degrees F., the temperature of the gases leaving the front end of the boiler now being about 700 degrees to 800 degrees F. The economizer would thus increase the boiler capacity end efficiency by another 9 to 14 percent.

5. Cutting down the coal consumption in any such ratio as indicated will decrease the amount of fuel burned per square foot of grate enough to reduce sensibly the amount of fuel lost as cinders, as it has been found that the throwing out of cinders increases rapidly after a certain point, going up nearly as the cube of the rate of combustion. In some experiments made by Professor Goss, this loss, as I remember, ran up to 10 percent.

The savings mentioned can be added together—that is, making one does not cut out the others, although there is some conflict between the exhaust heater, the economizer and the superheater. In other words, if an exhaust heater is put in, the water will be hotter when it reaches the economizer and naturally will not absorb the heat so readily, while the superheater will cool some of the gases going to the economizer. Nevertheless, there is a possibility of increasing the power capacity of the locomotive—that is, the horsepower that can be developed from a given weight and size—by 30 to 50 percent, with an equal saving of fuel. This is the more notable when it is considered that the weight of locomotives is now limited by the strength of the track structure to so much per wheel, while the size is hampered by the clearance limitations of bridges, tunnels, etc.

6. Exhaust steam, of which there will still be a large surplus going to waste, can also be used in the winter time for heating passenger trains, which is worth while not only because of the considerable percentage of boiler capacity now required for heating with live steam, but also because all possible power is needed in cold weather for hauling, on account of increased resistance due to increased viscosity of the lubricants used on the car axles.

I am not blind to the practical difficulties involved in the foregoing proposals, particularly in connection with



Diagrams Showing Method of Laying Out Three-Course Tapering Spiral the draft fan. Smokeboxes and blast nozzles are even now badly cut by cinders, although protected by screens of heavy and fine mesh. It is possible, however, to eliminate the cinders by some form of separator.

What is really needed is some one in the locomotive business to take the bull by the horns and build a locomotive on which these arrangements are used, and about the only people in a position to do so with any hope of returns upon the large expenditure required for research and development are Baldwins or the American Locomotive Company. Superintendents of motive power and master mechanics are too fully occupied with their routine duties and are too afraid of having the locomotive stop on the road for them to take any chances in radical departures. Other railroad officials take little interest in mechanical matters or in mechanical people and the propositions they have to offer.

It might seem that the experimental departments of some of the great railroad systems would take up research of this kind, but their attention appears to be concentrated on detail improvements, amounting possibly to a great deal when spread over their large volume of business, but nothing revolutionary or radical—George H. Gibson in *Power*.

Layout of Three-Course Tapering Spiral

Difficult Laying-Out Problem Simplified by Application of Well-Known Principles of Projection and Triangulation

BY R. J. HETTENBAUGH

This may look like a very difficult problem to lay out, but if the instructions are followed closely it will be found to be just the reverse, for it merely involves a few principles that are not found in the average run of problems in laying out sheet metal.

First lay out the plan and side elevation of the cylindrical center piece, around which the spiral wings are formed. Scribe the large circle in the plan equal to the largest diameter of the base. Divide the large and small circles in the plan into the same number of equal parts, and mark the points with letters and figures as shown. Scribe the base line in the side elevation equal to the large circle in the plan and from the outer points scribe the tapering lines to the top, showing the contour of the spirals. As this is a three-pitch spiral, the side elevation will be divided into three equal parts. These parts will be subdivided into two parts, giving the half pitch of each of the three courses; each course is then divided into the same number of equal parts as was used in plan, two points being used in this drawing.

The next step will be to form the irregular curves in the plan. Project point 11 (which is the intersection of the half pitch line with the tapering of contour line) to the center line *A-B* in the plan. Find the center between points 1 and 11 on the line *A-B* forming point *X*. With point *X* as a center and *X*-1 as a radius, scribe the half circle which intersects the center line *A-B* at points 1 and 11. In the same manner project point 21 (which is the intersection of the full pitch line with the contour line) to the center line *A-B* and find the center between points 21 and 11 forming point *Y*. With point *Y* as a center and *Y*-11 as a radius, scribe the half circle intersecting the center line at points 11 and 21. This forms the contour of the plan view of the first course of the spiral. With points *Y* and *X* as centers scribe the half circles for the other two courses. Connect the points 1-*A*, *A*-2, 2-*B*, *B*-3, etc., with dotted and full lines as shown. These lines will form the base of the construction triangles, which will be explained later.

The next step will be to form the stretchout of the cylindrical center piece. Project two lines from the top and base of the cylinder in the side elevation. Set a pair of dividers equal to one of the spaces in the plan of the cylinder and step off the points *A*, *B*, *C*, *D*, etc., on the top line. Project these points to the base line parallel with the center line *C-D*.

From each of the twenty-one points which were found in the second paragraph scribe the broken lines at right angles to the center line *C-D* so that they cross both the side elevation and the stretchout. The points of intersection with the perpendicular lines in the stretchout will form points *A*, *B*, *C*, *D*, *E*, etc., or the contour of the spirals on the cylinder.

Next project points 1, 2, 3, 4, 5, etc., to the side elevation parallel with the center line *C-D*, so that they cross the horizontal lines; the points of intersection will form points 1, 2, 3, 4, 5, etc., or the contour of the outside of the spiral. In the same manner project points *A*, *B*, *C*, *D*, *E*, etc., to the side elevation so that the points of contact with the cross lines will form the contour of the spiral on the cylinder.

The construction triangles must now be formed as shown in Figs. 1, 2 and 3. As all the triangles are found in the same manner, I have only shown the three to give an idea of how they are found. With a pair of dividers take the true length of the line *A*-2 and place it on the horizontal line in Fig. 1. The height of the triangles will be equal to the distance between two of the cross lines in the side elevation. Place this on the perpendicular line in Fig. 1. Scribe a line across the two points just found forming the first construction triangle of the true length of line *A*-2. Next take the distance between points 1 and 2 in the plan and place it on the horizontal line in Fig. 2. Now take the distance between two of the cross lines in the side elevation and place on the perpendicular line. A line across the two points will be the true length of metal between points 1 and 2. Next take the distance between points *A* and *B* in the plan and place it on the base line in Fig. 3, also take the distance between two of the cross lines in the side elevation and place it on the perpendicular line in Fig. 3. A line across the two points will be the true length of metal between points *A* and *B*.

The last operation will be to form the pattern. Scribe a straight line at any convenient place on the sheet and lay off the distance between points 1 and *A* in the plan. This will be the true length of this line, as it does not rise, as will be seen in the side elevation. With point 1 as a center and the distance between points 1 and 2 in Fig. 2 as a radius scribe an arc. Now with point *A* as a center scribe an arc to cross the one just taken from point 1. The point of intersection will form point 2. With point *A* as a center scribe an arc equal to the distance between points *A* and *B* in Fig. 3. With point 2 as a center, scribe an arc equal to the distance between points 2 and *C* in the plan. The point of intersection with the arc just taken from point *A* will form point *B*. Continue in this manner until the pattern for the first spiral is complete.

In forming the pattern it will be noted that the dotted lines all rise and the true length must be found as in Fig. 1, while the true length of the full lines are shown in the plan, as they do not rise, as will be seen in the side elevation. The distance between the points 1, 2, 3, 4, 5, etc., must each be found, as they become shorter as the pattern is developed. The height of these triangles will all be the same, but the base of each one must be found as in Fig. 2. The distance between points *A, B, C, D, E*, etc., will remain the same as in Fig. 3 throughout the pattern, as the spacing and the rise is the same.

The pattern for the first course only is shown in this drawing, as the other two courses are found in the same manner.

Be sure when putting the pattern together that the points *A, B, C, D*, etc., in the pattern correspond with the same points on the cylinder, otherwise the spiral will be distorted and prove a misfit.

Among Pennsylvania Boiler Shops—II

Importance of Making Sketches to Scale Illustrated by Costly Mistake—Proper Shape of Boiler Patches

BY JAMES FRANCIS

The importance of a sketch with an order for boiler work, even if the sketch be a pretty poor one, is accepted by every boiler maker and "goes without saying." But the value of a good sketch is far greater than that of a poor one. There is another thing in connection with sketches which is not as fully comprehended, and that is, the great value of making even a very rough sketch approximately to scale. The writer recently had an experience in a fine Pennsylvania boiler shop which emphasizes this point to a marked degree.

The incident was, in fact, in connection with the boiler stack described in the May BOILER MAKER, in which it was found necessary to cut a length from one portion of the stack and attach the piece thus removed to another part of the construction, the statement in the May issue being in regard to the excellent quality of the cold riveting of the portion of stack removed.

Very naturally, when a man finds a mistake has been made and remedied, the next thing he does is to find out how the mistake happened. For mistakes will happen and the man who never made a mistake isn't worth his feed. In fact, if he never made a mistake it is pretty certain that he has never made anything worth mention!

The writer followed out this matter and ran down the cause of the trouble. The case promised to be very interesting because the man who made the sketch was a well-known civil engineer and one of the best draftsmen to be found in the United States. The boiler shop wherein the stack was made had a high reputation for careful work, and the manager of the shop insisted that the stack as sent out was exactly in accordance with the sketch. Therefore, the writer started investigation with a keen sense of having something well worth while to be found out.

The first thing done was to measure up the stack as it stood in place upon a little 25 horsepower boiler. The measurements given in the sketch were found to agree exactly with those of the stack and its surroundings after it had been put in place, with one section cut from piece *D* and attached to piece *C*, thus proving conclusively that the stack as it came from the shop was *not* in accordance with the sketch.

The next step was to make a scale drawing of the stack as shown by Fig. 1. This drawing was made from the figures given in Fig. 1, and for clearness the detailed elevations were omitted. Fig. 2 shows the scale drawing, with which the stack as erected agrees perfectly. It will be noted that the vertical length of stack *F* just clears an upper timber of the machine for which the stack was made—a Shoemaker gravel-loading machine; in fact, a steam shovel with a 25-foot bucket elevator substituted for the usual "dipper bucket on the end of a pole," as a countryman once described a steam shovel.

The stack, as partially erected when it came from the shop, extended more than two feet past the timber instead of being three inches therefrom, as called for by the dimensions in Fig. 1. Another strange thing developed, and that was the fact that there was a section of plate in the lower or oblique portion *E* of the stack, which, when removed and the elbow replaced without said length, brought portion *F* to the exact required position, which plate section having been again riveted in position, but this time to section *F*, made the stack fit with exactness.

Upon asking the boiler maker how he determined the lengths and sizes of the several sections, and finding that he had laid out the stack to scale, full size upon a number of sheets placed on the floor of the shop, it was necessary to conclude that the stack had been made exactly right: that the sketch was right, but that the trouble occurred through the sketch not being approximately to scale.

The pieces of the stack having been all made and rolled up, were assembled, and it was probably a very natural thing for the workmen, when putting the stack sections together, to look at the sketch, Fig. 1, and conclude that the stack sections *C* and *D* were each somewhere nearly of the same length; therefore the last section was put into shorter piece *D* instead of into *C*, where it belonged, for the reason that the sketch, Fig. 1, gives no idea that the two parts *C* and *D* are so different in length as is shown at *E* and *F*, Fig. 2. There, evidently, is where the mistake took place, and it emphasizes very strongly the making of even the roughest sketches approximately to scale.

That it is possible to make sketches in this manner will be quickly made plain to any man who will try it. After a very little practice almost any man can make a free hand sketch which is remarkably close to scale. All that is necessary, in addition to practice, is to keep the matter of scale and dimensions in mind when making the sketch. If working to a scale of one-half inch to the foot, it is certainly very easy to lay off a quarter of an inch when six inches is to be represented upon the sketch. Thus, by keeping the working scale of the sketch in mind when making the sketch, it will be found very little trouble indeed to make sketches so close to scale that mistakes like the one here described will never be made.

The writer has devoted considerable space to this matter, for the reason that the mistake is one which often gives trouble, the cause of which may be laid to almost anything besides the sketch; therefore the importance of making eketches as clearly and as accurately as possible.

There is too great a tendency to carelessness in the making of sketches, where, as one writer once aptly put the matter, "He made a single crooked line and then began to talk about it!" Certainly a man cannot be too careful in making a sketch. The picture is intended to be a guide which will keep the workmen exactly upon the right road when making the construction which the sketch is intended to illustrate. Then, by all means, as great care should be taken while making the sketch, as in making the article itself.

The same thing, I am sorry to say, is evident in the making of memoranda. I recently saw a man take from his pocket a piece of paper upon which he had set down the data necessary for a bit of boiler work, and, I am sorry to say, the gentleman spent all of ten minutes over the paper trying to remember how the thing went and what the items of the memoranda really meant.

Is it to be wondered at that when memoranda and sketches are made in such a loose, slipshod manner trouble is pretty sure to occur? It has been shown above that even with a perfectly accurately dimensioned sketch trouble did visit the job, and it may well be imagined how much trouble may be caused from a carelessly made sketch which contains some inaccuracy of dimensioning.

"Why is it," recently said a boiler inspector to a young boiler maker who had been taking "exams" for boiler inspector, "that you boiler makers cannot learn the proper way of shaping and applying patches?

The Shape of Patches

"Now take this question which you have been figuring on. I asked you to sketch out a patch for a cracked sheet, and here (Fig. 3) is what you have given me for an answer to the question, and I'll tell you, son, that patch is sure enough to 'make a boy strike his daddy'!"

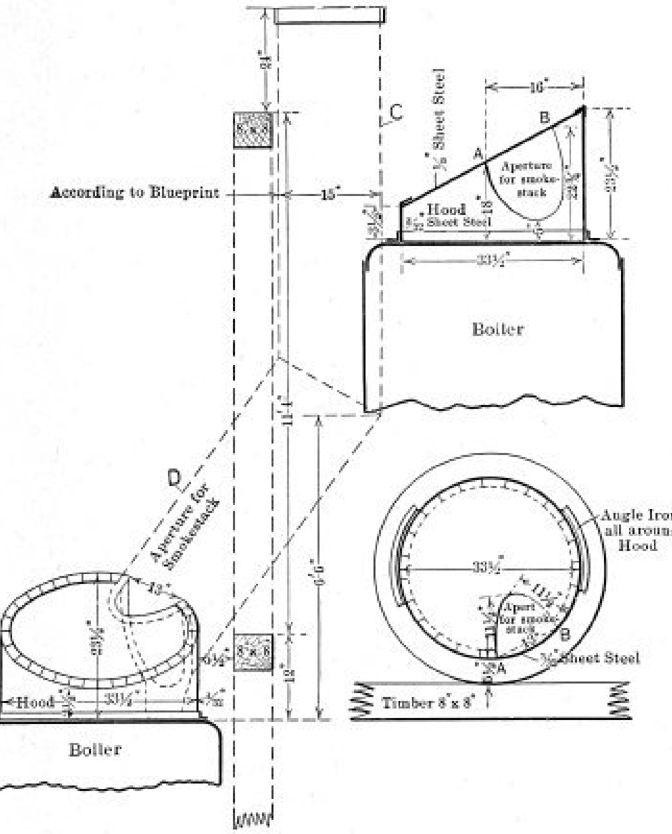


Fig. 1.—Detailed Drawing of Stack

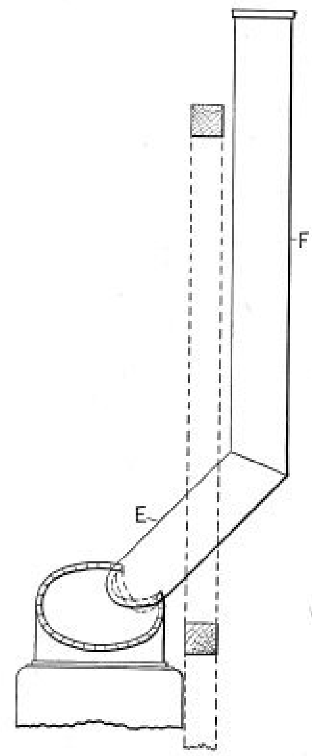


Fig. 2.—Stack Drawn to Scale

"But, what is the matter with it, Mr. Inspector?"

"About everything which possibly could be the matter with a bum patch! To begin with, that kind of a patch will not hold and should never be allowed. I will condemn such a patch just as quick as I set eyes on it and without doing any measuring or figuring whatever!"

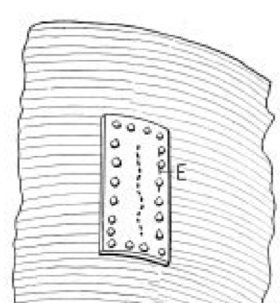


Fig. 3.—The Boiler Maker's Patch

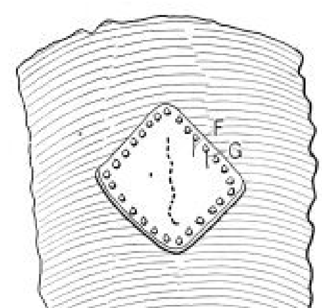


Fig. 4.—The Inspector's Patch

"But where is the error? It seems to be a patch which will cover the crack as indicated by the dotted line, and I am sure that I do not yet get on to what the trouble may be."

"Well, now, son, you have passed a good 'exam' thus far in the game, but as my old schoolmaster used to say, 'that is where you dulled.' Don't you see that the patch cannot be as strong as the original shell was, and that as the shell split there is no reason in making the repair with a patch weaker than the original sheet! See?"

"Yes, I believe I do. The rivet section of the patch cannot figure much more than 56 percent, and, by thunder! that would make the patch too weak, wouldn't it?"

"It sure would, son, and that is a thing which you always have to look out for in boiler inspecting. If you don't 'keep both eyes open tight,' somebody sure will put over a weak patch, to let go when nobody is looking for further trouble."

"But how is a patch to be made as strong or stronger than the original sheet before the crack?"

"It can't be made stronger than the original sheet, but it can be made a whole lot stronger than the patch shown by Fig. 3. Here! Just take a look at Fig. 4. Do you see any difference in arrangement of the patch and rivets?"

"Sure. There is a whole lot of difference. The patch in Fig. 4 is diamond shaped, or perhaps square, while in Fig. 3 the patch is rectangular."

"Yes, there is that difference, all right, but that is not what I mean. Just look at Fig. 3 again. At *E* you will see between the rivets a dotted line which indicates where this patch will fail. Or, should the patch be made very thick, where the shell of the boiler will tear apart between the new rivet holes under sufficiently high steam pressure inside the boiler."

"I see what you mean, Mr. Inspector. If the rivets are placed close together the metal of the patch or the shell may tear. If the rivets be spaced far enough apart to save the sheet, then the rivets may shear off under the heavy pressure. I get you now, Mr. Inspector, and I'll confess that I hadn't thought of that end of the matter when I sketched the patch as shown by Fig. 3."

"That's it, son! Just what I expected you to say—you 'hadn't thought of that!' But now I hope you will realize the importance of an inspector's being 'always on the job' and never omitting or forgetting anything. You see, son, it's just this way: A boiler inspector *mustn't* forget. He *never* must let the slightest unsafe or indefinite detail get past him without having fully investigated it and run into the ground the slightest element of danger or doubt which may be contained therein. I tell you, son, a boiler inspector has got to be sure of himself all the time.

"And, after you get your inspector's papers, never take anything for granted. See for yourself, think for yourself and measure for yourself. Then if you make any mistake it will be on the side of safety, and no inspector was ever brought up 'on the carpet' for that."

"I'll do it, Mr. Inspector, but please give me your reasons for advocating the patch shown by Fig. 4. Just how and why it is better than that shown by Fig. 3."

"All right, son. I'll give it to you straight, even though I feel pretty confident that you have the whole matter in your head already. Evidently you want to add a bit to the advice just handed to you and 'hear for yourself' as well as see, eh?"

"Sure. Thought if you gave me the whole dope, straight from the shoulder, I would be sure to have it just right."

"Good for you. You are sure 'getting there.' By looking again at Figs. 3 and 4, you will see that at *E*, Fig. 3 there are but eight rivets to withstand the stress upon the patch, whatever it may be. But at *F*, Fig. 4, there are thirteen rivets available to carry the same amount of pressure which must be carried by eight rivets with the patch arranged as in Fig. 3. Get me, son?"

"I surely do, and I can see something else also. In Fig. 3, should the patch or the shell start to tear at *E*, the line of failure will run from one rivet to the next until the whole patch has torn apart. But in Fig. 4, even should there come a time when the sheet tears under the stress, the lines of rupture will not run from one rivet hole into the next, but they will run lengthwise of the boiler, as shown at *F* and *G*, thus preventing the letting go of the entire patch even should the rivet holes begin to tear under excessive stress."

"I see that point, Mr. Inspector, and I will try always to keep it in mind when patches are to be examined. But tell me, isn't it necessary to cut away the old shell underneath the patch? You do not show in the sketch that the shell is to be removed. How about it?"

"There are times, son, when it is necessary to cut away the shell under a patch. Such a time is when the patch is upon a fire sheet, directly exposed to direct flame. Then it will be necessary to cut away enough of the old shell to let the water get at the patch fast enough to carry away the heat which the patch receives from the flame. When a patch is above the fire line, then, of course, it will not be necessary to cut away the old shell underneath the patch."

A Plate Planing Stunt

In a little shop among the mountains, where they do lots of things by clear nerve and horse sense, the writer recently saw large boiler plate being planed upon the calking edges of the plate, on a little one-horse open side planer, the bed of which was very long but not more than two feet wide. And still, sheets 20 feet long were being planed, and planed well and quickly on that little machine.

A stout I-beam, supported a couple of inches above the planer bed by bolts and blocks at either end permitted the sheet to be clamped fast by means of wedges driven under the I-beam. The free end of the plate was supported upon a light, easy running car, the axles of which ran upon friction wheels in order to make the car run as lightly and as easily as possible.

Two cars were provided, the one next to the planer being placed upon a track upwards of 40 feet in length. Another car was placed farther away from the planer upon a track only about 20 feet long. Both these cars were used when the ends of long plates were being planed, but only one car was in use during the planing of the sides of plates and for all ordinary work.

Effect of Caustic Soda on Boiler Steel

In certain districts where feed water for boilers contains sodium hydroxide, many boiler troubles have appeared which have given no little concern to boiler users and makers. Such water is found in the central eastern part of Illinois, in the Fox River Valley in the northern part of the same State, and in portions of other States. The engineering experiment station of the University of Illinois has just completed an investigation of this source of boiler distress, and the results are published in Bulletin 94, by S. W. Parr. It was noted that boilers using feed water containing sodium hydroxide often developed fine cracks radiating from rivet holes or extending from hole to hole. The experiments showed that the effect upon the metal is to cause brittleness, which makes it less capable of withstanding steam pressure and temperature changes. Among the remedies suggested is the addition of a salt having properties which cause it to react with the alkali and yield a harmless product.

Steam Boiler Regulation in Massachusetts*

Development of State Boiler Inspection in Massachusetts —Scope of the Laws and Rules—Record of Inspection

BY GEORGE A. LUCK †

Legislators in Massachusetts have generally had keen sensitiveness for the safety of her citizens, especially in safeguarding life and property from the operation of steam boilers and engines and other pressure vessels. Massachusetts has never been content to follow, but has always aimed to be a pioneer in such matters, and it is universally recognized that even now, when much is being done to build upon her foundation, she is still forging ahead in the matter of improved design, construction, installation, inspection and operation of steam boilers and their appurtenances.

The original boiler inspection law of the Commonwealth of Massachusetts was Chapter 418 of the Acts of 1895, approved by the governor on May 29, 1895. That act created the boiler inspection department of the District Police, the salaries of the boiler inspectors being fixed at $1,500 per year. By Chapter 834 of the Acts of 1913, provision was made for increase of the salaries by $50 each year until they reached the sum of $1,750 per year for each State boiler inspector.

Steam Boiler Rules

The members of the Massachusetts Board of Boiler Rules were named by the Governor in July, 1907, and comprised the Chief Inspector of the Boiler Inspection Department as chairman, one member representing the boiler-using interests, one member representing the boiler-manufacturing interests, one member representing the boiler-insurance interests, and one member representing the operating engineers. Soon after organization, correspondence and conferences were commenced with prominent boiler manufacturers, insurance companies and mechanical engineers regarding their best practice in constructing various types of boilers, and the information thus obtained was used as a basis for the first issue of rules for the construction of steam boilers for installation within this Commonwealth.

The dates of the various issues of such rules have been as follows: August 30, 1907; September 18, 1907; November 19, 1907; January 9, 1908; March 24, 1908; June 9, 1908; October 1, 1908; August 5, 1909; January 2, 1915; May 12, 1916 (the present rules). Thus you will see that the Massachusetts Board of Boiler Rules has been on the job quite continuously, and I may add that further changes are being considered by the Board at the present time.

So many thousands of copies of the Massachusetts steam boiler rules have been issued that their requirements are pretty thoroughly understood all over the world, but for the benefit of any who have not been made familiar with the latest issue, I will explain a few of the more important features.

Air Tank Inspection Law

The date of the original air tank inspection law (Chapter 629 of the Acts of 1913) was May 8, 1913, which was amended by the substitution of the present air tank inspection law (Chapter 649 of the Acts of 1914), approved by the Governor on June 9, 1914. The air tank inspection law and the air tank regulations prescribed by this Board in accordance therewith are given in a separate pamphlet.

The total number of Massachusetts standard boilers and air tanks constructed under the Steam Boiler Rules formulated and the Air Tank Regulations prescribed by the Massachusetts Board of Boiler Rules has been as follows:

Year Ending October 31.	Mass. Std. Boilers.	Mass. Std. Tanks.	Combined Total.
1908 (from May 1)	519	....	519
1909	1,365	....	1,365
1910	1,642	....	1,642
1911	1,604	....	1,604
1912	2,002	....	2,002
1913	2,860	....	2,860
1914	2,738	....	2,738
1915	2,291	214	2,505
1916	1,665	178	1,843
Total	16,686	392	17,078

Manufacturers so desiring have had no difficulty in constructing boilers which met the requirements of both the Massachusetts Rules and the Boiler Code of the American Society of Mechanical Engineers.

Engineers' and Firemen's License Laws

The date of the original air tank inspection law (Chapter 471 of the Acts of 1895, was approved by the Governor on June 5, 1895.

MASSACHUSETTS DISTRICT POLICE—BOILER INSPECTION DEPARTMENT—INSPECTIONS, EXAMINATIONS AND FEES PAID TO STATE TREASURER EACH YEAR.

	Inspections			Examinations			
Year Ending Oct. 31.	Boiler Insp. Dept.	Insurance Companies.	Total.	Engrs. and Firemen.	Operators of Hstg. Mchy.	Total.	Fees Paid to State Treasurer.
1893....	171*	....	171	....	...	....	......
1894....	405*	....	405	....	...	....	......
1895....	306	....	306	1,605	...	1,605	$15,263.00
1896....	719	....	719	11,703	...	11,703	6,628.00
1897....	1,528	....	1,528	9,274	...	9,274	8,699.00
1898....	1,961	....	1,961	5,655	...	5,655	9,590.00
1899....	2,626	....	2,626	5,981	...	5,981	13,142.00
1900....	2,364	....	2,364	6,472	...	6,472	11,438.00
1901....	2,814	....	2,814	6,389	...	6,389	13,203.00
1902....	2,583	....	2,583	6,518	...	6,518	11,447.00
1903....	2,448	....	2,448	5,873	...	5,873	10,977.00
1904....	2,441	...	2,441	5,850	...	5,850	10,628.53
1905....	2,555	4,080	6,635	5,725	...	5,725	12,832.00
1906....	2,363	12,000	14,363	6,612	...	6,612	15,382.50
1907....	3,043	12,467	15,510	7,140	...	7,140	18,801.00
1908....	3,698	13,739	17,437	7,129	...	7,129	22,066.00
1909....	3,763	16,032	19,795	6,657	...	6,657	23,735.00
1910....	3,837	15,972	19,809	6,867	...	6,867	23,356.00
1911....	4,510	15,986	20,496	6,948	161	7,109	25,036.00
1912....	4,334	16,766	21,100	6,737	291	7,028	22,604.00
1913....	5,403	17,006	22,409	6,405	134	6,539	25,558.00
1914....	6,746	18,010	24,756	6,490	147	6,637	27,457.20
1915....	6,987	19,456	26,443	5,364	141	5,505	27,698.00
1916....	7,360	19,254	26,614	5,174	116	5,290	27,766.00
Totals.	74,965	170,768	255,733	142,568	990	143,558	$383,257.23

* Preliminary investigations.

Original Boiler Inspection Law (Chap. 418, Acts of 1895), May 29, 1895.

Original Eng. and F. Lic. Law (Chap. 471, Acts of 1895), June 5, 1895.

Original Op. of Hstg. Mchy. Law (Chap. 656, Acts of 1911), July 11, 1911.

Original Air Tank Law (Chap. 629, Acts of 1913), May 8, 1913.

Original Ammonia Compressor Safety Valve Law (Chap 467, Acts of 1914), May 2, 1914.

* Paper read before American Boiler Manufacturers' Association, Pittsburg, Pa., June 25.

† Deputy Chief, Boiler Inspection Department of Massachusetts, and Chairman, Massachusetts Board of Boiler Rules.

OPERATORS OF HOISTING MACHINERY LICENSE LAWS

There has been also a law relative to licensing operators of hoisting machinery when the motive power is mechanical and other than steam (Chapter 656 of the Acts of 1911, as amended).

The magnitude of the work done in the inspection of steam boilers and air tanks, and in the examination of applicants for license as steam engineer, fireman or operator of hoisting machinery, by members of the District Police Boiler Inspection Department of Massachusetts, is indicated by the tabulation on page 217.

The only other subject conferred upon the Massachusetts Board of Boiler Rules by the Legislature is the Ammonia Compressor Safety Valve Law (Chapter 467 of the Acts of 1914, approved by the Governor on May 2, 1914) and rules were formulated in accordance therewith, copies of which are printed separately.

A careful perusal of the various pamphlets and extracts from the Massachusetts State Laws mentioned above will give a pretty fair idea of the scope and operation of the various laws and rules affecting the Massachusetts Board of Boiler Rules.

Making the Business Earn a Profit—III

Various Items Which Make Up the Overhead Charges—The Proprietor's Salary; It's Influence in Cost Accounting

BY EDWIN L. SEABROOK

The July article of this series closed with the enumeration of twenty-five items of expense, or overhead, which applies practically, with few exceptions, to all those engaged in the boiler making business.

It may be well to note that no amount was stated for these respective items, because no two firms would hardly agree as to what these amounts should be. Even though they kept an accurate record, no two would have the same experience. These amounts must be determined from the records of the business, and not from guesswork or hearsay that the overhead of some competitor was such and such an amount. It is a matter of individual determination for each business.

One may pay $40 a month rent, another $70. One may be satisfied with a salary of $1,600, another may want $2,000. The cost of taxes, telephone, insurance and other items will vary. It might be well to discuss a few of these items.

RENT

It costs something to maintain a place of business, and this is generally termed rent. Every firm that pays rent knows, or ought to know, that this is an important part of the overhead. Some think they are free from this item of expense because they own their own property. The folly of this view may be illustrated by an incident that occurred in a Western city. The writer was discussing the question of overhead with a small manufacturer. When the question of rent was approached he said: "I own this building and do not have to include this item in my overhead." He was asked how much he would rent the building for if he were not using it himself, and he replied, "Fifty dollars a month."

The writer said to him: "You are willing to make your customers a present of $600 a year simply because you own the building?"

This manufacturer had never thought of the proposition in just this light, and admitted that he should charge to his overhead a proper rental for the building. The business is chargeable with the item of rent, if the building is owned by the firm, for just as much as it could be rented to some one else. If those owning buildings desire to arrive at a fair rental value, let them take the valuation at 5 percent, add taxes, insurance, upkeep, etc., and charge the total as rent.

INSURANCE

Insurance of all kinds, such as employers' liability, team, auto-truck, fire, etc., is a safeguard to the business and should be carried by everyone. Nearly all the States require the employer to carry workmen's compensation. The premiums upon all classes of insurance that protect the business are a charge upon it, and therefore a part of the cost of conducting it.

TAXES, PRINTING, ETC.

Taxes, advertising, telephone, printing, stationery, postage, etc., scarcely need any comment. Some one may say: "Why charge the business with taxes? It is a personal matter." Taxation is necessary. The existence of the business occasions the tax and is, therefore, chargeable with it. The telephone is a business necessity; it costs something. It is therefore proper that the business should bear this cost. Letterheads, envelopes, bill heads, time cards, and other printed matter are a necessity for the proper conduct of the business. Separately these cost but a small amount, but in the course of a year quite a sum. Some may think that the few cents spent daily for postage is not worth keeping an account of, but for a whole year these small daily amounts equal a sum that is often quite surprising.

CARFARE

This item is somewhat in the same class as postage. Not very much each day, but the total in the course of a year is considerable. The smallness of the expenditure does not do away with the fact that the nickels, dimes and quarters are going out on a business errand: and if they are not to be a total loss, provision must be made for their return.

SHOP SUPPLIES

This is a constant source of outgo. Small tools, such as tongs, hammers, wrenches, chisels, etc., are continually wearing out, or are lost, and must be replaced. The business does not get these gratis—they cost real money.

LOST TIME OF MECHANICS

Lost time for mechanics that must leave the shop for repair work, etc., is inevitable, and is often far more important than is realized. This lost time is no reflection on the mechanic; it is inherent to some parts of the busi-

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ness and as such should be charged with the time so lost. If an accurate account of the time lost by mechanics, through no fault of their own, should be kept, it would surprise many firms. Like many other business leaks, it creeps in without attracting attention. How much to charge for such lost time depends on the individual business, and each one must ascertain the proper allowance from his own records, and it is important that such a record be accurately kept. A good authority in one business estimates this loss at 5 percent of the mechanic's time. This loss is a real one, and the time unavoidably lost by the mechanic is a proper charge on the business.

Freight

In most cases freight can properly be added to the cost of material. If it cannot be charged as a part of the material, or to a contract or customer, it should be made a part of the overhead.

Light, Heat, Power

These are more or less necessary to the maintenance of the business and really need no explanation. While these all go into "overhead," it is well to keep a separate account of each.

Depreciation

Machinery, tools and equipment are constantly wearing out and must be replaced. A new machine, if used but a week, has depreciated in value, because it is no longer new from a commercial standpoint. How much does it cost to replace shop tools every year? The machinery is constantly wearing away; how soon will it be gone, how much will it cost to replace it?

What would be thought of a boiler maker who bought a machine for $500, worked for others for mechanic's wages, using the machine, and in a year wore it out? Would he not be giving the machine away?

Does this not take place in actual practice where no allowance is made for depreciation? An allowance annually should be made for depreciation of machinery and equipment, so that when these are worn out they can be paid for from these allowances and not from "profits." Repairs to equipment, etc., should be included in the "overhead" items.

Allowances

Disputes and misunderstandings in business transactions are bound to occur. Reductions are frequently necessary to secure settlements. How much do these allowances amount to in the course of a year to secure a settlement, and not because they are justified? Undoubtedly there are cases where the demand for an allowance is justified, but in most cases these are a proper charge on the business and form a part of the cost of conducting it.

Hauling

This item includes the maintenance and upkeep for the equipment used in hauling, whether it be done by horses or auto-trucks. This should include the entire cost of operation, such as feed, repairs, shoeing, licenses, depreciation, etc. It should also include the driver's wages. If the driver does mechanical work part of the time, for which a charge can be made to the customer or contract, the portion of his time given to hauling only should be included in the "overhead."

Bad Accounts

The boiler making business cannot be conducted on a strictly cash-over-the-counter basis, consequently a certain number of losses through bad accounts, the cost of collecting others, are inevitable. Some have questioned the justice and fail to understand why business losses should be charged to "overhead." Why make the good customer pay the losses incurred by the poor one? It should be borne in mind that such losses are inherent to the business, are incurred by it; they are a natural, legitimate expense and should be charged to it.

The good customers in every line of business are paying for the losses incurred by those who fail, or from whom it is impossible to secure payment. This refers to legitimate losses and not to "wild-catting" in extending credit. Extraordinary losses and speculation should be borne personally, but the average percentage of bad accounts, cost of collections, etc., should be charged to overhead; these should be averaged for at least five years rather than the amounts taken for any single year.

Association Dues

Every business man should connect himself with his trade organization and consider such as a part of his business. No expenditure will bring so large a return for the amounts spent for—or shall we say invested in?—the trade association.

Interest on Investment

The legitimacy of charging interest on capital is questioned by some. These claim that capital is invested for the purpose of securing a gain or profit, and is not entitled to an interest charge in the "overhead." Without attempting to argue the question either way it does not seem that there is much difference between capital invested in a building, for which rent may properly be charged against the business, and that invested in the business itself. As there is a general disposition to make the "overhead" too little rather than too much, it might not overload the "overhead" to make a reasonable charge for the capital invested. Interest on borrowed money, which is not charged to the interest and discount account, should be charged to "overhead."

Salaries

This part of the cost of conducting business is exceedingly important; it is probably the largest single item of the expenses and more liable to misapplication than any other expenditure. More mistakes are made with "salary" and "wages," so far as these apply to the owner of a business, in connection with "overhead" than with any other item. The item of salaries should include amounts paid to the proprietor, stenographer, bookkeepers, superintendent, and all others who are not directly connected with the production part of the business.

It is at this point that a radical distinction must be made between the two classes of labor, commonly termed productive and non-productive. The average boiler maker is too familiar with the distinction, in practice at least, to make any comment on these two classes necessary. The terms productive and non-productive are used to classify the two kinds of labor rather than to indicate that one produces and the other does not, for all labor is productive. The work of the mechanic can be charged directly to the customer or contract, and hence is termed productive labor. That classed as non-productive is a direct charge on the business through the part it takes in its management.

The most important item to be considered in the salary list is that of the proprietor. It is generally conceded even by the most indifferent to "overhead expense" that amounts paid for office help are naturally a charge on the business. Unfortunately, for some reason never clearly defined, many proprietors do not consider or include the amount they take from the business as a salary and expense. For some unknown reason they mistake salary for profit. Salary comes into existence the minute operations begin, and ofttimes before. Profit does not begin until the transaction is finished, completed in every detail and paid for.

The amount drawn by the owner of the business should be charged to "overhead" unless he works a part of the time, for which he can make a charge to a customer or contract. Many owners say that they work with their mechanics and charge this time to the customer, etc. They claim their pay in the form of wages as a producer rather than salary of a non-producer, and should not be charged to the cost of conducting business. This line of reasoning is true up to a certain point, seems quite plausible for the entire case, but a little analysis will show that the proprietor is deceiving himself. In the first place, a business must be very small indeed where the owner can devote all his time to mechanical work. There are estimating, collecting, customers to be called upon, the attending to many business details entirely removed from the mechanic's sphere. Many owners give themselves credit for doing a larger amount of mechanical work than is generally possible.

After questioning hundreds of proprietors in many similar lines of business, it is safe to say that not more than two-thirds of the time can be given over to mechanical work and the vast majority are not able even to put in one-half of the time at work mechanically for which they can make a direct charge. Taking care of the business makes a very definite demand on the time of the owner. An expense is created by this demand and the business should be charged with it. For the purpose of illustrating let two things be assumed: First, the owner draws $30 a week from the business; second, he works one-half the time, for which he can make a direct charge to a customer or a contract. From what source comes the difference between his charges for the mechanical time and the $30 he proposes to draw at the end of the week? It is quite evident that there is only one legitimate source from which it can come—the business—and before it can be taken from this source it must be put into it through the "overhead."

Unquestionably the salary of the owner is the weakling in the cost of conducting business in many establishments. If he can give a part of his time to mechanical work, for which he can make a direct charge, the difference between this and the amount drawn from the business should be charged to the cost of conducting it. If all his time must be given to the management, then his entire salary should be charged to "overhead."

The September number of The Boiler Maker will deal with the analysis of an actual business and getting the cost of conducting business, or "overhead," into the price.

Boilers and Pressure Vessels: Inspections, Recommendations, Repairs, Calculations, etc.—I

Questions from Boiler Inspector's Examination Paper—General Data Blanks for Horizontal Tubular Boiler

BY "THE VAGRANT"

The preponderance of engineers in the boiler inspection field has long been a subject of acrimonious discussion among boiler makers. The old stereotyped cry of "What does an engineer know about boilers?" is constantly reiterated. Without laying any claim to superiority or ability, I will endeavor in this series of articles under the above caption to try and explain why the engineers occupy the inspection field almost to the exclusion of boiler makers. I shall also endeavor so to treat the subject that those who wish can, with the information and references given, qualify themselves to pass a creditable examination before a State Board.

Being a boiler maker myself, and doubtless possessing considerable of the arrogance attributable to our tribe, knowing that many of our clan consider their ability and superiority as inspectors to be inherent and rightful as an heritage rather than through technical knowledge, and are wont to scoff at the idea of technical knowledge being just as requisite as mechanical ability, I append the following ten ordinary questions which have been asked in examinations. It will be beneficial for those who are interested in this series to make the attempt to answer them offhand.

In order that the greatest value may be derived from the attempt, the answers will be deferred until a subsequent issue.

(1) What pressure is allowed on a staybolt 1 inch diameter top of threads, pitch 4½ by 5½ inches, allowing 6,000 pounds per square inch of area?

(2) Boiler 66 inches diameter, 60,000 tensile strength, ⅜-inch plate, 100 pounds pressure. What percentage of joint is required?

(3) Drum head 36 inches in diameter, bumped 4 inches, ⅜-inch plate, 60,000 tensile strength. What is radius of bump and what is the pressure allowed?

(4) Cast iron steam nozzle on boiler, diameter 12 inches. What thickness required for 100 pounds pressure?

(5) Make drawing of water column and connection.

(6) What attachments are necessary for the safety of a steam boiler?

(7) What is the area to be stayed in segment of horizontal tubular boiler, 72 inches diameter, 34 inches from tubes to shell?

(8) Show by calculation how and why there is twice as much resistance to transverse rupture as there is to longitudinal rupture.

(9) Give specifications of requirements of horizontal

tubular boiler, 66 inches diameter, to be allowed 125 pounds pressure.

(10) Where should the fusible plug be located in: A vertical tubular boiler? A Babcock & Wilcox? A Stirling? A Scotch dry back? What are the requirements of a soft plug?

It has been suggested that, in order to make this series of greatest possible service, a question box be opened in connection therewith. I shall, therefore, invite and attempt to answer any legitimate question in connection with inspections, calculations, allowable repairs, reserving the right to publish any questions and answers that may be of sufficient general interest to warrant so doing.

Beyond all question, the most prevalent type of stationary boiler in use to-day is the horizontal tubular. This "king of power" is probably a familiar object to all civilized people. I shall therefore have to devote more time to its discussion than the exigencies of the occasion would otherwise seem to warrant.

A typical standard boiler of this design is shown in Fig. 1. We will proceed to make the necessary measurements, filling out what is called a "data slip" and make the calculations accordingly. Data slips for special types of boilers are printed containing the questions peculiar thereto. The general data question blank suitable for the majority of boilers is appended herewith:

GENERAL BOILER DATA REPORT

Use This Form at First Internal Inspection Only.

Inspector. No. ....
................................Dept. ....
Address ....
Business ....
Location of boilers..
Number of boilers on premises?......................................
(Make diagram on back hereof giving number and location
....
as used in plant.)
This report covers Boiler No. ....(1) Age?............
(2) Type of boiler?.......(3) Diam.?.......(4) Length?.......(5) No. of courses?.......
(6) How riveted?.........(7) Size of hole?.........Pitch?..........
(8) Thickness of shell plates?.........(9) Head?.........(10) Lowest tensile strength?.........
(11) Sectional C. I. boiler; width?......Length?......No. of sections?......
(12) Watertube boilers; No. of drums?.....Diam?..... Length?.....
(13) Internal furnace; how many?......Diam?......Length?...... Plain or corr.?......
(14) Thickness of furnace sheets?.....................................
(15) Number of tubes or flues?...................Diam.?...............
(16) Height of segment over tubes?...................................
(17) Give number, size, type and condition of braces above and below tubes ....
(18) Staybolts; vertical pitch?...........Circumferential?...........
(19) Diam. over threads?.....................
(20) Dome: Diam.?...........(21) Thickness of sheets?............
(22) How riveted to shell?............(23) How braced?............
(24) Is opening in shell full size of dome?..........................
(25) Is man hole frame cast iron or wrought?.........................
(26) Size?......................Strength ample?......................
(27) Safety valve: Type?......(28) Size?......(29) Area of grate surface?...............................
(30) Is there a stop valve between boiler and safety valve?..........
(31) Fusible plug?......................(32) Location? ....
(33) Is water heated before entering boiler?..........................
(34) Position of feed? ....
(35) Where is blow-off connected?....................................
(36) How protected from flames?......................................
(37) Are there any feed-water heaters, purifiers, etc., between check valve and boiler? ....
(38) Is steam gage correct?......(39) Condition of water glass?..... No. of try cocks? ....
(40) Can water columns and connections be readily cleaned?...........
(41) Size of main steam pipe from boiler to engine throttle?..........
(42) Condition and support?..
(43) Is condensation in main steam line cared for?....(44) How?....
(45) Efficiency of longitudinal seams?.....(46) Factor of safety?.....
(47) Pressure allowed? ....
(48) Safety valve loaded at?............(49) Hydr. test?............

RECOMMENDATIONS

....
....

INSTRUCTIONS

....
....
Date..

The answers are supplied as follows:

(1) *Age.*—If the factory number or authentic history of boiler is not available, I know of no other problem requiring keener or closer analysis in order to do justice to the answer. Boilers are in use that have been running over forty years; some boilers are worn out, some burnt out or discarded in a year's service. The law in some districts sets an age limit. Outside of regions where there are rigid State laws, in probably 15 percent of cases no authentic information can be had regarding the age of the boiler. One has, then, to approximate, using his gift of observation to the best advantage. For instance, if we should find a boiler built of an unusual number of small rings, or courses, with hand-driven rivets, insufficiently braced segment, blind rivet holes internally and close pitch, they are among the infallible earmarks which, when combined with iron plates and rivets, lap joint, iron fittings (cast), flanged dome, B. & L. valve and antiquated setting, prove the boiler to be a patriarch of the "steamboat days." Such boilers are occasionally found in rural districts, and in making calculations for the safe working pressure it is essential that a progressively increasing percentage be subtracted for depreciation due to age; probably nothing for the first five years of fair service, 1 percent for each succeeding year up to fifteen, increasing to 2 percent about the fifteenth year, and 1 percent additional each year thereafter, which would cut a boiler of the above type to about 15 or 20 pounds.

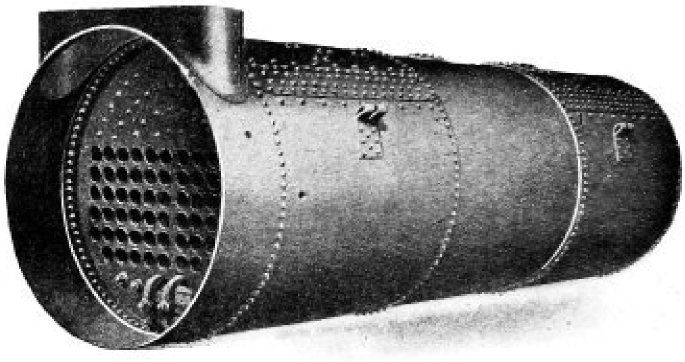

Fig. 1.—Standard Horizontal Tubular Boiler Built for 150 Pounds Working Pressure

(2) *Type of Boiler.*—In this case HT, or horizontal tubular, and for the moment we will confine our attention to this type exclusively and will take up and fill out data slips for other boilers in due course.

(3) *Diameter.*—This is not to be measured externally. It refers to the inside diameter of the outside course, or greatest *internal* diameter, for bursting pressures are to be determined from this measurement.

(4) *Length.*—This is not such an important factor. Whether it is 5 or 15 feet long makes but little difference. Length is generally taken from outside to outside of heads and the evaporative efficiency of the tubes is figured from this, as will be shown by a table later on.

(5) *Number of Courses.*—Generally three in this type of boiler, although for the sake of completeness it may be well to mention that some boilers have one long, continuous fire sheet from head to head, while the top is made up of two, three or more sections. As this arrangement contributes one continuous longitudinal joint, a serious defect is encountered, which, if the seam is over 12 feet long, is sufficient to condemn the boiler in some States, as will be discussed later.

(6) *How Riveted.*—Refers to whether double, triple or quadruple butt or double, single or triple riveted lap joint. (Complete calculations of the above joints will be made when individual boilers are taken for inspection and calculation.)

(*Continued on page 232.*)

The Boiler Maker

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NOTICE TO ADVERTISERS

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 25th of the month, to insure the carrying out of such instructions in the issue of the month following.

Opportunities for boiler makers, or for young men who desire to enter the boiler making trade and learn the business, have seldom been better than at the present time. The entrance of the United States into the European War has created an exceptional demand for boilers, more especially for marine and locomotive boilers. According to plans of the United States Shipping Board, hundreds of cargo carrying vessels are to be built as rapidly as possible and for the propulsion of these ships steam boilers and engines capable of developing 1,500 horsepower and upwards will be required in each case. This means that a large part of the capacity of boiler shops in the country which have the equipment and facilities for building marine boilers will be required by the Government to take up this line of work. Under such conditions and with the exceptional demands from railroads for locomotives, both for domestic and export use, there will be no lack of employment for capable boiler makers for months to come.

The Navy Department is also offering work as ship fitters in the navy yards at from $4.24 to $4.48 a day to boiler makers who have had experience in laying out.

Only in recent years, with the remarkable growth in size of steam turbine units for generating power, has the necessity for designing boilers in large units for operation under high pressure become apparent. Turbine generators are now being installed capable of delivering from 50,000 to 60,000 kilowatts. To produce boiler units commensurate with such proportions of power units, Mr. John A. Stevens, formerly chairman of the Massachusetts Board of Boiler Rules and also chairman of the A. S. M. E. Boiler Code Committee, some time ago requested one of the leading boiler manufacturers to give consideration to the design of a very large unit and suggested certain features of general design. This company, with the assistance of Mr. Arthur D. Pratt, consulting engineer, of New York, took up the matter and developed a boiler unit which can be constructed for practically any pressure or degree of superheat desired. This unit is illustrated and described in a paper on the "Evolution of the Steam Turbine in the Textile Industry," read by Mr. Stevens before the National Association of Cotton Manufacturers in Boston, Mass., on April 25, and through the courtesy of Mr. Stevens complete details of the boiler will be published in a later issue of The Boiler Maker.

As designed, this unit is a complete structure in itself, embodying boilers (of the watertube type), superheaters, economizers, forced and induced draft fan equipment, uptakes, stack, coal bunkers and ash hoppers. The unit is in reality made up of four independent sections, but they are more compactly arranged than has been the usual custom. Any section may be operated independently while inspecting, cleaning or repairing any of the remaining sections—that is to say, the boiler can be operated in quarters, halves, three-quarters or four-quarters.

The approximate size of this boiler unit is indicated by the following: Grate area, 936 to 1,108 square feet (projected area); water heating surface, 57,600 square feet; superheating surface, 14,352 square feet; economizer surface, 36,800 square feet (contemplated); total heating surface, 108,752 square feet. With these dimensions, the boiler would have a nominal rating, based on water heating surface, of 5,760 boiler horsepower, or, when operating at 300 percent, 17,280 boiler horsepower. With one section down for repairs the unit would easily supply steam for a 30,000 kilowatt turbine and its auxiliaries, while with the entire unit operating at 300 per cent it could deliver sufficient steam to operate a 45,000 kilowatt turbine. As boilers of this general type have been operated for short periods at 400 percent and over, under these conditions the entire unit would supply steam enough for a modern 58,000 kilowatt turbine using high pressure steam and high superheat.

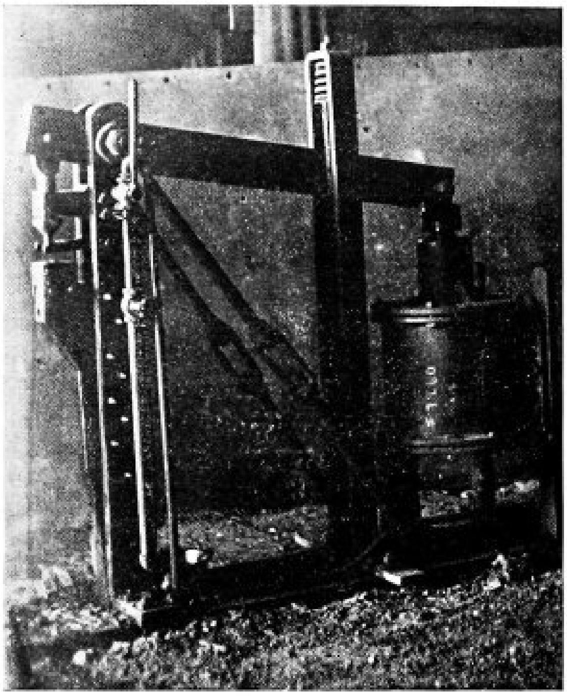
With this entire unit operating at 300 percent rating, it will convert into steam approximately 62,000 gallons of feed water per hour and the furnaces would consume about 25 to 30 tons of high grade bituminous coal per hour. The unit occupies an overall ground area of only 90 feet 6 inches by 84 feet 4 inches or, not including bunkers or firing aisles, 50 feet by 60 feet 4 inches. Some idea of the remarkable proportion of the boiler is given by the fact that there are approximately 10.75 miles of 4-inch tubes in the water heating surface alone, 5.19 miles of 2-inch superheating tubes, and 10.64 miles of economizer tubes. In all, there are no less than 26.58 miles of tubes in the unit.

Engineering Specialties for Boiler Making

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

Home-Made Punch

E. Marks, a boiler maker foreman at Douglas, Ariz., has improvised a punch which has a capacity for punching 13/16-inch holes in ½-inch boiler plate. As shown in the illustration, power for the punch is supplied by a 12-inch by 14-inch brake cylinder, which operates with compressed



Punch Made from Brake Cylinder and Guide Bar

air at 90 pounds per square inch. The arm of the punch is made from an old guide bar and the entire machine is mounted on an old sand board for a foundation.

This punch has been found very useful at the shops where it was built in connection with steel car construction.

Acorn Dies and Holders Prove Accurate and Adaptable

For a successful threading die not only must a high degree of accuracy and exactness of adjustment be obtained, but the tools must be of ample strength, easy to sharpen

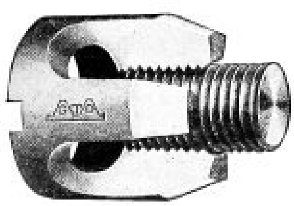


Fig. 1.—Acorn Die

and readily adaptable to various classes of work. To meet these requirements the Greenfield Tap & Die Corporation, Greenfield, Mass., is manufacturing the Acorn die and holder shown in Figs. 1 and 2.

The lands of the Acorn die are short and wide, so that they will not only be strong, but will also have no tendency to twist. The necessary radial movement of the lands is assisted by thinning the section immediately back of the thread, but increasing the width of the prongs at this point makes them uniformly strong and prevents torsional displacement. The base of the die and its seat on the body are ground flat and true to insure preserving absolute alinement when changing dies or when replacing them after sharpening. Notches on the base of the die register with dowels on the body, securing a positive drive.

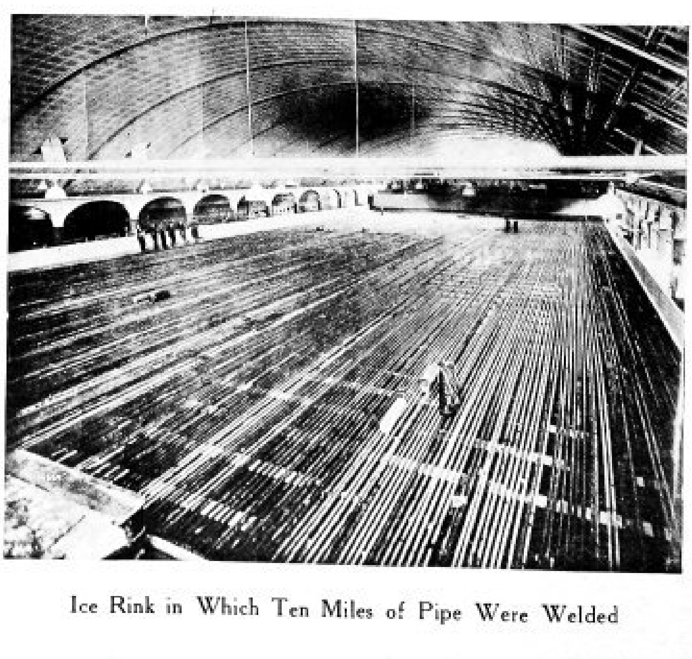
The die is secured to the holder by an adjustable cap, which fits over the die and is threaded on the body below the die seat with a thread of larger diameter. This con-

Fig. 2.—Acorn Die Holder

struction, it is claimed, prevents springing or other accidental misalinement. Slots in the walls of the cap permit the exit of chips that may collect inside the base of the die, and projecting the lands beyond the cap permits the heavier chips cut at this point to fall free of the holder. The nose of each large prong is beveled to conform to a corresponding bevel on the inside of the adjusting cap. The beveled surfaces of both die and cap are ground, assuring perfect contact with the bevels and a high degree of accuracy and adjustment.

Ten Miles of Pipe Welded by Prest-O-Lite Process

To make ten miles of pipe as one continuous pipe—make every joint leak-proof and trouble-proof after buried in ice—was the problem that confronted the builders of the Winter Garden Ice Rink at San Francisco. Investigation had shown that in many ice rinks where ammonia systems were built with screwed fittings, leaks frequently developed in the joints, necessitating shut-downs for re-



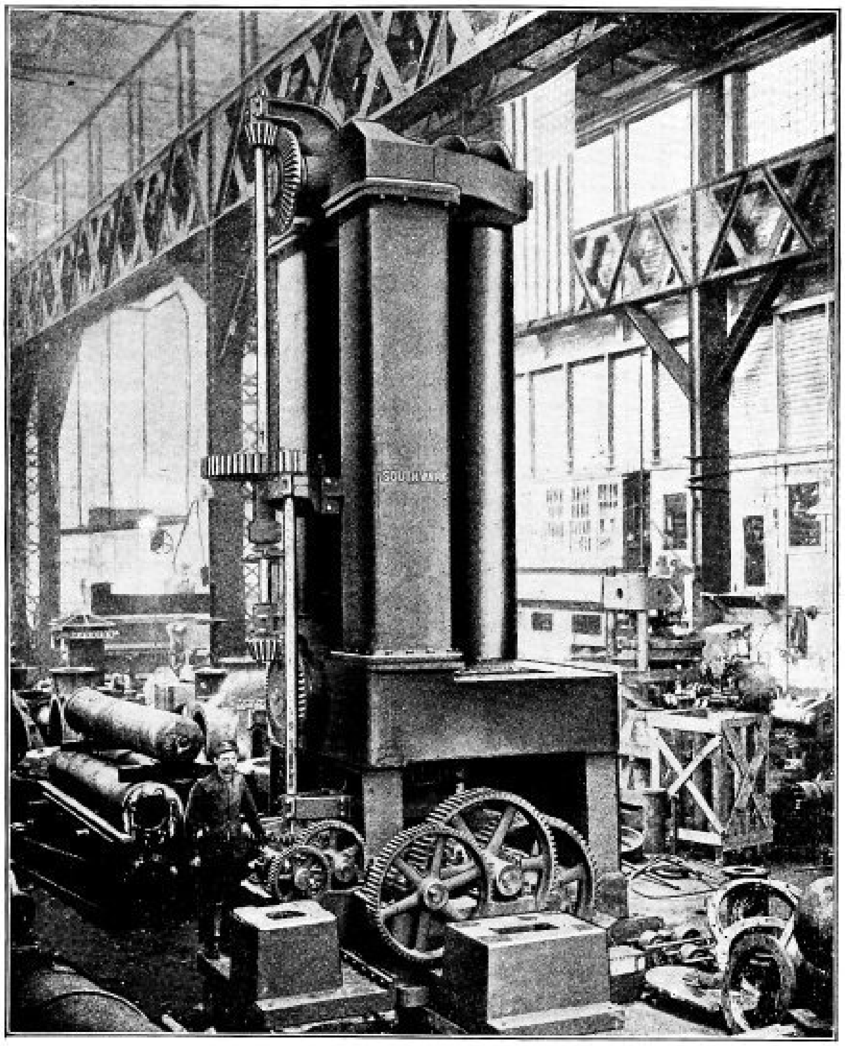
Ice Rink in Which Ten Miles of Pipe Were Welded pairs, to the financial loss of the management and displeasure of patrons. Oxy-acetylene welding by the Prest-O-Lite process not only made the San Francisco Ice Rink leak-proof, but made possible a remarkable saving in the purchase of pipe.

Instead of using new pipe, 55,000 feet of 2-inch "used" boiler tubing was purchased at a saving of 20 percent over the cost of new galvanized pipe. Every joint in the system was then welded by the Prest-O-Lite process, which employs Prest-O-Lite purified acetylene and compressed oxygen. The floor is 210 feet long and 90 feet wide, and the welded joints number considerably more than 2,000. The contractors, the Pacific Pipe Company, claim the work was done by average welders and that the cost per joint was approximately the cost of an ordinary screw connection.

Large Vertical Plate Bending Rolls Built by Southwark Foundry & Machine Co.

The Southwark Foundry & Machine Company, Philadelphia, Pa., is placing on the market a machine consisting of a vertical set of heavy bending rolls for marine boiler plate. The machine weighs 210,000 pounds, and consists of three vertical rolls, the main or center roll being 30 inches diameter and the two back rolls each 22 inches diameter, supported on a special type of bearings manufactured by the Standard Roller Bearing Company, underneath which, in a pit below the floor line, is the complete driving mechanism.

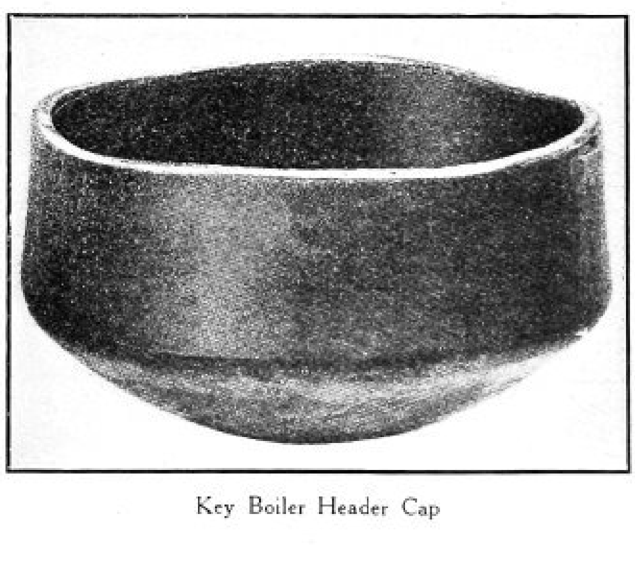
The screw-down mechanism of the main roll, which is operated by a motor separate from the main driving apparatus, is so arranged that it can be disconnected, allowing the main roll to be thrown out of parallel with the two back rolls for inserting or removing the plates which are to be rolled.



Vertical Plate Bending Rolls Built by Southwark Foundry & Machine Company

Boiler Head Handhole Cap

Fred Key, 641 Pierce Building, St. Louis, Mo., has placed on the market a pressed steel handhole cap for use in the tube headers of the Heine type in watertube boilers. As shown in the illustration, the cap has a convex end and



Key Boiler Header Cap

cylindrical body. The cylindrical body tapers and fits in the header like a cork in a bottle, the convex end being against the pressure.

After the cap is in place it is tightened with a specially designed self-feeding expander, which has a retarder on the feed to prevent tightening the rolls beyond the pressure which it is desired to exert. Caps of this type have been installed in boilers carrying 225 pounds pressure.

"Little Giant" Boiler Tube Extractor

John F. Robertson Company, Park Building, Pittsburg, Pa., has placed on the market a very useful tool, known as the "Little Giant" boiler tube extractor, which is designed

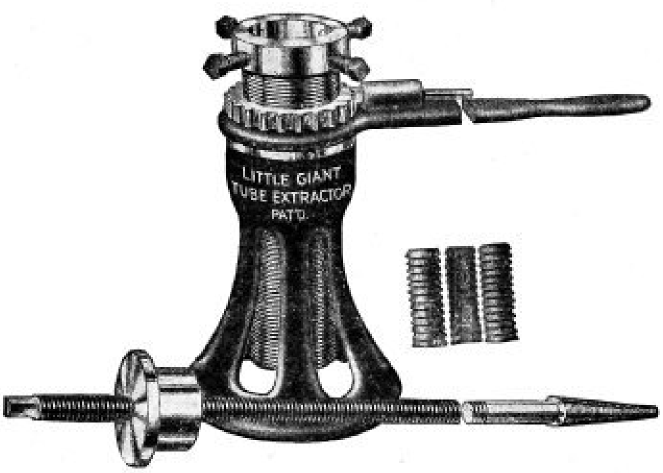


Fig. 1.—"Little Giant" Tube Extractor

to remove split or blistered tubes from any steam boiler having straight tubes. The construction of the tool and method of operation are clearly illustrated in Figs. 1 and 2.

To remove a tube relieve the tube in the front header, insert the three-part extractors shown in Fig. 1, screwing into same the expansion rod until a secure hold on the

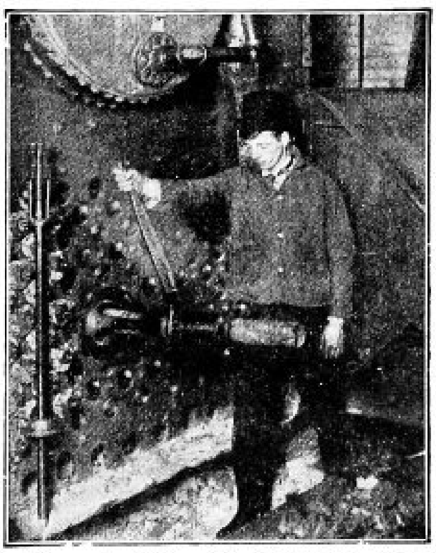


Fig. 2.—Removing Tube with "Little Giant" Extractor

inner side of the tube is obtained. Slip the extractor body over the exposed section of the rod, the base of which is then pressing the header. Screw the cap on the rod into the extractor body and firmly tighten the set screws on same. Then relieve the tube in the rear header and everything is ready to ratchet out the tube. After the tube has been drawn through the body of the machine, tighten the four set screws on the tube and continue to ratchet so long as the tube is too tight to be pulled through the extractor body by hand. It is unnecessary at any time to remove the machine from the tube when being extracted, and no cutting is necessary.

The tool is made in three different sizes, and each machine is furnished with one set of extractors for a given size tube.

Headlights and Turbo-Generators for Steam Locomotives

To meet the rigid requirements of locomotive headlight service, the General Electric Company, Schenectady, N. Y., has designed a turbo-generator set distinctly novel in its construction and representing the most advanced development in this class of apparatus along practical lines. Three years of exhaustive service tests and a knowledge accumulated from a vast amount of experience in turbine manufacture have resulted in the building of these turbines with the smallest number of parts consistent with the requirements of good design, durability, efficiency and close regulation.

The headlight supplied with the turbo-generator consists of an 18-inch silver-plated copper reflector, equipped with a simple focusing device mounted on a suitable table and enclosed in a steel casing of standard design. The deflector has a 2¼-inch focal length, which is sufficiently long for accurate focusing of the largest headlight lamps.

In addition to the turbo-generator and headlight, the necessary accessories are furnished in accordance with the requirements of existing headlight practice.

PERSONAL

R. M. Klein has been appointed sales manager of the International Oxygen Company, with headquarters at the company's main office, 115 Broadway, New York.

G. Hickey, formerly boiler shop foreman of the Grand Trunk Railroad at Toronto, Ontario, has been appointed general foreman at that point, vice E. Logan, resigned.

R. Rutherford is foreman boiler maker at an oil refinery at the following address: Refineria El Aquila, Minatitlan, Vera Cruz, Mexico. Mr. Rutherford wishes to get into communication with other foremen who are engaged in the oil trade and will welcome correspondence from men so employed.

J. F. Geiger, of Princeton, Ind., has been appointed boiler inspector for the State of Indiana.

R. C. Sermon, a former foreman boiler maker and boiler inspector, is conducting the Duluth Mechanical School at West Duluth, Minn., where courses of instruction in boiler inspection and laying out are given to boiler makers, structural iron workers, sheet iron workers and other mechanics. Mr. Sermon was for three years manager of the Hibbing Boiler Works; for five years he was foreman boiler maker of the Duluth, Winnipeg & Pacific Railway; for two years he was manager of the Duluth Manufacturing & Welding Company, and for a year and a half he was foreman of the structural iron department of the Universal Portland Cement Company. Mr. Sermon was also for two years deputy state boiler inspector of Minnesota.

Thomas E. Durban, for 25 years general manager Erie City Iron Works, Erie, Pa., has resigned and will hereafter devote his time to his position as commissioner representing boiler manufacturers of the country in behalf of the American Society of Mechanical Engineers Uniform Boiler Code, with offices in the Commerce Building, Erie.

Questions and Answers for Boiler Makers

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

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

Address your communication to the Editor of the Question and Answer Department of The Boiler Maker, 461 *Eighth avenue, New York city.*

Boiler Design Problem

Q.—(1) Given, a horizontal return tubular boiler using oil as fuel with shell 40 inches diameter by 26 feet long, and a 500 horsepower engine with a water rate of 26 pounds, will five boilers of the following layout of tubes take care of the above engine and will the layout meet marine requirements?

The layout of the tubes is shown in the sketch and the following are the calculations: Twenty 4-inch tubes are to be used; area of head, 40 inches diameter = 1,256.6 square inches. External area of 4-inch tube = 12.56 square inches. External sectional area of twenty 4-inch tubes = 251.2 square inches. Available area of head for steam and water space is 1,256.6 — 251.2 = 1,005.4 square inches. Steam space = one-third available space in boiler. Therefore, $\frac{1,005.4}{3}$ = 335.1 square inches, area of steam space. Water space = 1,005.4 — 335.1 = 670.3 square inches. Since the area of the steam space is 335.1 square inches and the diameter of the head 40 inches, the height of the steam space may be calculated to be 8.36 inches, as shown in the sketch. Allowing 3 inches of water above the top of the tubes, the centerline of the top row of tubes is 8.36 + 3 + 2 = 13.36 inches from the top of the boiler shell. The twenty 4-inch tubes are spaced 5¼ inches between centers vertically and horizontally.

Heating Surface.—The heating surface in the two heads = twice the area of the water space, or 9.3 square feet. The internal surface of one 4-inch tube 26 feet long = 25.39 square feet. Internal surface of 26-foot tubes = 517.8 square feet. Heating surface of shell = two-thirds of total area, or 181.5 square feet. Total heating surface of boiler = 9.3 + 517.8 + 181.5 = 708.6 square feet. Total heating surface for five boilers = 708.6 × 5 = 3,543 square feet. One square foot of heating surface evaporates 3.5 pounds of water. Therefore, 3,543 × 3.5 = 12,400.5 pounds of water will be evaporated per hour under normal conditions.

A 500 horsepower engine with a water rate of 26 pounds uses 13,000 pounds of water per hour. Since the water used by the engine and that evaporated at the boilers are approximately equal, will the boiler supply the necessary steam without being overloaded?

Q.—(2) Total heating surface of one boiler is 708.6 square feet. Basing the horsepower on 11 square feet for one horsepower, will the horsepower of each boiler be $\frac{708.6}{11}$ = 64.4?

Q.—(3) Will it be practical to use 4-inch tubes in a boiler 26 feet long?

Q.—(4) Is a manhole required in the top and bottom of the head for marine work, or is one manhole in the bottom of each head and one in the top of the shell of the boiler sufficient?

Q.—(5) Are the calculations for questions (1) and (2) correct? If not, please give proper method for the layout of tubes for this problem?

R. A. T.

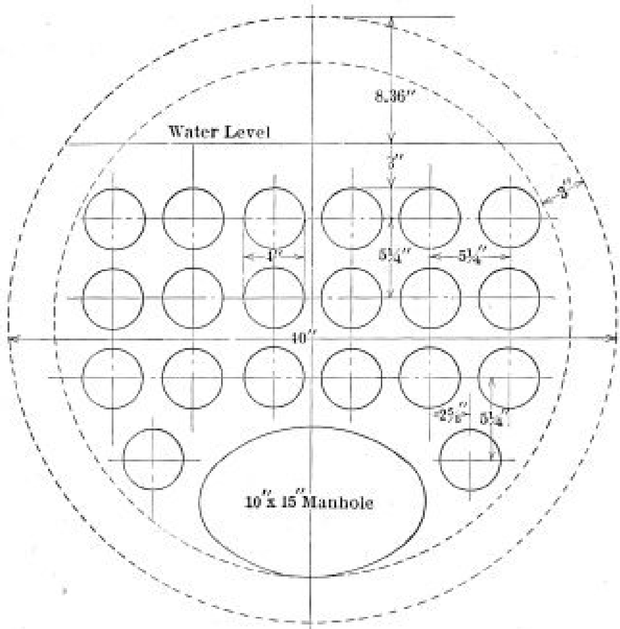
A.—(1) In reply to your inquiry on the design of a tubular boiler according to the specifications furnished, we wish to advise that we could not treat at great length the different features of this subject in the Question and Answer column.

There are a number of important matters the boiler designer must keep in mind when planning power boilers of sufficient size and durability to meet certain requirements. Naturally, the *first* consideration is to choose the type of boiler best suited to do the work at least expense in its operation, upkeep, etc. *Second*, to determine the required amount of steam needed, and whether one or more boilers of the type chosen are necessary to meet the demand. *Third*, the amount of fuel to be burned and the kind of grates needed. *Fourth*, the proportioning of grate area, heating surface, size of tubes, etc. All of these factors affect the size of the boiler or boilers, so, therefore, the designer must exercise good judgment in handling such problems.

The 500 horsepower engine, according to your data, requires 13,000 pounds of water per hour to run it. The generation of steam per horsepower per hour should be in excess of the demands so that the boilers need not be forced beyond their maximum capacity. By forcing boilers at higher rates than designed for, the heating surface absorbs a smaller proportion of the heat from the fire; consequently, the temperature of the gases entering the chimney is higher. This condition is uneconomical.

In rating the generation of steam at 3½ pounds of water per square foot of heating surface, the total heating surface required equals 13,000 ÷ 3½ = 3,711 square feet. On these data as a basis, the size and number of boilers can be decided approximately by the use of rules covering this subject. In general, the following points should be observed in designing tubular boilers:

1. The top row of tubes should be placed not over a distance of two-thirds of the diameter from the bottom



Arrangement of Tubes in Boiler Head

of the shell, so as to allow ample steam space. Allow at least a depth of 2 inches of water above the upper part of the upper row of tubes.

2. The following table gives the size of tubes generally used in practice for tubular boilers:

Diameter of Boiler in Inches	Diameter of Tubes in Inches
36 to 38	3
38 to 60	3½
60 to 72	4

3. The tubes should be arranged so that the rows are not staggered, but so they are parallel. A clearance of 3 inches between the tubes and the flange of the head should be allowed. The length of the tubes should not be excessive; ordinarily for tubular boilers they are made sixty times the diameter of tube used. The tubes in the bottom row should be placed far enough from the bottom of the boiler so as to have a large body of water directly in contact with the hottest part of the shell. The horizontal spacing between tubes should be about one and a half times the diameter of tube used. The vertical spacing may be a trifle smaller than this.

According to the General Rules and Regulations prescribed by the Board of Supervising Inspectors, the following rule is given governing manholes:

"All boilers built on and after August 1, 1914, shall have a manhole opening above the flues or tubes of not less than 10 $\times$ 16 inches, 11 $\times$ 15 inches, or of an equal area in the clear, and shall have such other manhole openings in other parts of the boiler as may be required by local inspectors."

Usually two manholes are sufficient for tubular boilers, one in the shell and one in the tube sheet below the tubes.

Ordinarily, tubular boilers are not made over 18 feet long, and it is the usual practice to increase the length as the diameter is increased. This is done so as to have, for commercial purposes, uniform standard sizes for stationary power plants. You will now understand that your design for these boilers is of an unusual length for the diameter used. Such a size would require a very long boiler setting and one that would take up a great amount of space. The sizes of tubes specified are entirely too large for the diameter of the head. Using smaller-sized tubes, a better distribution of the tubes can be had, and also an increase of heating surface. Attention is called to the area of the segment of the head, which is given at 335.1 square inches for a height of 8.36 inches.

According to the following formula, the area of a segment of a head can be found, the result being close enough for practical purposes:

$$A = \frac{H \times H \times 4}{3} \sqrt{\frac{D}{H} - .608}$$

in which A = area of segment,
H = height of segment,
D = diameter of head.

The area of the segment equals

$$\frac{8.36 \times 8.36 \times 4}{3} \sqrt{\frac{40}{8.36} - .608} = 366\tfrac{1}{2} \text{ square inches.}$$

This calculation shows that you made a mistake in determining the height of the segment. Under the heading "heating surface" you figure on twenty-six 4-inch tubes, while in the given specifications twenty tubes are called for.

The method of rating the horsepower of boilers according to a number of square feet of heating surface is an approximate one. The best plan is to determine the horsepower according to the amount of water the boiler will evaporate. The evaporation of water into steam depends on the heating surface of the boiler and its arrangement, the grate area, rate of fuel combustion, draft, etc.

Load on Stayed Flat Surface

Q.—Please give formulæ for figuring the load which will cause the area indicated by dotted lines in the following diagram to bulge. Boiler pressure, 200 pounds per square inch; tensile strength of plate, 55,000 pounds per square inch. J. A. W.

A.—We are unable to give you a simple and easily understood rule for finding the pressure or load that will cause the plate, in your question, to *actually buckle*, but we can give you rules for finding the safe working pressure from which you can reason back to the probable pressure that would cause a bulge. The bulging pressure would have to be determined by trial, as each individual case is a law unto itself. Bulging pressure, bursting pressure and collapsing pressure are sometimes calculated arithmetically, but when an actual test is applied, the pressure at which the plates *"give"* may not be the same as that found by figures.

In your problem the staybolts are pitched 8 inches center to center. According to a recent revision of the A. S. M. E. boiler code, the support given the plate by the flanged portion is very closely 3 inches (see the June, 1917, issue of the A. S. M. E. Journal); this means that each stay supports 8 $\times$ 8 = 64 square inches (neglecting the comparatively small area occupied by the stay itself, which is on the side of safety, anyway). From this we further find that the space in question is 24 $\times$ 4 = 96 square inches area total, and it is supported by 1½ stays, as can easily be traced out from the diagram submitted. As the pressure given is 200 pounds, then 200 $\times$ 96 = 19,200 pounds total, and 19,200 ÷ 1½ = 12,800 pounds supported by each stay.

But we find that by referring to the A. S. M. E. code book of 1914, Page 51, Table 3, the maximum allowable pitch of stays for 9/16-inch plate and for 200 pounds

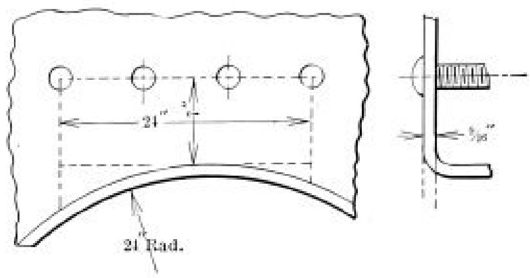


Diagram of Flat-Stayed Surface

pressure per square inch is 7 inches. This shows that your 200 pounds pressure is too high for the thickness of plate and pitch of stays considered, when judged by the code.

This is further borne out by the following rule for the safe working pressure, as found on Page 50 of the code book:

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

in which P = maximum allowable pressure per square inch,
t = the thickness of plates in sixteenths of an inch,
p = maximum pitch of stays,
C = 120 for screwed stays, through plates over 7/16 inch thick, with the ends riveted over.

Then, applying this rule to your data, we have,

$$P = \frac{120 \times 9^2}{8^2} = 151 + \text{ pounds per square inch,}$$

which is the maximum pressure allowed for that case. This also agrees within one pound of that given in Table 3, Page 51, of the code book. In order to safely carry 200 pounds, the pitch of the stays would have to be 7 inches instead of 8 inches, as at present.

With the pitch of stays at 8 inches, as given, and assuming a factor of safety of, say, 2.4, then the pressure at which bulging might occur will be in the neighborhood of 2.4 $\times$ 150 = 360 pounds per square inch, under the conditions as stated in the question. This means a total force of 360 $\times$ 8^2 = 23,040 pounds, or closely 10 tons acting on the plate between the stay and tending to bulge it out.

We may say that the foregoing is based upon the fundamental formula for beams supported on two opposite ends and uniformly loaded.

OBITUARY

Frank L. Bigelow, president and treasurer of the Bigelow Company, boiler manufacturers, New Haven, Conn., died suddenly on June 20 while on the golf links in Hamden, Conn. Mr. Bigelow was 55 years of age. He was a graduate of Yale University, class of 1881, and had wide financial and social connections.

Letters from Practical Boiler Makers

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

Comparing Allowable Working Pressure on Bumped Heads

In your issue of May, in answer to a request from a reader you give a formula and calculations for thicknesses and working pressures on bumped heads. Your formula of

$$W.P. = \frac{t \times T}{6 \times (\frac{1}{2} \times R)}$$

produces a working pressure of 127.3 pounds per square inch on a ½-inch thick head, 72 inches radius of dish, 72 inches diameter. This is so much greater than the A. S. M. E. Code (now quite universally in use) that I think it deserves to be mentioned which authority is being used in any given case.

The A. S. M. E. Code,

$$W.P. = \frac{(t - \frac{1}{8}'') \times T}{5.5 \times (\frac{1}{2} \times R)}$$

allows in this case 104 pounds per square inch working pressure.

The Massachusetts Boiler Code, as per amendment No. 31,

$$W.P. = \frac{t \times T}{8.33 \times (\frac{1}{2} \times R)}$$

allows in this case 91 pounds per square inch working pressure.

U. S. Board of Supervising Inspectors Marine Law is

$$W.P. = \frac{t \times T}{5 \times (\frac{1}{2} \times R)}$$

allowing in this case 152.7 pounds.

National Board of Fire Underwriters is

$$W.P. = \frac{t \times (.6 \times T)}{5 \times (\frac{1}{2} \times R)}$$

allowing in this case 91.7 pounds.

Also note that the F. S. of 8.33

$$\left(\frac{55{,}000}{8.33} = 6{,}610\right)$$

in the Massachusetts Code just about eequals the

$$\frac{.6 \times 55{,}000}{5} = 6{,}600$$

the Underwriters' rules.

The varying results can be explained by the fact that the factor of safety in all cases differs considerably; also that in the A. S. M. E. formula ⅛ inch is arbitrarily added to the thickness of all heads of all diameters. It does not seem quite right to add this ⅛ inch to a head, let us say 3/16 inch thick by 24 inches diameter, and also to one of ¾ inch thick by 96 inches diameter, as simply extra thickening; one would think that this extra should progress in proportion as the heads increase in thickness and diameter.

I enclose herewith a table of thicknesses, working pressures and diameters of bumped heads as per the A. S. M. E. Code.

WORKING PRESSURES PER SQUARE INCH ON DISHED HEADS—A. S. M. E. CODE

$$\text{Thickness} = \frac{5.5 \times \text{working pressure per square inch} \times \text{radius to which head is dished}}{2 \times \text{T. S. of material}} + \frac{1}{8}''$$

$$\text{Working pressure per square inch} = \text{thickness} - 1/8'' \times \frac{2 \times \text{T. S. of material}}{5.5 \times \text{radius to which head is dished}}$$

Material = 55,000 T. S.
Radius of dish = diameter of vessel
Factor of safety on vessel = 5
Factor of safety on heads = 5.5

Thickness	Diameter of Vessel also Radius of Dish												
	24"	30"	36"	42"	48"	54"	60"	66"	72"	78"	84"	90"	96"
3/16"	52.1	41.7	34.7	29.8	26	23.1	20.8	18.9	17.4	16	14.9	13.9	13
1/4"	104.2	83.4	69.4	59.6	52	46.2	41.6	37.8	34.8	32	29.8	27.8	26
5/16"	156.3	125.1	104.1	89.4	78	69.3	62.4	56.7	52.2	48	44.7	41.7	39
3/8"	208.4	166.8	138.8	119.2	94	92.4	83.2	75.6	69.6	64	59.6	55.6	52
7/16"	260.4	208.3	173.6	148.8	130.2	115.7	104.1	94.7	86.8	80.1	74.4	69.4	65.1
1/2"	312.5	250	208.3	178.6	156.2	138.8	124.9	113.6	104.2	96.1	89.3	83.3	78
9/16"	364.6	291.7	243	208.4	182.2	161.9	145.7	132.5	121.6	112.1	104.2	97.2	91
5/8"	416.7	333.4	277.7	238.2	208.2	185	166.5	151.4	139	128.1	119.1	111.1	104
11/16"	468.8	375.1	312.4	268	234.2	208.1	187.5	170.3	156.4	144.1	134	125	117
3/4"	520.8	416.6	347.2	297.6	260.4	231.5	208.3	189.4	173.6	160.2	148.8	138.8	130.2

NOTE.—If manhole in head, thickness to be ⅛ inch more for the same pressure.

NOTE.—If vessel has concave head, working pressure equals .6 of the above table.

THIS TABLE PRODUCES THE SAME RESULT

Thickness of Head	Constant for Plain Head	Constant for Manhole Head
7/16"	6,250	3,750
15/32"	6,875	4,375
1/2"	7,500	5,000
17/32"	8,125	5,625
9/16"	8,750	6,250
19/32"	9,375	6,875
5/8"	10,000	7,500
11/16"	11,250	8,750
23/32"	11,875	9,375
3/4"	12,500	10,000
25/32"	13,125	10,625
13/16"	13,750	11,250
7/8"	15,000	12,500
15/16"	16,250	13,750
1"	17,500	15,000
1 1/16"	18,750	16,250

$$\text{Working pressure square inch} = \frac{\text{Constant}}{\text{Radius to which head is dished}}$$

Constant or thickness = working pressure × radius to which head is dished

The pressure allowable on the girth seam of a head is another matter from the thickness of a bumped head.

In the above:

$W.P. =$ Working pressure,
$t =$ Thickness $= \frac{1}{2}$ inch,
$T =$ 55,000 tensile strength,
$R =$ Radius of dish of head $=$ 72 inches,
$F.S. =$ Factor of safety,
Diameter of Head $=$ 72 inches.

Lake View, N. J. E. C. Leers.

Are You Afraid?

Why is it that some fellows let the fear of being fired, or getting a mean bawling out, allow them to cover up their mistakes? No other trade is so largely dependent on honest workmanship as that of the boiler maker—for any defects that he might cover up in his work in order to "get by" may ultimately result in a serious catastrophe.

Experience has taught us that whatever is consciously covered up will eventually be brought to light, but the sad thing is that many times it is too late to correct the evil. In the long run, the fellow who makes mistakes and covers them up to save his own skin or the humility of telling his employees of his carelessness will generally find out that his disgrace or failure was only delayed, and when he has been found out his shopmates and others brand him as a blunderer and sneak.

A man with a desire for a clean career should think of the years lying ahead of him, and when in the course of his day's work something goes wrong, form the habit of confiding in the boss—it will mean happiness and success.

Helper.

Analyzing Your Superior

Every fellow has the right to take an analysis of the man above him, and those who are desirous of making headway should do so. Is the man above you a help or a hindrance to you? Is he a progressive man, is he narrow or broad-minded, does he share the problems of the plant with you, his subordinate, or does he think shallow thoughts and spend much time over unimportant, trivial matters? Does he hold the reins of authority tightly in his own hands, or does he intrust a portion of it to you? Does he try to unload responsibility on you without also giving you the relative authority? Is he afraid to have progressive men under him? Does he seek your judgment, or is he afraid to leave things for you to act upon? How did he come to attain his position as boss? Where was he a few years ago, and has he advanced to his present position by merit or favoritism? Is he now at a contented standstill, or does he aspire to a better place? These, and many more questions you, a subordinate, may rightly ask yourself.

When you honestly make the most of yourself, you have a right to expect advancement. Many men have had their skill or talents curbed or dwarfed, and their future prospects blurred, while working too long under the wrong kind of superior.

You, as a subordinate, should look at this point blank, and make sure that you are not allowing yourself to be warped and bent by any such environment. In this progressive age there is too broad a field and too much at stake to allow an incompetent superior to spoil your chances. But you must also be sure that you are fair and deliberate in your analysis of him, for he alone may not be to blame. You may have to ascertain many things about the power that controls him, and you must not fail to sum up the stock of good and bad points of your own self. Are you fair in your attitude towards him? Do you seek to co-operate with him, or do you buck up against his orders and then criticise him behind his back?

Concord, N. H. C. H. Willey.

Area of Segment of Circle

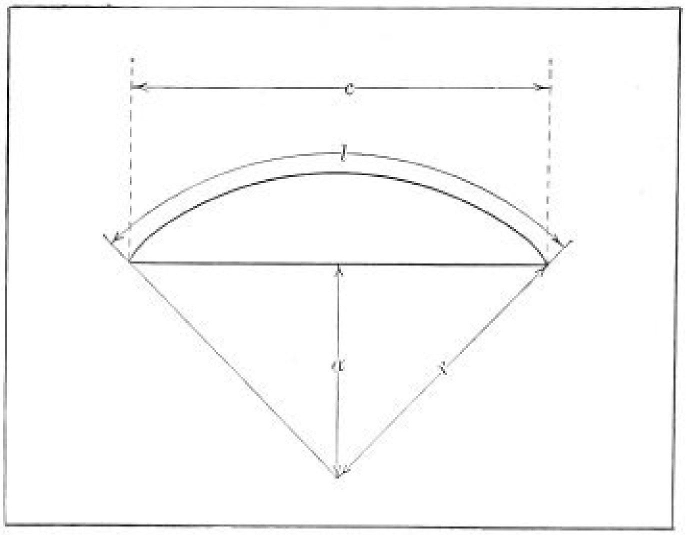
Since boiler makers and designers are often troubled with the finding of the area of circular segments, I have endeavored to find a formula that is the extreme of simplicity. This is the best I can do:

$$\text{Area of segment} = \tfrac{1}{2}\,(lr - cd),$$

where $l =$ length of arc,
$c =$ chord,
$r =$ radius,
$d =$ distance from center of circle to base of segment, or r-h.

I prefer this formula because it does away with all tables. It is easily remembered. All measurements are either known or easily made.

My method of arriving at the area is easily understood.



Sketch Showing Dimensions of Segment of Circle

The area of the whole slice shown in the sketch herewith is

$$\frac{lr}{2}$$

The area of the triangular part is, of course,

$$\frac{cd}{2}$$

The area of the segment is, therefore, simply the difference between the two, or

$$\frac{lr}{2} - \frac{cd}{2} = \tfrac{1}{2}\,(lr - cd)$$

New York. N. G. Near.

Take An Inventory

What sort of a man is the fellow who is your boss? Is he alert and progressive or is he narrow-minded and afraid to have wideawake, successful men about him? Does he extend a helping hand and encourage you, or does he try to keep you in what he thinks is your place—the rut of regular work? Does he allow you to use your own judgment or does he think that only he should pass judgment on the work? Where was he three years ago—has he moved up or has he remained at a standstill?

It is the right of every man in the shop to ask himself these questions, especially if he is ambitious and seeking advancement. Many men have allowed their immediate superior to curtail their talents and ambitions and spoil their future prospects, either by working too long under such a poor boss or patterning themselves after him.

Any aspiring young man should, after a fair length of time, take a careful inventory of his abilities and qualifications, and those of his boss, and the condition of the shop in which he works. If in the summing up he thinks it is better to change into another field of the work, he should do so. The world is immense, and there are many shops where the best a man can give is very soon recognized and rewarded.

But do not place too much blame on the shoulders of the man above you at being held back, for perhaps by the very environment of the shop he was forced to be a small man. Generally where merit is not rewarded, or ingenuity, progress and skill remain unrecognized, the real trouble lies in the firm's selection of poor business executives and methods.

"Bucker-Up."

Trisecting An Angle

It is the general understanding, I believe, that a triangle cannot be trisected geometrically. That fact has been dinged into my ears ever since I knew anything about geometry. I didn't believe it, of course, because it looks like a very simple matter, and as a result I have spent many an hour working over the problem. Thus far my results have been zero and I have decided that I won't try it any more. Therefore, to those who say there is no such word as *can't*, I must retort, "You *can't* trisect an angle geometrically."

The most interesting thing to me, though, is the total amount of time that has been spent on the problem since the time of the gentleman who first conceived of the idea of trisecting the angle. I don't know who he was, but he *sure* got us into a world of trouble and we are now as far away as ever.

In looking up a matter in the New York City Public Library the other day, I happened to run across the file box containing the word *angle*, and there, big as life, was the title "Angle, Trisecting the," repeated over and over. So, just as a matter of curiosity I looked the list over casually and found that there are over a dozen leaflets and treatises on the subject varying in number of pages from seven upward. I estimated that there are 415 pages in the library on the little subject of "Trisecting the Angle." And all we know about it now is that it can't be done.

New York. N. G. Near.

Be Frank

When one of your men comes to you seeking a special favor, and you feel that you cannot grant it to him, yet do not want to turn him down flat, do you put him off by saying, "Come and see me again, I can't look into it now," or "Call my attention to it to-morrow, I'm too busy to bother now?" Then when he does see you again about it, perhaps you ask him a few indirect questions and again turn him off by telling him you will give it consideration. You are hoping that he will see you do not want to grant the favor, and by evading a direct answer you think he will give up trying to gain his request.

This is not a fair attitude to use towards your men. The employee asking a favor is not in a position to demand a direct answer; he must necessarily humble himself and await your pleasure. Perhaps he has laid plans, or built hopes that you are going to grant his request, and you think that by not giving him a direct answer you are letting him down easy. But in reality it is an injustice to keep him in the dark as to what you intend to do about it. Be plain and frank with your men. Give them a direct answer and don't let them build false hopes. If you cannot grant their request for special favors, tell them nicely and pleasantly, or abruptly, that it is not in keeping with your policy, or some other such answer. But let them know definitely where they stand. This appears to be the best policy for executives to use.

Superintendent.

Total Area of Flue Ends

Here is a chart that will be found handy by boiler designers or engineers who wish to determine the square

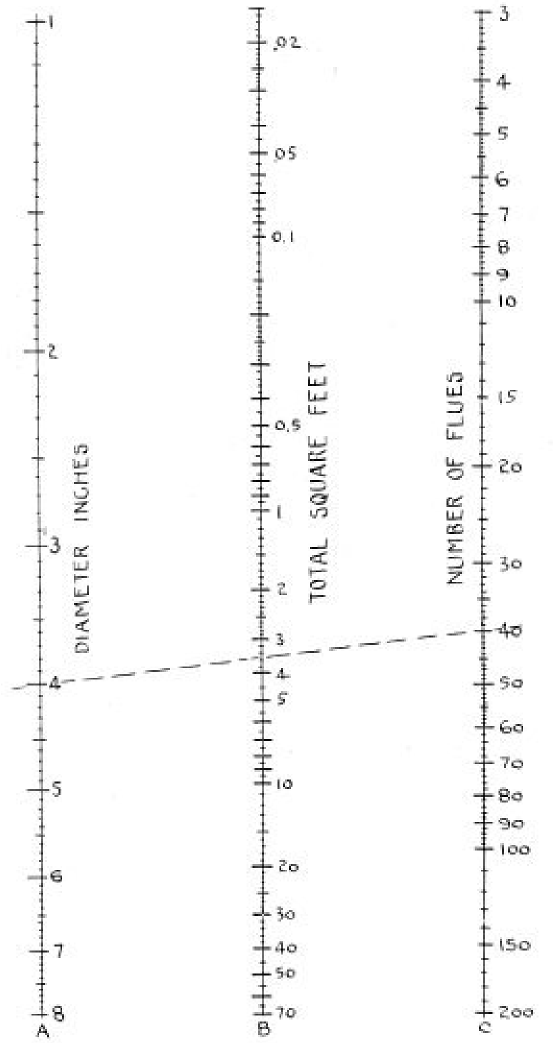


Chart Giving Area of Tube Ends

feet of area taken up by the ends of tubes or flues. This applies equally to the front end or the rear end.

All that is necessary is to lay a straightedge across the chart connecting the diameter in inches (column *A*) with the number of flues (column *C*) and the intersection with column *B* immediately gives the total number of square feet.

For example: In computing the square feet of heating area that must be subtracted from the front end of the boiler on account of 40 flues 4 inches in diameter, how would the chart be used?

Connect the 4 (column *A*) with the 40 (column *C*) as indicated by the dotted line drawn across this chart, and the answer is shown as 3.5 square feet in column *B*.

The range of this chart, it will be noted, is great enough to include any ordinary boiler end. Column *A* ranges all the way from 1 to 8 inches. Column *C* ranges all the way from 3 to 200 flues. While column *B* shows as high as 70 square feet and the chances are very slight that such a great area would ever be obtained in boiler ends, still it is included in this chart because occasion may arise where one would have 200 flues, 8 inches in diameter, and the total area of the fronts might be sought.

New York. W. F. Schaphorst.

Watch Your Chance

Jim Miller is a gloomy sort, and grumbles more or less,
He says "they" block his every move and keep him from success,
And that a fine chance he once had, but—well, he didn't take it,
Because, you see, that bogey "they" just wouldn't let him make it.
The boss was always down on him no matter how he worked;
He had a grudge against him and said he always shirked.

I said to him: "Take my advice. You've got more than one chance,
There's dozens waiting for you to help you to advance.
So never mind the chance that's past, but for the next look out;
If you're content to jog along, you won't advance, no doubt.
Do everything that you are told and do it with a will;
Don't measure out your work by hours and try your time to kill.

"Just watch your chance, and meantime study hard to qualify,
Remember, you must look ahead toward your goal so high.
Go forward step by step—there is no short cut to success,
And master thoroughly your trade—do not at some points guess;
Your failure or success, my boy, will be just what you make it,
Now when your chance comes will you be well qualified to take it?"

Concord, N. H. C. H. Willey.

Boiler and Pressure Vessels: Inspections, etc.

(*Continued from page 222.*)

(7) *Size of Hole.*—As is well known, it is sometimes a difficult matter to estimate correctly the size of rivet from the appearance of the finished head. Cone, button, or countersunk flat, each makes a different showing; and if a rivet is not cut out for measuring, an estimate will have to be made. The following table is of particular value in making this estimate. Being taken from the American Society of Mechanical Engineers' Code book, it has some authoritative value and has been adopted by some States as a guide for inspectors when estimating size of rivets:

Table for Sizes of Rivets, Based on Plate Thickness

Thickness of Plate		Diameter of Rivet After Driving	
1/4	13/32	11/16	13/16
9/32	7/16	11/16	15/16
5/16	15/32	3/4	15/16
11/32	1/2	3/4	15/16
3/8	9/16	13/16	1 1/16
	5/8		1 1/16

It will be noted that the diameter of hole is given rather than the diameter of the rivet, on account of the fact, when properly driven, the rivet fills the hole and is consequently slightly larger. In using the above table, even should there be a slight error, it will be on the side of safety, unless there are obvious visible abnormalities.

(10) *Lowest Tensile Strength.*—On new boilers, in perhaps 90 percent of cases, the stamps are plainly visible, the layerout having enclosed them with a circle of paint. On all boilers from reputable concerns, the TS stamp is either plainly visible, or accurate data may be had from the builders. When, as in the case of old boilers especially, the TS cannot be stated accurately, 55,000 is taken for steel plates and 45,000 for iron.

(To be continued.)

BOOK REVIEWS

The Slide Rule: Its Operations and Digit Rules. By A. Lovatt Higgins. Size, 2¾ by 4 inches. Pages, 13. New York and London, 1917: Whitaker & Co. Price, 4d.

This is a compact reference book explaining the operation of slide rules and their application to mathematical problems. The author is demonstrator of engineering at the Queen's University, Belfast, Ireland.

The New Tinsmith Helper and Pattern Book. By Hall V. Williams. Size, 4¼ by 6¾ inches. Pages, 354. Illustrations, 248. New York, 1915: U. P. C. Book Company. Price, $2.

This book was originally published many years ago, but the demand for a new edition made it apparent that an entirely new treatment of the subject was necessary in order to cover the ground; therefore the book, with the exception of a single chapter, which has been rearranged and amplified, and possibly some fifty pages of problems and tables, is entirely new. While the book is designed for tinsmiths and sheet metal workers, many of the problems, so far as the geometrical work is concerned, would undoubtedly prove useful to boiler makers who are engaged in the layout of sheet metal work. The first four chapters, for instance, take up mensuration, simple geometrical problems, conical problems, elbows and piping, all of which are applicable to sheet metal work in the boiler shop. Many of the problems given in the fifth chapter, which is on furnace fittings, are also applicable to the boiler maker's work, if due allowance is made for the difference in the thickness of metal used.

Triangulation Applied to Sheet Metal Pattern Cutting. By F. S. Kidder. Size, 6 by 9 inches. Pages, 272. Illustrations, 124. New York, 1917: The Sheet Metal Publication Company. Price, $2.50.

As the method of triangulation is used most in laying out work where the objects to be built have irregular curved surfaces, it is highly important that the layerout in a boiler shop have a thorough understanding of this method. Once the elementary principles on which triangulation is based are understood, the application of the method to almost any problem becomes relatively simple. This subject cannot be mastered, however, without a careful study of elementary geometry. All this information is given in this book in logical sequence, leading up to the application of triangulation to the layout of very complex curved surfaces. It may be stated, however, that the problems explained in the book are thoroughly practical problems, and cover the kind of work which the layerout ordinarily has to perform.

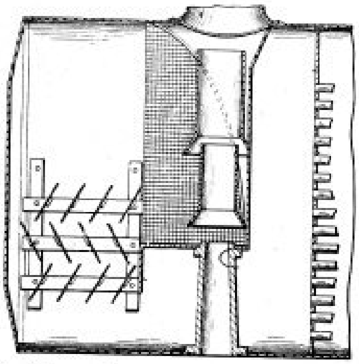
Selected Boiler Patents

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

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

1,223,388. SPARK ARRESTER. ALBERT EDMUND HUDSON, OF TORONTO, ONTARIO, CANADA, ASSIGNOR OF ONE-THIRD TO HENRY BUSH SPENCER AND ONE-THIRD TO ROBERT HUDSON, BOTH OF OTTAWA, ONTARIO, CANADA.

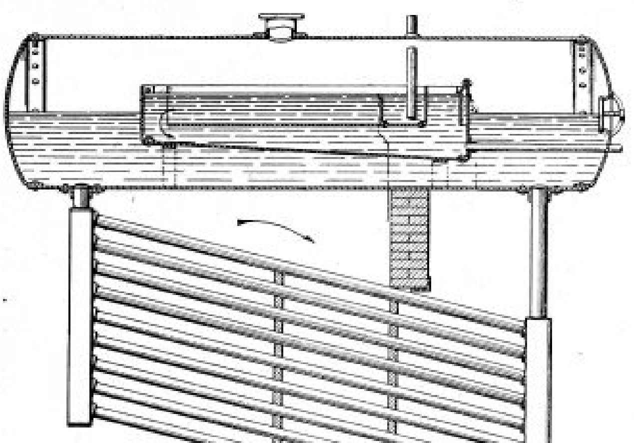
Claim.—The combination with a boiler, of a spark arrester consisting of a baffle wall extending transversely across the upper portion of the smoke box of the boiler and provided with a lower offset portion of substantially V-shape, having a flange therearound, a curved perforated baffle wall located in front of the said baffle wall and coacting therewith,



a pair of vertically disposed straps adjacent baffle wall, a plurality of pairs of longitudinal extending bars carried thereby, a plurality of transverse bars carried by pairs of said longitudinal bars angularly disposed thereon and perforated baffle plates carried by said transverse bars in front of the perforated baffle wall, the adjacent rows of said plates being angularly disposed in opposite directions and staggered relatively to each other.

1,224,662. STEAM BOILER. THOMAS T. PARKER, OF NEW YORK, N. Y.

Claim 1.—In a horizontal steam boiler, an open-top main receptacle within the same having at one end a feed-water outlet located above the normal boiler-water level and having also a depending shield directly



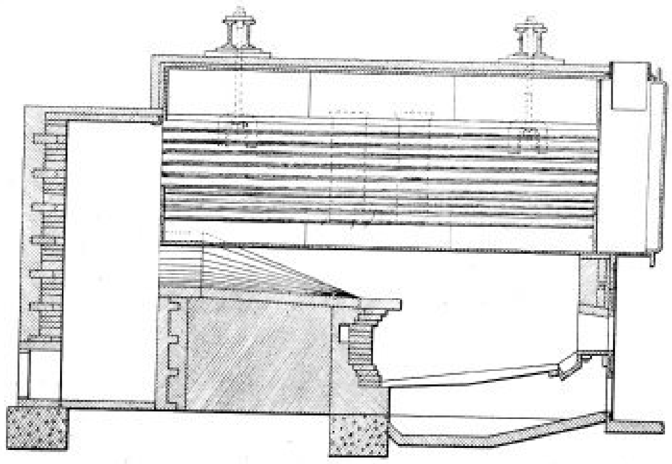
in front of the outlet, an auxiliary open-top elongated receptacle supported within the main receptacle above the bottom of the latter, said auxiliary receptacle being closed at that end adjacent the said outlet and open at the opposite end, and means for supplying feed-water to said auxiliary receptacle. Six claims.

1,225,292. BOILER TUBE CLEANER. GLENN W. WATSON, OF DETROIT, MICH., ASSIGNOR TO DIAMOND POWER SPECIALTY COMPANY, OF DETROIT, MICH., A CORPORATION OF MICHIGAN.

Claim 1.—The combination with a furnace wall, of a rotatively adjustable cleaner tube extending through said wall and provided with one or more jet nozzles, a supply conduit for said tube, a fitting for connecting said supply conduit with said tube having a swivel connection with the latter and including a laterally deflected portion or goose-neck, a spur-gear mounted on said tube, a pinion in mesh with said spur-gear having a journal bearing on the laterally deflected portion for said fitting, and manually operable means for rotating said pinion to impart a slow and steady movement to said rotative tube. Four claims.

1,225,293. STEAM BOILER. HOWARD J. WEBSTER, OF PHILADELPHIA, PA.

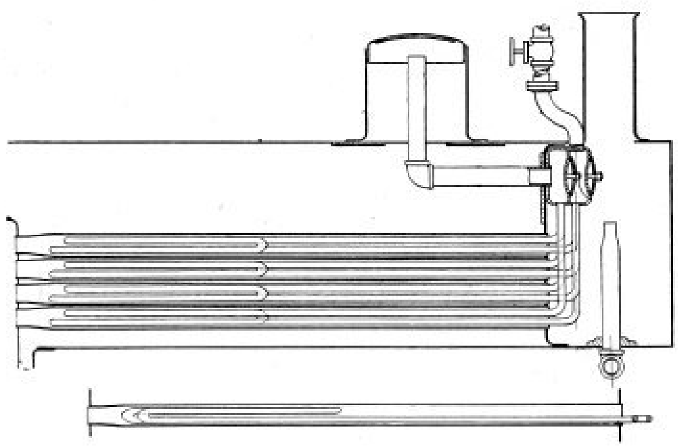
Claim 1.—A return flue boiler comprising a shell, a plurality of separated groups or banks of horizontal fire tubes arranged within the shell from the upper section of the boiler down to the lower section of the boiler shell and the outer tubes of the outer groups being spaced from the boiler shell, thereby forming unobstructed narrow longitudinal vertical passageways between the groups or banks of fire tubes and passageways between the outer tubes and the boiler shell, said vertical passageways between the groups of tubes being arranged intermediate of the central vertical plane and the outer shell of the boiler, whereby when heat is applied to the exterior of the lower portion of the shell and to the interior of the fire tubes, the water within the boiler shell elevated at the upper and central section of each group of fire tubes during the generation of steam within the boiler, is permitted to directly pass into and circulate in a downward direction in the vertical passageways between the groups or banks of fire tubes to the bottom section of the



boiler and thence in an upward direction between the rows of fire tubes in each group or bank and in the passageways between the boiler shell and the outer rows of fire tubes of the outer groups or banks and the generated steam will pass unobstructedly into the upper steam space of the boiler. Seven claims.

1,224,990. SUPERHEATER. CHARLES D. YOUNG, OF ALTOONA, PA.

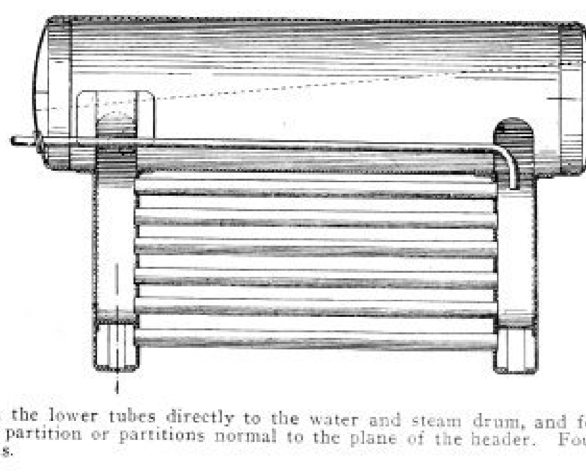
Claim 1.—In combination with a boiler having a fire box and smoke box and fire tubes extending through the boiler from the fire box to the smoke box, and a pair of superheater headers, an inlet for supplying saturated steam from the boiler to one header, an outlet from the other header, and a plurality of superheater tubes each having one end connected to one header and the other end connected to the other header,



such tubes each leading into a fire tube at the front end thereof, extending in a straight length from its point of entrance into the tube to a point adjacent the rear end of the fire tube, recurving and extending to the front a relatively short distance as compared with the length of the fire tube, then recurving and extending to a point adjacent the rear end of the fire tube, and finally recurving again and extending in a straight length out through the front end of the fire tube. Two claims.

1,225,304. BOILER. PAUL A. BANCEL, OF NEW YORK, N. Y.

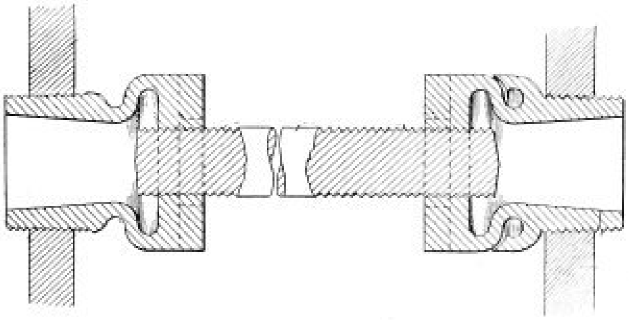
Claim 1.—A header or water leg for watertube boilers, provided with a separate passageway within the same to convey the steam and water



from the lower tubes directly to the water and steam drum, and formed by a partition or partitions normal to the plane of the header. Fourteen claims.

1,225,501. FLEXIBLE SLEEVE FOR STAYBOLTS. ANTON G. RUBER AND CLARENCE H. PORTER, OF ALBANY, N. Y.

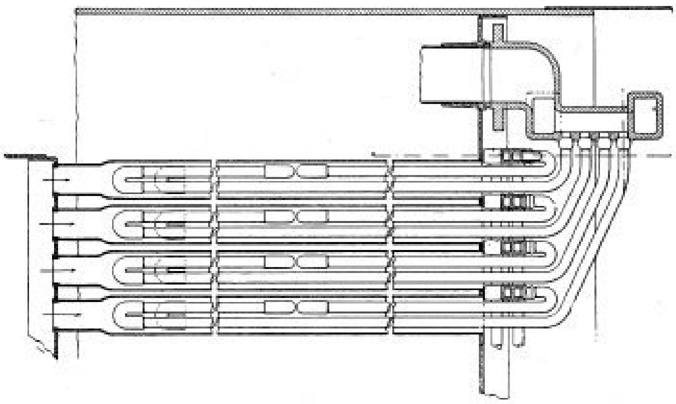
Claim 1.—A flexible sleeve for staybolts, provided at one end with means for securing it to a boiler wall and at the other end with a head adapted to receive a wrench and having a threaded opening, a flexible



web adjacent the head and an annular passage adjacent the web for increasing the flexibility of said web. Four claims.

1,225,846. COMBINED SUPERHEATER AND ECONOMIZER. RUDOLF M. OSTERMANN, OF CHICAGO, ILL., ASSIGNOR TO LOCOMOTIVE SUPERHEATER COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

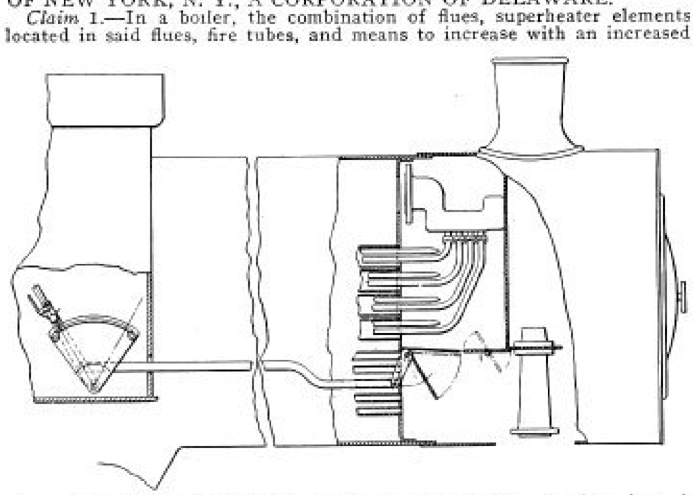
Claim 1.—In a boiler provided with a plurality of enlarged flue tubes, the combination with each of some of such tubes, of a superheater element comprising four serially disposed pipes, two of which are in one plane and extend substantially the entire length of the flue tube, while



the other two are in a parallel plane and extend from the rear ends of the longer pipes to a point well to the rear of the smoke box, an economizer element in the same plane as the shorter leg of the superheater element and extending from the end of said shorter leg to the smoke box, means for passing steam from the boiler through the superheater elements and means for passing water through the economizer elements to the boiler. Five claims.

1,225,986. DAMPER. NEAL TRIMBLE McKEE, OF YONKERS, N. Y., ASSIGNOR TO LOCOMOTIVE SUPERHEATER COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

Claim 1.—In a boiler, the combination of flues, superheater elements located in said flues, fire tubes, and means to increase with an increased



steam demand the proportionate part of the hot gases flowing through the fire tubes. Four claims.

1,227,305. GAGE GLASS FOR STEAM BOILERS. THEODORE L. PETERSON, OF BROOKLYN, N. Y.

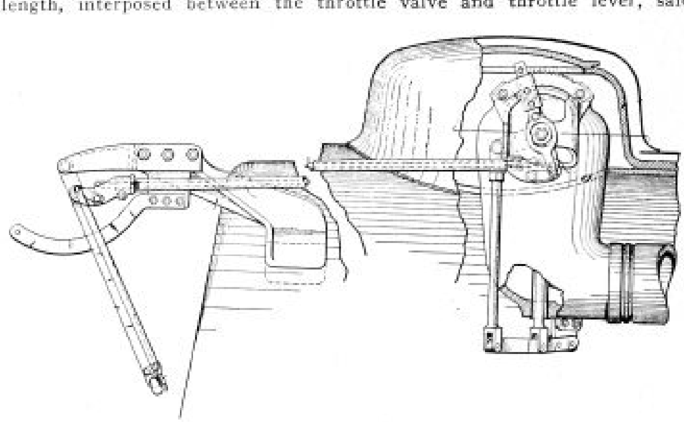
Claim 1.—A water level gage for steam boilers, comprising a glass tube, the wall of which at the upper extremity of the tube is of greater thickness than the wall at the intermediate portion, the bore of the tube being of uniform internal diameter. Two claims.

1,230,776. SMOKE CONSUMER AND FUEL ECONOMIZER. SYDNEY H. PUDNEY, OF TORONTO, ONTARIO, CANADA.

Claim.—In a device in combination a combustion chamber, a reduced hollow extension having a door opening into said combustion chamber, a removable hollow door support fitted horizontally upon said extension and projecting therebeyond, a dependent bracket formed and carried by said door support and disposed snugly against the upper end of said extension and at right angles thereto, a hinged plate mounted upon the lower end of said bracket and spaced inwardly of the outer end of said door support, a lid fitted to close said door support and arranged parallel with said bracket, a crank carried by said plate outside of said support and means independent of said lid, controlling said crank and adapted to cause said plate to occupy angular positions with respect to said bracket.

1,227,096. THROTTLE-VALVE MECHANISM FOR LOCOMOTIVES. HARRY S. VINCENT, OF RIDGEWOOD, AND WILLIAM P. STEELE, OF PALISADE, N. J.

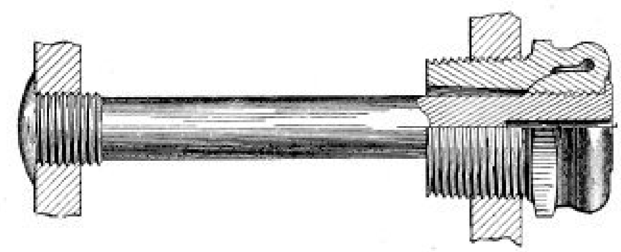
Claim 1.—The combination, with a locomotive boiler, of a throttle valve; a throttle lever; connections, positively coupled throughout their length, interposed between the throttle valve and throttle lever, said



connections extending longitudinally exterior to the boiler, and precluding variation of length through any admission of lost motion in operation; and means for locking said throttle valve in adjusted position without rendering said connections subject to strains. Seven claims.

1,230,048. STAYBOLT FOR BOILERS. BENJAMIN E. D. STAFFORD AND ETHAN I. DODDS, OF PITTSBURG, PA., ASSIGNORS TO FLANNERY BOLT COMPANY, OF PITTSBURG, PA.

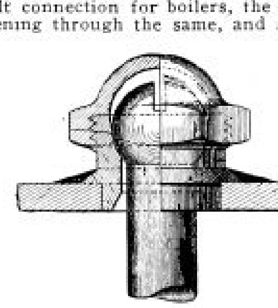
Claim 1.—In staybolt construction, a sleeve externally threaded and provided with an internal seat, and a yielding member projecting out-



wardly from the outer end of said sleeve, and provided with a shoulder to engage the seat within the sleeve, the said yielding member adapted to support the outer end of the staybolt. Three claims.

1,229,961. FLEXIBLE STAYBOLT CONNECTION FOR BOILERS. CHARLES HYLAND, OF PITTSBURG, PA., ASSIGNOR TO FLANNERY BOLT COMPANY, OF PITTSBURG, PA.

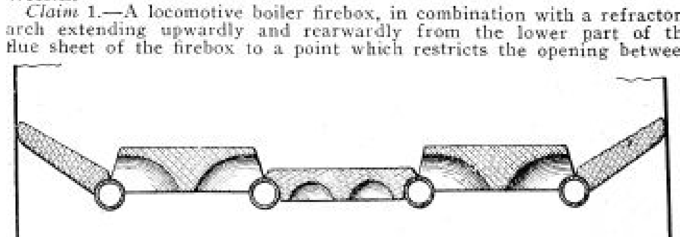
Claim 1.—Staybolt connection for boilers, the combination of a boiler plate having an opening through the same, and a staybolt sleeve having



an integral shoulder to rest on the outer face of the plate and an integral flange conforming in size and shape to the opening in the plate and resting within the latter, the shoulder being secured to the plate by welding. Two claims.

1,229,393. LOCOMOTIVE FIREBOX ARCH. JOHN L. NICHOLSON, OF CHICAGO, ILL., ASSIGNOR TO AMERICAN ARCH COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

Claim 1.—A locomotive boiler firebox, in combination with a refractory arch extending upwardly and rearwardly from the lower part of the flue sheet of the firebox to a point which restricts the opening between



the arch and the crown sheet to an area not exceeding and preferably less than the aggregate area of the flues and said arch containing preferably uniformly distributed upwardly and transversely extending passages whereby the lack of area in the passage at the rear end of the arch is compensated and the products from the fire chamber are subdivided into conflicting longitudinal and transverse streams in the space above the arch and rearward of the flue sheet. Sixteen claims.

THE BOILER MAKER

SEPTEMBER, 1917

Ten Years of Boiler Standardization

Conception of Standard Specifications for Steam Boilers First Advocated in Massachusetts—Promulgation of Massachusetts Boiler Rules—Formation of A. S. M. E. Boiler Code Committee—Widespread Adoption of A. S. M. E. Code

BY JOHN A. STEVENS*

John A. Stevens, Chairman A. S. M. E. Boiler Code Committee

IT occurred to the writer that some of the readers of THE BOILER MAKER might be interested to know something of the vast amount of energy put forth to standardize boilers in America, and it is a pleasure for me to give a brief history of the subject.

The conception of a standard specification, I believe, was first advocated by Mr. Joseph H. McNeill, who for many years was the very able chief inspector of the State of Massachusetts Boiler Inspection Department, and through the very earnest endeavors of Mr. McNeill and the operating engineers of Massachusetts, most ably sponsored by the late Curtis Guild, Jr., Governor of Massachusetts and later Ambassador to Russia, the Massachusetts Board of Boiler Rules was created. The writer looks back with pleasure on being one of the members of the original board, which consisted of Joseph H. McNeill, chairman; John A. Stevens, representing boiler-using interests; Frederick H. Keyes, representing boiler-manufacturing interests; Robert J. Dunkle, representing boiler-insurance interests, and William M. Beck, representing operating engineers.

Upon the retirement of Mr. Frederick H. Keyes, Mr. Bartholomew Scannell, of Lowell, Mass., one of the patriarchs of the boiler industry in this country, was appointed in his place; upon Mr. Scannell's resignation, Mr. Henry H. Lynch was appointed. The late Mr. Thomas R. Armstrong was also a member of the Massachusetts Board of Boiler Rules at one time.

FIRST MEETING OF MASSACHUSETTS BOARD

The first meeting was held July 5, 1907, in a very small and hot room on the fifth floor of the State House, Boston, Mass., at which meeting Mr. McNeill stated to the other members of the Board his ideas of a standard specification for all stationary boilers to be used within the Commonwealth.

We forthwith set to work to formulate a standard which would be, first of all, safe, and, second, commercial. We held meetings weekly and oftener, for practically the first three years of the service. Incidentally, I might mention that the correspondence was very prolific. It came from all known authorities whom we could interest enough to send us any good data which they had on boilers which would make the steam boiler of the future reasonably safe; almost without exception we had prompt and efficient replies from all those well qualified to give advice.

PUBLICATION OF MASSACHUSETTS RULES

From time to time as we were in a position to do so, we issued pamphlets of instructions to boiler manufacturers and inspectors, stating how the rules should be applied in the construction of boilers, until we published the issue of August 5, 1909, which was the last and main issue made by the original members of the Massachusetts Board of Boiler Rules, and which issue embodied all that was necessary for the guidance of those manufacturing and inspecting stationary steam boilers for the Commonwealth of Massachusetts for that period.

While this work was going on, the forces in the Inspection Department were augmented, more rigid watch was kept of existing boilers and more thought, patience and skill put into the manufacture of new boilers; in other words, the educational process was advanced and has advanced ever since Mr. McNeill started this system.

In the meantime the writer made a trip to Europe and interviewed several of Europe's greatest boiler engineers with special reference to additions or deductions from our

* Consulting Engineer, Lowell, Mass.

rules, and we were very highly complimented in Europe on the rules formulated.

The present Massachusetts Board of Boiler Rules, in addition to their boiler standardization work, has formulated very valuable air-tank regulations.

The Board consists of:

Geo. A. Luck, chairman;

Frederick A. Wallace, representing boiler-using interests;

Henry H. Lynch, representing boiler-manufacturing interests;

Robert J. Dunkle, representing boiler-insurance interests (member of Board since its conception);

Edward D. Mullane, representing operating engineers.

Uniform Standardization of Steam Boilers Undertaken by Mechanical Engineers' Society

In 1911 the late Colonel E. D. Meier, then president of the American Society of Mechanical Engineers, suggested in his far-reaching foresight that the American Society of Mechanical Engineers undertake the work of standardization of steam boilers in a more complete manner than was possible with the State of Massachusetts, and the writer was appointed chairman of the original committee of the American Society of Mechanical Engineers for the purpose of creating a standard for that society. This committee was called "The Committee to Formulate Standard Specifications for the Construction of Steam Boilers and Other Pressure Vessels and for Their Care in Service," and originally consisted of:

John A. Stevens (chairman),
Wm. H. Boehm,
Rolla C. Carpenter,
Richard Hammond,
Chas. L. Huston,
Edward F. Miller,
H. C. Meinholtz (deceased),
E. D. Meier (deceased).

Upon the death of Mr. Meinholtz, Col. E. D. Meier was appointed in his place.

Col. Meier took a most active part in the formation of the A. S. M. E. Boiler Code, and up to within a few days of his death had it constantly before him. It is one of the regrets of the members of the Boiler Code Committee that he could not have lived to have seen the fruition of the work he so wisely started.

The A. S. M. E. Committee proceeded on similar lines to those followed by the Massachusetts Board of Boiler Rules in counseling with all qualified authorities, manufacturers and large users of boilers, producing its preliminary report and thereafter issuing at different times other preliminary reports up to the issue which was given to the public in 1914.

Appointment of Advisory Committee

At one stage in the work it was found advisable and necessary to amplify the original committee by appointing an advisory committee composed of some of our most celebrated steam engineers, for it was believed that the great interests of our country should not have "taxation without representation," and it has always been admitted that boilers built to the standard of the American Society of Mechanical Engineers cost more money than boilers built otherwise, and are indeed worth more.

In appointing the Advisory Committee, men were chosen to represent all of the large interests affected—such as railroads, consulting engineers, large manufacturers of different types of boilers, engineering schools, thus bringing their keen interest in the promulgation of standards among our engineering institutions, steam heating boiler manufacturers, watertube boiler manufacturers, boiler insurance companies, threshing interests and boiler users.

The members of this Advisory Committee consisted of the following:

F. H. Clark, railroads.

F. W. Dean, consulting engineers.

Thos. E. Durban, Boiler Manufacturers' Association Uniform Specifications Committee, for all types of boilers.

Carl Ferrari, National Tubular Boiler Manufacturers' Association.

Elbert C. Fisher, Scotch marine and other types of boilers.

Arthur M. Greene, Jr., engineering education.

Chas. E. Gorton, steel heating boilers.

A. L. Humphrey, railroads.

D. S. Jacobus, watertube boilers.

S. F. Jeter, boiler insurance.

Wm. F. Kiesel, Jr., railroads.

W. F. McGregor, National Association of Thresher Manufacturers.

M. F. Moore, steel heating boilers.

I. E. Moultrop, boiler users.

Richard D. Reed, National Boiler and Radiator Manufacturers' Association.

*H. G. Stott, boiler users.

H. H. Vaughan, railroads.

C. W. Obert, secretary to committee.

In the appointment of the Advisory Committee we were most fortunate in selecting men who proved to be real workers, and who, moreover, were naturally possessed of analytical minds—men not afraid to admit when they were wrong and not afraid to be insistent when they were right.

The writer wishes to mention especially the great assistance given the committee throughout the early stages of the formulation of the A. S. M. E. Code by Mr. Henry Hess, vice-president of the society, who counseled with and guided us with special reference to our conferring with other large societies interested in the standardization work, notably the American Society for Testing Materials, and also other societies which were more or less interested in a boiler standard. He also very wisely advised us not to have anything to do with legislation or politics, and had we attempted to work through these channels we would have caused the downfall of the code early in its life.

Space prevents us from mentioning the great assistance accorded us by manufacturers of boiler material, irrespective of their own desire to manufacture only one standard material for boilers, the great help accorded us by the boiler insuring interests and the help accorded us by the railroad interests of America and the large boiler users.

Through the entire formulating period of this work the writer was most ably assisted by his associate engineer, Mr. Walter Slader, and he wishes here to give him credit for the very valuable work he did throughout this long and arduous task.

In passing, I wish to give all due credit to *Power*, THE BOILER MAKER and several other engineering periodicals which have from time to time issued articles in sympathy with the movement.

The work of the Boiler Code Committee of the American Society of Mechanical Engineers was founded on the standards originated by the Massachusetts Board of Boiler Rules, but it should be noted that the work of the American Society of Mechanical Engineers is a great deal

* Deceased.

more complete and far-reaching than the Massachusetts Standard. In the first place it specifies in detail the chemical and physical properties of all material entering into the construction of boilers, and gives rules, formulæ and tables which have been checked and rechecked by men of national reputation, and in many cases verified by testing laboratories; that is to say, in many cases rules or formulæ were withheld until actual tests in laboratories were made, in order to prove the mathematics.

Therefore, it is with pleasure that we note that the code has been adopted, or is in the process of adoption, in great States, such as New York, New Jersey, Pennsylvania, Ohio, Indiana, Michigan, Wisconsin, Minnesota, California, and such cities as Kansas City, Scranton, Pa., and St. Louis, Mo., and even in the Republic of Argentine and the Republic of Paraguay, of South America.

A. S. M. E. Code Thoroughly Tested in Practice

This would indicate that the code has been through a very severe process of trial and has been found to be, as stated, the best in existence for governing the construction and inspection of stationary boilers.

It is also gratifying to the writer to note that, according to specification No. 2362 for power plant equipment at the Naval Training Station, Newport, R. I., boilers and accessories used by this department are to be in accordance with the A. S. M. E. Boiler Code.

As the writer has many times stated in public, the Boiler Code of the American Society of Mechanical Engineers is intended for the young men. Many of our older engineers know all that is in the code and then some more, but in looking forward to the future the writer, for one, is always especially careful in the endeavor to see to it that our young engineers are started correctly.

In regard to the cost of this work, it is interesting to the writer to review the enormous amount of money spent directly and indirectly by the engineers having to do with the standardization of boilers in America. It was stated authoritatively in New York at the completion of the A. S. M. E. Boiler Code, issue of 1914, with index, that the work, if paid for at ordinary professional rates, would have cost at least a quarter of a million dollars. Further, it was stated by a member of the Boiler Code Committee in New York recently that by the time the code is universal in the United States the cost will run close on to a million dollars.

Uniform Boiler-Law Society Created

The policy of the American Society of Mechanical Engineers does not permit its members or the members of its committees to have anything to do with projects political or commercial, and, through the foresight of Thomas E. Durban, the American Uniform Boiler-Law Society was created, the officers of which are:

Thomas E. Durban, chairman, administrative council.

E. R. Fish, American Boiler Manufacturers' Association.

H. P. Goodling, National Association of Thresher Manufacturers.

F. W. Herendeen, National Boiler and Radiator Manufacturers' Association.

M. F. Moore, low pressure steel boiler manufacturers.

I. Harter, Jr., watertube boiler manufacturers.

John H. Wynne, locomotive manufacturers.

Walter Plehn, steam shovel manufacturers.

H. N. Covell, hoisting engine manufacturers.

Chas. S. Blake, boiler insurance companies.

John Hunter, National Electric Light Association.

D. J. Champion, boiler materials.

Mr. Durban advises the writer that they have expended on an average of $1,000 per month since they started on the work of interesting the States to adopt the A. S. M. E. Code. This money is being spent to bring the code prominently before the people and to explain its advantages.

Boiler Code Congress

On December 4 and 5, 1916, the American Boiler Code Congress was held at Washington, D. C., where the official representatives of twenty-three States were present, and it was unanimously voted to approve the Boiler Code of the American Society of Mechanical Engineers.

We also had a very able sponsor from Toronto, Canada, in Mr. D. M. Medcalf, chief boiler inspector of Ontario, who is fully alive and awake to the advantage of having the same code in vogue in the Canadian provinces as in the United States.

The writer would mention that whatever assistance he has given to this work has been given in the spirit of true Americanism—to wit, for the good of the service. Incidentally, this service has been of great educational value to him. He has made acquaintances everywhere and a great many friends in the pursuit of this work, and has had the pleasure of acting as chairman of the American Society of Mechanical Engineers' Boiler Code Committee since its inception.

"Standardization," an American Creation

For those who do not know, the idea of "standardization" is strictly American, being an American creation; for instance, the standard fire hose coupling, the standard berry basket, the standard electric lamp socket, the standard cement specification, standard structural shapes, standard screw threads, and of late, the standard ship; and a standard boiler construction using one standard of boiler materials and accessories would naturally appeal to the highest and broadest type of business men in the spirit of maximum conservation and efficiency.

For the States which have not adopted a standard, the only work that is necessary is of an educational nature; for, when the entire case is fully explained, the code is usually adopted. For those States which have not adopted the A. S. M. E. Code the writer would recommend its adoption, as being the most complete boiler law of any in existence at the present time.

Further, a permanent committee has been established by the American Society of Mechanical Engineers for adding to and deducting from the A. S. M. E. Code as the art advances, and also to assist in the interpretations of the code in States and municipalities where the engineers are not conversant with its rulings. In other words, the American Society of Mechanical Engineers is very advisedly in a position of a "clearing house" for boiler engineering.

Completeness of the Code

The writer's thought has always been to have the code so complete that all that was necessary in ordering boilers was to name the type, amount of heating surface required and the working pressure desired, and where credits and reputations are good, a postal card order might suffice, since the fact that a boiler has been properly stamped with the symbol of the American Society of Mechanical Engineers would be positive proof that all the purposes of the contract and every detail of the code requirements were fulfilled.

The A. S. M. E. Code is the result of the combined ideas of several thousand engineers who have assisted the committee from the start up to the present time in producing the right recommendations.

The code is now under its first revision and the revised printing will be ready for the public within a few months. The proposed revisions are being published from time to time in the journal of the society, with the idea that all those interested may be given an opportunity to discuss them before they are brought to their final form for adoption. The greater part of the revisions will be made to clarify the text, and not to change the intent, of the original code.

The writer has often been asked how many boilers there are in America; to which he would answer that as nearly as he can glean there were about 600,000 power boilers in 1914.

He would also state that the boiler business in America is said to amount to $500,000,000 of products per year. These figures, however, are subject to revision by anyone who knows more of them than the writer does.

It will probably take another five to ten years to standardize boilers in America.

In closing, let it be said that it is the earnest wish of the writer that all those not conversant with the code might become so and assist in putting this code into general service at the earliest opportune time.

He also wishes to thank all those who have assisted in any way in the promulgation of the A. S. M. E. Standard.

The Engineering Council

The formation of an Engineering Council is the outgrowth of a real need for proper consideration of questions of general interest to engineers and to the public, and to provide means for united action upon questions of common concern. Many such questions have come up in the past and will arise in greater number in the future. This war has brought out very impressively the actual need for united action of some kind. At present the Council is concerned only with four societies, because that seemed the most practical way of getting a group of men together to answer the immediate needs, but these societies do not assume to speak for all engineering societies in the country. Criticism that they are exclusive in any way is utterly mistaken. There is the hope that such a Council, by proving itself effectively, may lead to much wider co-operation in a strictly representative body for all engineers, and thus pave the way for a very much larger union in the future.

The four societies concerned at present are the American Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers. They have come together in pairs from time to time in the past for special purposes, and there have been general conferences on subjects requiring immediate settlement, but until the Council was definitely organized in June there was no permanent body to advise all the societies. We have had many fruitful discussions in the past leading to useful action. The Standardization Committee, which has been organized to represent five societies, has passed upon commercial standards of all kinds. This committee has great possibilities and it should be enlarged enough so that its influence may become very widespread.

Many problems have already been presented before the Council. Its personnel, made up of twenty-four men representing equally the four societies, is well balanced and judicial. The first duty was necessarily the organization and appointment of standing committees, as follows:

1. Committee on Public Affairs.
2. Committee on Rules.
3. Committee on Finance.

Certain questions relate, however, to the war and the assistance that engineers can render. A committee, to be called the American Engineering Service Committee, was appointed with instructions to invite the co-operation of all engineering societies. Its present duty is the tabulation and listing of the members of the five societies represented, in order that we as a profession may be in a position to take a larger part in the industries after peace is declared. This tabulation has already in part been done, but in a rather unsystematic and unequal way. It is hoped that the new committee, by having additions from other societies, may make a final and lasting tabulation of all the engineers in the United States. The list is to be kept in the Engineering Building for general use in government problems and in the industries.

Finding the Right Men for Special Government Service

At present the committee is devoting its attention to the immediate need of the hour, namely, the procurement of men for special service in the government. A list of specialists in the societies has already been completed. There are three methods by which engineers may enter United States service: first, through some organization; second, through individual application to a department of the government, and third, through selection by the conscription law. But this is war service wholly, and not civil service, which is the same now as it has always been. As a matter of fact, a great many engineers have already entered through the engineering societies, through colleges, and through various special boards in Washington. The importance, however, of a complete list of engineers and their professional specialties cannot be over-rated. Such a complete list can be made only with the help of the local as well as of the national societies.

Another committee, called the War Committee of Technical Societies, was appointed to assist any organization in Washington, such as, for instance, the Council of National Defense, the National Research Council and the Naval Consulting Board, in any way in which it can bring to the attention of the engineers of the country the necessity for thought and help in the numerous problems that arise.

A council organized by the enlargement of the present Engineering Council can be very effective in many ways without interfering with the autonomy of any individual society. Every society has some definite purpose of its own and also some which it holds in common with all other societies. One of the latter purposes relates to public service and to co-operation.

In organizing the Council provision was made for the election to membership of other national engineering and technical societies. There is no doubt that rules can be made under which these societies may become members. This will involve consultation and discussion in the future.

The office of the Council will be in the Engineering Building, 29 West Thirty-ninth street, New York City.

PERSONAL

John H. Harris, formerly assistant foreman and boiler inspector at the Pere Marquette Railroad shops, Grand Rapids, Mich., has been appointed boiler inspector for the Ames Iron Works, Oswego, N. Y.

Among New Jersey Boiler Shops

Practical Ideas, Combined with "Horse-Sense," Make a Small Shop Thoroughly Efficient—Useful Kinks Adopted

BY JAMES FRANCIS

The writer recently had the pleasure of visiting one of those little shops where most of the plant consists of ideas and horse sense. The entire plant would hardly make more than a shed for one of the larger shops and the entire working force consisted of the father, son and two men, one of whom was an old man who had been with the concern for many years. The other was a very young man—an apprentice, in fact—who as yet was a mere beginner at boiler shop matters.

The father, almost through with this world's troubles, no longer took a very active part in shop affairs. He worked a few hours each day and was always ready with advice and counsel, but the younger man took the brunt of the work. Yet this little shop was famed far and wide for the excellence of its work and for handling difficult work which required a high degree of skill and patience. "Palmer can do it if anybody can," was the final verdict when difficult work was seeking some one to do it.

Home-Made Overhead Traveler

In this little shop the writer saw a home-made overhead traveler which would often prove a godsend to the little shop whose owner might be trying hard to build up a business from nothing but brains and pluck. The little traveler was placed crosswise of the shop, a distance of about 20 feet, and the supporting members were two pieces of railroad iron, about 60 pounds to the yard, which were cut to the width of the shop and the ends of the rails built into the shop walls. A middle support, consisting of a forged hanger, had been placed in the middle of each rail.

The traveler ran upon the top of the rails. The traveler consisted mainly of a 6-inch I-beam about 6 feet long, which distance comprised the transverse travel of the traveler. Upon either end of the I-beam heavy plates had been fastened by means of gusset plates or corner-clips on one side and the usual angle iron connection on the other side of the I-beam.

The plates, which were about 4 feet long, were placed just inside of the treads of the two rails above described. Sway braces, four in number, one from either end of the inside guide plates, were brought to the middle of the transverse I-beam and bolted securely thereto.

Two more plates were then attached to the two plates above described, and all four of these plates were of the same dimensions, viz., about 4 feet long, 6 inches wide and ¾ inch thick. The second set of two plates was placed outside the first set and separated therefrom by distance blocks of such thickness that the outside plates formed guides which projected downward past the outer edges of the rail treads, while the first described pair of plates fitted in a similar manner inside of the rail treads. The six distance blocks were then about 1 inch less in length than the width of the plates in question. The above-mentioned plates and distance blocks were all riveted firmly together and fastened rigidly and squarely to the 6-foot I-beam already described.

Four cast iron wheels were turned and finished and put between the pairs of end-plates above mentioned, and to make the friction less the pulleys, or truck wheels, as they might be called, were bored larger than the 1½-inch pins which supported the wheels and ⅝-inch pins were inserted all around the pins or shafts and inside of each wheel, which thus became fitted with "pin bearings" and moved under considerable weight with very little friction.

Before the I-beam was put in place, a traveler was placed upon said beam. This traveler consisted of a U-shaped bit of ⅝-inch boiler plate with four inwardly projecting studs upon each of which was placed a small truck wheel of sufficient diameter and thickness to run easily upon the lower flanges of the 6-inch I-beam above mentioned.

The little four-wheeled trolley thus formed carried a heavy differential chain hoist which served all purposes in handling work in the shop and could also be easily removed from the traveler for duty on outside work. The motive power for this little overhead traveler was one-man power, and the lateral and transverse travel of the suspended load was effected in a very simple manner by simply pulling or pushing the suspended load in the direction it was to be moved.

No motors to burn or wear out in that overhead traveler; very few journals to be lubricated or repaired, and the traveler was right there when needed and was never out of order or out of business for the lack of an operator. And it would handle almost anything which could be brought into the shop.

Handy Little Forge

In this same little shop the writer saw in use one of the slickest little heating forges that it has been his lot to come across. The forge took up almost no room whatever of the shop floor space, as it was placed snugly against the side wall of the shop, but could be moved out into the middle of the floor at a moment's notice, and without tearing out anything fixed or permanent.

Fig. 1 will give some idea of the construction of this little forge, which, even though small, proved to have an enormous capacity for heating, even on large work.

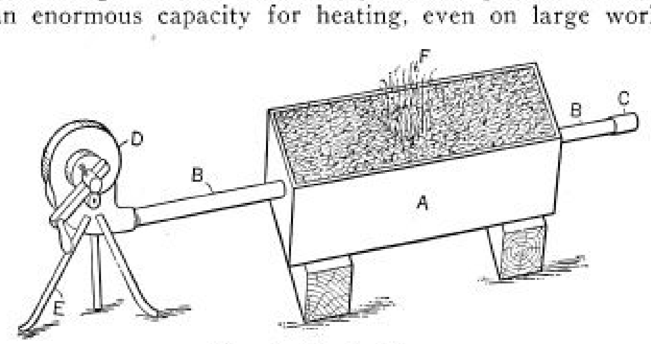


Fig. 1.—Handy Forge

In the making of this forge the proprietor evidently laid hands upon a convenient casting. Instead of making a box of boiler iron, say of ⅜-inch thickness, for the body of the forge, a cast iron box, *A*, about 5 feet long and 16 inches square chanced to come along, and it was utilized by drilling out a bit of metal from each end of the box, in the center thereof, so that a 3-inch pipe could be thrust through the box, lengthwise, as shown at *B B*.

A bit of cotton waste was thrust into the free end of the pipe and a tomato can, *C*, proved a fitting closure for keeping the waste in place. A blower, *D*, was attached to the other end of pipe *B* and a tripod made up of 1-inch pipe and strap iron served to hold the blower in position in such a manner that it could be readily slipped on and off of pipe *B* as occasion demanded whenever the forge was moved from one place to another. And sometimes this forge was to be found out in the yard, doing a pretty heavy flanging job.

A couple of square 12-inch blocks completed the material required for the forge, and the use of these blocks is plainly seen in the engraving. At the time the writer saw the forge in operation it was delivering a bit of fire not more than 5 inches across—not quite as large as a man's hat—and the older boiler maker was heating the ends of 1½-inch angles for cutting in a manner to be described here a bit later.

Upon looking the forge over more closely, it was found, as shown by Fig. 2, that the pipe *B B* was perforated upon

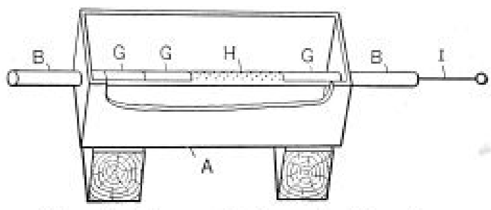


Fig. 2.—Twyre Holes and Clean-Out

its top side almost its entire length inside of box *A*, and that such portions of the pipe as were not in use to deliver air were covered by semi-circular strips of thin sheet iron, which fitted closely to the outside of the pipe, as shown at *G, G, G*.

When a long fire was required, the requisite length of perforated pipe was uncovered by sliding back or removing entirely one or more of clips *G*. At the time the writer saw the forge in operation, not more than 3 inches of the perforations were uncovered and a very small, circular fire was the result, as shown at *F*, Fig. 1. By removing all the clips, *G*, a fire nearly 4 feet long should be provided almost instantly.

Cleaning out of the air pipe *B* was effected in a very simple and ingenious manner. Tin can *C* was removed from the end of pipe *B*, the cotton waste pulled out, and a little heavy work at the blower soon cleaned out pipe *B*. At any time that a collection of dirt had accumulated which the blast would not remove, a little stirring up with a poker, *I*, thrust into the end of pipe *B* soon loosened the dirt accumulation and the blast was able to drive it out.

A bit of angle iron work chanced to be going on in this shop while the writer was present, and a few kinks were brought out which looked mighty good to him, and he believes they will be appreciated by THE BOILER MAKER readers. Some supports were required for a rush repair job on a foundry cupola and a special T-shape had heretofore been used. But on account of the time necessary to obtain material at present, it was determined to use plain angles, driven together to form T-iron.

TRANSFERRING HOLES

To use the 1½-inch angles for this work, it was necessary to cut away one flange for a certain number of inches at either end, also to drive the pieces together in pairs, also to mark and punch the holes within the capacity of the punching machine in the shop. Owing to the construction of said machine, ½-inch holes could be punched only from the flange side of the angle—that is, from that side on which the flange projected upwards.

In marking the angles in pairs, some of the holes were necessarily laid out on the bottom or flat side, and it became necessary to transfer these holes to the other or angle side of the piece. The transferring was effected in a very easy and accurate manner by means of the transfer tool shown in Fig. 3. It was made from a piece of thin

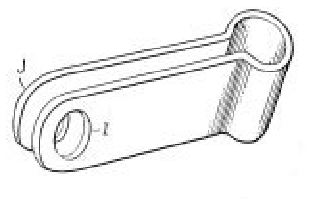


Fig. 3.—Transfer Tool

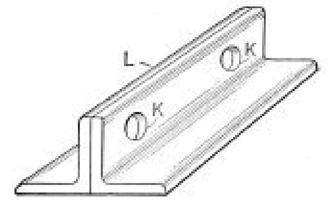


Fig. 4.—Transfer of Hole Markings

steel, was about 4 inches long, and the steel seemed to be about 1 inch by ⅛ inch or thereabouts. The hole *I*, ½ inch in diameter, was drilled through both legs of the tool, extending through leg *J*, same as shown at *I*. The manner in which this handy little tool was used will develop later in this story.

A pair of the angles to be worked is shown by Fig. 4. The holes *K, K*, have been drilled in one piece and marked upon the flat or bottom side of piece *L*, after which the punched piece is removed and the holes punched in piece *L*. But it was found impossible to place the piece in the punching machine flange side down, therefore the marked holes must be transferred to the other side of the angle before the punching machine can get in its work.

The manner in which the holes are actually transferred from one side of the angle to the other is shown by Fig. 5. A hole as marked through the other angle is shown at *M*.

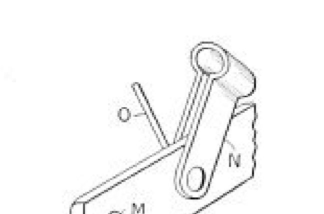


Fig. 5.—Using a Transfer Tool

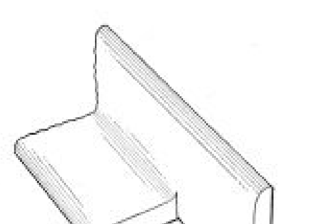


Fig. 6.—Flush Cutting Angles

The other marked hole is present, but has been hidden by the transfer tool *N*, which was applied to the angle as shown, with the hole in the tool fair with the marked hole on the flat side of the angle.

Once the transfer tool has been accurately located upon the marked hole, the tool is pinched by the fingers, bringing the tool firmly against both sides of the angle and causing the tool to be held there firmly while the hole is marked on the other side of the angle by means of the scriber *O*. A bit of slate pencil or soapstone marker may be used in place of the scratch, if found desirable to do so.

In this manner, the holes were transferred with great exactness to that side of the angle which permitted the power punch to get in its work in a manner which was impossible from the other side of the angle, owing to the size of the chuck which held the punch proper in the machine.

In connection with the little cupola job noted above, another interesting bit of work was seen in process in the little boiler shop in question. The ends of the angles, the drilling and marking of which is described above, had to be cut back for several inches and one flange removed in such a manner that the portion of the angle shown at *P*, Fig. 6, shall be no thicker than the top of the flange.

Flush-Cutting Structural Steel

This means that the round portion at the bottom or root of flange *Q* must be cut off so as to leave flange *P* same thickness at the bottom as at the top. It was required to do this work with the chisel, no filing, grinding or otherwise finishing the angles being permitted, as the cost thereof could not be carried by the job.

The man who did the work, after trying several methods of holding the angle during the cutting process, finally adopted the one shown by Fig. 7. The angle was held

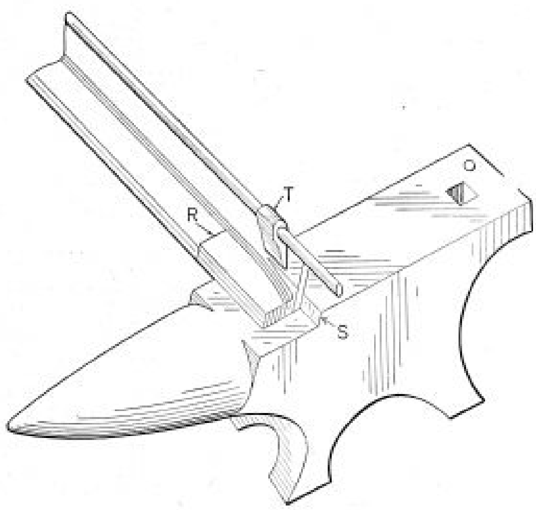


Fig. 7.—Method of Flush Cutting

fair upon the anvil by a helper, as shown by Fig. 7, the corner of the angle resting in the corner of the anvil at *S*. Then a very sharp-handled cold chisel *T* was procured and the cutting angle had been ground very flat and very sharp, so the tool could be made to pick up its cut without dodging, and at the very beginning of the curve or fillet which joined the two members of the angle.

The end of the cut is shown as marked at *R*. The cut was commenced at the extreme end of the angle, where the very sharp chisel picked up the cut more easily than was possible anywhere else in the cut, as at the very end the chisel could be applied at a sharp angle with the start of the fillet, when, if started anywhere else, the end of the chisel must have been applied flat to the cut and a start made along the whole width of the chisel, something it is very hard or almost impossible to do. But on the end of the angle the chisel very readily picked up the cut, which, once started, was followed easily and a very clean, smooth cut made right up to mark *P* with the trouble merely of keeping the chisel fair upon the work.

This method of holding the angle eliminated entirely all tendency of the angle to dodge. The angle *S* of the anvil supported the angle in two directions and a much better job was easily done in this manner than was possible with the channel held in any other way—even in the jaws of a heavy vise.

With the angle thus supported and held, the cross cut *R* was also much easier made, and when cleaning out the cut at the roots of the angle or fillet there was very little trouble in holding the angle while the chisel cut to the very corner of the angle. Even the hack saw, and ten times the amount of time taken by flush-cutting as above, could not make a cleaner job than was done in the corner of the old shop anvil as shown by Fig. 7.

Oxy-Acetylene Welding is Proving a Valuable Factor in Conservation

A locomotive on a Central Western railroad was towed into the general shops one day with a badly damaged cylinder. In fact, it was first decided by the shop foreman that the case was hopeless as far as repair was concerned. The road was pressed for rolling stock and the shop superintendent decided that the damaged cylinder could be welded and the engine kept in service. The oxy-acetylene process was used and the cylinder made as good as new at a trifling expense. A new cylinder would have cost around $750, while the cost of welding was less than $20, not taking into the final account the saving of time.

This example illustrates the conservation now in force among railroads as well as among machine plants of various kinds, owing to the high price of metal and labor.

A paper company was sadly in need of metal cores, on which the big rolls of paper are wound. Tube mills were far behind in their orders and there was a slim chance of getting any action in that direction. Some one thought of the junk heap, where broken and defective cores were piled. Out of a three years' accumulation the company was able to reclaim several carloads of the tubes through the simple process of cutting and oxy-acetylene welding short lengths into desired lengths.

Boiler Tubes Reclaimed

One Western railway was preparing to tie up several hundred locomotives because of the shortage in supply of renewal boiler tubes. Digging into a five years' accumulation of junked boiler tubes, the company was enabled to salvage and repair, through oxy-acetylene welding, more than enough tubes to put all the "dead" engines in commission, when rolling stock was so badly needed, and at an expense that made it well worth while.

High speed steel is growing so scarce, owing to the enormous demand for it, that many concerns are meeting their urgent needs by oxy-acetylene welding short ends of this material into pieces large enough to be used again in tool making.

Small tools in most plants rapidly run into money, and considerable losses are experienced, even in normal times, if breakage is not taken care of. Therefore modern welding processes are coming into daily use in all of the larger shops and many of the smaller ones, merely to cut down this waste that saps the profits of the year's business.

Efficiency engineers have long contended that the best way to save tools, machines and material is to reclaim them and use them over again, if it can be done at a profit. Of course, if shops were still dependent on the old forge idea for welding, this salvaging would be out of the question, but modern engineering has shown the way out and is rapidly promoting the use of the electric and oxy-acetylene welding processes.

In one plant, stub ends of nickel anodes, used in electroplating, were sold as scrap at a low price to get rid of them, until it was found feasible to weld them together and thus use up every bit of the material at an enormous saving. It was like sticking a small piece of soap, left from the old bar, onto a new cake and getting 100 percent use of the article.

Making the Business Earn a Profit—IV

Getting the Cost of Conducting the Business into the Estimates or Prices for Work Turned Out

BY EDWIN L. SEABROOK

By what method can the boiler maker get the cost of conducting business, of overhead, into his estimates or prices? This is exceedingly important, as the price received for work, or services performed, is the only source through which the amount expended for overhead can be returned to the business. When the boiler maker puts material and labor into a contract, there is only one source from which he can expect these expenditures to be repaid—the price received. He puts the cost of his labor and material into the price. If the full amount expended for these gets into the price, the same will be returned to the business through it. If, for any reason, he fails to include the full amount expended for labor and material in the price, the difference must be a loss. The cost of conducting business must likewise get into the price before it can be taken out of it or returned to the business. If this *cost* is underestimated, or any portion of it not included in the price, there will be a loss of just the amount that failed to get into the price.

There can be no escape from paying the amounts demanded by the business for the cost of conducting it. Many of these items are spot cash; in general practice most of them are paid before the accounts for merchandise. The *business* insists that the expense of conducting it shall be paid promptly. There is another important fact that demands consideration. This overhead expense goes on continually—holidays, delays, slack periods, dull times, make no difference to it; it stares the business in the face every business day in the year, and if the business is to survive and prosper it must be met. The cost of conducting business demands the next turn at the cash drawer, after labor is paid, and must be accommodated.

Percentages of Expense Items

In considering the items of overhead expense in the two preceding issues of The Boiler Maker, nothing was given as to the respective amounts of such items. To illustrate how this *expense* is to get into the estimates and prices it is necessary to give a concrete example of the receipts and expenditures of a business for a whole year. The illustration used here is taken from a business similar to the boiler making trade and is based on actual facts. While the business is not of exactly the same character as boiler making, the fundamental principles of ascertaining the cost of conducting business and applying it to estimates and prices are the same. Certain items and their relation to each other may differ, but the computation of overhead expense, the method of putting it into the price, are essentially the same. The total amount of business and expenditures differ slightly from the amounts developed by the business, but this difference in no way affects the results of the analysis.

Total amount of business		$19,605
Productive labor cost	$8,234	
Material cost	6,274	
First cost	$14,508	

It will be seen from this that the principal items—productive labor and material—amount to $14,508, or, as termed by some, first cost. This leaves a balance of $5,097 from the total amount received during the year. If the proprietor had no other expenditures he could call the $5,097 remaining at the end of the year his own, or profit. When the results of the business were analyzed at the end of the year, it was found that the balance, after deducting the amounts paid for labor and material, or first cost, did not correspond with that on hand. It developed that a profit had been earned, although it was only a few cents on each of the $19,605 received. Where was the difference between $5,097 and the profit? It was not in losses or bad debts; it was not owing by the customers; neither was it in the bank. It had been spent for maintaining the business, and a further analysis disclosed these to be for the year as follows:

Rent	$288
Insurance, fire and liability	186
Taxes	31
Telephone	48
Printing and postage	40
Shop supplies	39
Lost time of workmen	81
Light and heat	52
Depreciation	92
Allowances	60
Hauling, including wages and upkeep of equipment	1,000
Collections	12
Dues, trade organizations	12
Salaries, office	676
Salary, proprietor	1,500
Total expense, conducting business	$4,117

This was the expense of conducting the business and had to be met before a dollar of profit was made.

The complete financial transactions for the year were:

Total amount of business		$19,605
Expended for cost	$4,117	
Expended for productive labor	8,234	
Expended for material	6,274	
Total expenditures	$18,625	
Profit	980	
		$19,605

From this analysis it will be seen that the total amount of business is composed of four elements: Cost of conducting business, or overhead, productive labor, material, profit. If we think of a large tank containing the entire receipts of the business for the year and this tank emptying itself into smaller ones, it will help to illustrate the source through which these four elements come. They must get into the price before they can become a part of the volume of business.

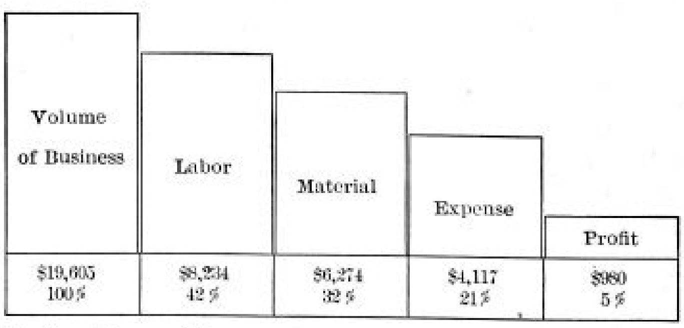


Fig. 1.—Diagram Illustrating Relation Each Element Bears to Total Annual Volume of Business. Each of These Must Go Into the Price

How shall the expense of conducting the business, $4,117, be applied or distributed so as to be included in the price and returned to the original source—the business? It will be seen from the illustration that this sum

($4,117) is just as much a part of the volume of business as that paid for material or spent for productive labor. The boiler maker should be able to trace the amount spent for material and labor all the way through the contract. He should likewise be able to trace the amount expended for conducting the business on each contract. This expense goes on continually and should likewise be going into the price.

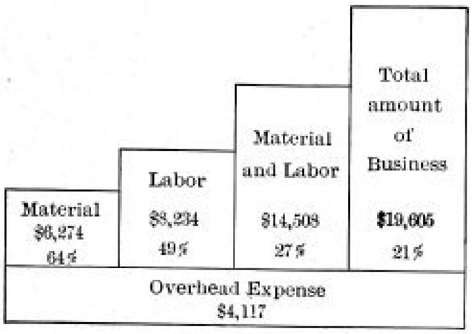


Fig. 2.—Diagram Showing Relation in Percentages That Overhead Expense Has to Cost of Material, Labor, Material and Labor Combined, and Volume of Business.

A study of Fig. 2 will will show that the cost, $4,117, holds a certain relationship, or proportion, to the volume of business, also to the other elements and combinations that make up the volume.

Profit in this relationship is excepted because that does not become an element, or part of the volume of business, until the other three items are met—in fact, there may be no profit. There must be material, labor, expense, but in the place of profit there may be a loss. The method of applying the relationship of expense to the other items comprising the total amount of business will be simplified if they are presented in the form of dollars and cents rather than percentages. The composition of a price, or estimate, will be much easier and better understood if it is built up as is done in actual practice rather than start with the selling price of 100 percent and separate it into its various parts.

Fig. 2 shows that the overhead expense, $4,117, bears a certain relationship to the other items of the business, which is expressed in percentages; these may be considered as just that many cents.

The owner of the business during the year paid $8,234 for productive labor. When he paid $1 to his mechanics he paid 49 cents for the cost of conducting business. Material cost $6,274. For every dollar paid for this, 64 cents was spent for overhead. Labor and material combined amounted to $14,508; when a dollar was paid for these, 27 cents went for overhead.

How Each Dollar Goes into the Business

From every dollar received for the total volume of business, $19,605, transacted during the year, 21 cents was paid for the cost of conducting it. How little of each of the total number of dollars received during the year could be claimed by the proprietor and the amounts disbursed for other purposes is forcibly shown in Fig. 3.

In applying the cost of conducting business it is necessary to have a starting point or base upon which to build. There are four methods, or bases, upon which the expense of conducting business mav be put into the price. There are labor, material, material and labor combined, total amount of business. These methods relate to estimating and will be treated in another article.

The problem of getting the overhead expense, $4,117, into the price would be very simple if the entire amount of business for the year, $19,605, were in one contract. The total expense for the year could be included in the contract price. Business is made up of many transactions of various amounts, and not done in one lump sum. This is still further complicated by unequal proportions of labor and material in the various contracts, and the relation that these bear to the total amount expended for each during the year and the entire volume of business.

If the yearly business, $19,605, be represented by a square divided into 100 parts, productive labor would cover 42 parts, material 32, expense 21, profit 5. The problem of applying the overhead expense would still be very simple if this relationship were the same year after year. The amount of material and labor varies each year, also the expense of conducting business, but this is probably more staple than either material, labor, profit, or volume of business.

It must be evident, therefore, that the expense of conducting business must go into the price of each contract or piece of work performed. Three of the methods named

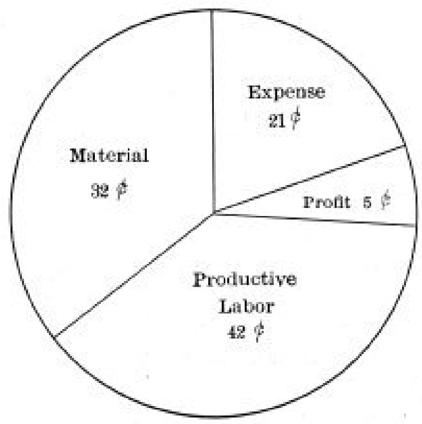


Fig. 3.—Diagram Illustrating the Amounts and for What Purposes Each Dollar of the $19,605 Received Was Spent. Note How Small a Part of Each Dollar Received the Proprietor Could Retain as Profit

above will be illustrated, but it is not proposed to go into estimating or compilation of prices with these.

PRODUCTIVE LABOR METHOD

Material will cost	$150.00
Labor will cost	90.00
	$240.00
Expense conducting business, 49 percent productive labor	44.10
Cost	$284.10

LABOR AND MATERIAL COMBINED METHOD

Material will cost	$160.00
Productive labor will cost	100.00
	$260.00
Expense, 27 percent, labor and material combined	70.20
Cost	$330.20

SELLING PRICE METHOD

Material will cost	$140.00
Productive labor will cost	80.00
	$220.00
Expense, $220 ÷ .74 = $297.30 × 21 percent =	62.53
Cost	$282.53

In the latter method reference to Fig. 1 shows that the combined cost of labor and material is 74 percent of the volume of business or selling price. The expense is 21 percent of the selling price; hence the cost price is $282.53.

Each of these methods has its advocates and opponents who claim advantages and disadvantages. The difference in these methods will be discussed and illustrated in a succeeding article.

In some respects placing the expense on productive labor is comparatively new; it is probably the easiest and simplest of the three. It is based upon the theory that time measures practically all the expense; salaries, rent, etc., is each so much per unit of time and has no relation to the amount or cost of material. How long does it take the work to be done is the standard by which its share of the overhead expense should be determined. The advocates of this method contend that labor is more staple in quantity and price than material and varies the least of all the price elements.

The method of applying the overhead expense on labor and material combined is advocated by those using it, because it distributes this cost over a wider margin. The material required can be more accurately determined than labor. If the labor is underestimated, but combined with the material, as a base upon which to distribute the overhead, it will be more evenly applied than if borne entirely by productive labor. The points raised in favor of the labor and material combined method apply to the selling price method. The expense is distributed over the widest area possible, so there is less danger of loss from too little of the expense getting into the price than in the other two methods.

Perhaps some boiler makers have the idea that because they are managing their business at a small cost it must be making a correspondingly large profit. Some features in this respect are worth considering. The following results taken from the business of two firms in the same line will serve to illustrate that small overhead does not necessarily mean a larger profit.

	No. 1		No. 2
Productive labor	$4,600.00		$4,828.00
Merchandise	7,500.00		4,630.00
Overhead expense	2,995.00		3,873.00
	$15,095.00		$13,331.00
Selling price	14,500.00		14,990.00
Loss	$595.00	Profit	$1,659.00
	Percent		Percent
Cost, productive labor	65.11		80.22
Cost, material	39.93		83.65
Cost, volume	20.65		25.83

An analysis shows that the one making the profit had a much higher expense ratio in every particular than the one sustaining a loss. Low expense of conducting business is not necessarily an indication that the business is earning a good profit.

Cost Ratio Equalized

Is there a wide difference in percentage of expense between firms in the same line in the same city or town? This is a question that very naturally arises, but it may well be doubted if businesses in the same line are conducted profitably whether there can be but little variation in the percentage of overhead expense. If this were not so the expense ratios for different firms would be high for some, medium, low, and very low for others. Business is not conducted on such varying expense ratios between different firms. Some may think their operating expense is much lower than their competitor's and estimate accordingly. Whatever difference there may be in the percentage of overhead expense, it is too slight to make little, if any, difference, in prices. One firm may have some advantage in a low expense rate on a particular item, but this is generally offset by some disadvantage which is overlooked or not considered. The expense of conducting business, as it affects a certain trade in a given community, is along a general, even line. The following principle may be laid down for this feature of overhead expense:

The expense ratio is practically the same for all properly managed businesses of the same line in the same community.

Computing the Overhead

The expense account should be compiled at the end of each year. A careful study of these items presents an opportunity for reduction, if any can be made. The man who keeps no expense account cannot intelligently attempt a saving in this respect, because he has no means of comparing the expense of one year with another.

There is no uniform percentage of cost of conducting business for every case. Each one must determine his own expense from his records and experience. While there is a similarity of expense percentage running through the boiler making business in every locality, this is not a safe guide by which the individual can measure his own expense. The cost of conducting business results from a combination of different items, is influenced by different factors, such as labor, cost of material, profit. In a very real sense each business is individualized, must tabulate its own experience and expense of conducting business. It is not possible to intelligently make up estimates or prices unless the subject of overhead expense is mastered and properly applied.

(*To be continued.*)

Welding and Reinforcing by the Electric, Oxy-Acetylene, or Other Processes

Prescribed, by the Board of Supervising Inspectors, United States Government.

All calking edges on internally fired boilers may be reinforced by these processes.

Calking edges of the shells of externally fired boilers, above the fire line only, may be reinforced.

Cracks extending from edge of lap to rivet, except on seams below the fire line in externally fired boilers, may be welded.

Cracks not exceeding 30 inches in length in back connection sheets, wrapper sheets, bottoms of combustion chambers, heads and other stayed surfaces may be repaired by welding.

Where cracks are repaired by welding, holes shall be drilled entirely through the plate at each extreme end of the crack, except in small cracks from rivet to calking edge.

Circumferential or lengthwise cracks not exceeding 16 inches in length in plain or corrugated furnaces may be welded.

Where plates in back sheets of back connections, wrapper sheets of sides and bottoms of back connections of any boilers, side sheets and legs of furnaces and bottoms of furnaces of firebox boilers, and other stayed surfaces are reduced in thickness not exceeding 40 percent of the original thickness, they may be reinforced, such reinforcing not to exceed an area of 200 square inches in any one plate.

When such reinforcing extends over stays and braces, such stays and braces shall come completely through the reinforcing so as to be plainly visible to the inspectors.

When the corroded portion of stayed or riveted surfaces of the back sheets or wrapper sheets or bottoms of back connections of any boilers, or side sheets and bottom sheets of furnaces or legs of firebox boiler exceeds 300 square inches, the same may be repaired by the removal of the corroded portion and the replacement thereof by a new piece of plate, the edges of the new plate being welded in position.

Staybolts, braces or rivets shall pass through the body of the new plate as before, the area of the new piece not to exceed 24 inches by 24 inches, or 30 inches, in any one direction, the welded edges to be V'd or beveled along the joint prior to welding.

Where plates of shells and other parts of internally fired boilers subject to tensile strain are reduced in thickness by corrosion not to exceed 25 percent of the original thickness, they may be reinforced, such reinforcing not to exceed an area of 200 square inches.

Where calking edges and laps have been reinforced, local inspectors shall require the rivets to be cut out and redriven if they find by inspection that it is necessary.

No welding shall be allowed in cracks in the shell plates or other plates subject to tensile strain.

Cracks extending through rivet holes in single-riveted or double-riveted seams in stayed surfaces of back connections of any boilers or side sheets of legs or bottoms of firebox boilers which are stayed surfaces may be welded up to a length of 6 feet exclusive of rivet holes.

Where cracks extend through rivet holes in stayed surfaces, the piece extending from the rivet to the edge of the lap may be removed where convenient to do so, and the place where the piece has been removed may be replaced by being built up and reinforced by either of these processes.

Where leaks develop around staybolts and the staybolts are otherwise intact, the nuts may be removed from the ends of the staybolts and the staybolts may be welded into the shell by welding a beveled collar or ring around the staybolt. The width and depth of such collar shall equal one-half of the diameter of the staybolt. In all such cases of applying welding rings or collars around staybolts, the material shall be hammered while in a glowing state as it is applied.

In all cases where metal is deposited on stayed surfaces, the operator shall hammer, when practicable, the deposited metal while it is in a glowing state.

No repair work by any welding process shall be allowed until coupons showing the character of the work proposed to be done by the applicant have been tested and submitted, together with an explanation and report of the test, to the local inspectors of the district where the work is being done. The local inspectors shall then satisfy themselves whether or not such process can be used with safety on the boilers of steam vessels.

In every case where repairs are to be made by these processes on the boilers of steam vessels subject to the inspection of this service, the parties making the repairs are required to notify the office of the local inspectors, in writing, giving a full detailed description of the repairs to be made, the location of the vessel, and the time the repairs are to be begun, so that inspection may be had, if practicable, prior to and during the time the work is being done.

The application for permission to use this process on boiler repairs of any particular vessel implies a guaranty on the part of the applicant that the work shall, in material, flux and workmanship, be equal to that of the samples furnished.

Cracks in wrought iron or wrought steel headers, and cracks or sand holes in cast steel, semi-steel, ferro-steel, malleable iron or cast iron headers, manifolds, crosses, tees and ells may be repaired by welding cracks or flowing metal into sand holes. Such repaired material other than headers and manifolds shall be subjected to a hydrostatic test of three and one-half times the working pressure after such repairs are made. Reinforcing by building up of any of the above-mentioned articles other than headers shall not be allowed.

When crown-bar bolts have deteriorated or wasted away at top of combustion chamber under the crown bars, such deterioration not to exceed 25 percent of the original diameter of the bolt, such bolts may be built up or reinforced by any process of autogenous welding.

Where tube sheets of boilers have deteriorated not to exceed 25 percent of their original thickness, or where cracks have developed in tube sheets, the same may be reinforced and repaired by any process of autogenous welding, and the beading on the ends of tubes may be welded to the tube sheets by the same process. (Secs. 4405, 4418, R. S.)

Steamboat-Inspection Rules Amended

The Steamboat Inspection Service has issued a circular letter dated August 24, 1917, addressed to inspectors of the service, boiler manufacturers, manufacturers of boiler plate, and steamboat companies, containing amendments of the general rules and regulations of the Board of Supervising Inspectors, and approval of vessel equipment and boilers, as adopted by the Executive Committee of the Board at a meeting held from August 15 to 22, inclusive, 1917.

Tensile Strength, Steel Boiler Plates

The restrictions relating to tensile strength required for steel boiler plates as contained in amended rules were struck out of the rules and regulations by the following amendment:

Section 5 of Rule I, General Rules and Regulations, all classes, reading as follows, was struck out:

"The tensile strength determined by the tests shall be not less than 58,000 pounds per square inch of section, nor more than 73,000 pounds per square inch of section, and the elongation measured in a gage length of 8 inches shall be not less than 20 percent."

And the following paragraph was substituted therefor:

"All steel plates tested shall show an elongation of at least 20 percent measured in a gage length of 8 inches."

Area of Segment of Boiler Head—Flat-Seat Safety Valve

The following paragraph relating to determining the area of segment of boiler head was struck out:

"The area of the segment of a head to be stayed shall be that surface contained within a line drawn 3 inches from the inner circle of the head and 2 inches from the tubes or flues."

The following rule for determining the discharge capacity of a flat-seat safety valve was adopted:

"The discharge capacity of a flat-seat valve shall be one and four-tenths times that allowed for a bevel-seat valve."

Pipe Boilers Approved

Under the provisions of Section 4429, R. S., the following-described pipe boilers were approved:

Emergency Fleet Corporation's standard watertube boiler, presented by the Emergency Fleet Corporation, Washington, D. C.

Foster marine boiler, presented by the Power Specialty Company, New York, N. Y.

Meier boiler and Meier superheater, presented by the Heine Safety Boiler Company, Phœnixville, Pa.

The action of the Executive Committee received the approval of the Secretary of Commerce on August 22, 1917, under the provisions of Sections 4405 and 4491, Revised Statutes.

Copies of the circular letter, which contain the amendments in full, may be obtained on application to any board of local inspectors.

Among Railroad Boiler Shops—I

Methods of Patching Water-Leg Corners at Clifton Shops of B. & O. R. R.—Electric and Oxy-Acetylene Welding

BY JAMES F. HOBART, M. E.

Locomotive boiler water-legs have an uncomfortable habit of wasting away and cracking in the sheet down close to the mud ring, and right in the corner at that, where one almost needs a double pene hammer to do work with. Leaks in the water-leg corners frequently mean costly patching and a lot of uncomfortable hard work, but the writer recently saw some corner patching done in the Clifton shops of the B. & O. R. R. (S. I. R. T. Division, Mr. S. R. Gallagher, boiler maker), which seemed to fill the bill so completely that the method could well be used in other shops.

Water-Leg Corner Patches

Fig. 1 shows one of the corner patches complete. It is formed as will later be described, and rivets *A A* are driven right through patch, sheets of water-leg and the mud ring. The fastenings *B B* are screwed into the patch, plate and mud ring, cut off and riveted on the outside as

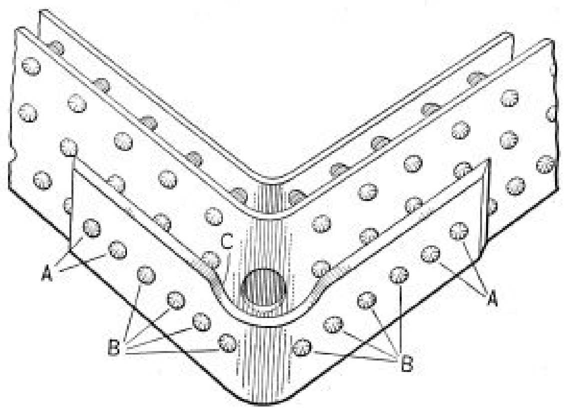


Fig. 1.—Water-Leg Corner Patch

shown. It will be noted that the patch has been cut away a bit at *C*, in order to clear the clean-out hole plug when in place.

The several steps in the making and applying of the patch are shown by the several engravings herewith; Fig. 2, showing the lay-out of the patch, one of which is usually applied to each corner of the water-leg, making four patches to each boiler.

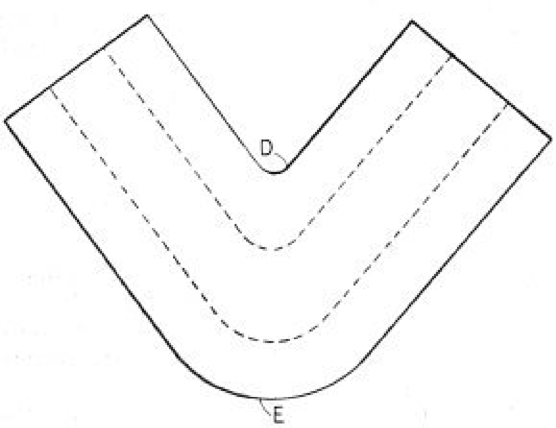


Fig. 2.—Patch Blank

The patch blank is to be flanged up along the dotted lines, and this will, of course, cause the finished patch to be thin at *D* and thick at *E*, and this is good, for the reason that all kinds of corrosion and wear take place on the outside at *E*, while comparatively little trouble is met with on the inside at *D*.

The first step in flanging is to "belt" up the inside edge as shown at *F*, Fig. 3. This is usually done right under the boiler; the heated plate, after having been roughly flanged up, is held in place against the water-leg and the flange *F*, shaped right against the water-leg plates.

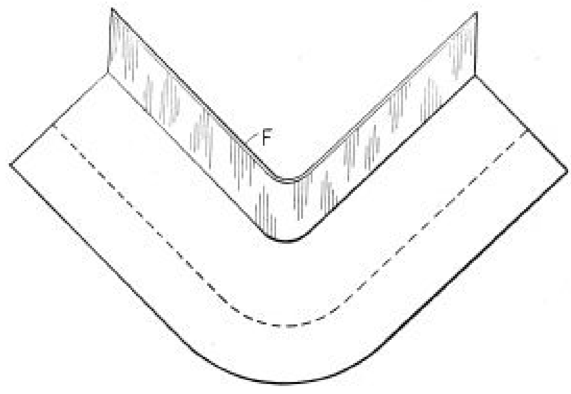


Fig. 3.—First Flanging Step

The other edge of the patch may also be flanged up against the water-leg sheets, but it is the fashion in the Clifton shops to flange the second edge of the patch against a special form made for the purpose and kept in the tool room when not in use. Fig. 4 shows a form for this purpose which is simply a piece of cast iron, without finish and of same width as the thickness of the water-leg.

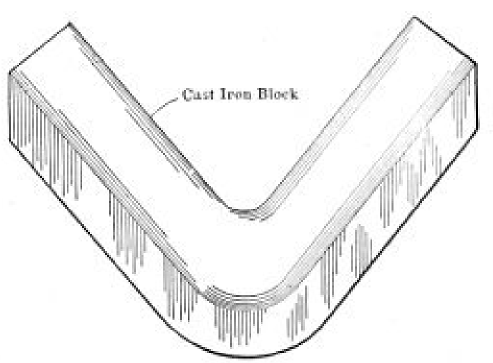


Fig. 4.—Corner Flange Form

The corners of this form are rounded to the same radius as the bottom of the water-leg, and the form is made a trifle smaller than the leg in order that the flanged plate may fit the water-leg snugly. The wasting away of the sheet at bottom of water-leg may cause the patch to be too loose unless it be made a trifle small, as noted above.

When the patch is found to be too snug a fit it is driven into place as far as it will go; then an acetylene flame is played against the tight spots, and after the patch has been heated a bit a few blows from the hammers will make the patch slide home and fit like a glove.

Fig. 5 shows one of the fully flanged corner patches, and it may be noted that there is considerable of a radius inside of the patch at the bends. This radius, of course,

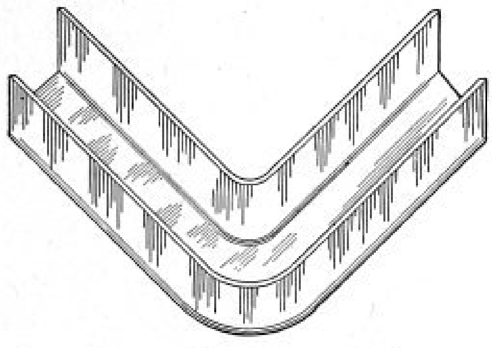


Fig. 5.—Flanged Corner Patch

to be varied to make the patches fit closely to their respective corners. The better the fit the better the job when finished.

As soon as the patch has been fitted to suit the foreman, holes *H H* are drilled right through patch and water-leg. Possibly these holes may be marked and drilled to fit the old holes through water-leg sheets and mud ring, but it is

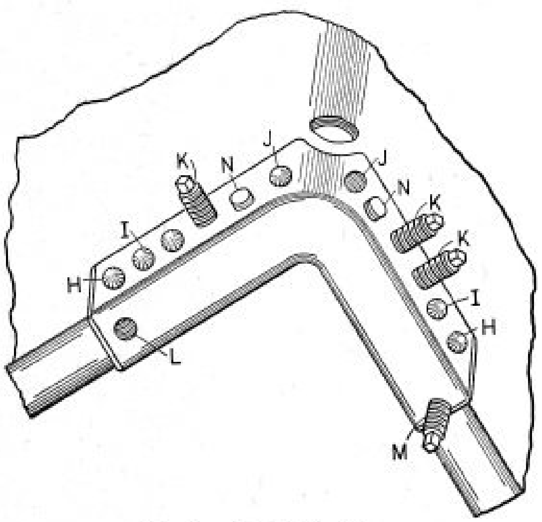


Fig. 6.—Patch Fastenings

at least ten to one that the old rivets are rusted solid in the ring and that to drift out the old rivets and to mark the holes so they will come fair is a much more costly operation than to let the old rivets stay in place and drill new holes for rivets *H H,* also for *I I.*

But holes *H H* are drilled first and bolts inserted and the nuts set up, after which the holes *I I* are drilled and rivets driven therein, the bolts then being removed from holes *H H* and rivets driven in those holes also.

Should any more fitting be found necessary it is done at this time, the patch being heated by acetylene flame as found necessary, but it is well that the fitting be all done before rivets *H I* are driven, and then there will be no danger of buckling one part of the patch while trying to fit another part closer to the water-leg.

Holes *J J* are next drilled and into them are screwed tight fitting solid staybolts, the outer ends of which have been squared for a wrench, as shown at *K K K.* In drilling all these holes care is taken not to drill through the mud ring or deep enough so that screwing in the solid stays can spring the portion of the mud ring at bottom of the drilled hole.

After the staybolts have been screwed tightly into holes *J J* all the other holes are drilled and tapped and screws driven into each of them as tightly as possible. In tapping the holes for the solid stays, a bottoming tap is used to finish the thread in each hole in order that each stay may be forced to a solid fit with no chance of its ever becoming loose in the mud ring, something quite likely to happen were the holes used as left by a plug tap without the bottoming tap being used.

It will be noted that two holes have been made in the bottom of the patch as shown at *L* and *M.* These are also "blind" holes and are bottomed as described above. After solid staybolts have been screwed into all the holes they are left projecting for a time, as shown at *K K K,* but later are cut off so as to project about ⅜ inch, as indicated at *N N,* after which the cut off bolts are driven same as any rivets, but driven cold, a regular rivet head being formed as well as possible.

Before the solid stays are cut off, the edge of the entire patch is welded to the water-leg shell, the edges of the patch having first been chipped to a regular calking edge by the "air gun." The narrow place, *C,* Fig. 1, was also trimmed to shape with the air-chipping hammer, after which, and before the bolts were cut off, the edges were welded as stated, but not with acetylene and oxygen. The welding was done electrically and the resulting joint proved to be as soft as the softest steel and capable of being chipped, calked or otherwise worked exactly the same as the regular boiler plate.

Calking the Patch

In fact, the edges of the patch were gone over with a calking tool in the air gun after welding, thereby giving the appearance of a calked seam around the patch instead of a welded one. The writer noticed the holding power of the edge seam when it became necessary to trim a bit under hole *C,* Fig. 1, in order that the washout plug could clear the new patch.

The weld did not pull apart, neither did the cut metal free itself readily from the old plate as a chip was taken along the patch. Instead of the weld letting go readily under stress of the chipping, it was necessary to take another cut along the old sheet in order to shear off the welded metal which adhered tightly thereto.

After the cut had been made at *C,* the patch was not again welded at that point, but the edge was calked with the air gun, two tools being used, one after the other.

The edges of the patch having been finished by welding and calking as described, an oxy-acetylene cutting torch was brought out and the solid stays all cut off about ⅜ inch from the patch, as shown at *N N,* Fig. 6. The cutting off of each 1-inch screwed staybolt only required nine seconds, including the time necessary for shifting the cutting torch from one bolt to another.

Timing the Cutting of Bolts

The writer timed the cutting of several of the bolts, and it did not vary appreciably from nine seconds each. It is often very convenient to be able to count seconds with considerable accuracy without the aid of a watch. The writer did this while timing the cutting torch action.

The writer has for a long time used the following-described method of second counting, and as something of that kind is very necessary in photography, the second-counting business was worked down to a pretty fine point. To count seconds, I say (to myself perhaps) "one chimpanzee, two chimpanzee, three chimpanzee, etc., until the required number of seconds have been ticked off.

It was found that it required three seconds to bring the torch into position and heat the staybolt sufficiently for the oxygen to get hold of the metal. The cutting commenced at the beginning of the fourth "chimpanzee-second," and was finished before the ninth second had been quite used up. The 1-inch bolt had been cut smoothly off and was ready for riveting, which was done by a very large "air gun," which carried a tool large enough to handle the head of a 1-inch rivet.

Electric and Oxy-Acetylene Welding

In the Clifton shops both kinds of welding were in constant use—whenever required, of course—and the electric method was employed upon all work which was to carry pressure or which might need machining after welding. The oxy-acetylene method was employed largely in doing work not subjected to the above requirements. At the time of the writer's visit some wasted away portions of boiler plate were being built up by electrically welding more metal upon the wasted surfaces. I saw both methods in use at the time upon a locomotive which was in the shop. The electric welder was mending cracked places in the locomotive frame, while the oxy-acetylene man was mending a cracked exhaust nozzle and a few minutes afterward was cutting off the solid staybolts described elsewhere.

The writer finds that the general consensus of opinion among boiler workers is that the oxy-acetylene flame should not be employed in welding boiler seams or other parts which are to be used under steam pressure. This for the reason that no matter how carefully a weld may be made, no man can tell what kind of metal the weld is composed of after the welding operation has been finished. There are so many metallurgical changes possible in the metal while under the influence of the welding flame that no man can tell what may happen, and the safest way is to avoid altogether the use of the acetylene flame for welding pressure work.

But, on the other hand, the electric weld seems free from this objection. There is not a stream of oxygen impinging upon the hot metal during the operation, neither is there a stream of carbon (acetylene) directed in like manner upon the hot metal. What too much oxygen may do is very forcibly indicated during the action of the cutting torch and what too much acetylene can accomplish is sometimes seen when a weld comes from the torch so very hard that no file can touch it and no machining, save grinding, is possible.

On the other hand, the electric weld usually comes from the arc as soft as the welding-stick metal with which the job was done. True, there is in this method the possibility that the shell metal may be injured greatly by holding a portion thereof at a melting heat long enough for atmospheric oxygen to unite therewith and thus weaken the steel, but usually the electric welder is far too uncomfortable in his headgear to keep any metal heated any longer than is absolutely necessary to complete the welding process, therefore the danger of oxidizing or of carbonizing boiler plate by the electric method of welding is very slight.

There is, however, one great danger, which exists equally in either method of welding. That danger is that the two pieces of metal be not perfectly united by the welding process, through insufficient heating or by ignorance of the welder to make the proper manipulations. The only way to avoid this possibility of inferior work and of danger in boiler welding is by the use of brains and experience. A good mixture of the two will enable safe electric welds to be made almost anywhere in a steam boiler.

It is true that safe welds have been made by the oxy-acetylene methods—lots of safe welds, in fact—but nevertheless there is so great a possibility of inferior work and of transformed metal by this method of welding that it should be "taboo" on all steam boilers or other pressure work where failure could cause danger or disaster.

For cutting out portions of a steam boiler for repair purposes there is nothing which will begin to do the work of a good oxy-acetylene cutting torch, but after the sheet has been cut, just follow the example set by the Clifton shops as noted above, and weld in the new pieces of plate by the electrical method! That is a "safety first" proposition, and don't you forget it!

War Is Turning the Scrap Heap Into Silver Dollars

It has not been so long ago since most plant managers, superintendents and owners regarded anything thrown into the scrap-pile as waste beyond reclamation. Probably two things have contributed more than anything else to change their opinions of waste—war and modern welding processes.

In ordinary times the scrap-pile is a neglected avenue for the escape of profits. Now that war has pushed up the prices of raw material to dizzy heights, the American plant owner and factory man have begun to analyze their scrap heaps. Usually they find huge accumulations of damaged or worn machinery, tools, "short ends" and other material that represents considerable profit thrown away. Face to face with labor shortage, metal shortage and the time factor, plant owners are reclaiming these worn and damaged machines and broken tools and putting them back to work earning profits.

Recently an engineer for an oxy-acetylene concern made an investigation in a Western mining field. At one big mine he found in the scrap-piles, dollies and dies for drill sharpening, worth $9 each, which could be welded and put into service at a cost of about $1 each. The mining company was on the anxious seat, too, as to when it would be able to get more new material. It was found that the scrap heap would yield a three-months' supply of good material in a year's scrap accumulation.

At another time the engineer found a year's supply of tram buckets, worth $40 each, with broken bottoms, that could easily be repaired by welding at a slight cost. In addition he found a three-months' supply of stamp stems and short ends of tungsten steel, which could be welded and give a year's supply. He found crusher plates of manganese steel worth $20 each, slightly too big for the machines then in use, but which could be cut down by the oxy-acetylene process at small cost and put into service again at an enormous saving.

The various processes of welding have made it possible to reclaim an enormous amount of metal machines and tools that formerly were sold as waste and at a fraction of the original cost. Nowadays any kind of metal—steel, iron, both cast and malleable, brass, bronze, copper, aluminum, sheet iron and precious metals, such as gold, silver and platinum—can be welded and broken parts made as good as new.

At a heat of 6,300 degrees F., produced by the combustion of acetylene in oxygen, any of these metals fuse and run together, a virtual remolding of the parts.

A railroad company had a big accumulation of scrapped driving wheels for locomotives, most of which had cracked spokes. The demand for more rolling stock, caused by

Are Fire Box Sheets Welded With The Oxwelding Process Efficient?

Answer:

The tensile strength of a single lap riveted seam is approximately 52% to 60% of the strength of the metal itself.

By tests, it has been proven that the tensile strength of a seam welded by the Oxwelding Process is from 80% to 85% of the metal itself.

Why not submit your boiler repair problems to our staff of experts, who are constantly in touch with the application of the Oxwelding Process to the special needs of the steam railroad field?

OXWELD RAILROAD SERVICE COMPANY

Railway Exchange
CHICAGO

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war pressure, caused the company to reclaim these wheels; and the oxy-acetylene welding process did the work, saving the road several thousand dollars and making it much more in profits through putting discarded engines to work.

A big milling concern rummaged its scrap heap and discovered a quantity of discarded gear-wheels—castings with teeth broken out. At a trifling cost new teeth were fused into the castings, making them as good as new and saving the concern an enormous amount of time.

America is said to have the biggest scrap heap in the world; but as conservation is the scrap heap's worst enemy, it is expected to be greatly reduced before the war is over. Perhaps by that time the nation will have learned how to turn metal scrap into silver dollars.

Boilers and Pressure Vessels: Inspections, Recommendations, Repairs, Calculations, Etc.—II

Answers to Additional Questions on Inspector's Data Slip for Horizontal Tubular Boiler—Recommendations

BY "THE VAGRANT"

We will complete the data slip as rapidly as possible, leaving the more essential remarks and calculations to fall under the head of inspections.

Questions Nos. 11 to 14, inclusive, deal with watertube boilers and are not answered on this sheet.

(15) *Number of Tubes or Flues, Diameter.*—Some distinction is made between a tube and a flue, a furnace and a combustion chamber. The marine and the stationary man will differ in the definition. For the present we will define all lap welded or seamless boiler tubes 4 inches or under and defined by gage as tubes. Diameter, referring to boiler tubes, is, of course, measured on the outside. Tubes are practically always beaded or flared, but, as they are made in standard sizes, no difficulty is experienced in measuring.

(16) *Height of Segment Above Tubes.*—This measurement is to be taken from center of top, inside of shell, to top of tubes, and has to be measured accurately. The formula and table for calculating bracing, etc., will be given in their proper place.

(17 to 24, inclusive). Not taken.

(25) *Is Manhole Frame Cast or Wrought?*—In all late types of boilers the manhole frame or reinforcing plate is of pressed steel or wrought flanged plate. Old boilers have cast frames as a rule; the type shown at "A," however, is rarely met with outside of heating boilers.

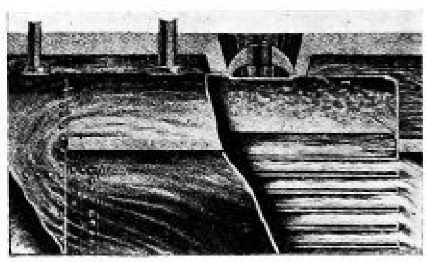
(26) *Size.*—11 inches by 16 inches is the most common; 2 inches narrower on all sides is often found on smaller heating boilers. There are as a rule, however, three reasons. Size of boiler does not permit larger; heating boilers frequently hugging the basement ceiling do not allow the lifting out of plate or entering of hole, and the distance from tubes to shell is so close that there is not room internally to enter and make the turn.

(27) *Safety Valve, Type and Size.*—This is one of the most important questions. Calculations for finding same will be given further on. The answer required here is: whether spring pop or ball and lever. The size is always stamped on the body of the valve, and on late type spring pops a metal tag gives the opening pressure, the closing pressure and the pounds of steam it is capable of discharging within a specified time.

(30) *Is There a Stop Valve Between Safety Valve and Boilers?*—I have never found one yet. They are never allowed under any condition.

(31) *Fusible Plug, Location.*—If absent, make notation and recommendation. In this type of boiler it is placed in the rear head 2 inches above the top row of tubes.

(33) *Is Water Heated Before Entering Boiler?*—A sufficient answer is yes or no. The temperature, however, makes considerable difference on the economy and



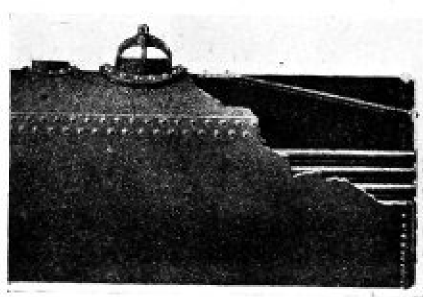


Fig. 2.—Manhole Frames

life of the boiler. Open heaters (which will be discussed later) cannot possibly deliver water hotter than 212 degrees F. The general average of heaters ranges from 150 to 200 degrees F.

(34) *Position of Feed.*—Some boilers feed through the blow-off pipe. The front head system, however, is much more efficient; a pipe carrying the water from front head through the boiler to near the back and discharging is better practice.

(35) *Where is the Blow-Off Connected?*—In 99 percent of cases, at the back on the bottom of the shell, where it should be protected by a brick pier or similar housing. In a few cases it has been found issuing from the side.

Recommendations are always in favor of having the blow-off placed at the lowest point of the boiler and giving the boiler sufficient pitch so that sediment and water may drain out through it.

(36) See above.

(37) *Are There Any Purifiers, Heaters, etc., Between Check Valve and Boiler?*—Answer: Look and see.

(38) *Is the Steam Gage Correct?*—The answer cannot be given positively until it is tested with the master gage that inspectors carry. Some State laws are such that the gage has to be tested at every internal inspection. As a rule, gages register weak, rather than heavy or strong, and consequently err on the side of safety.

(39) *Condition of Water Glass.*—With dirty water or grease in water, boilers have a tendency to foam or prime. In heating boilers, where the water is not changed for a season, the inner surface of the glass has a tendency to become coated and opaque, making it difficult to determine the real water level without close scrutiny. It is to prevent the continuance of such conditions that this blank is numbered.

(40) *Can Water Column Connections Be Readily Cleaned?*—In Question 5 of the first chapter of this serial article it was requested to draw a water column connec-

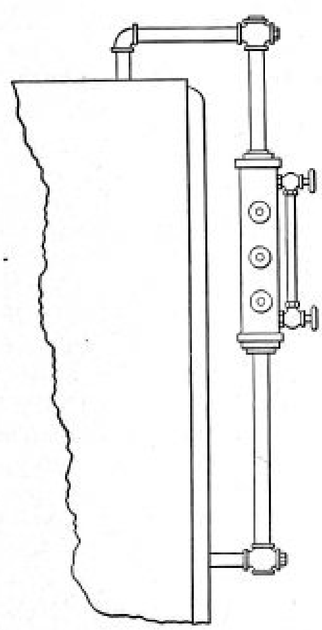


Fig. 3.—Water Column Connections

tion. Fig. 3 illustrates one. Observe that crosses or tees are used in place of L's. This is to facilitate cleaning up. It might also be well to state that brass plugs should be used, cast iron being difficult to unscrew when the joint has once been made.

(41, 42, 43, 44)—Taken later.

(45) *Efficiency of Longitudinal Seam.*—Full calculations and illustrations to be given later.

(46) *Factor of Safety.*—5 is used mostly nowadays.

(47) *Pressure Allowed.*—This answer will have to be derived from general data as to thickness of plate, efficiency of joint, diameter, age, etc. Examples will be given later.

(48) *Safety Valve Loaded to?*—This means what is the popping point, or how many pounds pressure will the steam load be before the valve lifts.

(49) *Hydraulic Test.*—If given, state amount. It is generally given for old boilers, doubtful boilers, suspicious defects, after repairs, transfers, sales, etc., and is generally 1½ times the working pressure.

Recommendations.—Have to do with the defects discovered, if any, or to suggestions as to improvement, safety, economy and efficiency. Things of unusually timely interest and worthy of attention follow under *Instructions.*

(*To be continued*)

Boiler Economy with Peat Fuel

Peat fuel, under favorable conditions, can be economically utilized for the production of power through the media of the steam generator and steam engine, according to B. F. Haanel, chief engineer Division of Fuel and Fuel Testing, Department of Mines, Canada. He bases his claim on results of tests to determine the value of peat fuel for the generation of steam. They are described in Bulletin 17 by John Blizard, Department of Mines, Canada, from which the following extract was published in a recent issue of the *Iron Age.*

The cost of the peat fuel delivered to the power plant, he explains, must be less than that of a quantity of good steam coal equivalent in heating value, in order to permit of its competition, as peat is much bulkier than coal possessing equivalent heating value, and its storage in sufficient quantity to permit the continuous operation of a power plant is a difficult problem; also the handling of large quantities of peat fuel involves problems of a more or less serious nature. On the other hand, he points out that peat burns freely to a fine, easily handled ash, permitting of its almost complete combustion, so that the cost of handling the ash can be reduced to a minimum. Generally, Dr. Haanel believes that peat fuel for steam raising cannot compete with good steam coal costing $5 or less a ton; but as the price of coal increases, peat fuel for steam generation, wherever large deposits of peat suitable for fuel purposes are available, will become a serious competitor of coal.

PEAT FOR MAKING COMBUSTIBLE GAS

Economy and efficiency, however, are the keynote of these modern times, and in the future, in his opinion, it is hardlly likely that any form of fuel will be utilized for steam generation for the production of power unless steam is indispensable to the carrying out of some chemical process, or other industry, and he believes that so far as the generation of power is concerned, the more economical method to employ is the conversion of the peat fuel into a combustible gas which can, in this form, be burned in a gas engine or used for the different heating furnaces in metallurgical works.

Many of the peats so far examined in Canada, it appears, have a very high nitrogen content, which can be recovered in the form of ammonia when the peat is burned in a by-product recovery reproducer and, in this manner, many of the peat bogs may become the source of one of the most valuable artificial fertilizers, ammonium sulphate.

The tests described in the bulletin comprise a series of seven, four of which were carried out on a marine type Babcock & Wilcox watertube boiler, and three on an internally fired boiler of the portable locomotive type. One of the tests on the watertube boiler was for the purpose of obtaining complete flue gas analysis, the remainder being run to determine the economy of operation. The peat was hand-fired and was said to be of excellent from 16 to 20 percent moisture. A summary of the re-quality, containing only a small percentage of dust and sults obtained from six tests as outlined in the bulletin is as follows:

SUMMARY OF BOILER TESTS USING PEAT

	Watertube Boiler			Firetube Boiler		
No. of Trial	71	72	73	83	84	85
Moisture percent in peat	15.7	15.7	20.3	19.2	20.1	19.2
Net calorific value of fuel as fired, B. t. u. per lb	7,490	7,490	6,990	7,130	6,970	7,110
Peat fired per hour, lb	476	586	569	160	214	341
Peat fired per square foot of grate surface per hour, lb	20.5	15.5	15.0	17.7	23.8	37.9
Equivalent evaporation per hour from and at 212 degrees F., lb	1,950	2,322	2,250	621	802	1,054
Equivalent evaporation per hour per square foot of heating surface, lb	2.88	3.43	3.32	2.89	3.73	4.9
Pounds of dry flue gas per pound of peat	12.4	9.8	11.1	9.8	9.1	6.5
Temperature in flue leaving boiler, degrees F	720	760	715	690	690	750
Equivalent evaporation from and at 212 degrees F. per lb. of peat as fired, lb	4.10	3.96	3.95	3.89	3.74	3.09
Thermal efficiency of boiler furnace and grate, based on the net calorific value, per cent	53.1	51.3	54.8	52.9	52.1	42.2

Boiler Shop Kink

The sketch in Fig. 1 shows a very useful idea for constructing an "Old Man," or drill post, for use on external drilling on almost any sort of round work. The chains for securing the V foot of the post to the work can be tightened by means of twin buckles, or driving in wooden wedges between the chain and the shell.

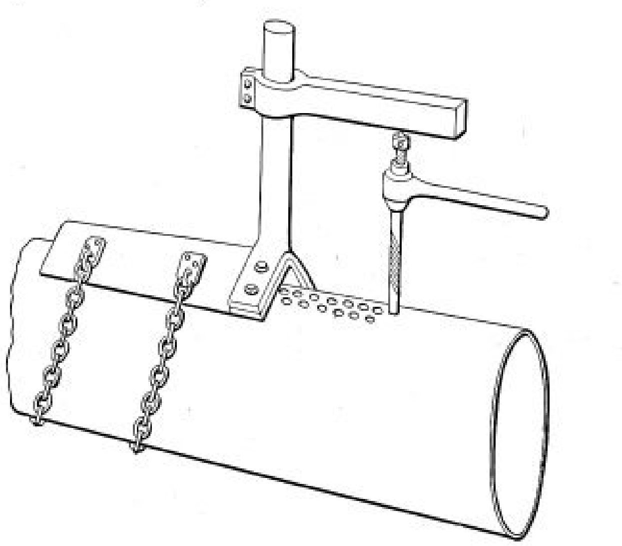


Fig. 1.—"Old Man" for Round Tank, Boiler, Stack, etc., Work

This idea is thought to be original with the writer.

Concord, N. H. C. H. Willey.

Chart for Determining the Total End Pressure

Boiler designers and users often have occasion to compute the total pressure exerted on the entire end of a boiler, drum, large pipe or other cylindrical shape. This computation arises so often that an alinement chart for this purpose is presented herewith.

Simply lay a straightedge across the chart as indicated by the dotted line, and the answer is immediately found in column *B*.

For example: What is the total pressure exerted on the end of a boiler whose internal diameter is 40 inches, the pressure of the steam being 80 pounds per square inch gage?

Connect the 40 (column *C*) with the 80 (column *A*) and the intersection with column *B* shows the total pressure to be 100,000 pounds.

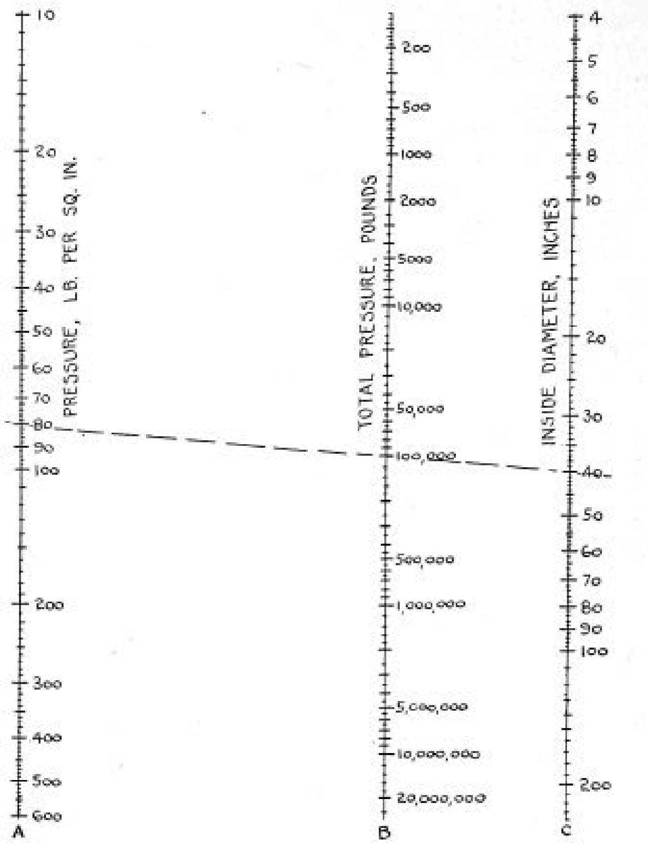


Chart for Finding End Pressure on Cylindrical Vessels

Inversely the chart may be used for determining the permissible pressure per square inch where the total pressure is known. Thus, if the total pressure or strength of the shell were known to be 100,000 pounds, and the diameter was 40 inches, the same straight line would show the pressure to be limited to 80 pounds per square inch.

The range of the chart is wide enough to readily care for any ordinary problem met with in boiler practice. It is very seldom that a pressure higher than 600 pounds is to be found in steam practice. Of course, in hydraulics that pressure is commonly exceeded, and in a few instances, as in automobile practice, higher steam pressures are used, but we do not generally include automobile boilers under our heading. Anyway, should the pressure happen to be 1,000 pounds per square inch, it would be an easy matter to use the point in column *A* corresponding with 100 and then simply add a cipher to the answer. Thus, if the pressure were 800 pounds and the diameter 40 inches, the same dotted line drawn across this chart would serve the purpose, and by adding a cipher to the answer we get 1,000,000 pounds.

As for the diameter of boilers, that seldom runs over 200 inches, but if you have a diameter smaller than 4 inches or larger than 200 inches, this same chart can be used, anyway, by shifting the decimal point *two* places to the right or left in column *B*, with one place shifted in column *C*.

For example, using the same dotted line already drawn across the chart, if the diameter were 400 inches instead of 40, the decimal point would be moved two places to the right and the total pressure would show as 10,000,000 pounds instead of 100,000. And if the diameter were 0.4 inch instead of 40 the decimal point would have to be moved four places to the left, making the answer 10 pounds.

It is thus evident that the chart can be used to cover almost any problem of this character, no matter what the pressure or diameter. N. G. Near.

The Boiler Maker

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NOTICE TO ADVERTISERS

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 25th of the month, to insure the carrying out of such instructions in the issue of the month following.

The progress which has been made in the United States during the past ten years towards uniform standardization of steam boiler construction is a record in which boiler makers, manufacturers and engineers may take a pardonable pride. Readers should remember, however, that the ultimate success of this movement rests in their willingness to work unremittingly for the adoption of uniform standard boiler laws in those states where such legislation is not now in force.

John A. Stevens, chairman of the A. S. M. E. Boiler Code Committee, predicts that it will take another five to ten years to standardize steam boilers in America. Why not get busy and cut this time down to three or four years? It can be done, if all hands get together and help the good work along.

Boilers for the standard wooden steamships of 3,500 tons deadweight carrying capacity which are being built for the United States emergency fleet will be of the marine watertube cross-drum type, with straight tubes expanded into continuous stayed steel plate headers.

This boiler has been designed by the United States Shipping Board Emergency Fleet Corporation, which has charge of the building of the ships for the Shipping Board, with a view of providing a simplified type of boiler composed of small parts which can be manufactured in large quantities with the utmost rapidity by practically any boiler shop in the country, wherever it may be located. The urgent need of getting the greatest possible number of cargo vessels into commission as quickly as possible to offset the destruction of merchant ships by German submarines, made imperative the adoption of a type of boiler that can be constructed by any boiler shop with its ordinary facilities and without the necessity of providing special machinery or equipment. It was necessary, also, that the boiler be of such type that it could readily be dismantled after construction and shipped from points inland to the seaboard.

Complete plans of this standard watertube boiler will be published in the next issue of THE BOILER MAKER. In the meantime, the following particulars will give to those who have not already had an opportunity to study the plans and specifications a good idea of the size and construction of the boiler.

As stated above, the boiler is of the cross-drum type with straight tubes expanded into continuous stayed steel plate headers. The height to the center of the steam drum is 11 feet 5½ inches; the width of the furnace front 13 feet 4¾ inches, and the depth from the furnace front to the back of casing 8 feet 10 inches. The grates are 6 feet 6 inches long by 11 feet 11 inches wide, giving a grate area of 77.45 square feet. The total heating surface is 2,544 square feet, making a ratio of heating surface to grate area of 33 to 1.

The heating surface is distributed as follows: tubes, 2,452 square feet; front header, 33 square feet; back header, 38 square feet; drum, 21 square feet. The tubes, of which there are 414 in all, are hot rolled, seamless steel, 3 inches outside diameter, of No. 11 B. W. G., except the three bottom rows, which are No. 10 B. W. G. All of the tubes are straight except the two top rows, which are bent to a 36-inch radius near the back header.

The steam drum is 42 inches inside diameter with bumped heads, one of which is solid, ⅝ inch thick, and the other 11/16 inch thick with a 11- by 15-inch manhole. The back header is stayed with 1¾-inch hollow staybolts and the front header with 1½-inch solid staybolts.

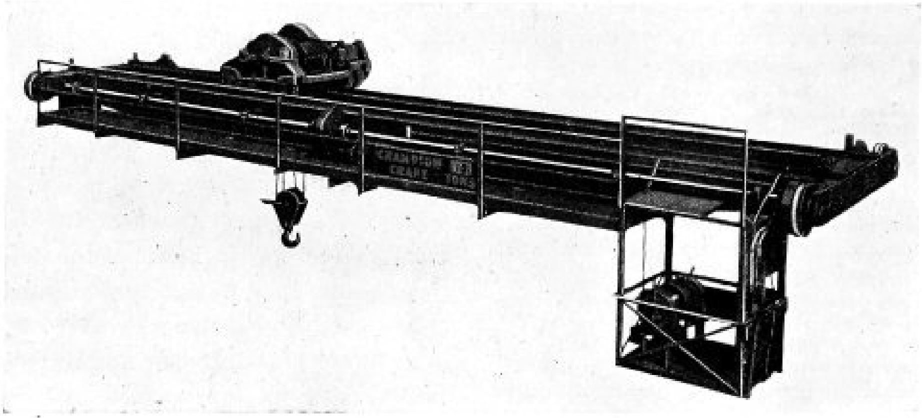
The boiler is designed for a working pressure of 200 pounds gage, and a hydrostatic pressure of 400 pounds gage. It will be fitted with a system of forced draft and is designed to evaporate 15,000 pounds of water per hour, with feed water at 200 degrees F. when burning about 20 pounds of anthracite coal per square foot of grate. The specifications embody the latest rules and regulations of the United States Steamboat Inspection Service applying to marine watertube boilers for ocean and coastwise trade, and the design has been approved by the Board of Supervising Inspectors and by the American Bureau of Shipping. No punching will be allowed on inside plates. All drilling and reaming for rivet holes shall be done from the outside after the plates are assembled. The use of drift pins will not be allowed. "Bulled" rivets are specified where possible, and they must be driven at a cherry red heat and held in the riveting machine at least thirty seconds.

Engineering Specialties for Boiler Making

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

Traveling Shop Cranes Built by the Bigg-Watterson Company

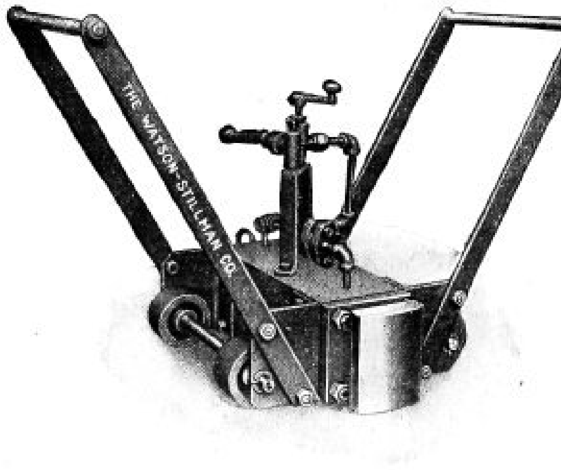
With a view to meeting the most severe requirements usually called for by shop crane specifications and at the same time producing a machine from the standpoint of high efficiency, the Biggs-Watterson Company, Cleveland, Ohio, has placed on the market the Champion Crane, which has a capacity of 15 tons. As shown by the illustration, the main frame of the crane is composed of two box-section steel girders, thoroughly braced with heavy gusset plates to prevent twisting of the structure, and fitted with special trucks at each end. On this bridge-like structure the operating trolley containing the lifting mechanism travels. Separate motors operate the trolley and bridge, all operated by controllers in an operator's cage at the end of the crane.



Champion Electrical Traveling Crane

Portable Bending Machine for Steel Shapes

The Watson-Stillman Company, New York, has brought out a new tool for use in metal working, designed to bend heavy steel shapes. It is a very compact machine, built as light as consistent with the work it is intended to do. The machine consists of a cylinder, ram and operating valve, mounted upon broad rollers so that it may be moved quickly over the bending slabs by handles at either side of the machine. It is thus possible to bend long members to template, without reheating and with a minimum of labor.



Portable Machine for Bending Bars and Shapes

A loose pin is provided which fits into the holes in the bending slabs, and serves as an abutment for the machine. The ram is double acting and its movement both forward and returning is under perfect control at all times. Provision is made to prevent overstroke. The illustration shows the machine equipped with a screw stem stop and release valve, but a single lever operating valve can be furnished if desired. Power may be supplied from a suitable pump, or preferably from an accumulator service. The machine is built as shown with a movement at right angles to the axis of the ram, or in a direction parallel to it.

The machine illustrated has a 10-inch stroke and develops 18 tons at 1,500 pounds per square inch, and 20 tons at 1,750 pounds per square inch pressure. It weighs 750 pounds.

Automatic Starters for Induction Motors

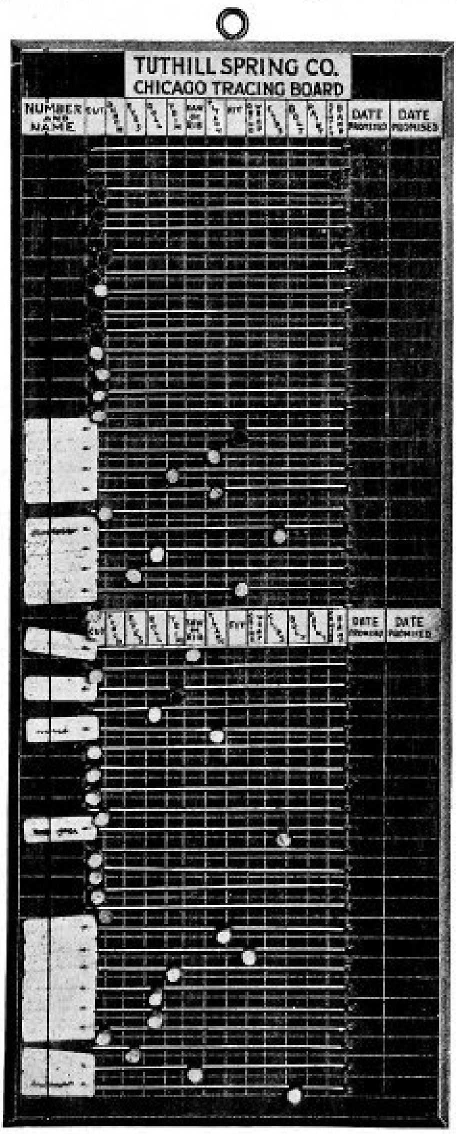
In order to aid manufacturers in their efforts to increase production and reduce operating expenses, the Westinghouse Electric & Manufacturing Company, East Pittsburg, Pa., is manufacturing automatic starters and controllers for motor-driven machinery. These automatic starters are for use with single phase or polyphase squirrel cage and wound-rotor induction motors, where it is desired to start the motor from a remote point or where automatic acceleration is required to guard against improper starting by unskilled operators. They are simple, reliable and rugged in construction, consisting of a magnetic contactor panel and a master switch, which may be either a push button, a float switch, a pressure regulator, or similar device for closing the control circuit, depending upon the service. The vital element is the magnetic contactor. The contactors used on these starters are of a type which has been used by the Westinghouse Company with marked success in steel mill, cement plant and mine installations where the requirements are extremely severe. The contactors are opened by strong spring action assisted by gravity. The destructive action of the arc is reduced to a minimum by strong blowout coils and arcing horns. The operation of the starters is very simple.

The advantages resulting from the use of automatic starters for induction motors comprise absolute protection to both operator and expensive machinery, proper starting at the most rapid permissible rate, economy in operation and maintenance, convenience of remote control, and automatic operation.

Keeping Track of Orders with a Tracing Board

Keeping tabs on orders so that delays are noticed, the causes discovered and deliveries made on schedule time, is a problem common with all manufacturers. The Tuthill Spring Company, of Chicago, formerly kept track of the progress of orders through their plant by a card index system. Each day the exact location of each job was noted on a card, and the superintendent or shipping clerk was able to keep posted on just what was taking place by fingering through the cards.

However, an engineer of the Tuthill Spring Company, Mr. Harold T. Moore, trained in working out short manufacturing cuts, devised a better way. The tracing board



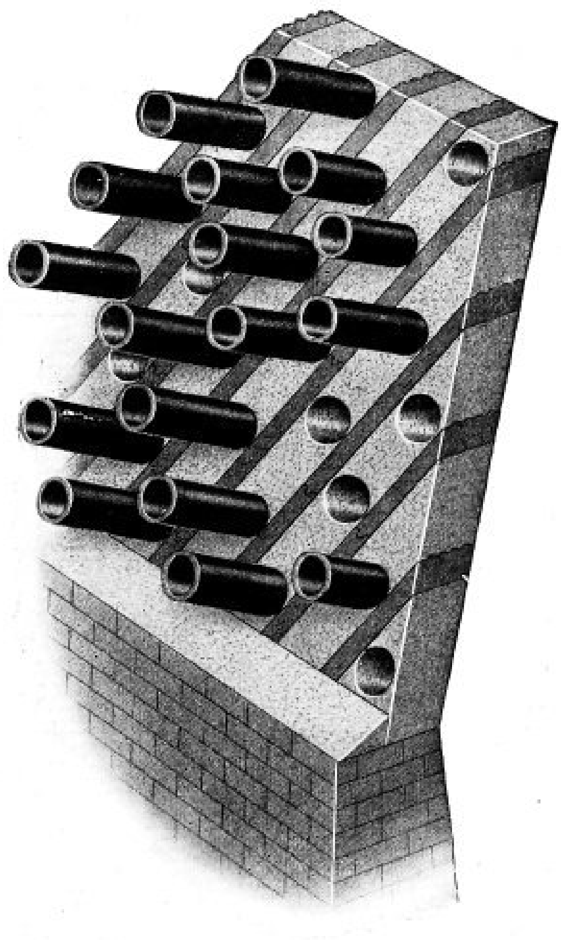
Tracing Board for Keeping Tabs on Progress of Work in the Shops

shown in the picture is the result. The one illustrated is used in tracing Chicago orders. Each day the entry clerk, in much shorter time than it took to make the card records, can bring his tracing board up to date. The merest glance tells the superintendent, or anyone else interested, the exact status of each job.

Tight Boiler Baffles

Everyone interested in steam plants knows the importance of tight baffles, the difficulty in making them tight and keeping them tight. Composition or poured cement walls have not been a success, while tile laid against flame plates are easily knocked out, resulting in leaks, which cause loss of heat and high stack temperatures.

The Turner baffle wall, made by The Engineer Company, 17 Battery Place, New York, is built tight and stays



Baffle Wall Laid in Diagonal Shelves

tight, it is claimed. It is composed of fire brick laid as diagonal shelves on the boiler tubes; the pockets formed by the tubes and the tile being completely filled with a fire-resisting cement in a plastic condition. The plastic cement, in setting, shrinks away from the tubes so that a cold tube may be easily pulled out and renewed without injuring the wall. The expansion of the tube when hot closes this space and makes the wall tight. Bent tubes can be replaced with straight tubes and the enlarged hole closed with the plastic cement by the boiler room force. In case of accident the wall is easily repaired.

The baffle can be built sloping forward or backward at any angle, and the best form of pass secured. It is self-supporting; no flame plates are needed; it will not crumble; walls built four years ago are still sound and tight.

The Russian Information Bureau, with offices in the Woolworth building, New York city, has been established and is supported by the Russian Provisional Government and is in constant correspondence and cable communication with Petrograd. Its purposes are to supply the American public with exact reliable information regarding economic, financial, political and cultural conditions in Russia. Information for readers of The Boiler Maker regarding market conditions in Russia will be supplied by this Bureau.

Questions and Answers for Boiler Makers

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

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

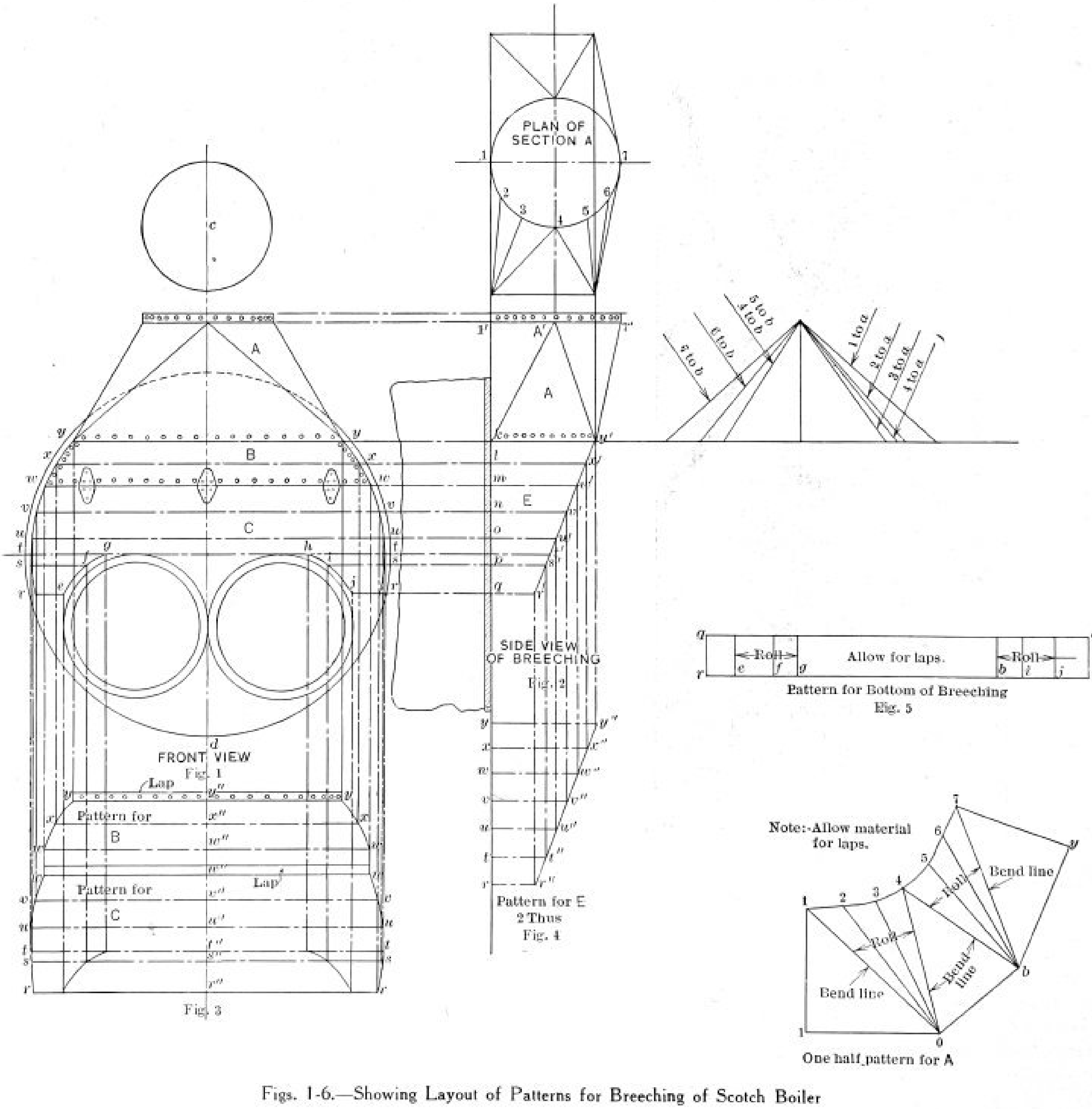
Address your communication to the Editor of the Question and Answer Department of THE BOILER MAKER, *461 Eighth avenue, New York city.*

Layout of Breeching

Q.—Will you please explain the development of the patterns for a breeching shown on the enclosed drawing? S. B.

A.—The shape of the breeching is brought out clearly in Figs. 1 and 2, which show respectively the front and side elevations of the object. The breeching in this case is made of six sections. Section *A* is a tapering transition piece running from a rectangular opening to a circular one where it joins the stack. The center for the stack opening, as shown in the plan view, Fig. 2, is off center with respect to the rectangular view. The front view shows the position of Sections *B* and *C*, and the side view their slope towards the boiler.

Development of Transition Piece A. Construct a plan view of the object showing the relations between the rectangular and circular openings. Divide the circle into equal parts; only one-half of this view need be divided. Connect points 1-2-3-4 with *a* and 4-5-6 and 7 with *b*. Determine the true lengths of these radial lines as shown



Figs. 1-6.—Showing Layout of Patterns for Breeching of Scotch Boiler

by the triangles to the right of the elevation. The bases of those triangles are equal respectively to the radial lengths in the plan; the height is the same for all, being equal to the height of the transition piece. The pattern for one-half of A is developed in Fig. 6. As the construction lines are all numbered to indicate the steps in the layout, the layout of the pattern should be understood without further directions. Fig. 7 is a pictorial view of

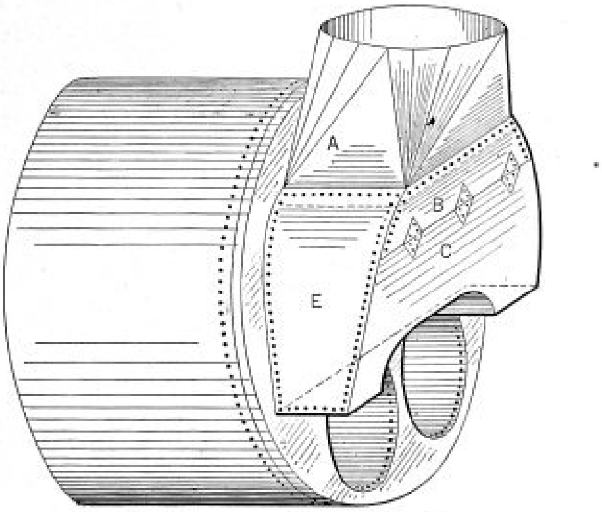


Fig. 7.—Perspective View of Breeching

the object and it shows the position of the construction lines on its surface.

Pattern for E. Lay off, as in Fig. 4, a line y-r equal in length to the arc y-r of the front view. Transfer the spaces y-x, w-v, etc., of the front view to Fig. 4. From the side view project the widths k-y', l-x', m-w' to the pattern E.

Patterns for B and C. Sufficient construction lines must be drawn in the front and side views. Space the arc for this part of the breeching, as at y-x-w, etc., and project these points to the side view at y'-x'-w', etc. Lay off on the vertical line c-d below the front view the points y''-x''-w'', etc., equal to the distance between y''-x'', x''-w'', etc., of Fig. 4, and then draw the parallel horizontal lines through these points. From the front view project vertical lines from the points y-x-w, etc., to intersect the corresponding construction lines in the patterns B and C. Allow for laps. The laying out in the shop would be a little different, as these widths would be transferred with the use of the trammels.

Pattern for Bottom Plate of Breeching. The width of the pattern equals g-r' of the side view, Fig. 2. The length equals the sum of the straight and arc lengths r-e, f-g, h, etc., of the front view. The pattern is a rectangular plate as shown in Fig. 5. Allow for laps. Fig. 7 is a view showing the position of the sections of the breeching as they would appear when assembled together and attached to the boiler.

Weakest Part of Stirling Watertube Boiler

Q.—Where is the weakest part of a Stirling watertube boiler, and why?

A.—A Stirling boiler, like any other boiler, must have its several component parts analyzed to determine the pressure allowable, and the weakest section found which, divided by the factor of safety, gives the allowable pressure. For example, assume the four drums are all 42 inches diameter, the tube sheets 9/16-inch thickness and the shell plates 7/16-inch thickness, with 3¼-inch tubes, spaced on 5¼-inch and 6¾-inch centers. Assume the lap seam of the shell plate and tube sheets to be 70 percent, we have,

$$\frac{7/16 \times 55{,}000 \times .70}{5 \times 21} = 160 + \text{pounds}$$

as respects the shell plate. With regard to the tube sheets, the tube holes are drilled 3 9/32 inches and spaced in close pitch 5¼ inches, and in the wide pitch 6¾ inches apart. To get the efficiency of the ligaments, take one narrow and one wide pitch, substituting two tube holes, or 5¼ + 6¾ − 2 × 3 9/32, which gives efficiency

$$\frac{12 - 6.5625}{12} = 45.3 \text{ percent.}$$

Since the tube sheet is 9/16-inch thickness, we have

$$\frac{9/16 \times 55{,}000 \times .453}{5 \times 21} = 133 + \text{pounds}$$

as respects the tube sheet, and, as we are seeking the weakest section of the boiler, it follows for obvious reasons we should take the 133 pounds, which is based, of course, on a factor of safety of 5.

With regard to the bumped heads, one blank and one with manhead in each drum, both bumped, say, to 42 inches radius, assume the blank head to be ½ inch, the others ⅝ inch, then from table in June issue we have worked out constant of

$$\frac{7{,}500}{42} = 178 + \text{pounds}$$

as respects the drum heads. Since the pressure determined from the tube sheets is the lowest value, it shall be used as respects the four drums. Taking next the tubes, if these are standard gage No. 11, and properly installed, having the ends projecting not more than ½ inch, nor less than ¼ inch, and properly flared at the ends, with the center row in the mud drum alternately beaded, then the boiler could be allowed 133 pounds working pressure provided fittings, etc., were suitable and the boiler was properly supported. In the latest modern construction of this boiler, the long seams are butt joint double strapped, and the shell plates and tube sheets are of equal thickness in order to make a proper butt strap joint.

Hence the weakest part of a Stirling watertube boiler, while ordinarily the tube sheet ligament, must be determined by calculating the several parts as in the foregoing.

Management Questions, Etc.

Q.—(1) Kindly let me know through your Question Department if it is customary to assemble all irregular work before shipping? For instance, suppose a furnace is tapered and every course is different; also the downcomer and other riveted pipe around a blast furnace is usually made with many different degree elbows, twists, etc. Is it good shop practice to trust entirely to the layerout or to fit up everything so as to check it and be sure?

(2) What does the average boiler work cost per ton for shop labor in a fairly equipped shop at the present time? If you can, please give separate costs on heavy, medium and light work.

(3) In developing templates from a working sketch drawn to scale, is there a chance of an error in calculating true lengths? For instance, a working sketch is drawn to a scale of 3 inches to the foot. If I develop the true length of any line in the working drawing and then multiply by 4 will I be absolutely right in all cases?

(4) How are the shop results recorded in a modern plant? Is a daily record of the tonnage completed each day a proper method of knowing what a shop is doing? Do the large shops divide the total monthly tonnage into the total monthly payroll, and thus getting the cost per ton do they use the figures obtained to judge the results in the shop? Do you see anything against such a method? It is being done in the structural shops.

(5) Can you give me the titles of a few books dealing exclusively in boiler shop management and costs. I do not want anything on laying out, as I had the second edition of "Laying Out for Boiler Makers" and a few more.

"BUCKERUP."

A.—(1) The best results are secured when irregular objects referred to are assembled in position so as to determine whether the connections are properly made, and if they fit together. This procedure will increase the shop cost, but the additional expense is offset in the field when the job is erected.

(2) This question cannot be answered directly, as so many conditions affect the construction and marketing of boilers, sheet metal work, etc. In some localities labor and material costs are higher than in others; also the shop methods, equipment and management vary; therefore, it is practically impossible to state prices for the work mentioned.

(3) Templates made from developments drawn to scale can be accurately laid out in the manner you state.

(4) A good system in recording the cost of work in the shop is to provide suitable time cards covering each operation in the construction methods followed. Each order of boilers or light sheet metal work is given an order or shop number. These time cards are filled out by the men, charging their time consumed in each branch of the work to the respective order number. There are a number of systems employed in basing the cost of production, in general the total cost includes the following charges: labor, material, overhead depreciation and general expense.

The plan of charging a rate per pound or ton may be satisfactory for standard work, providing the system of arriving at the rate is in keeping with cost of doing business and insures a fair profit. The rate will always vary as conditions of the market and labor problems vary, etc. The best plan, it seems, is to have a system that shows what it costs to handle each of the shop operations, the overhead expense, material costs, depreciation of buildings, machinery and tools and incidental expenses. Knowing these costs, the manufacturer is able to quote intelligently and to meet competition. Shop costs in boiler shops are not based on the tonnage handled; each operation of the work is usually placed on a time basis and a rate paid per hour for the work.

(5) "Production Factors in Works Management," by "Church"; "Work, Wages and Profit," by H. L. Gantt; "Factory Organization and Administration," by H. Diemer, M. E.

60-Degree Elbow Development

Q.—Will you please show me how to develop a 60-degree elbow?

O. H.

A.—Fig. 8 shows such a construction and how the sections are developed. Draw first the base lines *y-x-z*, 60 degrees apart. Make *m-p* equal to the diameter of the elbow. With *x* as a center, describe arcs from points *m*, *r* and *p*. To locate the length of sections so that a symmetrical elbow will be obtained, divide the center arc *r-s* into one less the required number of sections in the elbow. In this case there are three sections, so the arc *r-s* is bisected at *a*, thus locating two equal parts. The distances *r-u* and *v-s* are each equal to one-half the distance *u-v*. Through points *u* and *v* draw radial lines connecting with *x*. On these lines the miters lie between the sections *A-B* and *B-C*. The outline of the sections in an elevation is obtained by drawing perpendiculars to the line *x-y* from *m* and *p* to intersect the radial line 1-*x*. Outline 1-7-*p*-*m* is the correct elevation of section *A*. The section *B* is drawn next by extending lines from points 1 and 7, tangent to the arcs as at *b* and *c*. Outline *c*-*d*-7-1 is the required view of *B*. Section *C* is drawn in a similar way.

Pattern Development

One-half of the pattern for *B* is drawn on the line extended from *b* to *x*. The stretchout of the whole pattern is equal to the circumference of the profile plus the amount needed for laps. The construction lines for laying off the pattern are located with the use of the profile view; this will be understood from the drawing. Length of line 1′-7′ is equal to the arc distance 1-7 of the circle and is divided into the same number of divisions. The points being numbered as illustrated assists the layer-out in following the construction better and insures accurate work.

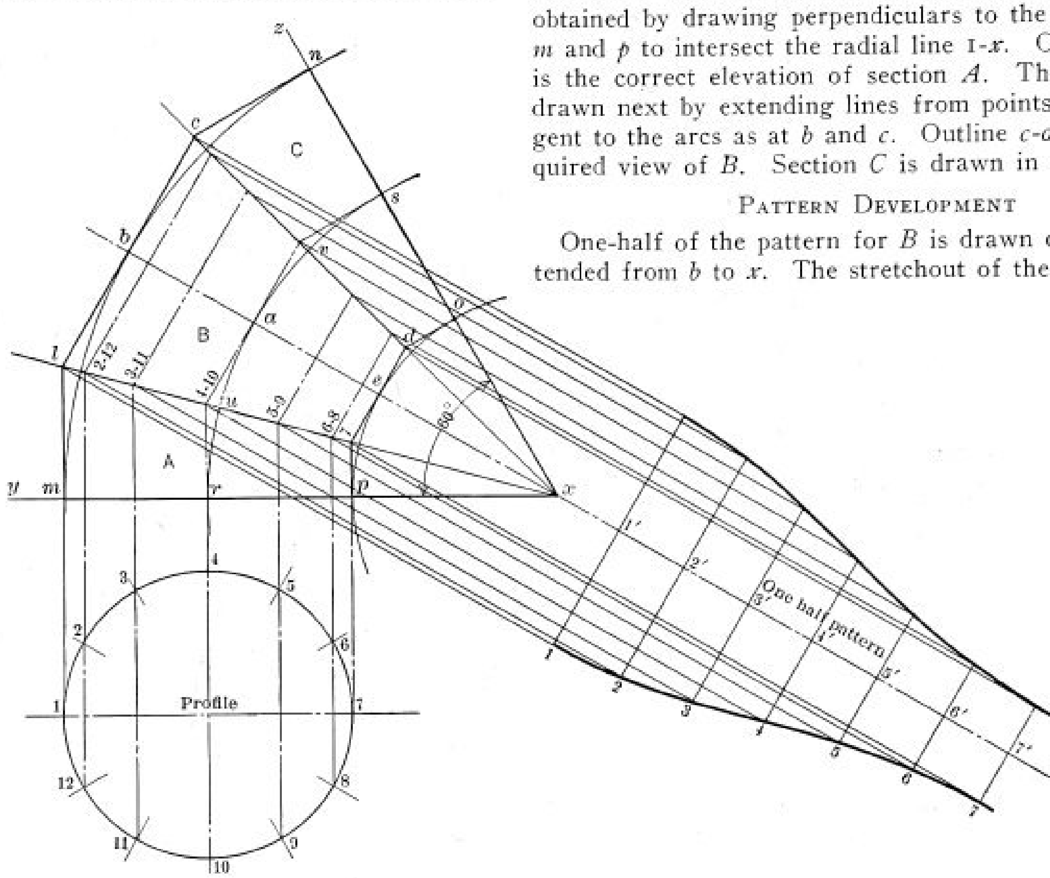


Fig. 8.—Construction of 3-Piece, 60-Degree Elbow

Welding Patches at Bottom of Boiler

Q.—Can patches be welded at the bottom of tubular boilers?

R. S.

A.—Yes, but the job should be done by an honest, experienced mechanic, who fully understands the work, so as to insure a strong welded joint and one that will resist shocks. The rules governing welding issued by the Federal Government are a good guide as to what may be done with this method of repairing boilers, etc., in marine work. These rules are issued by the Board of Supervising Inspectors, Department of Commerce, Washington, D. C.

Letters from Practical Boiler Makers

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

Closing Rivets at the Wrong End

The method of riveting described by A. L. Haas in the article entitled "Closing Rivets at the Wrong End," published in the July issue, is a practice which the writer has been following for nearly ten years. I first started using it in repairing tanks in a small locomotive shop where I was foreman for about a year, and have continued this practice on new work.

It makes much better work and tanks have been tested to 40 pounds pressure without causing any leaks. When I first started to use this practice where I am at present employed the men called me crazy, but they soon learned to like the method. It not only saves time, but it also saves stock, as one-half inch is generally sufficient to form the head. As Mr. Haas says, to prove the matter simply means an experiment which anyone interested is at liberty to try.

Schenectady, N. Y. R. E. Howe.

Hand vs. Power Riveting and Closing Rivets at the Wrong End

The writer was very much interested in the letter from Mr. George H. Harrison in the July issue of The Boiler Maker.

Mr. Harrison states: "During eleven years' service in one shop equipped with the most modern machinery and turning out some hundreds of boilers per year, to our certain knowledge there *never* was passed a single boiler driven by steam or hydraulic pressure that did not require calking all over. We have yet to see the first boiler under test that had only a few rivets around the laps that required calking."

Merely filling holes is not riveting, but driving a good, tight rivet with either the hydraulic or Hanna type riveter will give you a rivet that will not require calking. We never calk the rivets driven by these machines, with the exception of a few around the laps.

All the rivets driven with the "gun" or air hammer are calked before we test the boiler. The boiler then goes to the testing floor, is filled with water, and the pressure applied, and our work shows up good. Usually two or three driven by hydraulic pressure show a slight weep on a boiler of 160 or 175 pounds per square inch working pressure.

Those leaking are an odd one about the end of the butt straps on the head or girth seams. Driving 90 to 96 rivets 7/8 inch or 1 inch diameter per hour may be fast riveting, but is not good work in boiler construction. They will not be tight and will require calking. It costs two cents to calk a rivet, piecework rates, and a calked rivet never looks good; therefore the better plan is to drive a few less rivets and drive them right, and cut out the calking expense. Let Mr. Harrison watch the "bull" gang drive the rivets on a girth seam, have them drive one quarter of it according to their regular practice, then each of the other quarters at different speeds, and take note of the color showing when they come off the rivet. Then see this same boiler on the test, before any of the rivets have been calked. Instead of oilskin coats and gum boots, our usual practice is to have the boiler filled, tested and passed by the inspector the same day, and often the boiler is not full of water when the inspector arrives on the job.

The toggle and lever type of air riveter gives exactly the same results as the hydraulic riveter or "bull." The five largest locomotive fireboxes ever built were riveted with these two types of machines and were tight.

It is also our practice to drive the small sizes of rivets "the wrong way," as Mr. Haas puts it. The small sizes of steel rivets, 3/8 inch or 1/2 inch in diameter, can be bought, annealed, from the maker, or can be annealed in the shop and driven cold. We drive all 3/8-inch rivets cold and knock them down by inserting the rivet from the outside and holding on with a hammer or bar at the point of the rivet inside, using a chipping or calking hammer with a die in it on the head of the rivet.

We heat the 1/2-inch rivets and drive them the same way, using a small gun. This does fast and good work.

The writer has been greatly interested in the discussion on the marine boiler question, as he has built many of the Scotch marine type boilers, also many watertube boilers.

For hard service and dependability the writer believes that the auld Scot wins. There is an inquiry just now for a large number of marine watertube boilers. The banks of tubes on these boilers are so closely spaced and so staggered that it is impossible to get at the staybolts. Should a staybolt leak on the fireside of the water leg, it is impossible to tighten the staybolt without taking out the row of tubes in the way. Even then one has to go it blind, and may have taken out the wrong row.

You just guess where the leaky bolt is, then get out some of the tubes, hammer up the bolt that you believe is leaking, then put in the new tubes, replace handholes and fill her up and put on the pressure, only to find that you have been on the wrong bolt. Then you have to make another guess and do it all over again. No matter how carefully the staybolts have been hammered down, I have never seen a watertube boiler without at least three or four staybolts leaking, out of some 400 to 500 or more staybolts in the boiler. It is possible to test each waterleg of this boiler before the tubes are put in, but then there are about 1,000 holes to plug up in each waterleg and this will take some time.

By changing the tube layout on this boiler, more tubes can be put in, increasing the heating surface, yet leaving every staybolt exposed to view and accessible for repairs.

The drawings of these marine boilers make a pretty picture, but that is about all, so "nuff said."

Paterson, N. J. James Crombie.

Hand vs. Power Riveting

That diversity of opinion exists upon every conceivable subject goes without saying. There are, for instance, still some people who believe that the earth is flat. Still it comes as a great surprise that the superstition in favor of hand riveting should be endorsed by any man of experience.

The conditions depicted by Mr. Harrison are a first-class picture and exposure of the conditions prevailing in the bad old days of boiler making, when decent workmanship simply did not exist. His communication is less a defense of hand closure of rivets than a strong argument in favor of modern up-to-date practice involving all the appliances he so unsparingly condemns. A boiler works whose annual output ran into hundreds, where "there was *never* passed a single boiler whose rivets were closed by steam or hydraulic pressure that did not require calking all over, and that for many hours at a time, and where so bad did some of the fireboxes leak that the men entering them had to wear oilskin suits," must have been a curiosity and far from creditable to have been in association with for eleven years without finding rational remedies.

A works "where sal ammoniac rusting up was usual procedure and where live steam was a substitute for careful workmanship before any test could be attempted on any boiler," should have reserved its activities for making coal bunkers not guaranteed tight for small coal and should have abandoned any attempt to build boilers. In another paragraph the author says that "he has yet to see the *first boiler under test* with machine-driven rivets that had only a few rivets round the lap that required calking." If he really desires enlightenment he should pay a visit to any good modern plant and without a shadow of doubt he will revise his opinions.

The present writer is aware of more than one boiler whose acceptance was declined solely upon the ground that it was apparent that numerous rivets had been calked and the decision would be upheld by any competent boiler authority. Good modern specifications prohibit calking altogether; fullering the planed edges of the plates alone is permitted. Such specifications drawn solely in the interests of safety and to insure boilers of the highest classification (expense being quite a secondary consideration) prohibit the closure of rivets other than by hydraulic means wherever this is practicable. One authority does insist upon hand work in one direction. Fullering by pneumatic means is prohibited for plates under one-half inch thick, the reason being the damage done by carelessly operated pneumatic hammers on thin plates.

The troubles narrated by Mr. Harrison are due, in the writer's opinion, not to the closure of the rivets at all, but to punched holes unfairly located, inadequate sized rivets to compensate defective work and other quite removable causes not now common practice. If the contention here criticised enforces a single moral it is that the installation of a single modern device will not cut out the need for first-class work elsewhere. To build good boilers requires more than the installation of hydraulic apparatus to close rivets.

It is incredible that, with position drilled holes perfectly fair to each other, rivets of adequate diameter and length, properly heated and closed under 150 tons hydraulic pressure, calking of rivets would be needed. If such tinkering is required it is due to very sorry practice.

With holes punched in the flat, half blind in position, senselessly drifted over, irregular in shape—added to flogged up plate edges—rivets would never be tight in a general may even if 1,000 tons hydraulic pressure be applied to close them.

All opinions, however prejudiced and contrary to reason, have an explanation, and taking the facts as related the foregoing is the most likely.

Closing by hand, each hole would be inspected by the riveter, local adjustment made by reaming, iron rivets probably used because they suffer most abuse, and so some sort of a job could be made. If one thing on earth is certain, it is that a rivet closed under adequate hydraulic pressure is an infinitely better job than if done by any other means, pneumatic or hand. This premises that first-class workmanship is evident otherwise; even where the work is inferior hydraulic means gives the best work.

Taking the case of the hand-driven rivets instanced in the article. Foundation ring corner rivets have the holes drilled in position. There is no other means to effect the holing; as a consequence they are fair. Furnace rivets in a Scotch boiler are in a similar case, they *must* be position drilled. Where the man has any choice he chooses iron rivets, and in both instances it is scarcely possible to apply hydraulic closure. The present writer is of the distinct opinion that even pneumatic closed rivets are much inferior to hydraulic; they may in inexpert or careless hands be inferior to hand closure. The closure of rivets is the final term in a series of events, all of which are of equal importance. Closure by any means will not compensate for half-blind holes, inferior workmanship and all the defects common to past bad practice.

The boiler maker of to-day depends more upon his brains than his muscle. A boiler shop with twenty gangs hand-closing rivets is more like Hades than manufacture. There is no virtue in noise, only wasted energy. The boiler shop of to-day is silent, but far more effective than in ancient days; less picturesque maybe, but more productive. Its product is infinitely superior where modern methods are in operation throughout. There is literally no comparison to be made between work as depicted by Mr. Harrison and good modern production. In short, the day of main strength and ignorance has passed. These qualities never were any recommendation and there are a score of boiler shops in this country intimately known to the writer whose product is fit to rank with any piece of mechanism extant. They all close their rivets by hydraulic pressure, cut out their manhole openings, plane all plate edges, fuller their plates and never use either a punching machine or a flogging hammer upon cold plate. Moreover, in a dozen recent boilers built under the writer's supervision there was not a single rivet which needed attention from a calking tool, and merely a bead or two of water the first time test was applied, and that along seam edges. The majority were absolutely drop dry first time testing without any rusting up whatever.

It is proved beyond controversy that, *all things considered* (including subsequent calking), it is cheaper to position drill than to punch holes. Even structural yards, whose work is not pressure tested, drill in preference; it is easier, cheaper and more speedy.

Hydraulic closure of rivets is the best method yet discovered. When there is a better, the present writer will be among the first to proclaim its virtues and insist upon its application to any work under his supervision.

All existing punching machines should be sent to the junk pile, as they already have been in many modern shops. They are a temptation and a snare. Their only modern utility is to blank irregular shapes, and even so the modern cutting torch has supplanted them.

There is some unconscious humor in Mr. Harrison's remark that the rivets given the least attention were the ones which did not leak. Naturally, the less attention with a calking tool the tighter the seam. This leads directly to the reflection that in the case of the air receiver quoted calking only made confusion worse confounded. It is hardly to be expected that a shop wherein every rivet leaking was usual and who were unable to devise a remedy would be experts at calking.

The present writer's experience is so much at variance with Mr. Harrison's that, although it does not total half of the forty-seven years to Mr. Harrison's credit, he still believes that the question of best practice is not one of age at all.

Modern methods can produce boilers drop dry under test, free from maltreatment, whose durability is greater, material for material and pressure for pressure, than anything built by inferior former practice.

High pressures demand and must have every single step in production first class. It is not relatively expensive to insure this end. As stated before, it is believed, *all things considered,* to be cheaper, though naturally it demands a greater capital expenditure and more intelligence on the part of every man in the business. A boiler is not simply a contorted mass of plates which by infinite effort hold pressure. In a modern sense it is the product of brains, first-class plant and high intelligence. The day is not far distant now when the calking tool, punching machine and setting block will be forgotten. There is no need for them at present. They are survivals from a prehistoric era in steam practice and are superseded and out of date.

London, England. A. L. HAAS.

The Safest Boiler for Warships

I note that J. S. Grant still insists that the Scotch is superior to the watertube boiler for war purposes where the boiler must endure steaming for long-time periods. He asks the pertinent question: "Where has the watertube boiler (of any type) made good in war?"

After concluding the reading of Mr. Grant's arguments I momentarily thought he had friend Roberts and myself "going south" and that he couldn't be answered, but in a flash I saw where the question is misleading. I can't answer the question because there is no answer. Watertube boilers haven't made good in *any* war as yet, because they are comparatively new in warships.

As far as the present war is concerned, no side seems to have "made good" on the seas. Battleships have become so very delicate that we seemingly have to hold out nursing bottles to them at all times. They blow up internally, try to crawl ashore, collide, are subject to torpedoing, can't hit airplanes, and can be used for only "one kind of service." There is no such thing as an "all around" battleship such as we would like to have. The boiler is certainly an important part of a battleship, but it is obviously not "everything," and if you talk to a man on the street about the kind of boilers on battleships or warships he will call you "dippy," because the type of boiler seldom, if ever, gets into the newspapers. The kind of turbine, the size of the guns, the speed, and such things, are the important points in the eyes of the layman.

But these words, of course, do not "prove" anything. I cannot "prove" that the watertube boiler is the better and Mr. Grant cannot "disprove" it under the existing circumstances, and the same is true of the Scotch boiler.

It is a fact that when George W. Melville, Rear Admiral U. S. N., retired, late engineer in chief of the United States Navy, was put in charge of the engineering end of our navy there were practically no watertube boilers in any navy. The double-ended cylindrical firetube boiler was the standard form, and it was only in 1888 that he took the initiative and tried to get manufacturers interested in building watertube boilers for the United States navy. He had a hard time persuading builders to permit him to try out such boilers at, virtually, the expense of the manufacturer.

Since that time the watertube boiler has been given a very thorough tryout in peace times. Our engineers have had plenty of time to think matters over. They have run comparative tests time and again, and invariably the conclusions have favored the watertube boilers. This is true not only in our navy, but in other navies as well. The watertube boiler has become the favorite on land, why not at sea? Doesn't it seem logical that when an engineer spends his lifetime in the selection of the best boiler he should know considerable about the subject after finishing? The Babcock & Wilcox boiler is giving very good service in the navies of both our country and England (according to Melville) and now I notice that some Heine watertube boilers are to be used in some of our warships.

The watertube boiler is the *modern* boiler, the efficient boiler, the boiler of least weight, the boiler that can withstand the highest pressures and that can develop the highest speeds, and for those several reasons it is preferable for warships.

Mr. Grant's question is as unfair as the questions: "Where has the airplane made good in war?" "Where has the submarine made good in war?" "Where has liquid fire made good in war?" In fact, where has *anything,* new or old, made good in this war? Even the famous 17-inch guns haven't made good as yet.

After the war is over we can perhaps decide more definitely as to which boiler "made good," but at the present time we cannot. The watertube boiler is a new thing in warfare, like the airplane, the submarine, etc. We will therefore have to abide by the decisions of the men in authority, but, of course, that will not prevent Mr. Grant or myself from having opinions of our own, anyway. Personally, I still aline myself with the watertube boiler as being the better boiler of the two.

New York. N. G. NEAR.

Swaging Tube Ends

1. Why are the ends of boiler tubes swaged?
2. What benefit is derived from their use after being swaged?
3. Is the structure of the material injured in the operation of swaging?

The above questions appeared in the June issue of THE BOILER MAKER, and in answering them we will endeavor to show that the swaged tube is quite unnecessary in boiler work, and that a lot of time and expense can be saved by discontinuing their use.

The practice of swaging tube ends is an old one, which many years ago took the fancy of our engineers, beginning as a fad and ending in becoming a custom. Some of our oldest boiler makers remember its introduction and were much opposed to it, on the ground that it did no good and filled no good purpose. The primary object of the swaged tube was to gain stock in the bridge of tube sheet.

The second question is answered by saying that there is no other gain than in stock of bridge and possibly a few more tubes in the entire sheet, which we will show is no real gain only as far as it shows an apparent gain in heating surface of tubes. Taking it for granted that there is a little gain in stock, does that compensate for the abuse the tube is subjected to in the operation of being reduced? We think not.

How many of our blacksmiths or tube welders are there who can get a uniform heat on tube ends, swage them down to the required size and say that there has been no variation in the temperature of the entire set? There are very few, if any. When the tubes are made in the mills, the greatest care is taken to insure an even temperature, and to such a fine point has the manufacture of boiler tubes been reduced that it is quite safe to say that the temperature is maintained evenly throughout an entire heat, thus giving to the tube user an article to be depended upon in all cases.

But—and here is the rub—when a set of tubes are handed over to the tube welder, skilled he may be in the work of welding or swaging, but he is lacking in the most important part of the process—that of temperature. Now it is evident that the chemist who gives out the proper proportions of material to be used in the make-up of a certain grade of tube also arranged the proper heat that the furnace should be brought to to get the best results, as shown by his analysis, and, unless the tube welder is a capable man, and has made a study of furnace temperature, it will be quite impossible for him to handle a set of tubes without altering their chemical properties.

We know that tubes are swaged, that they are installed in boilers and that in many cases they give entire satisfaction. Where the tubes and tube sheet have a close fit, the effect of swaging is not so noticeable, and the alteration in structure of tube end is not seen, but where proper care is not taken to obtain a close and driving fit, the bad effects of the swage are soon apparent in the splitting of the tube end and the short life of the tubes.

Therefore, we say that it is impossible to reheat or tamper in any way with tubes and expect them to remain in the same condition chemically as they were when they left the mill. Then, again, the fiber or grain of the tube becomes coarse from swaging, and, when subjected to the rough handling from the pin and sectional expander, the end becomes brittle and will not stand the strain, with the result that pieces drop out of the head, or some other defect will show up.

Many of our best boiler makers, if questioned about the use of the swaged tube end, can give no good reason for its use. It was in use when they were learning the trade, and they are satisfied to keep on using it that wav without stopping to consider the reason why. Some will tell you it is reduced so that it will not come through the tube sheet too far, and that the shoulder should fit tight up against the tube sheet. Others say that the small end acts as a nozzle and anything passing through the small end will pass through the entire length of the tube and into the smoke box. Now all boiler makers working on run-in repairs know that such is not the case, that several rows of tubes in the bottom, sides and top of tube sheet are always stopped up, and are opened up with difficulty either with the hand auger, steam or air tube cleaner, proving that the reduced tube end is not a self-cleaner, and it is practically impossible to keep them clean and open, and especially is this so when the brick arch is used, and not properly looked after.

There is no direct benefit from the swaged tube end, but, on the other hand, there is much trouble and a lot of unnecessary work caused by its use. Much of the leaking trouble is caused by the accumulation of scale or mud around the shoulder of the reduced tube end, for, be it ever so tight against the sheet, there still remains room enough for scale to lodge. This is more noticeable where boilers are blown off under high pressure on washout periods, for then the scale-forming matter held in solution is not all blown out, but a thin film of it sticks to the tubes and tube sheet and is baked on hard and fast and is broken off with difficulty even in the rattler.

Again, with the swaged tube care enough is not always taken to insure a good tight fit at the firebox end. In many cases tubes being swaged to one size regardless of the size of flue holes, which necessitates the excessive use of the tube pin and sectional expander. Unless extra heavy copper ferrules have been provided for the enlarged holes in tube sheets, it matters not whether this work is done by hand or by air tools. Much of it can be avoided by the use of a straight, unswaged tube, for, as we pointed out in a previous letter, a straight tube can be installed with greater ease and in less time than one with a swaged end.

Heating surface of tubes is what our engineers figure on to show that engines have a certain horsepower, but they never take into consideration the state of the tubes in actual work, and the heating surface lost by being choked up, and the boiler does not come up to specifications and best results are not obtained.

In removing defective or burst tubes with swaged ends, and when such tubes are located behind steam pipes or exhaust box, there is but one way to remove them, and that is by way of the firebox. In such cases the tube hole must be cut or rolled out large enough to allow the tubes to pass out freely, thus robbing the bridge of the stock gained by the tube end being swaged. Again, it is apparent that if straight tubes were used, all that would be required to do would be to prepare the tube for removal in the usual way and, at the same time, take out the copper ferrules and the tubes will come out easily and without damaging the tube sheet or cracking the bridge, which risk is always run when the tube holes are enlarged by rolling.

In swaging tubes, proper attention is not paid to the dies, which are frequently found to be out of shape, and tubes are not swaged round but vary nearly 1/16 inch, which compels the use of the tube pin before they are restored to shape, and, at the same time, running the risk of splitting the tubes. Recently we were shown a set of tubes swaged from 2¼ inches outside diameter to 2⅛ inches outside diameter, and when finished and in their places in the boiler they had been pinned and rolled until they were bell-mouthed and the inside diameter of the finished tube was greater than the outside diameter of the tube before being swaged.

This speaks for itself and shows that the cost of handling and swaging could have been avoided if proper ferrules had been furnished and the tubes installed straight. If we say that a set of tubes subjected to the treatment which this set underwent were not damaged, not only in the process of swaging, but in the pinning and expanding, then we certainly know nothing about tubes. To the best of our knowledge, American engineers are the only ones who design boilers for swaged tubes, and, knowing that so many tubes get stopped up, thus cutting off their usefulness, why not do away with the tubes that stop up? Use less tubes, space the tubes further apart, give the bridges more stock, enlarge the tube holes, and install the tubes straight, avoid the cost of swaging and pinning, cut down the cost of repairs and the liability of distorted tube sheets and cracked bridges, and spare the boiler maker a lot of unnecessary hard work.

Pittsburg, Pa. FLEX IBLE.

The Fair Way

The value of knowing each individual employee's efficiency at all times is so vital to the success of the business that several of the foremost industrial enterprises have resorted to keeping efficiency records of each employee. Such records embrace previous employment and training, reason for application for employment with this firm, position applied for, position assigned, date entered employ, age, color, nationality, religion, married or single, number of dependents, home address, kind of locality, member of any organizations, clubs, etc., sobriety, conduct, health, intelligence, capacity for learning, work, responsibility, leadership, obedience, general character, attention to duty, alertness, initiative, punctuality, judgment, progress, ambition, aims, courage, energy, habits, enthusiasm, co-operation and skill. These records insure a square deal when selecting for advancement.

Concord, N. H. C. H. WILLEY.

Enterprise and Opportunity

We are many times reminded that opportunity knocks at every man's door at least once in a lifetime, and in the same connection that it is advisable to take time by the forelock, embracing the said opening.

Any proverbial saying universally applied is a dangerous proceeding. Its truth is always strictly limited and it should be remembered that quite a large amount of pocket philosophy is cut-and-dried nonsense.

Most folk wait for opportunity to stumble across them and spend their lives in an attitude of pious hope that sooner or later their chance may come along. Not all opportunity is big and pregnant with immense possibility. Such chances as come in the orbit of the average man are small and limited. Most folk term them the common round and daily task and few apprehend the value of the opportunities thereby afforded.

Repeated routine, the small matters of minor importance, if efficiently performed, yield one result so considerable that its value is everywhere recognized; the least reflective term the result character. In such sense every day is an opportunity and every hour a chance. Character upbuilt and tested by minor happenings is the key to bigger things. It may be broadly stated that enterprise makes and not finds opportunity. It is character which has enterprise which finds opportunity.

Character prays for scope to develop, not for a ready-made chance offered entire. It must always be remembered that the struggle is much more interesting than the end won. Without opportunity enterprise is vain, lacking enterprise opportunity is rare, without character either is useless.

The trivial things are apt to be despised; but since the mechanical world is a structure built upon trivial details, such have an importance greater almost than anywhere else. No task falling within the distinct range of one's duties can be derogatory to anyone's dignity. In literal deed and fact all work is honorable, or at least the spirit with which it is performed can so invest it. Those who are convinced of their superiority to the work in hand usually contrive to do it badly. A series of such happenings forfeits the confidence of a superior, who judges intelligence by its results, not by latent possibility. In such fashion one asset in the chance of greater scope—reliability—is gone. Confidence in a subordinate engendered by good performance of intrinsically small routine duties has more than once led to greater scope. Herein begins opportunity. The enterprise shown was a cheerful spirit capacity to wait and courage along perhaps a seemingly dismal road.

Some proportion of the disappointed whom one meets have to thank their grudging attitude and perfunctory ways, caused by their superior spirit, for want of success. Success, which has numerous meanings, has one upon which all can agree, in that it consists more in inward pain than large personal material possessions.

Character works best upon honor. To give a man charge, in however limited a field, is frequently to obtain better results. Few can do their best or show ability in a distinctly hostile atmosphere. Knowledge of appreciation and the trust reposed in them leads most men to render better service.

Business opportunities, no less than personal, rest upon enterprise. Most large things were first small. To refuse to consider the novel or the inception of new method is doubtful wisdom all the time.

Cultivation of the small customer is not less important than the retention of the larger, though pleasing the latter is of prime consideration. One old and astute business man termed the right attitude as "Keeping an eye on the rising sun." When invited to be enterprising the usual reply is, "Provide the opportunity." Enterprise would make it not wait for its arrival. Loss of business by failure to study the customers' peculiarities is now quite a usual newspaper text, while it is feared there is yet ground for its insistent recapitulation.

Scope for enterprise and its co-partner opportunity is a matter of present, not of future, consideration. To develop both means keeping the right attitude towards events. There are, for instance, opportunities in purchase no less than enterprise in sale. Right buying means often half sold.

Naturally we are blamed for lack of enterprise; we do not seize the opportunities open. The case is perhaps not so bad as the average publicist would have us believe. Certain it is that the spirit of adventure tempered by knowledge is as necessary to the manufacturer and trader as to the explorer. One result in each case is similar—the discovery of unknown territory.

Every day, however humble or however exalted, our work must needs contain opportunities; it is for enterprise to find, to grasp and utilize. Filling them is business, commerce, manufacture, trade or, in another sense, service; to take advantage, having found them, is certainly sanity.

Like a country, a works force consists of individuals, the humblest of which can show initiative and resource, both of which are qualities cultivated by an enterprising mind on the watch for better opportunity.

London, England. A. L. HAAS.

Pride of Craft

It was an expert sheet metal worker and coppersmith notorious in the shop for his dour and irritable disposition. He was busily engaged upon some rather nice and exacting work. Manipulative hand processes performed by a highly skilled craftsman are always fascinating to watch.

The inspector was a stranger to both shop and man, and he stood quite a long time, noting the masterly way in which the job was being handled. From his appearance it was apparent the mechanic was an old-timer. Unable to keep silence longer, and perhaps in the hope of establishing confidence more than out of mere curiosity, the visitor put the query: "Say, where did you learn your trade, my man?"

Irritated by the close scrutiny of his work, by his interlocutor's youth and rhetoric of the question, the answer came quick as thought, "Out of a ten-cent book, Mister."

The visitor had outstayed his welcome.

A. L. H.

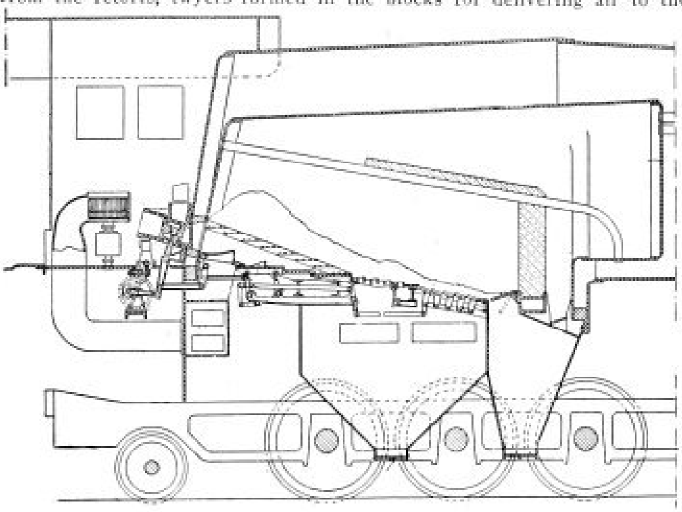
Selected Boiler Patents

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

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

1,228,456. AUTOMATIC FURNACE. EDWIN LUNDGREN, OF BROOKLYN, N. Y.

Claim 1.—In combination in a furnace, an inclined underfeed section, comprising downwardly inclined retorts for supplying fuel, extending from the rear of the furnace forwardly, and twyer blocks arranged in rows, which alternate with the retorts and over which fuel is forced from the retorts, twyers formed in the blocks for delivering air to the



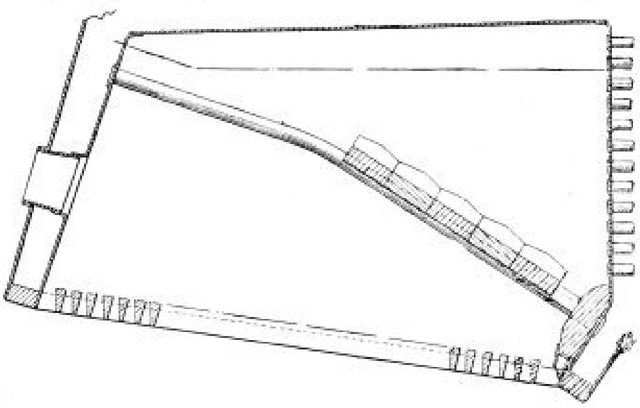
fuel leaving the retorts, an inclined overfeed section located adjacent the lower end of the underfeed section and over which fuel from said section passes, means for supplying forced draft to said twyers, means for supplying air to the over-feed section by induced draft and a dump grate located at the lower end of the overfeed section. Six claims.

1,228,632. FEEDING AND BURNING FINE FUEL. WALTER D. WOOD AND HENRY G. BARNHURST, OF ALLENTOWN, PA., ASSIGNORS TO FUEL SAVING COMPANY, OF ALLENTOWN, PA., A CORPORATION OF PENNSYLVANIA.

Claim 1.—In an apparatus for feeding and burning fine fuel, the combination of a fuel receptacle, a feed screw, means for actuating said screw, said actuating means, screw and receptacle being supported in the same unitary combination, a furnace, a pipe for transporting a stream of fuel to said furnace, and a nozzle at the end of said pipe, said nozzle being provided with counterbalanced automatically operated air valves, and means for carrying air or steam to said nozzle. Twenty claims.

1,229,376. LOCOMOTIVE-BOILER FIREBOX. JOHN L. NICHOLSON, OF CHICAGO, ILL., ASSIGNOR TO AMERICAN ARCH COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

Claim 1.—A locomotive firebox, in combination with a refractory mass covering and protecting the throat sheet thereof and terminating at the



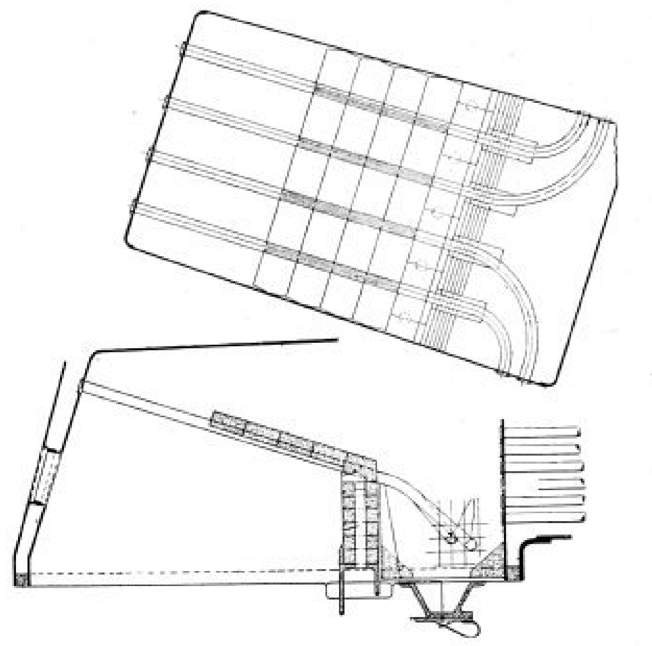
lower edge of the flue sheet, and a refractory arch springing substantially from said mass, but separated therefrom by a cinder opening, said arch terminating short of the rear wall of the firebox and there being a main gas passage rearward of the arch, the function of said mass being to heat the gases which pass through said cinder opening and protect the flues. Four claims.

1,228,999. SHAKING-GRATE FOR FURNACES. HERMAN R. WEBER, OF DENVER, COL., ASSIGNOR TO THE ECONOMY FURNACE COMPANY, OF DENVER, COL., A CORPORATION OF COLORADO.

Claim.—In a grate the combination of grate bars, side and intermediate supporting bars in which the grate bars are journaled, the intermediate bar being composed of a body member having sockets open at the top to receive the grate bar journals, and a removable filler member applied to the top of the body member and having part sockets for the grate bar trunnions, and means for removably securing the filler member in place, said last-named means comprising U-straps passing through registering openings in the two members of the bar, and a retaining pin passing through registering perforations formed in the body member and the arms of the strap.

1,229,379. LOCOMOTIVE-BOILER FURNACE. ALFRED H. WILLET, OF WEST NEW YORK, N. J., ASSIGNOR TO AMERICAN ARCH COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

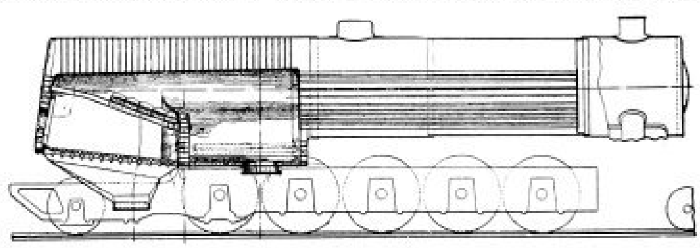
Claim.—The improvement herein described, comprising a locomotive firebox, its mud ring, throat sheet, and side sheets, in combination with a cross wall in said firebox rearward of said throat sheet, a combustion chamber being formed between said wall and throat sheet, a floor forming the bottom of said combustion chamber, a plurality of water-circu-



lating arch tubes having their forward ends secured in the side sheets at points forward of said wall and rearward of said throat sheet, said tubes extending thence upwardly and rearwardly beyond said wall, and an arch extending rearwardly from said wall and composed of refractory bricks resting upon said tubes.

1,229,383. STEAM LOCOMOTIVE. JAMES T. ANTHONY, OF EAST ORANGE, N. J., ASSIGNOR TO AMERICAN ARCH COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

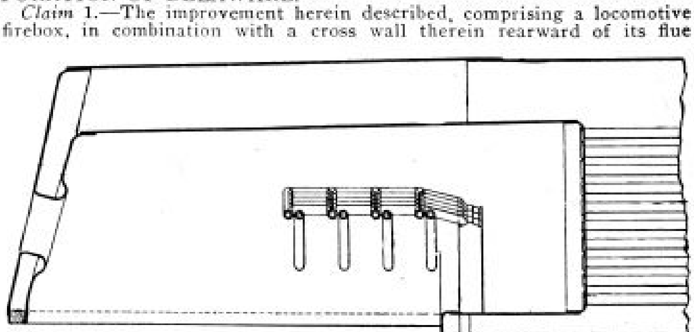
Claim 21.—The improvement herein described comprising a locomotive boiler containing a wide bottomed firebox section and a narrow bottomed combustion chamber section in communication therewith, a mud



ring having respectively wide and narrow portions conformed to the bottoms of said sections, said mud ring having a cross bar positioned at the point of juncture between said sections, a transverse water leg bottomed by said cross bar and connecting the side water legs of the boiler, arch tubes extending from the said leg to the opposite end of the firebox section, and clean-out openings in said leg for said tubes. Twenty-four claims.

1,229,392. ARCH CONSTRUCTION FOR SHALLOW FIREBOXES. JOHN P. NEFF, OF EAST ORANGE, N. J., ASSIGNOR TO AMERICAN ARCH COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

Claim 1.—The improvement herein described, comprising a locomotive firebox, in combination with a cross wall therein rearward of its flue



sheet and forward of its grate, and an overhanging arch extending rearwardly from said wall and composed of a plurality of transverse rows of bricks together with a plurality of longitudinally spaced pairs of oppositely inclined transverse water-circulating arch tubes which connect the side sheets of the firebox and support said bricks. Two claims.

The Boiler Maker

OCTOBER, 1917

Renewing Mud Drum Nipples

Method of Removing Old Nipples in Babcock & Wilcox Watertube Boilers—Setting the New Nipples

BY C. H. WILLEY

The 4-inch short length nipples of the B. & W. type watertube boilers that connect the headers and crossbox, or mud drum, call for a lot of attention and require renewal oftener than any other structural part of the boiler. This is due to their location, being attacked on the interior by a collection of corrosive matter around the necks of the nipples and on the outside by action of acids contained in the soot that adheres to their surface. This often becomes aggravated by allowing a leaky nipple to go unattended.

When circumstances permit, leaky nipples should be rerolled tight as soon as they are discovered. They should always be noted down in the repair notes, by all means.

Removing

A description of the method used by the writer in removing the old nipples and replacing with new might aid those who are required to do this difficult work. The average boiler maker or repair man who has come under my observation has proceeded down through the center of the length of the nipple, and then with considerable effort, waste of time, loss of patience and some cussing, hammer and batter with a chisel bar, trying to crush in or collapse the nipple in order to withdraw it; this method taking about an hour for each nipple and often injuring the nipple seat in cutting through the nipple.

The work is best done by pneumatic tools. The lower handhole plates of the header containing the defective nipple are removed, also the handhole plate of the crossbox. Next get into the furnace, taking a diamond point chisel; after clearing the asbestos packing and fireclay away from around the outside nipple, the point of this is placed directly in the center of the length of the nipple and driven through, as shown in Fig. 1. Then take a long, thin ripper chisel and start the heel of this in the hole made by the diamond point, proceeding to rip the nipple in halves, as shown in Fig. 2. The point of the ripper must be curved, and then it will easily follow the girth of the nipple. There is very little space between the bottom of the header and the top of the mud box, generally about 3 inches, and the nipple must be cut from the furnace side, so that a ripper long enough to cut through from one side must be used.

Fig. 1

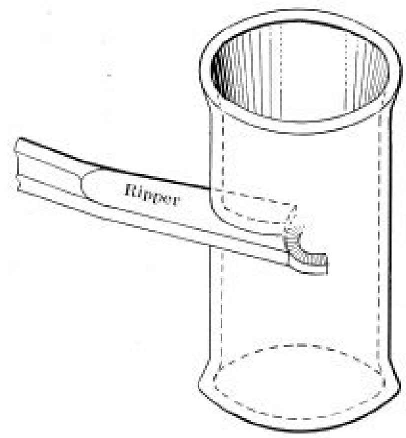


Fig. 2

After cutting in half, a long, slender diamond point with a blunted tip is used, as shown in Fig. 3, to drive down into the mud box the lower half of the cut nipple. The diamond point is shifted a few times in order not to cut through or injure the nipple seat. After taking out the lower half, a chisel bar will loosen the upper half, resting the bar on the edge of the mud drum and outer edge of the nipple. A few blows is generally sufficient to remove the upper half, but if for some reason it fails to respond readily the inner edge at *A* could be easily cut through with the ripper, collapsed, and removed, as shown.

Renewing

The new nipples should be of just the proper length to permit each end being belled or flared where it protrudes through the seats. The best method of cutting is by a pipe machine or lathe. This insures square ends and clean cut. Avoid the use of tube or pipe cutters or hack saw, if possible. Burrs should be removed—in fact, the edges should be slightly beveled for best results. The outside of the nipples should be brightened by sand blasting or polishing, either with a smooth file or emery cloth, making sure to remove the so-called mill scale. The nipple seats in header or cross box must be true if possible and brightly cleaned. If the nipple hole is much

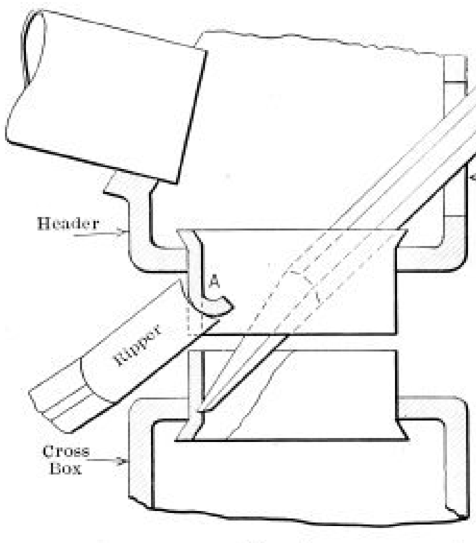


Fig. 3

enlarged, special nipples from upset 4-inch tubes may be required or the use of ferrules to fill the spaces. This has very seldom been required in the writer's experience. The new nipples should be belled on the lower end by driving in a tapered mandrel; this to be done before inserting the nipple in place. After belling the nipple, it is put in the cross box, fished along to the header, and

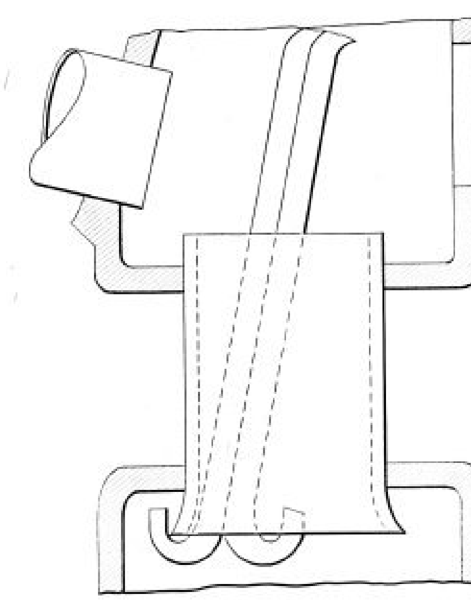


Fig. 4

then hooked up into place, with the belled end down, as shown in Fig. 4. The reason for flaring or belling the lower end before installing the nipple is that a better job can be done than by any attempt to flare it with rollers of the tube expander.

After getting the nipple in place, the expander tool should be fitted with straight rollers and the upper half of nipple expanded, making sure that the length of the rolls are divided to cover well the nipple seat of the header. A single eye-jointed mandrel is required to do this work. Roll till the feel of tightness is transmitted, then take out the expander and change the rolls from straight to tapered ones.

Place the large diameter of the rolls with the large diameter of the mandrel, then set the expander so that the rolls overhang the edge of the nipple and roll the flare or bell. When the top end is expanded, the method is repeated on the lower half. But a double eye-jointed mandrel is required and the flaring is not done by the rolls.

Chart for Staying Flat Surfaces of Boilers According to Lloyd's Rules

BY A. F. MENZIES

Most of the formulas used in boiler design are used only once in connection with any particular design. Those for flat surfaces, however, are used several times. In order to lessen the labor involved in figuring out each variation of the flat surfaces, the accompanying chart has been prepared.

The chart is based on Lloyd's Rules for the construction of marine boilers, and includes all the ordinarily used constants. To illustrate its use: Suppose the steam space stays come in conveniently at 18-inch centers, stays to be secured with double nuts and outside washers which are to be two-thirds the pitch in diameter and one-half the thickness of the end plate, the working pressure being 180 pounds per square inch.

Start at the top of the chart at 18-inch pitch and drop vertically to the correct constant, which, in this case, is 185 for steel plates. From the intersection with this constant line run horizontally to the 180-pound pressure line. From this intersection drop vertically to the plate thickness at the bottom of the chart, which will be found between 1 3/32 inch and 1⅛ inch. The latter thickness will, of course, be used. The dotted line illustrates the above example.

By reversing the operation the chart can be used to find the maximum stay spacing, which can be used with any given plate thickness, method of securing the stays and working pressure.

How Much Money Have You Thrown Away in the Scrap-Pile?

Saving hundreds and even thousands of dollars every year through an analysis of the scrap-pile is not a theory, but an actual demonstration one may meet with in many of the larger machinery plants, factories and mines of the country.

Now that the country is at war and all the departments of the Government are calling for conservation of this, that and the other thing, plant owners are thinking twice and scratching their heads before discarding a broken machine or a partly worn apparatus or tools of any kind. Through the various modern processes of welding—and especially through electrical and oxy-acetylene welding—machines, tools and materials are reclaimed and put back to work, earning profits, rather than being sold to the junkman for old iron.

The oxy-acetylene process, being simple and comparatively inexpensive to install and operate, has found much favor with plants for conserving machinery and material. It makes possible repair jobs never dreamed of a few years ago. The present high prices for raw material, coupled with the inability to get new machinery within a reason-

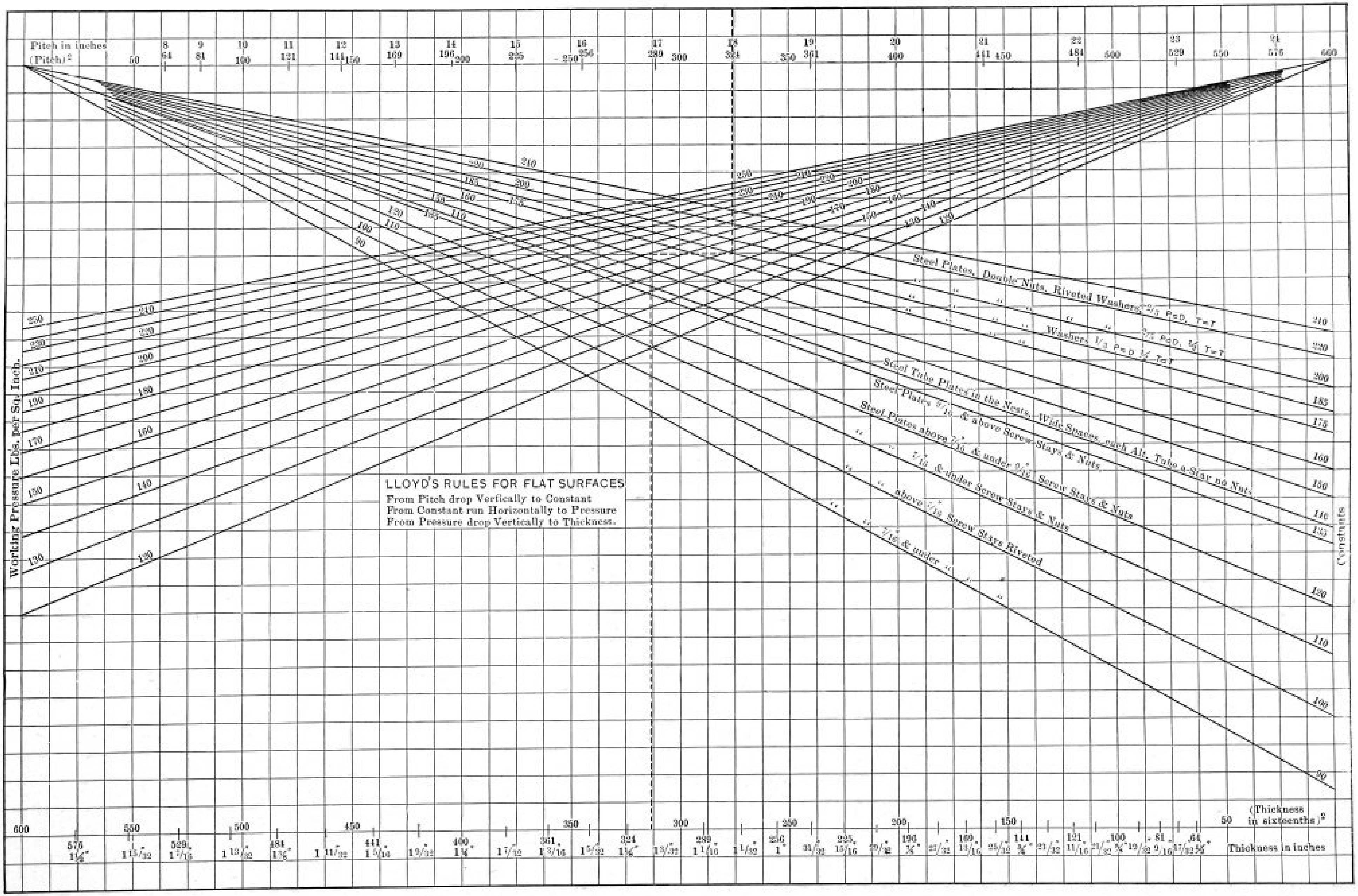


Chart for Designing Staying for Flat Surfaces of Boilers According to Lloyd's Rules able time, has sent plant owners scurrying for new processes that will help them keep the profits on the right side of the ledger.

An Eastern plant that uses many tools found one day their scrap-pile filled with disabled tools that represented thousands of dollars in lost profits. Reclamation was begun. Workmen were instructed to return all broken tools of whatever character to the storekeeper. The tools were than turned over to a machinist, who passed on whether or not it would be profitable to reclaim them. As a rule, it was found that by welding or "filling in," repairs could be easily and quickly made at a small cost.

Under the oxy-acetylene process, for example, the combination of oxygen and acetylene produces a heat of 6,300 degrees F., and fuses two pieces of metal, invariably leaving the weld as perfect and strong as the other parts.

The advantage of either the electric or oxy-acetylene processes is that the welding can be done often with the broken parts in place, without dismantling the machine, thus saving valuable time and much extra labor.

An automobile manufacturer in a Middle Western city found there was a big leak in the making of certain castings, through many castings with only minor defects being thrown aside as worthless. These losses were overcome by oxy-acetylene welding, used to fill up slight holes and in building up parts thinned by careless pouring, all at a cost much less than remelting and recasting.

One concern manufacturing chain belts was handicapped in delivering a rush order because a careless workman, in the roughing of some very large links preparatory to rounding them, took off too much in the rough cut of a number of pieces of the bar steel. As time would be lost in getting a new shipment of steel, the oxy-acetylene process was called into play and in a few hours the ruined links were built up again and made perfect, the order being delivered on time.

Another small firm uses the process in filling up gas blowholes in castings, as well as taking care of shrinkages and other imperfections. An automobile manufacturer rescued a large number of housings for gear shifts which were filled with pinholes. The holes were filled by adding metal under the oxy-acetylene flame, which fused the new metal with the old and made a perfect job. To spoil or damage a nearly completed piece of work costs money, and where it can be made over at slight cost means the plugging of another leak.

Development of the Pneumatic Drilling and Reaming Machine

Pneumatic Drill First Developed in Structural Iron Works—Early Drills of Rotary Type—Reciprocating Piston Drills Later Development

BY GLENN B. HARRIS

The pneumatic drill had its origin in the structural iron works of J. B. & J. M. Cornell, New York City. It was the invention of John Moffat, one of the foremen in this once well-known establishment. The drill was of the rotary type and crudely constructed, and its primary use at the time of designing was for the purpose of reaming punched holes in structural shapes. Originally it was operated by steam, but due to the inconvenience in conveying this fluid and the fact that the machine became so heated and the exhaust so troublesome to the operator, compressed air was substituted as an operating medium.

Mr. Moffat, like a great many inventors who produce something valuable, did not appreciate the worth of a strong or basic patent, and did not realize that the services of a thoroughly competent patent lawyer were as desirable as thoroughly capable counsel in a civil action or in a criminal prosecution. An advertising firm of patent solicitors was engaged, and the net result was to draft specifications and claims, which, in so far as the fundamental principle of the device was concerned, failed utterly to cover the invention, either in the way they were originally drafted or what the Patent Office did grant. There was one claim in the patent which the *solicitors* drew which, while it had no connection with the operative mechanism of the drill, was so valuable an adjunct to it that it made the handy use of the tool possible. It was undoubtedly an oversight on the part of his astute (?) patent solicitors, but this claim was liberally construed and sustained by the courts. Reference to this feature of pneumatic drill progress will be made later on.

Mr. Moffat, being a mechanical man, apparently had no appreciation of the true value of his invention, and was well satisfied to give the agency for it to one who was not well equipped to handle the proposition.

The drill was made in a shop not fitted for high-grade or duplicate work, and was rough in its exterior appearance and just as rough in its workmanship. A few crude circulars were sent to manufacturers, and in all probability one hundred machines were sold. Had there been concentrated action, a fairly efficient manufacturing and selling organization, this story might read differently. Sufficient to say, the Moffat drill dropped out of existence, but the patent which was predicated upon it was later to appear and prove a serious stumbling block to drill manufacturers.

The next drill to appear was designed by one Cathcart, and, similarly with the Moffat machine, was of the rotary type.

This drill also had its birth in a structural iron and bridge shop—the A. & P. Roberts Company (Pencoyd Iron Works), Philadelphia.

A large number of these drills were made in the shops of the Pencoyd works and were put into operation for drilling and reaming. They proved of considerable value as labor savers, for in drilling, instead of being compelled in the case of holes too large to be handled by a ratchet drill, to take the heavy work to a stationary drill, the light, portable pneumatic drill could be carried to the operation to be performed and the work more rapidly done than by a stationary drill.

The saving on the reaming operation was still greater. The reamer carried by the drill was through the punched hole almost instantly.

At the time of the production of the Cathcart drill in the Pencoyd shops there was engaged there as purchasing agent a young man, Mr. C. H. Haeseler, who was discerning enough to see that if the drill was of such material advantage to his concern it would be of the same benefit to those engaged in a similar line of industry, or, in fact, in any field where it would be more economical and convenient to convey the machine to the work rather than the work to the machine, or to perform the operation by hand. Mr. Haeseler negotiated with Cathcart and purchased his patent, which was just about as worthless a document as one ever parted good money for. It was nothing but a piece of junk, and not worth the red seal and blue ribbon which it bore.

The drill was extremely ingenious and possessed many valuable and patentable features.

Formation of Haeseler Company

Mr. Haeseler, who was at that time under the impression that to own a patent was an absolute guarantee of protection, resigned his position with the A. & P. Roberts Company and rented a small shop in Philadelphia, which he provided with such equipment as his means would permit. He had a small boiler and engine, and was fireman, engineer, foreman and the entire working force. Frequently he was compelled, on going to his shop in the morning, to thaw out frozen water pipes before he could raise steam.

The first drill produced by the C. H. Haeseler Company was finely nickel plated and its handles painted a beautiful red. This machine was taken to the Maryland Steel Company, at Sparrows Point, Va., and a demonstration of it given. The trial of the tool was most satisfactory, and the purchase of a considerable number was decided upon. When it came to a question of price, which was given, the query was put forth: "Now, what is the price without nickel plating and those pretty red handles?" A sale was consummated, and this was the beginning of the commercial success of the Haeseler drill, which rapidly went to the front and earned in one year 750 percent on the invested capital.

Mr. Haeseler, with the orders he was able to secure, was in a position to engage mechanics and proceed with the economical production of his drill, which was sold in large numbers.

At about this time a pneumatic drilling, reaming and tapping machine was brought out by Caid H. Peck, of Athens, Pa. This drill was also of the rotary type, but did not in any way approach the Haeseler drill, either in efficiency in operation or simplicity of construction. A limited number of these machines were manufactured, but met with indifferent success, and the life of the Peck Company was a short one, and its affairs were finally taken over by one of the large rock drill concerns.

First Reciprocating Piston Drill

The first reciprocating piston drill of which the writer has knowledge was designed by James H. Manning, who was master mechanic for the Atchison, Topeka and Santa Fe Railroad. This drill was compact, economical in the use of air, but lacked the refinement which an experience with this line of tools would have probably brought about. Its action was quiet and fairly free from vibration, and it had in it the essentials going toward the making of a very satisfactory device.

The Manning drill was handled by the Chicago Pneumatic Tool Company, and quite a number of these machines were placed on the market. At about this time, however, Mr. Joseph Boyer, the inventor of the well-known Boyer hammer, brought out the Boyer piston drill, to which reference will now be made.

The Boyer drill was compact and symmetrical in form and consisted of a cylindrical housing which was at all times filled with compressed air, and in which was located the motor. This motor was in the form of a three-cylinder, single-acting oscillating engine, the cylinders being carried by a rotating frame. This frame consisted of an upper and lower plate and was triangular in shape and free to revolve around its center on two bearings. The admission of air to the cylinders was regulated by valves which formed pivots on which the cylinders oscillated. The cylinders, as above stated, were of the single-acting type, and their inner ends were open; therefore, air at all times exerted a pressure against the open ends of said pistons. It would appear that with air exerting its pressure on all three pistons at the same time, there would be a state of equilibrium, but as one of the cylinders was always open to exhaust, a rotary movement was produced. The Boyer drill was extremely quiet in its action and lacked appreciable vibration. It was, however, in the opinion of the writer, better adapted for machine shop drilling than the rougher grades of work, which were performed by different industrial enterprises, such as reaming, tapping and running staybolts in boilers. For this work the rotary drill seemed to meet with greater success and to accomplish better results, and for unit of power delivered for unit of power expended the rotary drill seemed to be the superior of that of the piston type.

Piston vs. Rotary Drill

At a meeting held at the Franklin Institute in Philadelphia talks were given on a certain occasion regarding pneumatic appliances. The manager of one of the leading pneumatic tool companies dissertated at length on the merits of the piston type of drill. There was one present known to the trade as the "Ancient Mariner." He had been a lake captain, and was withal a bright man. In opening his talk, which was on the proper way of connecting air receivers with air compressors, he stated initially, "I have heard my friend discuss the merits of the piston drill and also d—n the rotary drill, but you can feed cobblestones to the rotary machine and they will go in one end and come out the other and the operation of the machine will not be affected. You can throw the drill out of a third-story window and catch it on the rebound and it will go to work;" and what he said was practically true, as it was an extremely sturdy piece of mechanism and performed its work most efficiently.

At this period in the pneumatic drill industry a suit was brought by Moffat under his patent on the rotary drilling and reaming machine. The suit was instituted against one of the largest machinery dealers in the country, and alleged infringement by reason of their having sold Haeseler drills. As I have previously stated, the Moffat patent was fundamentally weak, but there was a saving claim which served its purpose. The constructive mechanism, or, to be more correct, operating mechanism, was not covered by the terms of the patent, but there was the one claim setting forth the arrangement of the handles, by which the machine was manipulated. This claim called for two handles located at diametrically opposite points on the drill, and through one of which handles the motive fluid was conveyed to the drill, and through the other one of which the motive fluid was exhausted. The patent litigation was carried on for a considerable length of time, and finally resulted in a victory for Moffat and the payment to him of a very large cash consideration for his patent. This patent at that time had but a few months to run before its expiration; hence this feature of drill construction was shortly public property and promptly taken advantage of by others who entered the drill field.

The next competitor in the field was the Baird Machine Company, of Topeka, Kan. The only information I have regarding this machine was contained in their advertisements, and was never brought to the attention of the writer in a personal manner. The Baird drill was of short life, in so far as its marketability was concerned, and was never known of or recognized as a competitor of drilling machines then on the market.

Hurley Enters the Field

The formidable competitor of the Boyer and Haeseler drills now appeared on the market. It was the invention of Mr. H. J. Kimman, and was marketed by the Standard Pneumatic Tool Company, of which Mr. Edward N. Hurley, lately president of the Federal Trade Commission, and just recently appointed chairman of the United States Shipping Board, was the organizer and president. This drill was known as the "Little Giant." It was a straight reciprocating drill very much on the order of the Manning production. It was the smoothest running drill that had at this time been produced, and was entirely efficient in its operation. Large numbers of this drill were introduced, and it gained such favor with its purchasers that an extremely prosperous business was developed. It made great inroads into the business of the Chicago Pneumatic Tool Company, who decided on the purchase of the Standard Company. This accomplished, the "Little Giant" drill was manufactured by the Chicago Pneumatic Tool Company in a large and well-equipped shop and under the supervision of its inventor, Mr. Kimman. The "Little Giant" drill is now the best selling proposition of the Chicago company in this particular line of pneumatic tools.

Another entrant in the field for glory and money was the Columbus Pneumatic Tool Company. The machine manufactured by them was known as the "U & W," which were the initials of the inventors of the machine, and which caused the purchaser of one of them to refer to it as the "useless and worthless." Whether this appellation was a correct one the writer is not prepared to state, as his experience with this particular drill was of a very limited character. The Columbus Pneumatic Tool Company had but a brief and, therefore, probably not a prosperous existence.

The Keller Drill

Mr. Julius Keller at about this time organized the Philadelphia Pneumatic Tool Company. Mr. Keller had been associated with Mr. Haeseler in the production of the Haeseler drill, to which I have previously referred as the invention of Cathcart. I also made reference to the fact that the Cathcart patent was of no value. Mr. Keller began the manufacture of his rotary drill, which, had the Cathcart patent been properly framed, would have been, and undoubtedly so held by the courts to have been, a rank infringement. The Keller drill was well constructed and did its work efficiently. The Philadelphia Pneumatic Tool Company was purchased by the Chicago Pneumatic Tool Company, and the Keller drill is now manufactured and sold by this concern.

The Rand Drill Company, which had taken over the Caid H. Peck interests, consolidated with the Ingersoll-Sergeant Drill Company, which was engaged at that time in the manufacture of a general line of pneumatic tools. A piston drill was designed by Mr. Peck, which it is claimed is a surprisingly simple tool, economical in its consumption of air, efficient in its operation, and costing but little for upkeep. The motor of this machine is of the four-cycle, single-acting, reciprocating piston type, each pair of pistons being attached to opposite throws of a double crank shaft, and each acting in balance to insure smooth running.

As with all machines of this character which are at present marketed, the workmanship is of the highest order and absolute interchangeability of parts is obtained.

The Independent Pneumatic Tool Company was the organization of the late "Diamond" Jim Brady. The designers of this drill, which this company is now placing on the market, were Mr. Levedahl and Mr. Norling. These two gentlemen had been connected with the manufacture of the "Little Giant" drill at Aurora, Ill., and were therefore thoroughly conversant with this line of work.

Advancement of Pneumatic Tool Industry

The advancement of the pneumatic tool has progressed step by step through various stages never dreamed of in the early days of the industry. It is quite certain that the user has profited by these conditions through the benefit derived by increased efficiency and economy.

The Independent Pneumatic Tool Company's product is marketed under the name of Thor, the God of Thunder, of Norse mythology, and is an efficient machine.

It is not my purpose or desire to make any statement of the relative merits of the different pneumatic drills now manufactured by the different companies. I am content to make the statement that they are *all* efficient and that an intending user would not go astray in purchasing any one of those that are at present produced.

A drill operated by an electric current was constructed in the shops of Thomas H. Dallett Company, and was undoubtedly the first production of a drilling machine to be electrically driven. The Dallett Company, however, had no great faith in the commercial end of the device, and let it die a natural death. Other concerns started on this line of experimentation and exploitation, and have built up successful businesses with electric drills. The electric machine is suitable only for the finer grades of work and in shops wehere compresssed air is not present, but an electric current available.

Uses of Pneumatic Drills

The uses to which the pneumatic drill is put are numerous and probably well known to most all parties engaged in the metal industry. In addition to the employment of the machine for drilling, reaming and tapping and flue rolling, it was found to be a useful adjunct in many plants as an all-around air motor. In railroad shops the drill has been used with great success for locomotive valve setting and also for operating portable boring bars for reboring and lapping cylinders. It is also used to operate turntables. In laying track it has been found extremely useful for driving screw spikes and tightening bolts. In the yards and repair shops it can be used for operating car jacks. It is also utilized for drilling tell-tale holes in staybolts, for running in staybolt sleeves and for drilling out old staybolts.

In machine shops and power plants it has been adapted to the operation of portable key seating and oil grooving machines. It is also employed for rapidly centering shafts. It can be used for grinding air compressor and pump valves and in connection with a machine scraper head for cleaning boiler and condenser tubes. This handy machine is also utilized to operate a circular saw for cutting through old flooring and roofs and for the purpose of roughing out holes in floors for the passage of belting. A further use to which the drill may be put is that of operating filter presses, the operation of cement guns for machine agitators in cyanide mills, for opening and closing large gate valves and sluice gates, and in connection with a special portable machine for cutting holes in steamship hulls.

The "pneumatic drill" is also adaptable for wood boring, and has been found extremely useful in wooden bridge, ship and car building.

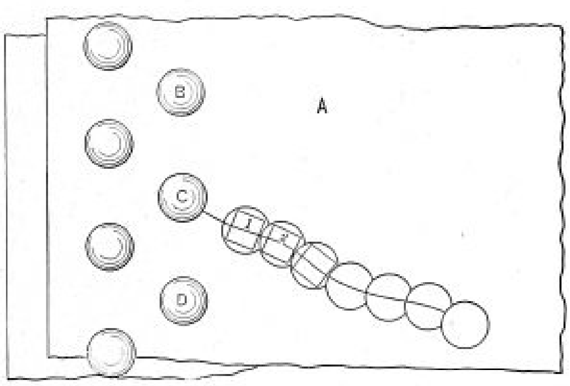
The introduction of this machine has proved of almost incalculable benefit to the manufacturing interests of this and other countries.

Emergency Repair of Crack in Boiler Shell

When this war broke out, I wanted to do my "bit," and, being twenty-eight years old and a boiler maker by trade, I went down to the navy yard and told them I wanted to enlist. They looked at my teeth, weighed me and punched me and asked me questions, and then I was accepted. I was sent aboard a ship a day or two after.

I am not a sailor, but I had been on a good many trial trips of ships and never was seasick, so I enjoyed the life for the first ten days, only I didn't have much to do. There was a sort of a boss boiler maker and another fellow named Cary on board. Everything went so smoothly I thought I wasn't going to get much experience, but at the end of the first ten days I saw something done which was new to me, so I thought it might interest your readers.

I am not much at making sketches, but here is one which will perhaps help out my description.



Plugging the Crack

The ship was fitted with four shell boilers which were quite new. One afternoon No. 3 boiler seemed to be leaking at the front end and Cary and I were ordered to go up on the boiler to see what the trouble was. When we got up under the deck beams it was so hot we could hardly see, but we ripped off the covering of the boiler and found a crack running from one of the rivets of the tube sheet down towards the longitudinal seam for a distance of about five inches.

The crack wasn't leaking badly, but spitting water and steam all the time. When we got down we reported and the chief engineer was sent for. When he had taken a look at the crack he was pretty red in the face and looked mighty sober. He ordered the boiler cut out and told the firemen to let the fire die down; then he went up on deck to talk with the captain. When he came down he said we would have to put a patch on the leak and wanted to know how long it would take us.

The foreman boiler maker looked it over and said it would take sixteen hours, as a man could not work up there on the boiler top for any length of time on account of the heat. But the captain wouldn't listen to this; he had to get somewhere and he had to have that boiler. Cary suddenly stepped up to the chief and said: "I have only been in the navy a short time and I may be getting in all wrong with you, but if you want that leak stopped I can do it inside of two hours if you will give me the men." The chief asked how he could do it, and Cary, taking a piece of paper and pencil, made a sketch and described his idea. After thinking the matter over a moment, the chief turned to the boss boiler maker and said: "See that this man gets all the help he wants. His suggestion will answer, but we will have to watch that leak carefully."

Carey got the carpenter down and got him to make a kind of backing up under the deck beams for the electric drill. Then he sent me up to the machine shop to have them make seven pipe plugs out of bar steel. A young officer went up with me and gave orders that the plugs were to be rushed right through. The head machinist was a clever fellow. He put a piece of bar steel through the head of the lathe, held it in the chuck, tapered the plug, then ran the die over it, cut it off long enough to leave the squares, screwed it into the T-fitting and shaped off the squares in a little shaper they had.

I went into the boiler room and by this time the steam had run down so that there was no pressure on the boiler. Cary and I got up on top of the boiler and he drilled the first hole through the boiler shell as shown on sketch and marked No. 1. This he tapped. Of course the electric drill was used, its head backing up against the rig that the carpenter had rigged up.

We had to wait a few minutes for the first plug, but it gave us time to cool off and get a rest. Then we screwed in the first plug, bringing the square so that when we drilled the second hole, for plug No. 2, it wasn't in the way of the drill which, it will be noticed, cut into plug No. 1 as well as into the shell of the boiler. Here is just the whole trick; if the plugs didn't cut into each other, there would be a steam leak between them.

We went down the crack to its end and a little beyond, as shown in the sketch, taking several rests, but we got the last plug in one hour and twenty-five minutes after we started, although we were both played out with the hard work and the heat.

The chief took a look at it and ordered steam got on the boiler. Then it was connected up with the rest of the battery and the plugs failed to show a bit of a leak anywhere.

We got an extra five days' leave when we came to port, but there has been no end of discussion on the ship as to whether the plugs weakened the boiler or strengthened it. They put a patch on while Cary and I were ashore. If I get nothing else out of my Government job, I think I have learned a clever trick, and so I am passing it along to others.

New York. A. FLOAT.

Union Iron Works Building New Power Plant

The Union Iron Works, Erie, Pa., manufacturers of steam boilers, have let a general contract for a new boiler and power house. The building will be one-story high, 58 feet by 89 feet in size, and will cost about $15,000. No new equipment will be put into the plant, as this change simply marks the removal of old equipment to a new site.

Layout of Twisted Y-Connection

**Problem Involving Angles in Two Planes—
Branches of Y-Connection Inclined and Twisted**

BY GEORGE A. JONES

First draw the line *A-B O S'* of the elevation of the required length of the pipe. Erect vertical lines downward through points *O* and *S'* and locate *C-E* and *D-H* the required distance the horizontal pipe *A-B* is above the horizontal pipes *C-D* and *E-H*. Now above the elevation draw the horizontal line *A-B* of the plan the length of the end section. At the required angle with the center line *A-B* put down the center line *B-C* of the inclined section No. 2. Likewise put down the center line *F-E* of section No. 1 at the required angle. Now draw the center lines *E-H* and *C-D* of the end sections parallel with the center line *A-B* of the other end. Draw the outlines of the pipes and this completes the plan for the present.

Extend *A-B* to the left and locate line *B-U* of the end elevation, making *B-U* equal *O-E* of the side elevation. Through *U* draw the line *E-C* at right angles to the line *B-U*. Extend the center lines *H-E* and *C-D* of the plan over to the end elevation and locate points *E* and *C*. Now draw the center line of the one inclined section *C-B*. Where the center lines of the branch cross in the plan as *F* run this line over to the center line *C-B* of the end elevation, and locate the point *F*. Draw the center line *E-F*. About the points *E-C* and *B* draw the circles, and this completes the end elevation of center lines for the present.

Sections Nos. 1 and 2 in the plan, being inclined, are foreshortened, so we must obtain the true lengths of these sections; also the true angles of the three elbows.

Obtaining the Correct Angles of Elbows

In Fig. 1 put down the line *A'-B'-C-D*. The same length as line *A-B-O-S'* of the elevation. Through points *A'* and *B'* erect vertical lines upward. Take the distance from the end elevation *C-B*, which shows how much the center line of one horizontal section is out of line from the other horizontal section, and transfer it to Fig. 1 as *A'-A* and *B'-B*. Now draw the center line *B-C*. Next draw the outlines and the miter lines about *A*; strike a half circle as shown, and lay out 6 equal spaces and number them 1 to 7, No. 1 being the back of the elbow and No. 7 the throat. Through these points draw lines parallel with the center line *A-B* to the miter line. On line *B-C* at any place as *E* draw a line at right angles to the center line. Run the points on the miter line to the line just drawn through *E*. This completes the layout for the two elbows *B* and *C*.

We will now draw the correct angle of elbow *E* in Fig. 2. Draw the line *F-R-L* the same length as line *Y-O-S'* of the elevation. At right angles to this line through points *R* and *L* draw lines upward. Take the diagonal distance *E-F* of the end elevation and transfer it to Fig. 4, as *R* to *E* and *L* to *H*. Now draw the center lines *F* to *E* to *H*. This is the correct angle of elbow *E*.

Draw the outlines, and about the point *H* draw the half circle and lay out six equal spaces and number them 1 to 7. Starting with 1 at the back of the elbow, draw lines to the miter line of the elbow. This completes the drawing for this elbow.

As stated before, sections 1 and 2 are not shown in their true length, as one end is higher than the other; therefore the branch and elbows will not lay on a flat surface. Such being the case, some twist between the developing lines for the branch and elbow will be required, and to obtain this twist an outline of the hole for the branch in the plan is necessary; also a section showing the miter line of the elbow *E*.

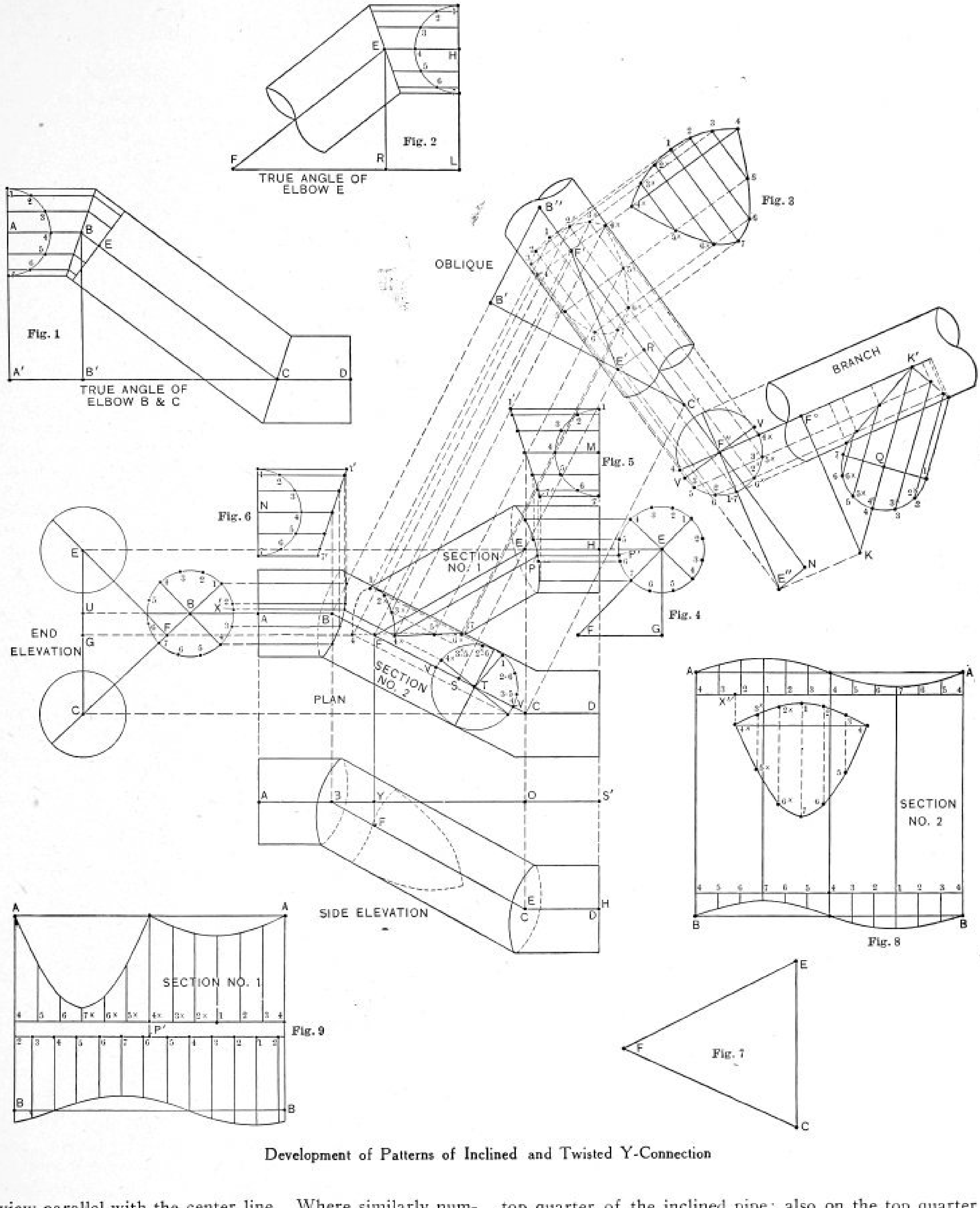
To obtain the hole for the branch proceed as follows: Parallel with the center line *B-C* of the plan erect the base line *B'-C'* in the oblique. Extend point *C* up to this line and locate *C'*. Also extend the point *B* up to the base line and above it, and locate point *B''*, making *B'-B''* equal *O-CE* of the side elevation, which is the height of one elbow above the other. Now draw the center line *B''-C'*, which is the true length of section 2 of the plan. Draw the outlines as shown each side this line of any length. As shown in the elevation elbows *C* and *E* are on the same level. The point *E* of the plan is extended up to the base of the oblique view *B'-C'*, and point *E'* is located. Now extend the point *F* of the plan up to the center line *B''-C'*, and locate point *F'*. Draw the center line *F'-E''*, which is the center line of section 1, and is still shown foreshortened, so extend the line *B''-C'* and locate the line *F''-N*, making the distance *F''-N* equal to *S-E* of the plan, the horizontal distance the elbow *E* is over from the center line of section 1. Through point *N* at right angles to *F''-N* draw line *N-E''*. Parallel with line *F''-N* draw a line through the point *E'* of the oblique view to this line, and locate point *E''*. Now draw the center line *F''-E''*. This is a correct end view of the branch. Through the center *F''* at right angles to line *F''-N* draw the line *V-V*. This line represents the vertical line through the center of the pipe when in position, and *F''-N* will be the horizontal. We are now ready to lay out the branch.

Laying Out the Branch

At right angles to *F''-E''* draw line *F''-K'*. Parallel with line *F''-E''* draw line *F°-K*, and extend point *E''* over to this line and locate point *K*. In the oblique view at right angles to line *B''-C'* and through point *E'* draw line and locate point *R*. Now take distance *F'-R* and transfer it to branch as *F°-K'*. Draw line *K-K'*, and this will be the correct angle for the branch.

To check this angle, in Fig. 7 erect line *E-C* equal to *E-C* of the plan, and with the true length of section 1 or *F* to *E*, Fig. 2, strike an arc from *E* in Fig. 7, and with the true length *F'-C'* of the oblique view strike an arc from *C*, Fig. 7, and locate point *F*. This angle *E-F-C* is also a correct angle, and the angle *K-K'-F°* should be exactly like it. If it is not, some mistake has been made.

If the angles are correct, draw the outlines of the branch and the half circle *Q*. Space the half circle in six equal spaces and draw lines to the miter lines parallel with center line *K-K'*. On the half circle about *F''* lay out six equal spaces as shown and numbered. Now, in Fig. 3 draw the line 1-7 parallel with the center line *B''-C'*. On this line lay out the shape of the hole for the branch in the usual way, and through these points run lines in to the oblique view at right angles to the line *B''-C'*. From similar points on the circle *F''* run lines up to the oblique



Development of Patterns of Inclined and Twisted Y-Connection

view parallel with the center line. Where similarly numbered lines meet will locate points, and a line traced through these points gives us the shape of the hole when the pipe is viewed in this position.

In the plan on the center line *B-C* at any place, as at point *T*, strike a circle as shown. In the oblique view at circle *F″* the line *F″-N* is horizontal, and line *V-V* is vertical, so transfer this circle to the plan as circle *T* with line *V-V* falling on the center line *B-C* as shown. In the circle *F″* points 1^x to 7^x are shown to be on the top quarter of the inclined pipe; also on the top quarter in the oblique view, so they must be on the top quarter in the plan. Now, in the plan on the circle *T*, through points 1^x to 7^x, run lines parallel with the center line *B-C* up to where the branch connection will be. From similarly numbered points in the oblique view drop lines down to the plan at right angles to the center line *B-C*. Where similarly numbered lines meet locate points, and a line traced through these points will be a correct view of the hole in the plan.

In this case all the lines have not been drawn, as it might confuse the reader, but enough have been drawn to make the method easily understood.

The hole in the plan now located, we can, from any of the points, arrive at the required twist for the layout of the patterns by having a correct view of the miter line of the elbows *B* and *E* in the plan, which is obtained as follows: Fig. 6 is drawn exactly like the developed end of the elbow in Fig. 1. Now, in the end elevation the center line, or axis *B-C*, represents the direction of the pipe, or where it crosses the semi-circle, as at 1 and 7, locates the back and throat. A line at right angles to *B-C* locates the sides of the elbow, as 4 and 4. Space these four quarters off as shown, and through these points draw lines parallel with line *B-V* into the elbow *B;* drop lines from similarly numbered points in Fig. 6. Where the lines meet in the plan will locate points through which draw the ellipse as shown by the full and dotted line. This ellipse is a correct view of the miter line of elbow *B* as it would appear when in its proper position. All the lines have not been drawn to obtain the ellipse, as it would be confusing.

Likewise obtain the ellipse for elbow *E*, Fig. 4, being the same as the end elevation *E-G-F*. As *E-F* is the axis where it crosses the semi-circle, it will locate point 1 the back and point 7 the throat. Space this circle in 12 equal spaces, Fig. 5 being the same as the layout, Fig. 2. Carry out the same method as for the other ellipse and obtain the ellipse for elbow *E* as shown by the full and dotted ellipse. Now, in the plan from the point 4^x or the longest part of the branch run a line parallel with the center line *B-C* to the ellipse at *B* and locate point *X;* then parallel with line *A-B* to the circle in the end elevation and locate point *X'*. Now run another line from point 4^x parallel with the center line *F-E* in the plan to the ellipse at *E* and locate point *P*. Run a line from *P* parallel with *H-E* to the circle, and locate point *P'*. We can now lay out our patterns.

Laying Out Patterns

Start with patterns for section 2, Fig. 8. First put down line *A-A* equal to the circumference, and square up the plate and put down line *B-B*. Make *A-B* equal to *B-C*, Fig. 1. Take distance *B-E*, Fig. 1, and put down in Fig. 8 as *A* to 4 and *B* to 4. Then draw lines 4-4 on both ends. Space 12 equal spaces off from 4 to 4 and run lines parallel with *A-B* through these points. Obtain lengths for these lines from Fig. 2.

In the oblique view take distance from center of elbow *B''* to center of branch *F'*, and transfer to Fig. 8, as shown by line 4^x-4. Now, in the end elevation point *X'*, or long part of the branch, falls between points 2 and 3 of the elbow, developing lines, so transfer this distance 2 to *X'* over to Fig. 8, as 2-*X'*, and drop line to the line 4^x-4. Then lay out the hole in the usual way.

Now take the pattern for section 1, Fig. 9. Put down line *A-A*, square up the plate and put down line *B-B*. Make *A-B* equal to *F-E*, Fig. 2, or *K'-K* of the branch. Put down line 4-4 and space off 12 equal spaces from 4 to 4. Make *A*-4 equal to *K'-Q* of the branch, and obtain lengths for the different lines from the branch, and lay out in the usual way.

Next draw line 2-2, Fig. 9. In Fig. 4 *P'*, or the long part of the branch, falls between points 5 and 6 of the elbow, so take distance 6-*P'*, measured around the circle, and transfer it to Fig. 9, as shown by 6 to *P'*. Lay out one-half the circumference on each side of point 6 and locate point 2 outside the pattern, and point 2 inside the pattern. Lay between points 6 and 2 six equal spaces, and draw lines parallel with line *A-B*. Now lay out the proper length for each line for the elbow.

The dotted portion shown outside the pattern is not left on, but is only used to finish the curve with.

This completes the pattern. The end sections are laid out in the usual manner, all patterns to be turned over to roll.

This problem will not be difficult to lay out if followed as here given. Only care must be taken in running the different lines from given points to obtain the desired lengths or amount of twist; that is, the full line for the hole in the plan is on the top part of the pipe, and lines carried from 4^x should hit the ellipse on the top part; also the top part of the semi-circles at *E* and *B*.

Before letting the patterns go to the punches check up in the patterns and be sure the hole is located in the right place in Fig. 8, and see if the elbow was started on the right lines in Fig. 9, and if the twist is correct.

Among New Jersey Boiler Shops—II

The Bending Rolls as a Brake—Countersinking Holes—Simple Device for Bending Tank Steel at Right Angles

BY JAMES FRANCIS

Why is it that some men can go into any old shack of a boiler shop with few tools and fewer conveniences and work up a trade which is profitable from the very start? Why is it and how do they do it? Perhaps it is owing to the same reasons that some men lose money from the beginning and run into the ground from the day they leave the little shack of a shop and move into a modern one with time-saving tools and equipment. Why, I don't know, but they do it!

"John" said to me recently: "I can't seem to think half as well here in the big shop as I used to do in the little one. There, I knew each and every tool, every weak place and every good point, and I could take advantage of what I knew. But here, everything is cut and dried and must be done by square and compass. I seem to have lost all my individuality and to have become just a little gear—yes, a little cog—in this big boiler-making machine. Say, I don't like it a bit and if I can't get to be a foreman pretty quick, I'll just have to flit and go back to the small shop again, where I feel more at home and can do things."

Why and Wherefore?

Now, there is just one word of advice to men who find themselves in a position similar to John's. They are almost determined to break away from the big modern shop and hike back again to the little old one-horse place. But—*don't you do it!* John is now undergoing a great test of his ability and fitness for a higher position. If he drops out and goes back to the little shop, it is certain that he is not a big enough man for the big shop, and that he had better stay in the little shop and potter around with one-horse jobs until he becomes too old to work.

But, if he rises to the occasion and doesn't let the big shop "get his goat," then he will soon begin to accustom himself to the different order of things in the modern shop and to make use of those things to the advantage and prosperity of the company for whom he is working.

John has, like many a young man in a similar position, got a bit of homesickness and is almost discouraged at the strangeness and the different order of things which he has to work with and to. And when you, Tom or Bill, have similar feelings, as you surely will some day, don't get discouraged, but stick right to it and work the problem out. There is a solution to it, same as there is to every other problem, and if you just buckle down to it and work just as hard as you did while in the little shop, you will quickly get the best of the matter and be able to do with it as you wish. And then—why, things will seem better, go easier and be better all around.

The trouble is that you, like the new college graduate, don't know how to apply your knowledge and power. In the old shop, when you had some complicated thing to do and only had simple tools to do it with, did you ever rumple up your whole disposition and say, "I'm going back to the farm"? No, sir; you just put your thinker to work, schemed out a way in which to do the difficult work with the simple tools the shop contained and came out of the test with flying colors.

And now, with better tools, better machines, better work and better contracts, you talk of "chucking" the job and "going home to mother"! Surely, that is not the manner in which you have earned your present position. Say, now, is it? Oh! John, John! Just "buck up" and let me see you get a strangle hold on the little problem which is bothering you now!

"It looks to me more than 'a little problem,' Mr. Francis. It seems to be a big rock which I can't dodge, move or climb over, and what I'm going to do with it is beyond me just now."

"Get busy, John. If you were building a railroad and came to such a rock as you describe, would you sit down, beat, and say that the road could go no farther on account of the rock?"

"Well, Mr. Francis, I hardly think I would do that. Not, at least, until after I had tried out what dynamite would do!"

"All right, John. There's hope for you yet. You haven't laid down yet. Only a bit tired, homesick for the old shop, and therefore unable to see and use the many advantages you have at hand in your new position. Get a move on and put some old shop ingenuity into the work. Why not, John?"

"I believe you are right, Mr. Francis. I have been thinking too much of the things we used to do in the little shop and how we did them, and it has rather fogged up things for me here. But I'll clear up things in short order and will get busy on the problems to be solved in the new shop. I believe I have been trying to do the work by the little old shop's standards and have forgotten to make use of the bigger ones now at hand. But just watch me and see if I don't make the big shop hum, now that you have opened my eyes a bit and shown me what a mistake I was making."

"That's the talk! The battle is won. When I hear you talk like that about a problem, I know the battle has been won and that the work is as good as done. Go to it, John, and you will win."

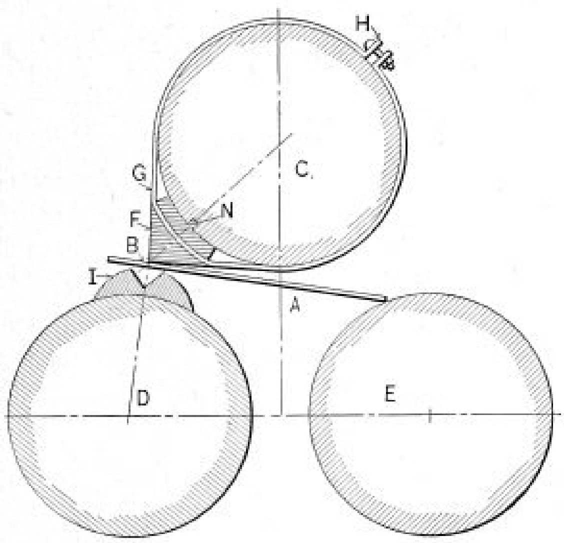


Fig. 1.—Brake Attachment for Bending Rolls

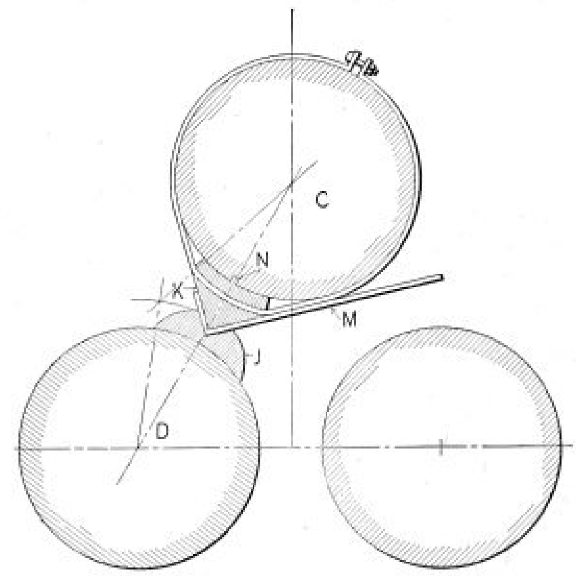


Fig. 2.—Action of Brake Attachment

The Bending Rolls as a Brake

"Mr. Francis, we have got a considerable job of bending ⅛-inch tank steel and a large number of right angle bends must be made which would work out very well on a brake for forming sheet metal. Seems to me that we will have to put in such a machine or at least rig up some kind of special machine to do this work. I know that purchasing a new machine at just this time will come like pulling a tooth, but, really, I see no other way out of the difficulty."

"Let's look at that a bit, John, before we order a brake heavy enough to handle plate ⅛ inch thick. I believe we can rig up the bending rolls so they will do the trick. Seems to me I saw a similar stunt once pulled off with a set of 10-inch bending rolls. Let's see? Yes, it was like this: the upper roll was made into a bending corner by applying the attachments shown by Fig. 1.

"In this engraving, *B* represents the point in plate *A* where a bend is to be made, in this case a right angle or 90-degree bend. The rolls *C*, *D* and *E* are shown in their relative positions when adjusted for bending ⅛-inch stock. The casting *F* is made large enough so that when the required angle is made in the plate at *B* the unbent portion of plate *A* shall clear the side of roll *C*, as shown by Fig. 2, and as hereafter will be described.

"Block *F* is a cast iron piece the same length as the roll and is shouldered down at either end to receive a clamping strap *G*, which is made fast to the roll and to the bending block *F* by a bolt, as shown at *H*. By loosening this bolt and a similar one at the other end of the bending block, the latter may be lifted off of the roll when regular bending is to be done.

"The bending block which lies upon the lower roll *D* is a simple casting with a notch cut therein, as shown, and block *I* is not fastened to roll *D*, but is simply laid thereupon and is held only by gravity and friction.

"Block *F*, however, may, if found necessary, as may be the case when heavy bending is to be done, be further fastened to roll *C* by means of a feather, *N*, or by a row of pins which project a short distance from the concave surface of block *F*, and are engaged by the slot in roll *C*. This slot, being that usually made in a bending roll for the purpose of assisting in catching a flat sheet the first time it passes between rolls which have been set together rather closely."

"Say, how does that rigging work, anyway? I should think the blocks *I* and *F* would be sliding around any old way. What's to make them come together just right so as to bite the sheet exactly where the bend is to be made?"

"That's all right, John. The upper or male block *F* is fast to roll C and turns with that roll at all times, either backward or forward. The lower or female block *I* is merely set on top of roll *D*, and as block *F* bites the sheet *A* and forces it down into the notch in block *I*, that block can take its choice of sliding around the roll to keep fair with block *F*, or the roll can revolve in its bearings under the pressure from block *F*."

"Oh! I see it, I believe. If rolls *D* and E are driven, then block *I* would keep up with block *F*, anyway. If the lower rolls be not power driven, then the pull of roll *C* would force block *I* into line with block *F*, either by the sliding of block *I* upon roll *D*, or by the turning of that roll in its bearings. Is that right?"

"Yes, John, that's the how of it. And if you will look again at Fig. 1, you will see that roll *C* has been revolved backward just enough so there is room between blocks *I* and *F* for sheet *A* to be slipped in between them. By thus doing, block *I* does not have much chance to get away from block *F*, as *I* will be engaged at once as soon as block *F* begins to move and the bending of sheet *A* must take place right in the notch in block *I*, thus locking the plate *A* and the two blocks *F* and *I* firmly together."

"Well, that's a peach of a stunt, isn't it? But I don't exactly see yet how the bending is done. Is the upper roll fed down by means of the adjusting screw at either end, or how is the business worked?"

"Fig. 2 will show just how it is done, John. By looking at that engraving you may see that when the angle has been fully formed, blocks *F* and *I*—we will call them *K* and *J* in Fig. 2—are thrown forward until the center of each is directly in line with the centers of rolls *C* and *D*. And by the bringing of the blocks together is the bending act performed in plate *M*, which in Fig. 2 is shown to have been bent to a right angle near one end of the plate.'

"Say! Don't the rolls and the blocks exert sort of a toggle joint action and thus put a very heavy pressure upon sheet *M* and the bend?"

"Yes, John, it might be stated in that way and you will see by further study of Fig. 2 that it makes no difference if the rolls be run ahead past the centers upon which they are shown in the engraving. Indeed, when a plate is being bent which is very heavy and hard to bend, the rolls may be given several short back and forth revolving movements which have a tendency to press and bend the plate into a very sharp angle in the bottom of the notch in block *J*."

"Well, say! How are you going to get the plate *M* out of the machine after a right angle bend has been made? Seems to me there will be trouble in doing that and in getting the block *J* back again into the proper position for bending another plate."

"No trouble there, John. Not a bit. You see that if the rolls should go ahead further than the position shown by Fig. 2, the bent plate would become loose and would fall out of the blocks *J* and *K* as soon as the rolls had gone ahead far enough. This could be done, provided the bent up portion of the plate was not wider than the distance between the upper and lower rolls."

"Is that the way work is usually removed after having been bent?"

"No, John. It is usually more convenient to reverse the rolls and back them up until the bent sheet can be removed from the front of the rolls. When removed in this way, it will make no difference how wide the bent-up portion of the plate or how close together the top and bottom rolls may be; for, as shown by Fig. 2, the angle has never gone past the center between the two rolls, hence the plate is very easily removed by backing up the rolls."

"How can a bent plate be removed if the rolls are driven ahead until the flanged-up portion is between the rolls?"

"It may be removed, John, by letting the top roll run farther and by holding the corner against block *J* until after the angle in the plate has passed the third roll, after which the plate will fall out of its own accord. But the plates had better be brought back past the front lower roll unless there be some special reason for removing the bent plates from the back side of the machine."

Countersinking Holes

"John, what are those men doing with that air drill? They seem to be forcing some tool into a heavy cut which is driven by the drill head. See, they are using a lever for forcing the tool into the cut, for all the world as we used to do when we drilled holes with a drill set in an ordinary 'bit-stock' or brace, same as is used by carpenters and millwrights. Haven't you gotten beyond that crude method of doing work? I am surprised to see it in this fine shop of yours!"

"Oh! Those men are countersinking a lot of holes and they are forcing the reaming tool to take as heavy a cut as the air head will drive."

"Why do you do the feeding of the cutter in such a crude manner? It does not look good to me. There are four men around that air drill and two of them are kept right busy all the time adjusting that lever and pulling against it. Why don't you rig up some better way of doing the pressure feeding act?"

"I sure am willing, Mr. Francis, to use a better method there, or anywhere else in the shop. Just bring on the method and we will try it out in short order!"

"All right, John, then you get busy and attach another air device to that drill head in a manner similar to what I recently saw in a shop where they hustled all the time and never had time for any lever foolishness in feeding countersinking tools."

"How is that cylinder applied and what is it to do?"

"The new cylinder is not a drill head. It is a simple piston and cylinder affair with a stroke of about 1½ inches. A longer stroke will do no harm, only it will take up more room than is sometimes desirable. A bar of heavy steel is to be fixed to the side of the drill head and the end of the bar bent over so as to hook under the sheet to be countersunk.

"The bar of steel will thus act as a sort of 'Old Man' to take the pressure of the cutter against the boiler plate.

The extra air cylinder is to be fixed to the bar of steel in such a manner that the turned over end of the bar is pressed against the back side of the plate in a manner which will feed the countersink into the cut. This may be done in two ways. The cylinder may be placed direct between bent-up steel arm and the back of plate, or the bar may be arranged to slide against the air head and the cylinder may be arranged to slide the bar back and forth to force the cutting tool against the plate."

"I should think the latter method would be preferable, for the reason that it does not require as much room between the end of the steel bar and the plate which is being operated on."

"Yes, John; that is sometimes a very necessary arrangement, for there may be places where countersinking is necessary where the room back of the sheet to be operated upon is very limited indeed. This method is the best, but it costs a bit more, is a little more complicated and is harder to make. But it's the best, after you once get it worked out."

Making the Business Earn a Profit—V

Estimating and Its Relation to Business Policies—Business Expansion—Percentage Basis Contracts—Profit on Labor

BY EDWIN L. SEABROOK

Estimating does not begin and end with the mere compilation of the various amounts making up a price. The policy of business management is really centered in the estimate, and this is reflected in the business-getting methods. Some of these may seem out of the ordinary, yet when closely examined it will be seen that they have developed into a well-settled policy. The various ramifications of the relationship of estimating and its bearing upon the business may well be considered, and some of these emphasized.

Turnover of Capital

A few years ago the cost of conducting business, or overhead, began to increase. To meet this a campaign developed in some quarters for more frequent turnovers of capital. "Meet rising costs with quick turnovers" became a slogan. Great stress was laid upon this by many writers and estimators as well.

In many instances the "turnover" was taken too literally and estimates were compiled accordingly. Many estimators seem to think that overhead expense is entirely eliminated by the process of rapid turnovers of capital. It is quite true that the percentage (but not the amount) of expense may be lessened by frequent "turnover," but there can be no possible benefit derived from this unless the increased amount of business earns the overhead and a profit. There is no greater fallacy than the belief that material and labor can be sold for less than these cost plus the overhead, in the expectation of making up the latter by volume.

In a large Western city a big public service corporation contracted with a stationery house for its supply of lead pencils for the invoice price plus ten percent. As the amount of this contract was large, the stationery firm reasoned that the amount, ten percent above the invoice price, was a clear gain. The overhead was eliminated because the goods were delivered immediately to the purchaser. A short time after this lead pencil contract was taken the stationery firm installed a very complete cost-finding system. To its surprise it found that the lead pencil contract of the public service corporation was handled at a loss, and gave it up.

In the haste to take big contracts without any overhead, thus throwing this burden on the balance of the business, many think the difference between actual cost and price received is velvet, or profit. If the boiler maker makes one hundred boilers a year, and makes a fair profit on seventy, has the contracts (volume or capital turnover) on the other thirty benefited him or not?

If the overhead expense of the boiler maker is, say, twenty percent, it is quite evident that this percentage must be added to *all* the contracts. If a portion of the business is taken on a smaller percentage, then a larger percentage must be added to the remainder. If anyone feels that "no profit business" must be taken, let him be honest about it. He should open an account with it in the ledger, designate it "no profit," "no overhead," or whatever term he pleases, but at the end of the year, when the overhead is computed, let it be on the volume of business that is charged with it, but do not include the "non overhead" amount.

No matter how quickly the capital of the boiler maker turns over, the expense necessary to conduct the business must get into it before there is any profit. If this rapid turnover is carefully analyzed, it will be found that the overhead expense is not reduced so much as is often believed. The volume of business does not reduce the overhead, and it is useless to strive for quick turnovers of capital unless a little of each transaction comes back in the form of profit.

Business Expansion

Capital turnover and business expansion are related. No one wants the business to stand still, and it is a most natural ambition to have it grow larger every year. This growth, or expansion, may be profitable or unprofitable. No business should grow more rapidly than the ability to handle it effectively develops in the management. Expansion is profitable only as the growth is substantial and fits in with many other controlling factors. Many have catered to the ambition to expansion, crippled themselves and retarded the profitable development of the business for a long time.

The record of one firm, covering a period of six years, vividly illustrates the fluctuating results of expansion without due regard to the other factors controlling the business. In one year this firm did a gross business of $52,000 and made a profit of nearly 10 percent, or $5,000. The next year the idea of expansion gripped the management and the business amounted to over $72,000, with a profit of $3,900, or over 5 percent. The third year the volume mounted up to $130,000, with a profit of something like $10,000, or a little less than 8 percent.

There were five other firms in the same city competing for the business. The expansion of the sixth firm was out of all proportion to the natural increase of business in the community. The amount of business secured by the other firms began to contract. These firms began to cut the price in order to get their share of the work. The firm with the expanding idea wanted (and needed) all the business it could get, so it began to cut the price in order to hold the trade. This price cutting trade war brought the business of the expanding firm the fourth year to less than $100,000, with a profit of about $1,800, or less than 2 percent. The margin between selling price and cost was getting very near the danger line. The business for the fifth year was $84,000, with a profit of $2,300, or less than 3 percent. The profit for the sixth year was over $3,000, or about 4 percent, on a volume of $71,000.

At the end of five years of experimental expansion the average profit per year was $4,200. The experiment demoralized the business for themselves and their competitors for months to come. How difficult it was to get back to the old standard need not be told. This expansion was undertaken on the theory that a large business could be done on a small margin, thus reducing the expense; the more business, the less expense, the greater the profit. The results, unfortunately, did not bear out the anticipation. Expanding beyond the natural increase of business forced it to be taken at a less profit than formerly.

Expansion is profitable only when all other factors expand accordingly—ability to manage the business, equipment, finance, expense, profit. The conservative estimator will consider all of these in compiling the estimate.

Percentage Basis Contracts

Will it pay the boiler maker to take contracts on a percentage basis? This depends on how well equipped the firm is to handle contracts of this nature and the size of the percentage. The firm with an expense of, say, twenty percent on material and labor, is not equipped to handle work for fifteen percent (nor twenty percent) on the bare cost of these.

Percentage basis contracting is done in many lines by firms on a large scale. These are equipped to handle the work in this way at a profit. If this class of work is not done exclusively it will be found that it carries its proportion of expense. If it requires a certain percentage to cover overhead expense on labor and material, which the boiler maker furnishes himself, a lesser percentage will not carry the contract through when these are not furnished, or is done on a percentage basis. The percentage contract demands supervision, bookkeeping, liability insurance, wear and tear on equipment, which must be paid for by the one performing the contract.

This class of contracts is often taken on the theory that volume of business lowers the expense. Such contracts do not decrease the *amount of expense;* they may lower the *percentage* of expense. The amount of expense and the percentage of expense for conducting business, or overhead, are two different things. The amount of this expense may be increased and at the same time the percentage decreased. This procedure, however, does not necessarily produce any more profit. In most cases it is better for the ordinary firm to adhere to one method in its contracting business. The percentage basis contract can be made profitable only when its proportionate share of the overhead expense is included.

How easy it is not to distinguish between the *amount* and *percentage* of overhead expense is well illustrated by a firm in one of the large eastern cities that did all kinds of roofing. It decided to increase its business by taking on other branches of sheet metal work. A short time after this plan was inaugurated a member of the firm said to the writer: "We regard the sheet metal portion of our business as a by-product. The roofing part of the business bears all the overhead expense. The sheet metal branch, such as cornices, skylight, and work of this nature, goes into the estimate at cost." The firm was increasing the amount of its business, but did not realize that its overhead expense was also increasing accordingly. It estimated on the theory that its overhead expense was stationary and would be borne by a part of its business—roofing—and that by combining the other sheet metal work on the building at cost with that of the roofing it could secure the contract. Doubtless there are boiler makers who have reasoned along the same lines and estimated accordingly. It is not possible to largely increase the business without increasing the overhead expense.

Profit on Labor

There are cases almost without number where the boiler maker, in jobbing, uses very little or no material. If these are considered individually, they will be done at a loss unless the overhead expense is applied on productive labor.

If the average expense of the boiler maker is a certain percentage of the cost of labor and material combined, it is quite evident that the percentage of overhead, if placed on productive labor alone, must be much higher. In the analysis of the business in the September issue of The Boiler Maker, shown in this series, the relation of expense to productive labor was forty-nine percent. In other words, where a dollar was paid to a mechanic, forty-nine cents was paid out for overhead expense. Using this as a basis to determine the cost per hour for the mechanic, where no material is used, we would have, assuming the mechanic is paid sixty cents per hour:

Wages of mechanic	$0.60
Overhead expense, 49 percent	0.29 2/5
Cost	$0.89 2/5

From this it is quite evident that the cost of the mechanic to the business is practically $0.90 per hour, and any profit from his work must be in addition to this.

Small Profits in Dull Seasons

Is it good business policy for the boiler maker, in slack times or dull seasons, to take work on small margins in order to keep the business moving and help pay the necessary running expenses?

While this is by no means an uncommon practice, there is, in its too frequent use, an element of danger. The harmony and smooth working of the business must be considered, and the extent to which this practice can be indulged depends on a knowledge of how much low profit work can be taken without disturbing these. The busy time does not necessarily come to all at the same time; unfortunately, some one is dull all the time. If the practice of accepting work in slack periods, at low margins, should be general, one or more in the community would be estimating low all the time. This would have a tendency to lower the standard of such a bidder and influence his competitors likewise. Undoubtedly there may be times when the practice is justifiable, but there is a danger of forming a low bidding habit. It is not easy to go from a low to a high estimating policy in a single bound. It is always easier to find reasons for estimating low than high. It is much safer to form the habit of taking no work unless the overhead expense is fully covered, together with a small profit.

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Profit

What is profit? Economists tell us that it is payment for the assumption of risk of the capital supplied to operate the business. Nearly everyone else considers it as excess of returns over expenditures in a given transaction or a series of transactions. In other words, it is residue, amount left over, earnings or gain. Strange as it may seem, the amount of profit sought is more generally applied on the definition of the economist, the risk involved in the transaction, than on a certain percentage of gain on all the transactions, although few estimators realize it.

The amount of profit to be added to each estimate is important, but is one of those business features that must be left largely to the individual judgment and preference. Adding a fixed percentage of profit on all estimates is advocated by many. This rule is probably broken more times than it is followed. The writer has talked with estimators in many lines of work, in all sections of the country, on the subject of how much profit should be added when the cost of material, labor and overhead expense is determined. Nearly all admitted that they observed no fixed rates whatsoever in determining the profit.

Whatever the amount of profit that can or may be added is liable to be influenced by several factors, and these are so various in the different transactions as to render the adherence to a fixed percentage not only unwise, but hardly possible. The amount of profit that is to be added is determined by many conditions surrounding each prospective contract. Its size, accessibility for handling, competitors, prospect for securing, probable amount it will carry, are a few of the factors governing the profit problem of the estimator.

Estimating is the vital feature of the business. It is not a mere matter of looking over the specifications, putting down the quantities and compiling figures. Into the composition of the estimate, and the proposal to perform the contract, go the policy of the business, and from these come the results of that policy and management.

Shakespeare once said: "The play's the thing." In the present day it might very well be said, where estimates are required before securing the order: "The estimate's the thing."

(To be continued.)

Boiler and Pressure Vessels: Inspections, Recommendations, Repairs, Etc.—III

Inspectors' Hand Tools—Instruments for Measuring Thickness of Material and Pitch of Rivets—Hammers—Portable Lamps

BY "THE VAGRANT"

In these days of uniformity and standardization, shop and hand tools are designed and utilized for the purpose intended. I notice that inspectors, however, carry an assortment or outfit compatible with individual idiosyncrasies. The few cuts following illustrate, not perhaps an ideal outfit, but one sufficient for all practical purposes.

The combination inside and outside caliper dividers, shown in Fig. 4, contributes one of the handiest tools for close and accurate work. In measuring the pitch of rivets in longitudinal seam, internally, the points are set to rivet centers, this then acts as a set gage from which the other rivets may be checked and the accuracy of layout tested with far greater precision and ease than could be found with a rule while working under cramped conditions. Owing also to free play of joints, measurements can be taken around corners, staybolts can be measured in the water space and the uncalked edges of sheets, sheared surfaces and plate edges that can not be reached with micrometer or rule are within range.

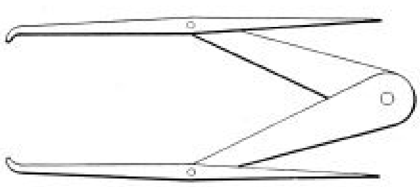

Fig. 4.—Inside and Outside Caliper Dividers

Hammers

I prefer the type shown in front and side elevation in Figs. 5 and 6, the broad and flat peen enabling one to dig the ashes from around blow-off, clean scale from sheet, scrape off soot and test short nipples. The point must not have a chisel edge, for then some of its value will be lost when belling out tube ends—both fire and watertube—when testing for ductility and crystallization, thickness and value. The taper should also be straight or even, the hammer well balanced and tempered so that a decided ring is produced when sound staybolts are struck.

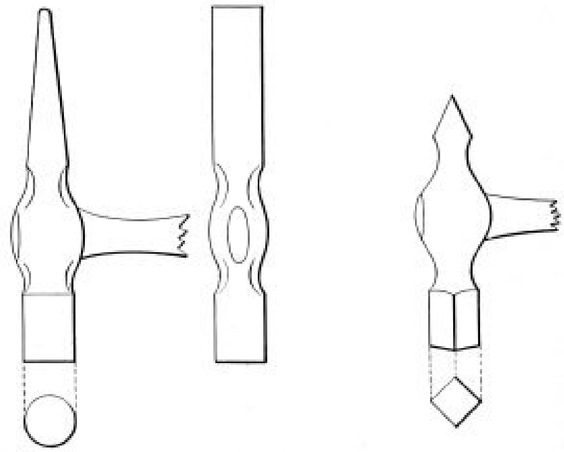

Fig. 5 Fig. 6 Fig. 7

A shop hammer for new work, as is sometimes used, is shown in Fig. 7. The peen here is a center punch. The face of hammer is ground sharp and square (as shown in plan).

Fig. 8 shows a convenient micrometer, measuring in hundredths or thousandths when required. A convenient feature is its slender body, allowing it to be inserted through a pipe or staybolt or rivet hole. For ordinary puposes, however, thirty-seconds are all that are required, and careful work with scale and divider or calipers will be sufficient.

LAMP

Of considerable importance is the illumination. Under proper conditions the electric light is the ideal. Around

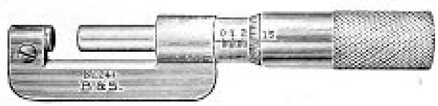

Fig. 8.—Micrometer

wet boilers, however, it is sometimes risky and even dangerous, and as not all plants have the conveniences or equipment, extensions, etc., necessary, the calcium car-

Fig. 9.—Calcium Carbide Lamp

bide lamp shown in Fig. 9 is highly recommended as convenient, being self-contained, safe and a splendid illuminant, cheap in first cost and operation and far ahead of candle or flash light.

The next issue will take up practical work and elaborate somewhat upon essentials and details.

(*To be continued.*)

Foaming and Priming in Boilers

One of the most troublesome features in connection with the operation of some steam boilers is encountered with the carrying of excessive quantities of water with the steam in the form of "foaming" or "priming."

Foaming or priming may result from a number of different causes, or a combination of a number of contributing causes, tending to restrict the free escape of steam from the water in the boiler. Among these factors to be considered are:

1. Quality of feed water used.
2. Presence of oil in the boiler.
3. Dirty boilers.
4. Load carried on the boilers.
5. Manner of drawing off steam for engines, etc.
6. Method of feeding boilers.
7. Method of firing boilers.
8. Type and construction of boiler.

Taking up class No. 1, the presence of large quantities of solid matter carried into the boiler in hard or impure feed water gradually increases the concentration of solids carried in solution and suspension because of the evaporation of the pure water and the leaving behind of the impurities. This concentration results in increased density of the water and usually produces a scum over the surface of the water, which greatly retards the liberation of the steam. As a result, there is set up a violent bubbling action in the boiler, brought out by the steam trying to free itself from the water, and the breaking of the bubbles, and this disturbance causes the carrying of water out of the boiler with the steam.

Where the feed water is high in carbonates of calcium and magnesium, the magnesium and calcium mono carbonate is thrown into suspension when the carbonic acid gas which holds them in solution are driven off at the high boiler temperatures. This magnesium and calcium is a very fine flour-like precipitate, which renders difficult the liberation of steam bubbles arising to the surface of the water.

Then the presence of quantities of sodium chloride (salt) and sodium sulphate, and also sodium carbonate, also accentuate priming or foaming action. Sodium sulphate is a resultant from the precipitation of calcium and magnesium sulphates with soda ash, usually employed in water softening systems, or as a base for boiler compounds.

The presence of oil in the boiler also increases the tendency to foam because the fatty acids of the oils combine with the calcium and magnesium carbonates contained in the feed water, forming an insoluble soapy formation which will obviously impede with the free escape of steam from the surface of the water.

Unclean boilers, resulting from the breaking down of old scale from the tubes and sheets of thickly scaled boilers, due to the addition to boiler compounds, etc., will naturally increase the foaming tendency because of the increase in the amount of solid impurities dissolved in the water. When a thick coating of scale which has been allowed to accumulate on the boiler tubes and sheets begins to break down and disintegrate, the solid matter thus released not only increases the foaming tendency, as mentioned above, but, further, those portions of the heating surface from which this scale has fallen away will, of course, absorb heat more rapidly than those portions covered with scale. As a result, there will be a violent boiling action around those sections of the boiler where the clean heating surface is exposed, and these local disturbances, due to violent boiling, will sometimes increase foaming trouble.

Where the steam boiler is too small for the work and is being considerably overloaded—i. e., where the liberating surfaces in the boiler are too limited for the amount and volume of steam being produced—the disturbances caused by the violent discharge of the steam from the restricted liberating areas will cause upheavals and hence foaming or priming. Water will also be carried over with the steam where the steam outlet provided on the boiler is too small to carry off quickly the full amount of steam generated.

The manner of operating the engines and drawing off steam from the boiler also has its effect on the foaming tendency. If the steam is drawn off suddenly and in large quantities, such as, for instance, in rolling mill or hoisting service, the water in the boiler may be literally heaved out of the boiler with the outrush of the suddenly released steam.

Further, where the water line is carried too high, thus restricting the amount of space available for the storage of the steam and for allowing time for the particles of water carried off with the steam to fall back, there will, of course, be an excessive amount of moisture and water in the steam. Foaming is also liable to be encountered where it is not the practice to maintain a fairly constant water level—i. e., where the water level is allowed to fall considerably, and then the boiler is pumped full of water.

Even the method of firing has its effect and bearing on the matter of foaming, because the violent boiling action caused by irregular or spotty firing or forced firing will oftimes give trouble from this source.

The type of boiler installed and the provision of ample water carrying capacity, steam storage space, steam liberation area, and ample steam outlet pipe size are all very important features that may increase or reduce trouble from foaming or priming. The use of a dry pipe at the steam outlet will serve to separate some of the water from the steam. Crowding of the tubes in a boiler will also accentuate foaming and priming, as well also poor circulation.

Where foaming or priming is experienced the proper action to take, and that immediately, is to check the flow of steam from the boiler and open the fire doors or bank the fire until normal conditions are restored. If the foaming has been due to dirty or impure feed water the boiler should be blown down and fed with fresh water until the concentration of soluble and suspended matter is reduced to the point where the operation is known to be entirely satisfactory.

If conditions permit, however, the best procedure is to completely empty out and wash the boiler and start with a clean boiler and a fresh supply of water.

However, in any plant where experience has shown there is any likelihood or tendency for the boilers to foaming, prevention rather than cure should be the practice, because once violent foaming gets under way its action is so quick and powerful that considerable damage can be inflicted before anything can be done to check it.

If the faulty design and construction of the boiler is the cause, then the only permanent remedy lies in the righting of the defects, although relief may be obtained by operating the boilers at light load, which, however, is not desirable or economical.

Where the foaming is not too violent relief can often be obtained by the use of properly designed separators located in the steam line. For most conditions a steam separator of large capacity, located above the throttle valve of the engine, will give ample protection, although in extreme cases a separator with extra large capacity for the storage of water should be installed on the steam line close to the boiler, so that the water removed from the steam can be drained back directly to the boiler with practically no heat loss.

The best preventative of foaming is to feed clean water to the boilers, for with a good supply of water which will not carry into the boiler large amounts of suspended or soluble impurities, a boiler should be able to carry a considerable overload without foaming or priming, providing, of course, it is properly designed and operated.

Where excessive quantities of mud and suspended matter are present in the water, proper filtration before it enters the boilers is the best course to follow. If this is not possible, constant and regular blowing down should be resorted to. The blow-off is also the best preventative where the feed water contains dissolved mineral impurities, and where, if water softening equipment is installed, considerable quantities of soluble alkaline salts, such as sodium sulphate, are present. The use of a surface blow-off in addition to the regular blow-off is often very desirable.

In this connection it might be said that the necessary blowing down of the boilers is frequently neglected in many plants, and mainly for either of two reasons: first, because the work of blowing down is found irksome, disagreeable and even dangerous by many engineers, due to leaky and faulty blow-off valves, and the usual location of blow-off connections in dark and inaccessible passageways behind the boiler settings. Proper equipment and attention to this feature in designing boiler installations is, of course, the only remedy for this condition. The second and probably the main objection to blowing down in many plants, is the fact that it is considered that blowing down is such an expensive matter because of the loss of water and fuel that it should be done only unless it cannot be avoided. Blowing down, however, must be considered as part of the price that must be paid on account of the use of poor or impure feed water, and that it is really not as costly as might be expected is shown by the following figures. Take a 150 horsepower boiler operating at 150 pounds pressure. At this pressure the temperature of the water in the boiler is about 366 degrees F. Figuring the raw water temperature as 60 degrees, this means that 306 B. T. U. have been added to each pound of water in the boiler. In a blow-off discharge of, say, about 75 gallons, or approximately 600 pounds, a heat loss of 306 by 600, or 183,600 B. T. U. is represented. Based on a heat value of 14,500 B. T. U. in the coal burned, we can assume that 10,000 B. T. U. are given up to the water by each pound of coal. This means the loss of heat from 18.36 pounds of coal each time the boiler is blown off. With coal at $3 per ton, this represents an actual loss of coal of about 3 cents per blow-off. If the feed water must be purchased, the cost of the quantity of water blown away must also be figured, but in any case it can be seen that the loss accompanying blowing down of boilers is not so serious as may be imagined, and particularly when taken in connection with the beneficial results obtained.

As showing that it really is worth while to prevent and reduce the foaming and priming tendency to a minimum, we can consider briefly the reasons why this action is undesirable.

In the first place, there in danger of wrecking the engine, due to the passage into the cylinder of large slugs of water. Turbine blades are also liable to damage by large doses of water. Then the excessive moisture carried over in the steam is bound to result in abnormal wear on the engine valves, valve seats and engine walls. The presence of mud and sediment which is sometimes carried over with the water thrown out of the boiler by foaming or priming action accentuates this wearing action, clogs piston rings, etc.

The presence of excessive water in the steam also washes away the oil placed on valves, seats and cylinder walls for lubricating purposes, and consequently necessitates the use of large and excessive quantities of oil to secure proper lubrication.

Then there is the loss in heat efficiency due to carrying out of the boiler of large quantities of water which, while heated to a high temperature, are not capable of producing useful work. Foaming also frequently makes it necessary to run boilers at extremely low load, and consequently at poor efficiency. The inconvenience, loss of time, cost of fuel, etc., attendant on shutting down engines and emptying boilers when foaming becomes too violent should also be considered.

Foaming and priming also sometimes causes great fluctuations in the water level in the gage glass in the boiler, and as a result of the false readings shown it is possible sometimes that low water may be carried, and burned tubes, or even an explosion, is the result.

Where superheaters are installed and foaming or priming occurs the benefit of the superheater is lost because the superheater acts merely to dry or partially dry the steam of the excess water it contains rather than superheating it.

The Boiler Maker

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NOTICE TO ADVERTISERS

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 25th of the month, to insure the carrying out of such instructions in the issue of the month following.

The campaign for the second Liberty Loan, which began on October 1, will close on October 27. Uncle Sam needs your help to win the war. Practice economy and invest your savings in Liberty Bonds!

The present war and the Russian Revolution undoubtedly opened a new era in Russian industrial development, and there is no question but that by a proper and active policy the United States will share largely in this development in Russia. Russia needs the help of American capital and business enterprise in her economic development. The United States, with a surplus capital and with a steadily increasing industrial production, requires the immensely large Russian market as an outlet for its trade and its investment. The two countries are in a position to supplement their respective requirements. The United States export to Russia always has been greater than Russia's export to the United States. According to the statistics of both countries, during the ten years previous to the present war there has been a remarkable increase in the exportation to the United States of Russian raw materials. Cotton holds first place in the United States export to Russia, but machinery and technical supplies hold second place in the United States export to Russia, especially agricultural machinery and implements. By creating direct connections with Russia, by careful study of the conditions of the Russian market, by an active trade policy, the amount of raw materials brought to the United States from Russia can be multiplied many times to the benefit of both countries. On the other hand, the United States has supplied and will supply Russia with all kinds of machinery, with all kinds of products that presuppose a highly developed industrial culture. The possibilities of such trade, very apparent before the war, are emphasized by the events of the war. Germany, which in 1913 held 52.6 percent of all Russia's import, is now withdrawn from the field. By proper and active policy the United States can now not only develop that line of her trade with Russia that showed a natural tendency to develop before the war, but even introduce into the Russian market a full line of goods never before brought into Russia from the United States. The Russian Information Bureau, recently established with headquarters in the Woolworth building, New York, will gladly answer any inquiries to this journal regarding trade conditions and the markets in Russia, so that our readers can take advantage of this remarkable field for export of boilers, boiler accessories and boiler making machinery.

Governor Strong, of the Federal Reserve Bank, appointed Mr. J. W. Lane, president of the E. W. Bliss Company, chairman of the Machinery and Machine Tool Trades Committee of the Liberty Loan Committee for the city of Greater New York.

Chairman Lane called together the following men, prominent in the machinery world, to co-operate with him: Henry Prentiss, president, Prentiss Tool & Supply Company, 129 Broadway; George Doubleday, president, Ingersoll-Rand Company, 11 Broadway; R. L. Patterson, president, American Machine & Foundry Company, 511 Fifth avenue; C. I. Cornell, president, Pratt & Whitney Company, 111 Broadway; Henry Fuller, vice-president, Fairbanks-Morse & Co., 30 Church street; John H. Lidgerwood, president, Lidgerwood Manufacturing Company, 96 Liberty street; A. J. Babcock, president, Manning, Maxwell & Moore, 119 West Fortieth street; Norman Dodge, vice-president, Mergenthaler Linotype Company, Tribune building; H. R. Swartz, president, Intertype Corporation, 63 Park Row; Geo. J. Low, F. M. Dyer & Co., 24 Broad street; Chas. A. Hirschberg, publicity manager, Ingersoll-Rand Company, 11 Broadway.

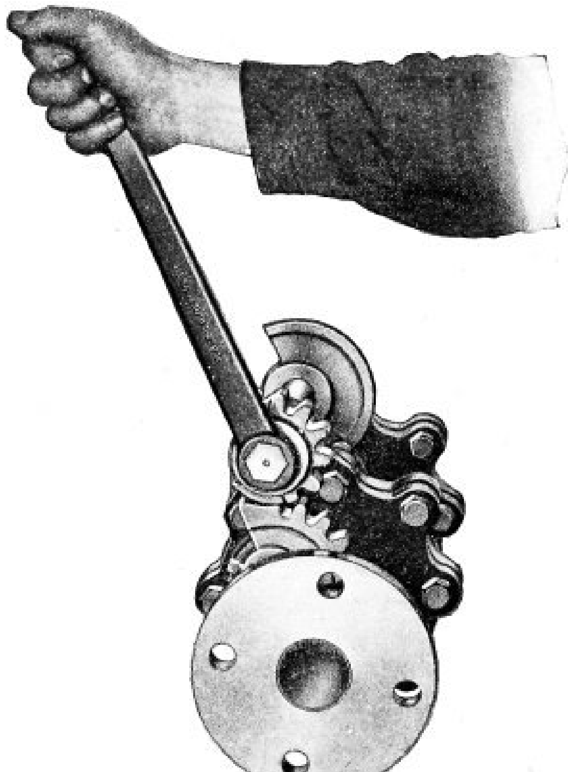
The Committee held its first meeting on Friday, September 28, and elected H. R. Swartz, vice-chairman, and Geo. J. Low, secretary, and appointed Chas. A. Hirschberg, publicity manager. Headquarters have been established on the sixteenth floor, 334 Fourth avenue, New York City, and manufacturers of machinery and machine tools, as well as their employees, are asked to communicate with the secretary at the above address for full information, subscription blanks and other material. Your support of this committee will aid the Government in its efforts to float the second Liberty Loan.

Engineering Specialties for Boiler Making

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

Everlasting Valves—Tandem Type

In the best boiler blow-off practice it has long been customary to use two valves, because steam users have realized more and more how expensive an apparently small leak through the blow-off valve of a boiler can be. It has frequently been the practice to make cne of those valves an Everlasting valve or some type of plug cock; i. e., type of valve which gives a straight-way blow through, the actual valve faces being covered (and not exposed to any scouring action) when the valve or cock is full open. Either this valve or cock has the characteristic of being quick opening. The other valve has customarily been some type of screw-operated, slow-opening valve. The object of their special design has mostly been to produce a valve of a slow-opening, screw-down type, the valve faces of which would, as far as possible, be protected from the scouring action of the mixture of water, mud and scale normally present in the blow-off of a boiler.



Opening Everlasting Valve

If the valve nearest the boiler be an Everlasting valve or a plug cock (in both of which the valve faces are not exposed to any scouring action when the valve is full open), and if the slow-opening valve furthest from the boiler is always opened and closed in the correct cycle of operation, then when blowing off the schedule of procedure is as follows:

Open the quick-opening valve next the boiler, full open; open the slow-opening valve, or the valve furthest from the boiler, and blow off; close the slow-opening valve, or the valve furthest from the boiler, slowly; close the quick-opening valve next the boiler.

If this schedule of operation be rigidly adhered to, a really tight blow-off connection is insured, provided that the quick-opening valve is absolutely drop tight to begin with and is properly made to stand up to its duty. This is the schedule of operation laid down in well-operated boiler plants. Unfortunately, it involves trouble, and what is liable to be considered unnecessary work on the part of the man whose duty it is to blow off the boilers—this because he has to open and close two separate valves. The result is that in a great many cases—whether the owners of the plant or their representatives in charge of the plant know it or not—what actually happens is that one of the valves is left open all the time and the blowing off of the boiler is done by opening and closing one valve, which, under those circumstances, soon begins to leak.

When that valve leaks, then it is left open all the time and the other valve is used until that also leaks. This leaky condition continues, costing money every hour, until someone in charge observes it or the operator reports it; then, at the first possible moment, the boiler is shut down, the valves are taken out and money is spent repairing them. All this is very expensive and would be to a very large extent unnecessary if the schedule of operation laid down above as the proper one were duly followed every time every boiler was blown off.

With the introduction of the Everlasting tandem valve, manufactured by the Scully Steel & Iron Company, Chicago, the blow-off valves of a boiler, it is claimed, can be inevitably and automatically operated in precisely the manner which insures that they will stay really tight for the longest possible period, and the trouble to the operator and the amount of labor involved in operating blow-off valves is cut in two. By means of a simple patented arrangement of two valves on a boiler blow-off line the "tandem valves" are both operated by a single hand lever or wrench or hand-wheel; and, no matter what the operator does or tries to do, inevitably the cycle of operations is as follows:

Operation of Valves

Let the valve next the boiler be called No. 1, and the valve furthest from the boiler be called No. 2. The operator takes hold of the hand lever, for example, and throws it over as far as he can (which is normally about one-half turn). By doing this he operates the valves as follows:

Valve No. 1 opens rapidly, full open valve No. 2 remaining closed and being locked closed during the operation of valve No. 1. After valve No. 1 is fully open it stays open and is locked open during the operation of valve No. 2, which now takes place. Valve No. 2 opens more slowly and the boiler blows off. This is all done by one motion of the lever, hand-wheel or wrench.

After the boiler has been blown off, when the operator starts to close the blow-off valve he takes (we will say) the hand lever and pushes it back to the closed position. By doing this he operates the valves as follows:

Valve No. 2—furthest from the boiler—closes relatively slowly, valve No. 1 remaining locked, full open, until valve No. 2 is fully closed. Valve No. 1 now closes rapidly.

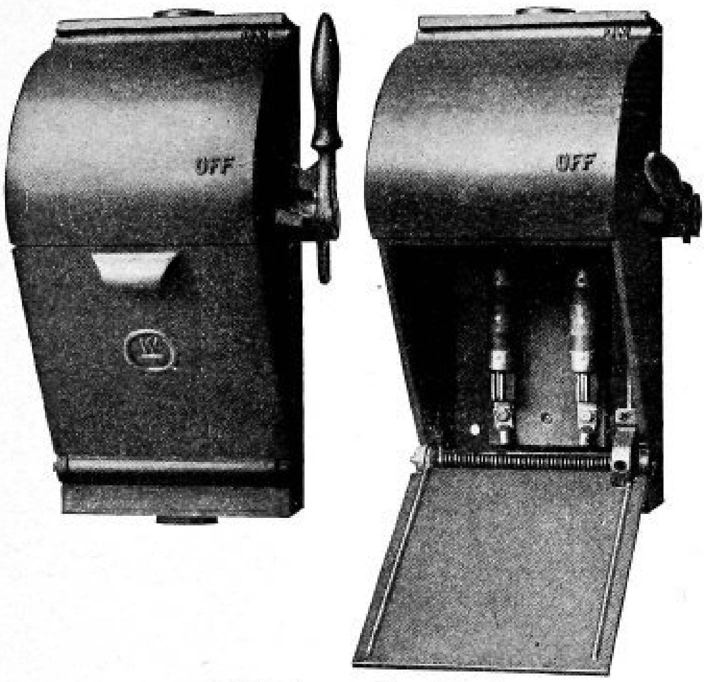
The entire operation of closing the two valves in this sequence being obtained by one continuous motion of the hand lever, wrench or hand-wheel, the result is that valve

No. 1 opens and closes at all times in still water. It is to be remembered that, being Everlasting valves, the valve faces are not exposed to any scouring action when the valve is full open. It is to be further remembered that, being Everlasting valves, it is impossible for any grit to get in between the valve disk and the valve seat.

A Real "Safty-First" Switch

In shops employing men with practically no knowledge of electricity and its attendent risks the need for an absolutely safe switch has become a necessity. The real safe switch is one so constructed that all live parts are totally enclosed and inaccessible. Means should also be provided for preventing operation by unauthorized persons.

The switch shown, which has been brought out by the Westinghouse Electric & Manufacturing Company, of East Pittsburg, Pa., is typical of the real safety switch.



Westinghouse Safety Switch

Its use assures the maximum protection implied in the word "safety." The complete device consists of an ordinary single-throw knife switch and enclosed fuse holders mounted in an exceptionally strong cast iron box, with an operating handle outside the housing. The box is designed for conduit connection and has a partition separating the switch blades from the fuse holders.

The upper or switch compartment can be opened only by removing two machine screws. This compartment should never be opened except when making connections, or in case of inspection or repairs, as the switch is opened and closed by the operating handle, from the outside, through a shaft and lever inside the box.

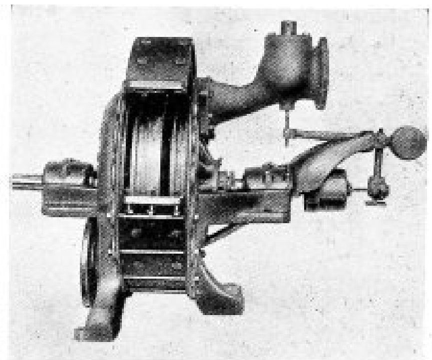
The lower or fuse compartment, containing the fuses and fuse holders, is the only part of the switch that need be opened, and then only to replace blown fuses. The door of this compartment is so interlocked with the switch by a vertically acting push rod which engaged a boss on the fuse-compartment door that it can be opened only when the operating handle is in the off position and the circuit broken. Furthermore, with the door of this compartment open it is impossible to close the switch. Thus the danger of a live line is eliminated.

The operating handle can also be locked with the switch in the open position, preventing tampering by unauthorized persons.

Curtis Steam Turbine for Fans, Blowers and Pumps

The General Electric Company, Schenectady, N. Y., has developed a Curtis steam turbine in a wide variety of capacities to drive fans, blowers and pumps for boiler feeding and circulating systems. It is called the Type L, and is of the impulse type. The number of stages and rows of buckets vary with the capacity.

A split wheel casing is used to permit ready inspection of the buckets, which are of bronze securely dovetailed



Type L, Curtis Turbine

into the rim of the wheel. The exhaust steam is free from oil and is well suited for heating feed water.

Speed regulation is close and reliable, and the speed may be changed by hand-wheel adjustment while the turbine is in operation. A constant running speed is maintained by a simple and powerful speed governor mounted directly on the shaft and controlling a double-balanced piston valve type throttle.

BOOK REVIEW

Elementary Mathematics for Engineers. By Ernest H. Sprague. Size, 4½ by 7¼ inches. Pages, 233. Illustrations, 101. New York, 1916: D. Van Nostrand Company. London, 1916; Scott, Greenwood & Son. Price, $1.56 net; 4d net.

For the man in the shop who is ambitious to take up engineering work and become an engineer, one of the first necessities is a knowledge of mathematics. To aid such students, this book has been prepared with a view of presenting in the simplest possible form elementary instruction in algebra, plain trigonometry, mensuration, spherical trigonometry, algebraic geometry and the differential and integral calculus. At the end of the book are numerous useful problems with which the student can test his grasp of the subject.

PERSONAL

Joseph McAllester, formerly boiler foreman of the West Albany shops of the New York Central, has been promoted to general foreman of shops, succeeding E. Williams, resigned.

A. Steylmeier, formerly assistant boiler foreman at the West Albany shops of the New York Central, has been promoted to the position of general foreman boiler maker at that point.

A plan has been submitted to the stockholders for the merging of the National Carbon Company, the Union Carbide Company, Linde Air Products Company and the Prest-O-Lite Company, into a new corporation. Under the plans the new company will be known as the Union Carbide & Carbon Corporation, and have have plants in many parts of the country.

Questions and Answers for Boiler Makers

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

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

Address your communication to the Editor of the Question and Answer Department of The Boiler Maker, *461 Eighth avenue, New York city.*

Pitting and Corrosion

Q.—(*a*) What causes pitting and corrosion? (*b*) What are the remedies?

A.—Pitting and corrosion are due to the chemical action of the feed water, and if allowed to continue will lead to the destruction of the boiler plate, stays, tubes, etc. Pitting consists of spots due to corrosion in different parts of the boiler, while corrosion in general affects the entire boiler parts in contact with the water. Corrosion is due mainly to acid feed water, or to some water which is not acid, but becomes so when it reaches a high temperature, or to oil containing fatty acid being brought into the feed water, or to galvanic action, etc.

The following table compiled by the Babcock & Wilcox Company gives an approximate classification of the impurities found in feed waters, their effect and ordinary methods of overcoming such conditions:

Difficulty Resulting from Presence of	Nature of Difficulty.	Ordinary Method of Overcoming or Relieving.
Sediment, Mud, etc......	Incrustation.........	Settling tanks, filtration, blowing down.
Readily Soluble Salts.....	Incrustation.........	Blowing down.
Bicarbonates of Lime, Magnesia, etc.........	Incrustation.........	Heating feed. Treatment by addition of lime or ot lime and soda. Barium carbonate.
Sulphate of Lime........	Incrustation.........	Treatment by addition of soda. Barium carbonate.
Chloride and Sulphate of Magnesium...........	Corrosion...........	Treatment by addition of carbonate ot soda.
Acid....................	Corrosion...........	Alkali.
Dissolved Carbonic Acid and Oxygen...........	Corrosion...........	Heating feed. Keeping air from feed. Addition or caustic soda or slacked lime.
Grease..................	Corrosion...........	Filter. Iron alum as coagulant. Neutralization by carbonate of soda. Use of best hydrecarbon oils.
Organic Matter..........	Corrosion...........	Filter. Use of coagulant.
Organic Matter (Sewage).	Priming............	Settling tanks, Filter in connection with coagulant.
Carbonate of Soda in large quantities.............	Priming............	Barium carbonate. New feed supply. If from treatment change.

Boiler Patches

Q.—Kindly provide a new subscriber with information on boiler patches and method of marking them off. E. T. D.

A.—This is a subject that would require a lengthy explanation and drawings to cover it fully; however, two cases that often arise are treated on.

Patching Large Shell Course at Girth Seam

The plate at the bottom of shell courses along the girth seam is liable to become defective. In patching the large course proceed as follows: Remove the damaged plate, cutting it to the shape shown in Fig. 1, so that the rivets will run diagonally instead of horizontal. A diagonal riveted joint is stronger than a seam of the same kind placed horizontally. The effective strength varies according to the pitch and size of rivets, number of rows of rivets, and the angle the seam makes with the girth seam. The stress per unit of section on the girth seam is only half as great as the stress on the longitudinal seam; for that reason the circumferential seams are usually single riveted. The method of determining the efficiency of

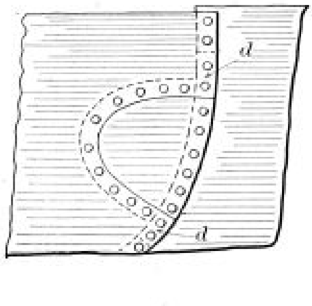


Fig. 1.—Showing Method of Patching Large Course at Seam

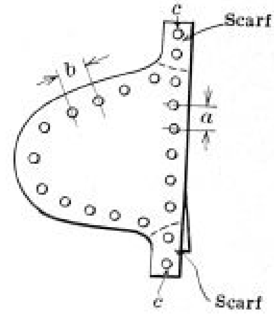


Fig. 2.—View of Patch

diagonal joints as compared with the solid plate will be found in the October, 1915, issue of The Boiler Maker.

After the plate is removed for the patch, file or chip off all ragged edges and burrs. This is necessary to insure a good fitting patch. The shape of the patch is made directly from the opening in the boiler by the use of heavy paper, or very light sheet iron may be used. Place the paper over the opening and with the peen of the hammer tap the edge of the metal around the hole lightly; this leaves the required impression of the shape of the opening on the paper. Cut the paper along the line so made and use it as a pattern, but allow sufficient material for lap on the patch. In Fig. 2 is shown the shape of the patch; the pitch of the rivets *b* in this case is equal to the pitch *a* of the girth seam. Note the projections at *c*.

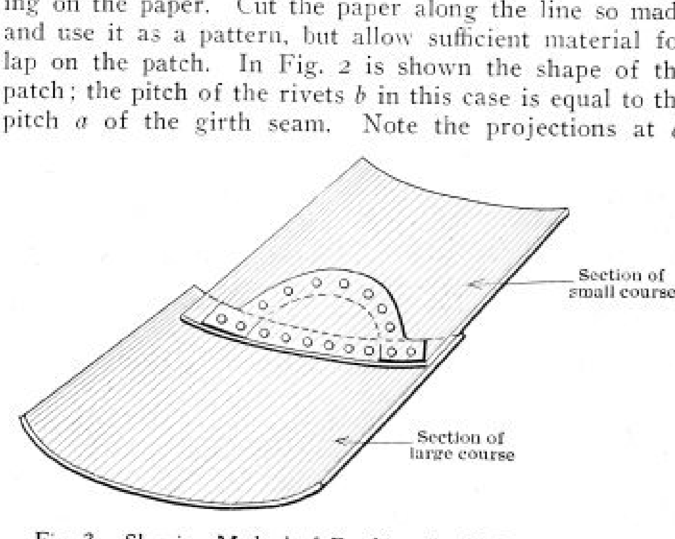


Fig. 3.—Showing Method of Patching Small Course at Girth Seam

These are scarfed so as to fit snug between the two shell courses at *d* (Fig 1). The plate at *c* is scarfed by first heating it and then thinning the plate by hammering it to the desired thickness. In applying the patch some boiler makers drill or punch the rivet holes in the shell course first; then fit up the patch and mark off the rivet holes. The patch is then punched, all burrs removed, riveted up and calked. Another method is to locate four or five holes in the shell, drill them, and fit up the patch as before. The patch is bolted in place and all rivet holes are then drilled through the patch and shell. It is then removed, holes countersunk in the patch, and then riveted up in place and calked.

Patching Small Course at Girth Seam

The same procedure is followed in this case as for the preceding one. In fitting such a patch, the inside shell along the girth seam must be thinned down by chipping it. Fig. 3 illustrates a patch of this kind. Both patches are applied on the inside of the shells.

Hemispherical Head Development

Q.—Please show a correct method of laying out a pattern for a segment of a hemispherical head, so the rivet holes can be put in the plates before dishing—that is, the holes on the flange. Some seem to think there should be a radius at the bottom flange line, while others do not. It will be noticed that a hemispherical bottom 18 feet diameter does not need flanging after dishing, as the bottom will come straight when dished to proper size. F. E.

A.—Lay off the center lines for the plan and elevation; with point *r* in the elevation as a center, describe a semicircle with a radius taken from the center of the head

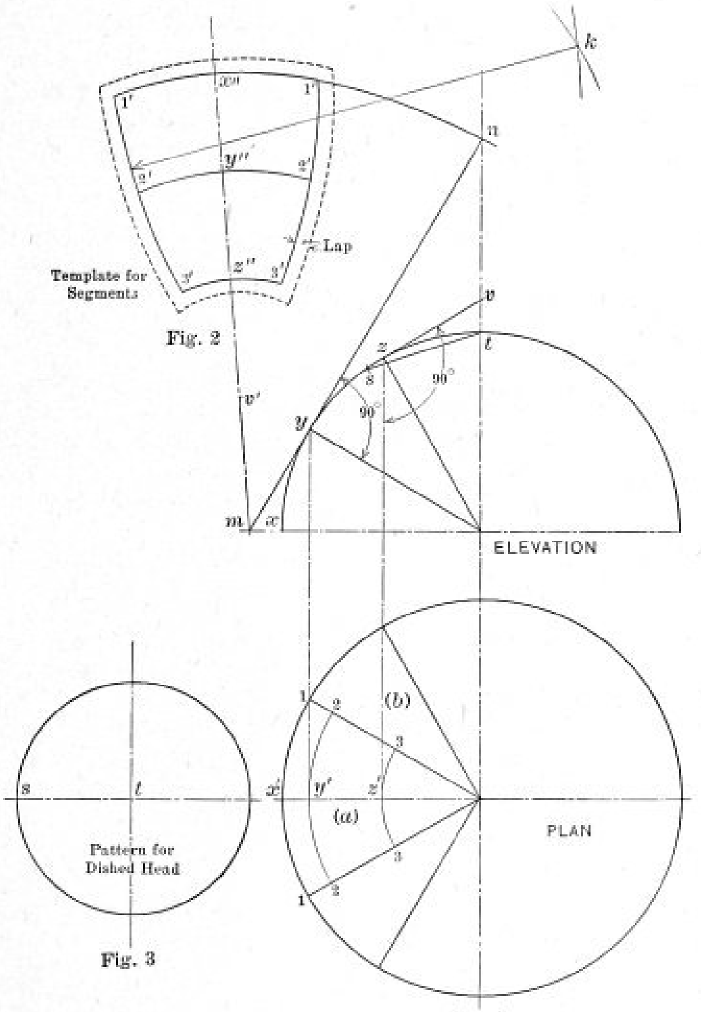


Fig. 2

Fig. 3

Fig. 1

to the neutral layer of the metal. Draw the circle plan view accordingly and space it into the required number of segments, in this case six.

Now consider only one of these segments, as at (a), shown within the points 1-*x*′-1-*t*′ of which a pattern will be developed for a template. This template is then used in marking off the required gores or segments of the head.

Divide the arc *x*-*z* of the elevation into equal parts, in this case the length of the arc is two-thirds of the length of the semicircle. At right angles to the radial line *r*-*y* draw line *m*-*n* tangent to the semicircle at *y*. With *m*-*n* as a radius describe the arc *x*″-*n*, and from point *m* draw a straight line *m*-*x*″ in any convenient position.

From point *x*″ lay off the arc lengths *x*-*y* and *y*-*z* of the elevation on *m*-*n*, thus locating the points *y*″-*z*″. Make the distance *z*″-*v*′ equal the length of line *z*-*v* of the elevation. This line is tangent to the semicircle at point *z* and is drawn at right angles to the radial line *z*-*r*.

With *m* in Fig. 2 as a center and *m*-*y*″ as a radius, draw an arc through point *y*″. With *v*′ as a center and *v*′-*z*″ as a radius draw an arc through *z*″, making both arcs of indefinite length. From the points *y* and *z* in the elevation draw vertical lines parallel with the center line *t*′-*n*, to intersect the horizontal line *t*′-*x*′ in the plan, thus localizing the points *y*′-*z*′.

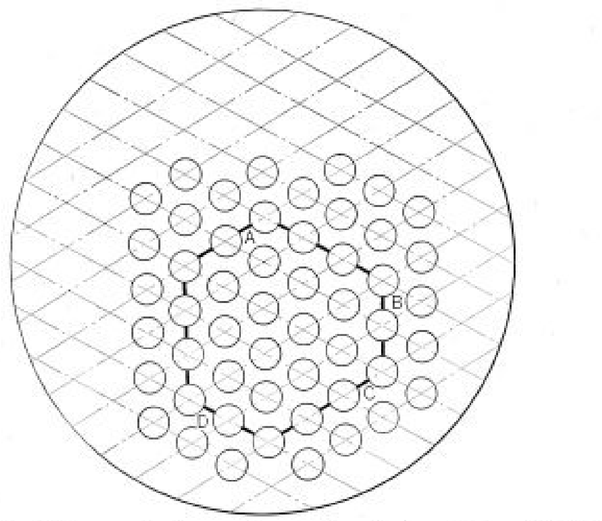
With *t*′ in the plan as a center, draw arcs through points *y*′-*z*′ to intersect the radial lines shown at points 2 and 3. Transfer the arc lengths 1-1, 2-2 and 3-3 of the plan to the pattern at 1′-1′, 2′-2′ and 3′-3′. These lengths may be laid off with a traveling or measuring wheel.

Now determine a center, as at *k*, from which an arc can be drawn through the points 1′-2′-3′ in the pattern. From this center also draw arcs for the outside edge of the lap. The segments are then raised or humped to the required curvature of the head.

If heavy plates are used, heat them before shaping the segments to form. Joining the segments is a circular dished head. The blanks for heads of this kind are easily laid off, the radius being equal practically to the distance between points *s* and *t* of the elevation. The arc distance *s*-*z* is the lap of the head over the small ends of the gores.

Welding Bridges in Tube Sheet

Q.—Recently we were called upon to repair a vertical boiler which had been burned in the middle of the lower tube sheet, due to the collection of mud in between the tubes. In the sketch showing the plan of the tube sheet the lines across the bridges between the tubes show how I cut the defective metal out. The patch was put in place, so that the half holes could be scribed on the plate, then the rest of the holes were laid out on the plate and drilled to size. The patch was then cut so that it would fit and beveled for welding. I then welded



one of the bridges at *A*, then another at *B*, and then at *C*, and finally at *D*. Then I went to work and welded the rest of the bridges as I came to them. After welding all of the bridges I found some of them had broken apart. I tried to reweld them, but they broke a second time. Although I have made a number of welds of various kinds, I have not had this trouble before. The only explanation I can give is unequal expansion and contraction. I shall appreciate any information which you can give regarding a satisfactory method of making this repair. J. G. P.

A.—The reason, probably, for the breaking of the welded sections after the patch has been fused to the head is due to unequal contraction and expansion in the tube plate and patch. To overcome this, it is advisable to first preheat the welded section and keep it in this condition until after the welding work is done. This may be done with the use of an oil or gas pre-heating torch. After the bridges are completely welded, I would suggest that you reheat the welded section again and allow the plate to cool slowly. This anneals the work and offsets stresses due to unequal expansion and contraction.

Letters from Practical Boiler Makers

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

Latent Abilities

Beneath the surface, every individual has lying dormant many latent capacities. Have you ever noted some friend of yours climb to the height of industrial success, and have you not made the remark, "I never thought it was in him"? If you took the trouble to further investigate, you would find that he had not known it until he began to examine himself and discovered that with a little effort he could develop ability and do things previously thought impossible. As he began to awaken these latent possibilities, each one led to others, and with surprise and enthusiasm he began to make people take notice of him.

It truly is a grand thing when a man begins to make the discovery that he has unthought-of capacities, and realize that by unswerving hard work and sacrifice of some personal pleasures and spare time he can secure for himself a place among those men of the business world who are marked as leaders.

When you notice some fellow rise to the better job, and he has, to your mind, no better qualifications than you, it is time for you to wake up and look yourself over—something's wrong.

After making allowances for favorable circumstances, the other fellow must have discovered some qualities, and trained them, which helped him to get there. It should be a matter of interest and an incentive to you to know that if a man of apparently your own ability got promoted, it might be your turn next. Give a little more thought to each task, and plan for the next one. As you note your improvement, so will others. Never entertain doubt, for doubt is the traitor of every decision to expand or forge ahead of your own initiative.

CLIMBER.

Making Good

Have you received your promotion or an increase in wages without soliciting it? If so, how did it affect your thinker? Did you get a little over-elated and begin to feel your importance, or did you analyze your past record and the manner in which you labored, in order that you might still further improve your worth and ability? There seldom comes to any individual an advancement or betterment of status and remuneration except that he has progressed and done a little more than his competitors.

Do more than you are expected—this has ever been a stepping stone to betterment. When you sell your services to your employer, if you measure out that service like the country store clerk does his sugar, putting into the scales just enough grains to balance the measure paid for, and sometimes cheating, then you will find yourself overlooked when it comes to selecting the fellow to take the better job. Remember that it is more urgent and necessary for your employer to advance you than it is to you to be advanced. For when he can advance you, it means that you are promoting the efficiency and success of your part in his business—have increased production or bettered the grade of work. No employer can be expected to aid the man who cannot or does not help himself.

Your job will be just about what you make it. If the stuff is in you, no one can hold you down but yourself. If you are not giving the best that is in you to your present job, your chances of hanging on to it, let alone ever getting a promotion, are mighty slender.

Look around you when you have finished your present task, and see if there are not some little extra things that you can do to make your boss take notice of you. Don't be afraid your fellowmen will call you a trimmer or accuse you of trying to play into the boss's favor. It takes men of determination and courage to arrive these days.

BOOSTER.

The Impatience of Modern Youth

At no time has the impatience of modern youth been more evident than at present. I was sitting near some of the youths in our shop on the bench during the lunch hour, and I overheard the following bit of conversation:

"What you goin' to quit for, Joe? Don't you like the shop?"

"Yes, but I was talking to a fellow in ———'s boiler works. You know they are booming over there and paying all kinds of money. I got the promise of a $12-a-week job if I go to work to-morrow, so I gave notice I'm going to quit."

After hearing this, I thought of the difference between the youth of to-day and the average lad when I served my apprenticeship. Here was a mere boy, seventeen years old, only part way through his apprenticeship, offering himself to a busy shop as a boiler maker capable of earning the $12 a week.

Impatient to jump ahead, he quits learning the trade at $6 a week and grabs the chance to make $12; perhaps he may earn it and continue to as long as the war boom lasts, but what of the time when the boom has ceased? Will his services be worth as much then as they would be had he continued his learning?

Of course there are some boiler maker lads who apply for these big jobs who are helping to support needy parents, but the largest percentage of the youths who are getting big money (for their age and experience) do not in any way profit by it. It is too generally the case that they find a vice or habit, in a little high life, that ruins all chance of development into decent manhood, it being due to nothing more than too much spending money.

Have you ever noticed a young, newly married couple of moderate circumstances possessing a whole houseful of nice new furniture—everything from a washing machine to a piano? All the nice things are there, and more, too, than the old folks ever got together in all the years of their married life. Of course, these are not paid for —the modern youth could not go that slow. This is the age of speed, so he gets them all in a week and pays for them on the installment plan.

The "royal road to learning" is too long and hard to travel for the impatient youth of to-day; he wants to start where his dad leaves off. It begins to show in them as young as twelve or fourteen years—they shake the knee pants, get into men's clothes and use tobacco, getting the idea that "it makes 'em look more like men." This impatient trait, that seems to be growing stronger every year in the average youth of the trade shops, is a large factor in the question, Why are not skilled mechanics more plentiful?

Experience.

Two Small Shop Kinks

The enclosed sketches show a couple of kinks of value to the small shop. Fig. 1 is called a bench hold-fast, and is invaluable for holding boiler tubes, round stock, etc.

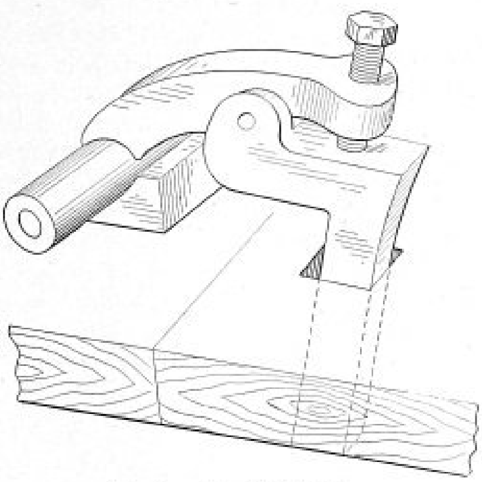


Fig. 1.—Bench Hold-fast

A number of square holes can be cut in the bench at most convenient places and the use of the hold-fast thus multiplied.

Fig. 2 shows another use for large size old files—that of making scaling or chipping hammers. The steel in

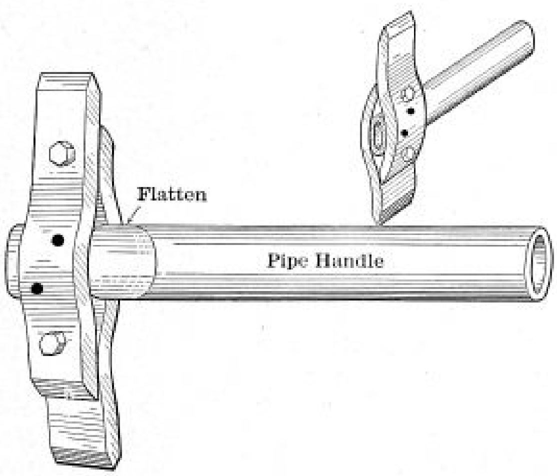


Fig. 2.—Scaling Hammer Made from Old File

old files when annealed is of excellent quality for scaling tools, and in view of the cost of good tool steel this is thought to be worth passing on as an economy kink.

Both sketches show plainly the construction of these tools and almost any boiler shop blacksmith can readily make them.

Concord, N. H. C. H. Willey.

Environment

The greater percentage of employees will reflect their environment. Only those of great force and self-mastery can obviate the view of material things and the suggestions of his surroundings. Physical conditions are greatly influenced by the mood, and the mood is also influenced by the condition of the physical being. Those who work amidst the noise and whirr of machinery in close, ill-ventilated, poorly lighted quarters, cannot be expected to arrive at work in the morning with an enthusiastic appetite for the new day's work.

E. T.

Special Gasket

Quite often when testing Babcock & Wilcox boilers that have seen long service, the boiler maker finds many of the handhole plate seats are much deteriorated and that the regular handhole plate gaskets will not hold tight. The writer has found that where poor seats like that shown in Fig. 2 are supplied with a special gasket (as

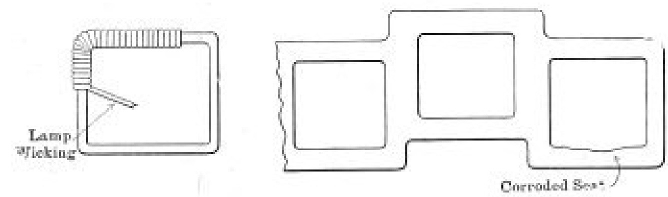


Fig. 1 Fig. 2

in Fig. 1) made from one of the regular ones by wrapping or winding with common lamp wicking soaked in red lead and carefully placed on the plate will cure the trouble.

When special gaskets are used, they should be given close attention when applying pressure, for, due to the thickness, they require considerable following up to make tight.

C. H. W.

The Boiler Inspector

The correspondence which has been published in The Boiler Maker relative to the experience necessary to properly qualify as a boiler inspector has been extremely interesting, as the subject is by no means "threadbare," although it would not be difficult to determine the experience of, or trade followed by, each one taking part in the discussion.

It is, of course, an easy task to convince the boiler makers that by "divine right" the position of boiler inspector is theirs, and likewise an engineer can see with "half an eye" that he inherently should inspect boilers; but it is a great deal more difficult to have the boiler maker agree that the engineer has opportunity or experience which would in any way fit him for the work, or vice versa.

No doubt there will be very few to agree that neither trade, nor profession, as some are pleased to term their vocation, is truly qualified to undertake, without special training, the important work of inspecting boilers, but such is the case; and, in view of the fact, the writer has a journeyman boiler maker's card, has an engineer's license, been a locomotive fireman, been instructor for several years in steam engineering, holds certificates of competency and appointments as a boiler inspector from several cities and states, is a member of the A. S. M. E., and has examined, employed and trained a great number of boiler inspectors, there can be no contention that the attitude herein taken is prejudiced.

If the history of the various boiler inspection laws is examined, it will be found that where the Brotherhood of Boiler Makers introduced and backed the legislative bills creating the office, there has always been the provision that the holder of the position should be a boiler maker having a certain number of years' practical experience at the trade.

Likewise, when one of the stationary engineering societies procure the passage of the boiler inspection law, it was invariably an engineer only who could qualify; and particularly is this true, and more or less logically so, when the boiler inspection law is connected with, or contains provisions for, the examination and licensing of stationary engineers.

To these conditions there are two exceptions: One is where the trade "left out in the cold" was able to force a compromise, and the other where the passages in the law defining the qualifications were poorly worded, enabling one of the opposing trade, with a good political pull, to put one over.

There have been cases where the disagreement over the qualifications of the inspector were so great, the fact that the law was, on the face of it, primarily for the protection of the public, was completely overclouded. So the contention that the boiler maker or engineer is best equipped by means of experience to inspect boilers, just because the law of a certain State or city so provides, is simply "rot," although it may freely be said that such a provision in the law indicates who were the best politicians.

There can be no disagreement that a knowledge of the design of a boiler is beyond the purely practical boiler maker or engineer, but is the result of studies which either may take up and become proficient in, depending upon the mental alertness of the individual. As a matter of fact, the men who are to-day designing boilers throughout the country have with few exceptions never driven a rivet nor opened a throttle. There remains, then, the practical work of construction and repair, installation and operation to be considered.

The engineer who has never had any boiler shop experience would be worse than lost if suddenly transferred to a boiler shop and burdened with the supervision of the work, and would be just as bewildered if compelled to determine just what repairs to make to a large number of boilers of widely different types. Likewise, the practical boiler maker would hardly be able to direct the setting, connecting up and operation of a battery of boilers, although that work has a direct bearing upon the safety of the boiler plant.

Those who have been "through the mill" and have helped pilot others, whether boiler makers or engineers, cannot help feeling that the claim that experience in either trade fully qualifies one to undertake the work of inspecting boilers, without a long, tedious "breaking-in" would be ridiculous, were it not so pitiful; for the expert boiler maker and licensed engineer have long hours of systematic study ahead of them of which they little know when they seek to become real boiler inspectors, and after they have reached a height where their opinions are of value to themselves and to the public they serve, they will agree that boilers should be inspected only by boiler inspectors, and that driving rivets and making feed water filters are but apprentice steps to boiler inspection, such as heating rivets is to boiler making and oiling is to stationary engineering.

It is to be regretted, but nevertheless true, that the average man is lacking in the power to concentrate his thoughts and arrive at a logical conclusion. This is especially true of those who have followed mechanical trades where the work is to a great extent routine and the developing of this ability, which must be possessed by the successful boiler inspector, is the hardest part of the "breaking-in" process.

Examples without number could be given of where the capable, practical mechanic failed to make good at supervising and inspecting simply because he could not realize that the difference of one factor in the equation completely changes the results.

While the belief that "It is a well-known fact that the railroads are leaders in the matters of efficiency," appearing in one of the articles on boiler inspection in the May issue of THE BOILER MAKER, is not so universal as the article in question would indicate, we can at least agree that there is a vast difference between the inspection and operation of track locomotive boilers and of stationary boilers. The locomotive is a self-contained engine practically unaltered from the time it leaves the shop new until it reaches the scrap pile, as each new part put in is made as nearly as can be a counterpart of the defective part removed, and with which the locomotive engineer has nothing to do. The stationary boiler, on the other hand, is often shipped "knocked down" and erected, walled in and piped up on the job, and should its design and type be such that it can be erected and placed in operation without the use of special tools, the stationary engineer usually oversees the work, if not actually performing the labor, which gives the stationary engineer a first-hand knowledge of conditions which have a marked bearing on the safety of the boiler, to say nothing of the close acquaintance he has with every tube, plate and brace as the result of his frequent cleaning of the interior.

The maintenance of the locomotive boiler and engine is a mater with which the locomotive engineer is not directly concerned, so his knowledge of the machine is limited—in fact, often woefully so—and there can be no logical ground for the conclusion that he is qualified to determine its safety, other than as that term may be applied to the few fittings, understanding, of course, that no reference is here made to the safety of the train as a whole, which depends to a certain extent upon the automatic air under the engineer's control.

The examination of a locomotive engineer, excluding that part covering train orders and air brakes, in no case compares in severity with the average examination which the stationary engineer must pass to obtain a license, both as to steam engineering theory and practice.

The locomotive boiler maker who is skilled in testing staybolts—and, by the way, not one in ten will lay a wager that all he marks are broken—has a knowledge "never learned at school," which, like the ability to ride a bicycle, is obtained only by experience; so we can agree that the logical locomotive boiler inspector, providing his experience includes all class of locomotive boiler repair and sufficient thought has been given to the boiler design, operation and appliances, is the boiler maker; but when called upon to exemplify his qualifications must not, as was recently done, ask his co-endeavorer in the seat ahead, *"What does factor of safety mean?"*

Reference has been made to some city whose boiler inspector had been a butcher, which, of course, merely shows the result of crooked politics; but there are, no doubt, butchers whose opinion regarding the design and safety of a boiler is just as valuable as the opinion of some boiler makers or the opinion of some engineers, for, as a matter of fact, the opinions of many of them are worthless.

The boiler maker who desires to become a boiler inspector, and there is nothing to prevent his doing so, should make a study of boiler material, design, construction, installation, repair and operation, and the engineer who has a like ambition should obtain a like knowledge.

The boiler makers as a whole should "build less boilers over the bar" and consider more fully the multiplication table. They can profitably cease to claim a complete knowledge of boilers "by right of trade," cease to ridicule the A. S. M. E. Boiler Code and encourage those responsible for the publication of the periodicals they read to "line up" with The Boiler Maker and similar progressive mechanical trade papers in presenting to their readers the latest practice in the art of boiler construction, so there will be no difficulty in "delivering the goods" when competitive examinations are held for positions as boiler inspectors.

The formulas necessary to use in order to determine the safe working pressure of a boiler have been reduced to a point where they may be understood by anyone with a knowledge of the multiplication table and percentage, and the columns of The Boiler Maker are always open for the complete explanation of anything in that line which is not understood.

Bumped Head.

Know Your Men

It has been generally conceded by eminent leaders of industry that in the personnel of the business lies its strength or its weakness. To develop the strength of any enterprise in the industrial field, those who compose the executive force should be men who have a profound interest and knowledge in both the business and its men. Perhaps the most valuable asset for an executive to have is that of knowing his men and the ability to apply this knowledge in successful handling of them to the best interests of both.

To so train the observation to be able to judge and analyze in a broad or general way the various types of human characters, and to classify each one according to his abilities, habits and aspirations, is a part of each executive's business education that he cannot afford to neglect.

This task assumes more importance and entails more personal efforts in proportion to the size of the business. When the number of employees is so great as to make personal contact of its chief executive and each individual a difficult or unfeasible task, then there is another course open to him, and that is to make each subordinate executive study the men under his immediate charge, and point out those of above ordinary merit or talent.

No business can ever assume such gigantic proportions that a chief executive cannot make each individual employee feel his personality. After considerable study and observation, it becomes easy for one to tell in a very short interview whether a man is mentally alert and ambitious, and what sort of an appetite he possesses for hard work. In a general way, each one of these things has a vital bearing on the individual's character and makeup.

In the heart of the humblest employee there may dwell a secret desire or aspiration to some day fill your job, and if you could stimulate such desire into ambitious effort, making that humble employee realize that you are noticing them—then multiply this humble employee by the total of the force—can you conceive the value of such to the business?

There is some doubt in the minds of many high grade executives as to the advantages of the "open door" policy of their office to the men. It would seem that should one bar the employees a right to a personal interview it would defeat all efforts of co-operation and harmony. A plan adopted by a successful executive in regard to the "open door" and employed with a good degree of success, is as follows:

During the noon hour of Monday, Wednesday and Friday the door is open for any employee with a request or a grievance to lay it before the chief executive. But it is known among the men that when a grievance or request involves their immediate superior, they must inform that person of their intentions to see the chief on such a day, and only when the nature of their business is such that their foreman or department head cannot aid them, or attend to it, should they interview the chief.

No executive can afford to shut himself away from his men. There are too many advantages to be gained from these face-to-face interviews. Often the impressions made by the attitude, expression of the eyes, manner of speech, qualities of personal appearance, etc., by the employee during such a conference, go further towards your understanding of him than anything that he may call to your attention in writing or through an office clerk. The value of personal contact is lost when the employee is allowed to think that he is acquiring a pull or attaining favoritism.

A great aid to better understanding and knowledge of employees is the so-called efficiency chart. This presents a record of each individual's health, brains, instruction, loyalty, enthusiasm, ambition, co-operation, personality, skill, character, and other traits that are of maximum value in analyzing a man.

Efficiency.

Oxygen for Boilers

When running plants under the improvised and usually adverse conditions of test, small points develop and have a knack of assuming undue prominence.

In most instances these side issues have nothing whatever to do with the results aimed at, while lessons of value sometimes thereby result quite apart from the matter in hand.

A recent instance it may seem foolish to quote occurred to the writer, and since it emphasizes a factor whose importance is less realized or more often taken for granted than should be the case it is here made public.

A plant dependent upon a steam boiler and whose nature need not be described consisted for the steam end of a vertical cross tube boiler 6 feet 6 inches by 12 feet. The entire plant was erected in the shop for steaming trials (for the result of which the writer was responsible), although the plant was not erected by him or under his supervision. The writer was only concerned with the due performance of the job to specified conditions.

After the trial was started up, it was found that the boiler, which should have produced steam much in excess of requirements, failed to obtain more than half pressure with the other gear running.

In defense of the poor steaming several explanations were tendered. The boiler, with stack, being entirely under cover, obviously was not in the best condition for draft. The fuel used was coke and the plant should use coal as fuel.

Now the firm in question employed several capable engineers and were accustomed both to the running of similar jobs and to best conditions. An examination of the fire showed this black and dull, and the question as to the location of the damper spindle with relation to the balanced arm discovered this in correct position.

Finally the real trouble became apparent. In putting down the boiler for test the packing used was a couple of 12-inch wide, 5/8-inch thick plates at either side. The space under the bottom of the boiler was thus only 1 1/4 inches. The width of the plates and their location also further choked the miserable air space provided.

The obvious remedy was then applied. By the aid of steel wedges and packing a 3-inch air space blocked only at three points 3 inches in width was given.

The fire went away with a rush, as if happy to suck in air, and hummed and purred delightedly. The steam gage pointer was soon vertical and the safety valves gave expression to their feelings. The stoker wore a less woebegone expression and everyone had quite a new alertness. Instead of apologizing for the lack of steam on the ground of the conditions of test, the excuse of a stock boiler was tendered that one 50 percent less in size would have been sufficient. As no one ever grumbles at a plenitude of steam and easy stoking, the fault was one easily condoned, and the test of the plant gave more than specified results, enabling the writer to report favorably thereon.

Now the boiler was placed by men who should have known, practical engineers of wide experience, yet the fact that more than half the fuel consumed in a boiler is plain atmospheric air at nothing per ton did not strike them as it should have done. No one had troubled about the question of adequate air space under the grate bars or how the draft was to be obtained. Normally at site a proper ashpit would have been provided, the boiler resting on brickwork or concrete, with the ashpit below.

The foregoing is a true story. It happened three days before the date of my writing this article.

No boiler is ever likely to be mounted permanently in a similar manner. The fact remains that the side issue on the job and its lesson is that the ashpit gets less credit than it deserves. We are apt to assume it a space for the collection of ashes merely; actually it is an air duct without which the fuel on the bars is valueless.

The average boiler maker, when he has made a closed elastic vessel to hold steam pressure in safe custody, is apt to assume that it is a boiler. Nothing is farther from the truth. A boiler consists in such a pressure vessel added to fire brick, fire bars, smokestack and ashpit. Minus the draft, natural or forced, the fuel cannot be consumed any more than steam can be produced without water. It is sure that a boiler consists no less of fire bars and ashpit than of tubes, rivets and shell.

The oxygen in the air is a fuel no less than coal. Neither is of value as a heat producer unless in chemical combination with each other, the effecting of which produces the heat we value by the change of state effected.

Air costs nothing, while coal has to be paid for. We value most those things we pay most for. As a consequence, the function of the air in a boiler's economy gets less credit, since it is free, and we rather look with suspicion upon something for nothing.

The product of perfect combustion is CO_2—carbon dioxide—one part carbon to two parts oxygen. Twice as much oxygen is necessary as coal, so that a full supply of air is twice as necessary as a due supply of coal. Seeing also that only one-fifth of air by volume is oxygen, then it takes ten times as much air as coal, and the importance of the free fuel is increased. Actually the proportion of CO_2 in the products of combustion from a boiler range from 10 to 15 percent of the total volume. The inert nitrogen and unconsumed fuel account for the remainder of the products made in the furnace.

Seeing that air is free, there is no sense in defrauding a boiler of its services by insufficient ashpit volume, nor is there sense in allowing ash to accumulate in a sufficient amount to hamper draft.

The boiler maker may often get the blame for a job of insufficient capacity when the fault really lies in the erection or bad handling of his product.

Fresh air, beneficial and necessary to human beings, is just as essential in the case of boiler furnaces, which is the moral of the story and the reflections suggested by the experience cited.

London, England A. L. Haas.

Boiler Compounds

For reasons which must be obvious, the editor has closed down this discussion. As the original mover of the resolution in favor of external treatment of feed water, indulgence is craved that the last word is spoken by the original proposer of the motion—myself.

I do not admit the validity of Mr. Wilson's arguments and remain unconvinced both by his facts or his controversial methods. I never claimed that distillation is a universal method of feed water rectification, consequently my critic's arithmetic has no validity. Data on boiler compound sales may prove that compounds are used. This was never denied; they *are* used—in inverse ratio to intelligence. Reports and investigations on the subject of boiler corrosion all avoid reference to the easy solution claimed by the boiler compound salesman. This looks as though his claims are discredited where they should be most prominent.

The writer is in possession of a large volume of evidence sought for diligently since the first of Mr. Wilson's articles appeared, but for good reason the editor cannot allow space wherein I can display my conclusions and quote my authorities, and perhaps it would serve no good purpose so to do.

The one point made by Mr. Wilson—that about sodium sulphate—neglects to add that it is inocuous to a boiler operating under normal conditions. As to the Chicago water supply, reagents are intended for reaction in the main, not in the consumer.

Doubtless earlier types of lime soda plant were defective, but modern plants of first-class type are a different proposition entirely.

It is an assumption warranted by facts in my possession that 20,000 lime soda plants of British origin are in operation. If the external treatment of water (and lime soda is very usual, although not the only method) is a failure, vast capital sums have been willfully squandered and are being constantly thrown away, for at least four considerable firms are solvent making little else. No less than four hundred lime soda plants from one source have been supplied to a single firm manufacturing water tube boilers.

Moreover, English main line railways—among the most conservative of engineering organizations—are installing lime soda plants, treating immense quantities of feed water daily.

In conclusion, Mr. Wilson states that my arguments are weak and silly. I pass without comment the undeserved gibe contained in the first paragraph of his May article, save to state that the inference is untrue in every particular. My object is not to convince him—that were a vain and thankless task. Tactics of the type he employs are common to street orators and weak cases. It is a maxim universally true that courtesy to the most stupid opponent is always worth while.

Hard cases and isolated instances prove nothing and make bad law. What is contended is that the evidence and its bulk is considerable. All points one way, and that is to the external rectification of feed water.

London, England. A. L. Haas.

Selected Boiler Patents

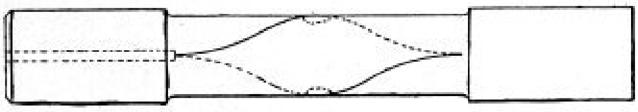
Compiled by

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

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

1,229,910. STAYBOLT FOR BOILERS. ETHAN I. DODDS, OF PITTSBURG, PA., ASSIGNOR TO FLANNERY BOLT COMPANY, OF PITTSBURG, PA.

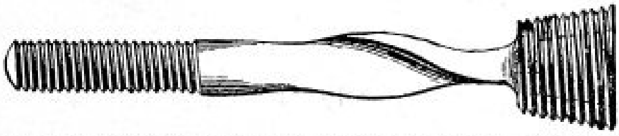
Claim 1.—As a new article of manufacture, a staybolt shank composed of a plurality of members, the said members being welded to-



gether at points intermediate the ends, thus leaving slots between the ends of the bolts and the intermediate welds. Four claims.

1,229,909. STAYBOLT FOR BOILERS. ETHAN I. DODDS, OF PITTSBURG, PA., ASSIGNOR TO FLANNERY BOLT COMPANY, OF PITTSBURG, PA.

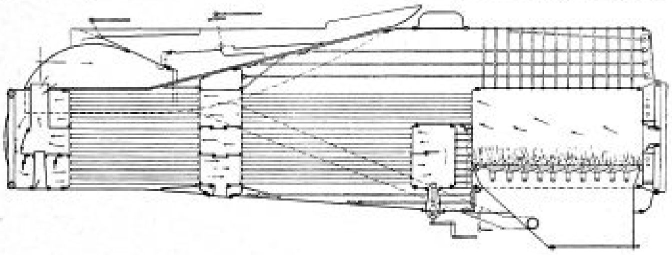
Claim 1.—A staybolt having a flattened and tapered shank, the cross



sectional area of the latter being approximately uniform throughout its length. Five claims.

1,229,588. SPARK ARRESTER. CHARLES W. CROWELL, OF BISCOE, N. C.

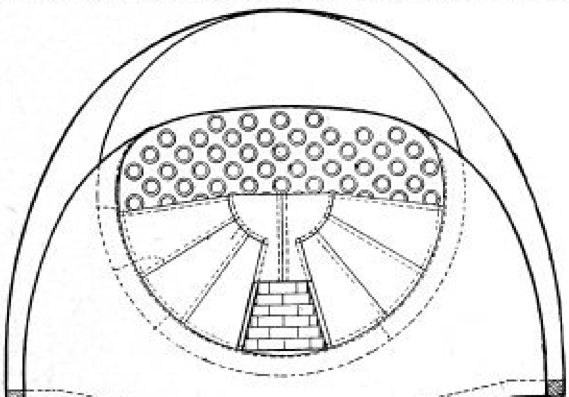
Claim 1.—A boiler having an outlet or stack arranged horizontally on the top with its discharge end at the rear and communicating directly to the atmosphere at the rear, a horizontal passage extending from the



front end of the stack where it opens directly forward and reaching partially through the stack, through which passage air may be directly passed from the front of the stack, and a damper for controlling the movement of air through said passage. Eleven claims.

1,229,385. WOOTEN-TYPE FIREBOX. ALFRED H. WILLET, OF WEST NEW YORK, N. Y., ASSIGNOR TO AMERICAN ARCH COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

Claim 8.—A locomotive firebox having a combustion chamber extension forward of its grate and throat sheet, in combination with an upright refractory wall erected on the floor and against the sides of said



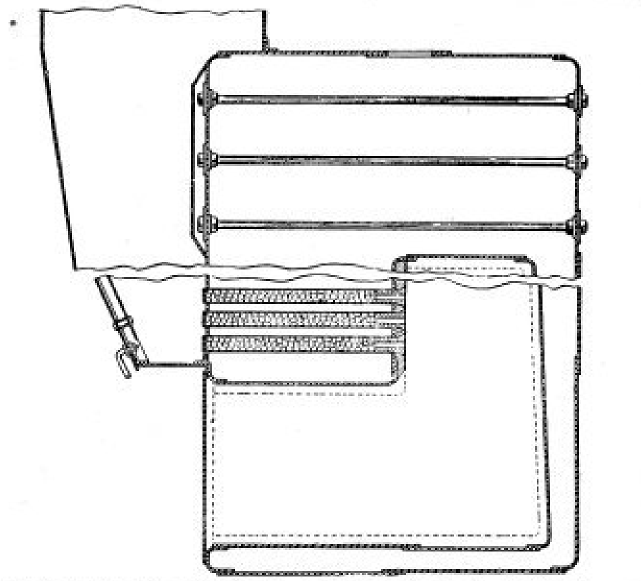
extension, said wall being composed of a plurality of radially positioned sector bricks and a central interlocking brick, and said bricks being shaped to present a rectangular clean-out opening in the lower part of the wall. Nine claims.

1,229,171. WATERTUBE BOILER. HENRY ALEXANDER TURNBULL, OF SURREY HILLS, VICTORIA, AUSTRALIA.

Claim.—A watertube boiler, comprising an inner and outer lining, a combustion chamber in the lower portion of the inner lining, a plurality of heating elements each consisting of a plurality of vertical tubes and upper and lower headers with which the tubes are connected, the elements being arranged with their tubes in staggered relation and their headers on the same level and close together, the lower headers being arranged directly above the combustion chamber, horizontal baffle plates projecting from opposite sides of the inner lining and through which the tubes pass, a steam drum, a mud drum, and a plurality of down-comers connecting the steam and mud drums, the steam and mud drums and down-comers being outside of the inner lining.

1,230,990. STEAM GENERATION. WILLIAM ARTHUR BONE AND JAMES WILLIAM WILSON, OF LEEDS, AND CYRIL DOUGLAS McCOURT, OF LONDON, ENGLAND, ASSIGNORS TO RADIANT HEATING, LIMITED, OF LONDON, ENGLAND, A CORPORATION OF GREAT BRITAIN.

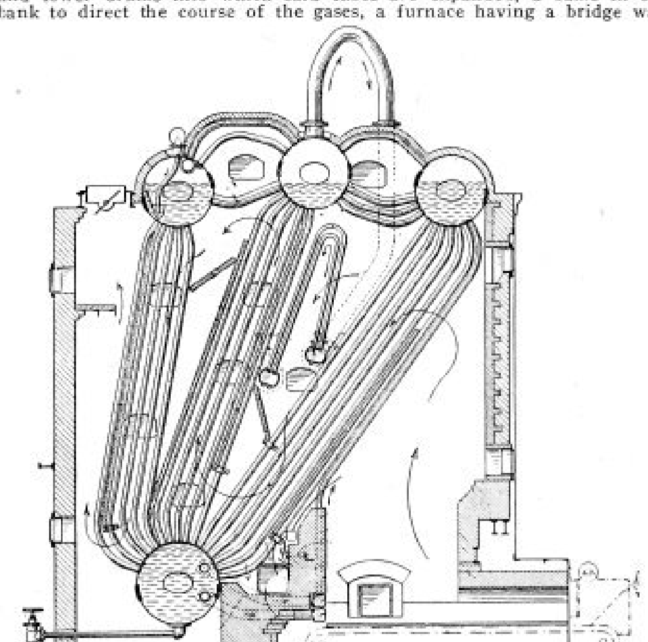
Claim 1.—Steam generating apparatus, comprising in combination with a boiler shell, a combustion chamber for the primary combustion of the fuel, a heating tube traversing the water space of the boiler and leading



from the combustion chamber to a suction offtake to receive the combustion gases and unburned fuel from the combustion chamber, said tube containing refractory material whereby the transmission of heat to the water from the hot combustion gases passing through the tube is increased and the combustion within the tube of unburned fuel is promoted. Nine claims.

1,231,896. STEAM 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.—A steam boiler comprising a bank of generating tubes, upper and lower drums into which said tubes are expanded, a baffle in said bank to direct the course of the gases, a furnace having a bridge wall,



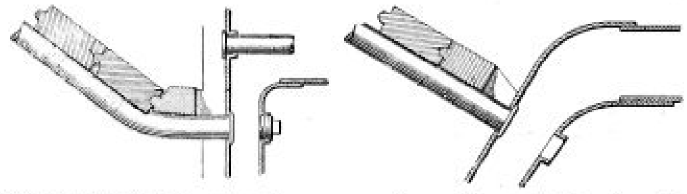
and a yielding seal between said baffle and bridge wall to permit of a movement of the lower part of the bank of tubes relatively to the bridge wall and to prevent leakage of the gases. Six claims.

1,232,687. FURNACE GRATE. CHARLES J. HUBER, OF BALTIMORE, MD., ASSIGNOR TO HUBER GRATE BAR & STOKING COMPANY, OF BALTIMORE, MD., A CORPORATION OF DELAWARE.

Claim 1.—In a furnace grate, the combination with supporting means, of a rearwardly sloping series of oscillatory grate sections each embodying a plurality of grate bars, a stringer bar intersecting said grate bars between the front and rear extremities thereof, and a guard wall also intersecting said grate bars at the extremities thereof, the lower portion of the outer face of said guard wall and the adjacent extremities of the grate bars being described on the arc of a circle of which the axis of movement of the grate section is the center, the upper portion of the outer face of the guard wall being concave on an arc of which the axis of the adjacent bar is the center. Seven claims.

1,231,854. FIRE-BRICK ARCH FOR BOILER FIREBOXES. MILLARD F. COX, OF LOUISVILLE, KY.

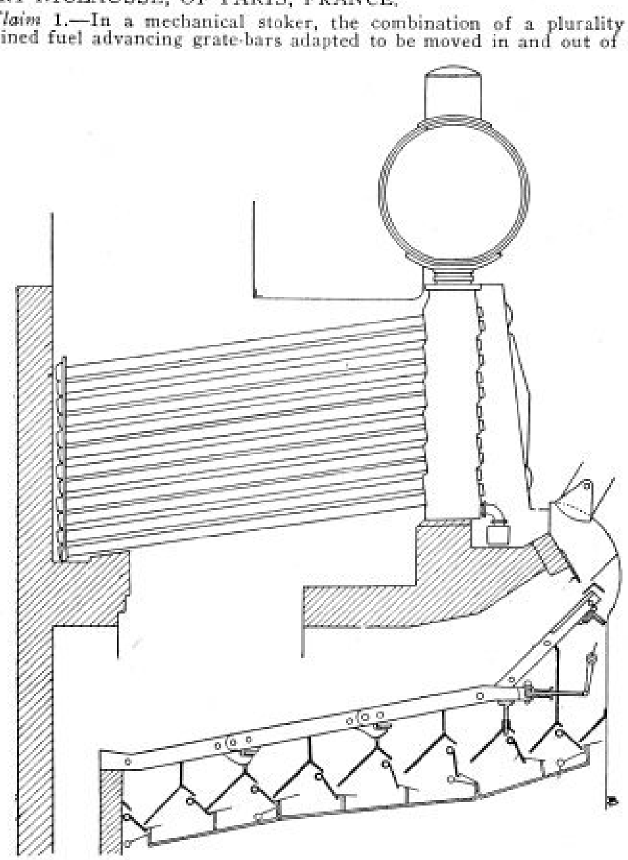
Claim 1.—A fire brick for firebox arches having a tongue at one edge and a groove at the opposite edge, with a spacing projection carried by the wall of the groove, the width of the tongue being such that only a



portion thereof may enter the groove of an adjacent brick when the bricks are assembled in an arch, whereby the body portions of adjacent bricks will be spaced apart. Two claims.

1,231,930. FURNACE GRATE. JULES NICLAUSSE AND ALBERT NICLAUSSE, OF PARIS, FRANCE.

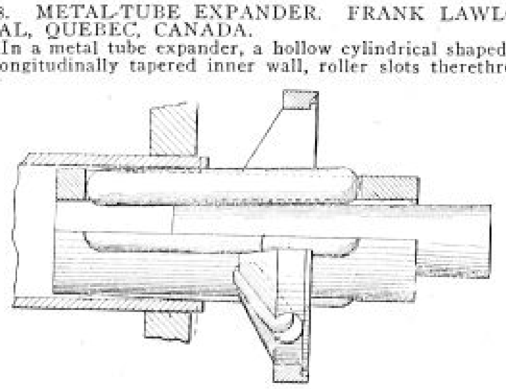
Claim 1.—In a mechanical stoker, the combination of a plurality of inclined fuel advancing grate-bars adapted to be moved in and out of the



inclined fuel supporting plane, other grate-bars inclined to the first-named bars for feeding fuel thereto and having lost motion engagement therewith at their ends, and actuating means for the bars. Five claims.

1,232,938. METAL-TUBE EXPANDER. FRANK LAWLOR, OF MONTREAL, QUEBEC, CANADA.

Claim.—In a metal tube expander, a hollow cylindrical shaped member having a longitudinally tapered inner wall, roller slots therethrough, an



annular rigid shoulder and slots in said shoulder dividing it into sections partitioning said roller slots and a removable ring rigidly secured to said shoulder, a plurality of rollers in said shoulder slots and a tapered pin engaging said rollers from the interior of said hollow member.

1,232,640. FEEDING AND BURNING FINE FUEL. WALTER D. WOOD, OF NEW YORK, N. Y., ASSIGNOR TO FUEL SAVINGS COMPANY, OF ALLENTOWN, PA., A CORPORATION OF PENNSYLVANIA.

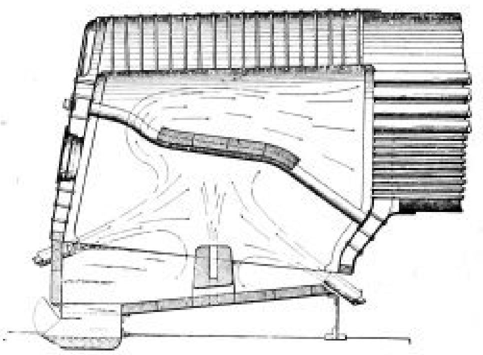
Claim 1.—In an apparatus for feeding and burning fine fuel, the combination of a mixing chamber, means for supplying fuel thereto, means for creating and supplying an air current, means for carrying said current to the mixing chamber and to the furnace, the current being divided for this purpose and that which passes from the mixing chamber being dust-laden, while the other part of the air current commingles with said dust-laden current and travels forward with it into the furnace, valve mechanism for controlling the amount of the air current, and other valve mechanism for controlling the quantity of the fuel supplied to the mixing chamber, together with means for jointly operating the valve devices. Ten claims.

1,231,803. ARCH PROTECTOR FOR BOILERS. DAVID SMITH, OF WELLESLEY, MASS.

Claim 1.—An arch preserver for a furnace mouth comprising a metallic conduit having a cylindrical outer wall and an inner concentric cylindrical wall having its ends flanged outwardly to engage the outer wall, the inner and outer walls being secured together by continuous welded seams to form an integral structure and inlet and outlet means adapted to provide connections to a fluid circulating system. Four claims.

1,234,870. BURNING PULVERIZED FUEL. VIRGINIUS Z. CARACRISTI, OF ALBANY, N. Y., ASSIGNOR TO LOCOMOTIVE PULVERIZED FUEL COMPANY, A CORPORATION OF DELAWARE.

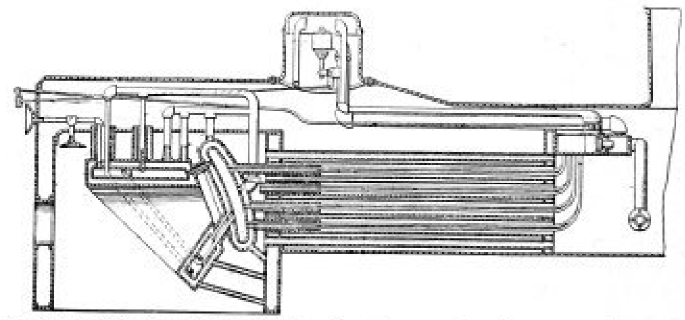
Claim 1.—The improvement in the method of burning pulverized or fluid fuel which consists in delivering a plurality of bodies or columns thereof to a furnace, upwardly and at different relative angles, toward



a substantially central locus of combustion therein, and deflecting the flame of the fuel, in a plane above said locus of combustion, from said locus of combustion toward the rear and top of the furnace. Three claims.

1,235,363. STEAM SUPERHEATER. JAMES S. NICHOLS, OF ATLANTA, GA.

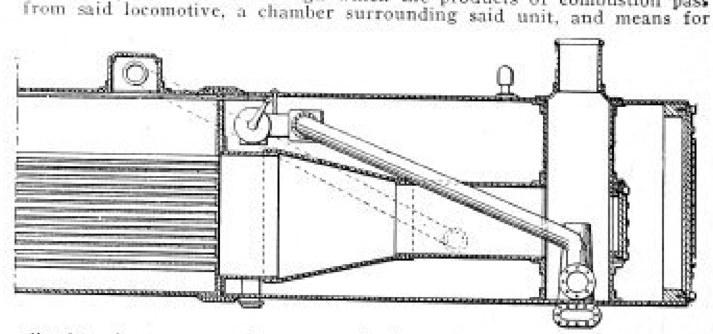
Claim 1.—The combination with a steam boiler having a smoke-box, of a superheater embodying a superheated steam chamber located in the smoke-box and connected to receive superheated steam from the superheater, means for conducting superheated steam from said chamber to



the boiler and also from said chamber to an outlet for use, and means located in said chamber connected to receive superheated steam and operative to direct such steam from said chamber to the boiler, said means being also operative to direct and throttle the flow of superheated steam from said chamber to said outlet. Fifteen claims.

1,235,412. LOCOMOTIVE. CAMPBELL E. ARNOLD, OF TAMPA, FLA.

Claim 1.—In a compressed air locomotive, a superheater comprising a funnel-shaped heat unit through which the products of combustion pass from said locomotive, a chamber surrounding said unit, and means for



allowing the passage of compressed air and steam into said chamber and other means for allowing the passage of said air and steam into the cylinders of said locomotive. Five claims.

1,231,894. METHOD OF REGULATING THE TEMPERATURE OF SUPERHEATED STEAM. DAVID S. JACOBUS, OF JERSEY CITY, N. J., ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, N. J., A CORPORATION OF NEW JERSEY.

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

THE BOILER MAKER

NOVEMBER, 1917

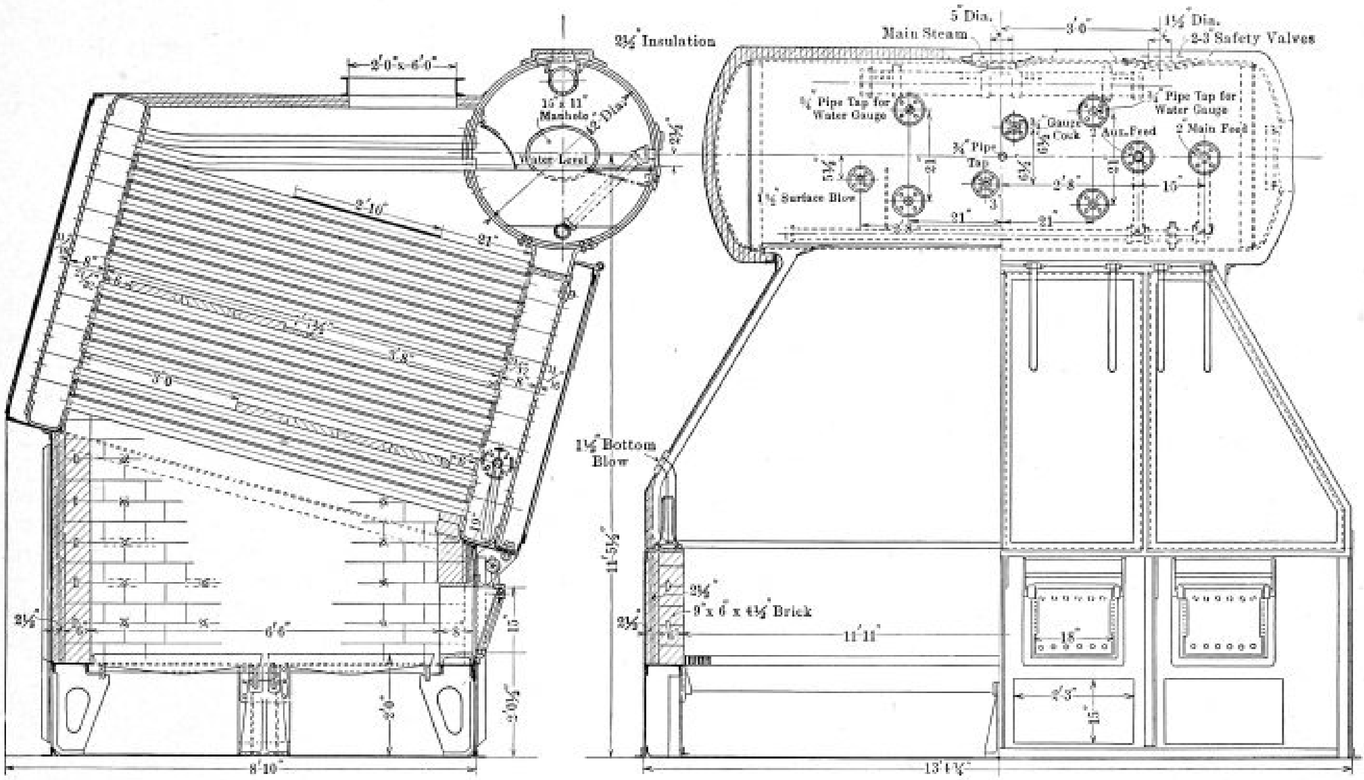


Fig. 1.—General Arrangement of Standard Boilers for Wooden Emergency Fleet

Standard Watertube Boilers for United States Emergency Wooden Steamships

Cross Drum, Straight Tube Type Watertube Boiler Designed by United States Shipping Board Emergency Fleet Corporation

As outlined in our September issue, the boilers for the standard wooden steamships of 3,500 tons deadweight carrying capacity which are being built for the United States emergency fleet will be of the marine watertube cross-drum type, with straight tubes expanded into continuous stayed steel plate headers.

This boiler has been designed by the United States Shipping Board Emergency Fleet Corporation, which has charge of the building of the ships for the Shipping Board, and the following is taken from the general specifications of the boiler:

Working pressure .... 200 pounds gage
Hydrostatic pressure .... 400 pounds gage
Grate surface .... 77.5 square feet
Total heating surface............ About 2,500 square feet
Number of 3-inch straight tubes, 7 feet 9½ inches long, No. 10 B. W. G. 94
Number of 3-inch straight tubes, 7 feet 9½ inches long, No. 11 B. W. G. 299
Number of 3-inch bent tubes, about 6 feet 5 inches long, No. 11 B. W. G. 11
Number of 3-inch bent tubes, about 6 feet 3½ inches long, No. 11 B. W. G. 10

The boiler will be fitted with a system of forced draft and is designed to evaporate 15,000 pounds of water per hour, with feed at 200 degrees F. when burning about 20 pounds of anthracite coal per square foot of grate.

These specifications embody all Rules and Regulations of the U. S. Steamboat Inspection Service, as amended to date, applying to marine watertube boilers for ocean and coastwise trade. The design having been approved by the Board of Supervising Inspectors and by the American Bureau of Shipping, no substantial departures shall be allowed unless submitted in writing, accompanied by suitable drawings, to the Engineering Department of the Emergency Fleet Corporation.

Tubes

Tubes shall be hot rolled, seamless, steel, 3-inch outside diameter, of No. 11 B. W. G., except the three bottom rows, which shall be No. 10 B. W. G.; all tubes to be straight except the two top rows, which shall be bent to 36-inch radius near the back header. The ends of all tubes shall be flared not less than 1/8 inch over the diameter of the tube hole and shall project through the tube sheets not less than 1/4 inch nor more than 1/2 inch before flaring.

Headers

Headers shall be constructed entirely of open hearth steel plates. Back header shall be stayed with 1 3/4-inch diameter hollow bolts, made from seamless iron or steel tubes, screwed in place and the ends riveted over. Front header shall be stayed with 1 1/2-inch diameter solid steel or iron bolts screwed in place and ends riveted over. They shall be drilled at the ends with a 3/16-inch hole to at least a depth of 1/2 inch beyond the surface of the sheet.

Drum

The steam drum will be 42 inches inside diameter, of open hearth steel plate, preferably in one sheet, with longitudinal seam butted and strapped inside and outside and riveted as shown, the butt straps to be formed under pressure to the proper curvature of the drum before assembling for riveting.

The drum heads will be spherically bumped and flanged by hydraulic pressure at a single heat and edges turned off true. The radius of the bump will be equal to the diameter of the drum. One head will be solid, 5/8 inch in thickness; the other head will be 11/16 inch thick and will have a 11- by 15-inch elliptical manhole flanged in and faced, and will be properly reinforced by a forged or cast steel ring, of the same depth as the flanging, conforming to the shape and curve of manhole as shown. To avoid grooving, the flanging shall be well rounded at the bend.

Holes shall be cut through the bottom of the drum as shown for the circulation of water to the front header.

Drilling, Riveting and Calking

Pilot holes for rivets, not to exceed 75 percent of the diameter of the full size finished hole, may be punched on outside plates only, such as tube and hand-hole sheets, front header connection to drum, outside drum butt strap, circumferential laps at drum's ends and pressed steel nozzles for main steam and safety valves. No punching shall be allowed on inside plates, with the exception of the few holes necessary for setting up bolts.

All drilling and reaming for rivet holes shall be done from the outside after plates are assembled; then the plates shall be taken apart, all burrs removed, oil cleaned off, and plates reassembled, metal to metal, using a sufficient number of parallel turned bolts fitting the holes to insure their accurate alinement before riveting. The use of drift pins will not be allowed.

To insure a well-proportioned rivet point, rivets shall be of sufficient length to completely fill the rivet holes and form a head equal in strength to the body of the rivet. Rivet holes shall be slightly countersunk in order to form a fillet at point and head.

Bulled rivets shall be used where possible and shall be driven at a cherry red heat and held in bulling machine at least thirty seconds.

Air riveting shall be done at practically uniform pressure, with an air dolly for holding on against air riveter.

All rivets shall be set tight in a careful and workmanlike manner, and all joints throughout will be carefully calked watertight on the outside without excessive calking. Inside calking will be allowed only at the discretion of the corporation's inspector.

Edges of plates shall be planed for calking and chipping of edges shall be avoided as much as possible.

Holes for screw stays shall be tapped fair and true and full thread.

Holes for tubes and staybolts will preferably be drilled full size from the solid plate, but centers or guide holes, not to exceed 75 percent of the diameter of the full-size hole, may be punched; the remainder shall be cleanly cut, drilled, or reamed to full size.

No bolts will be used for any purpose passing through the shell of drum or header plates.

Connections to Drum

The drum shall have two pressed steel nozzles, with an outlet for main steam and safety valves as shown. All other openings in the shell shall have forged steel pads located and riveted as shown. All nozzles and pads shall be formed by pressure to the exact curvature of the drum before riveting, and shall be drilled and tapped for studs to suit "American Standard" extra heavy flanged valves and fittings.

Internal Fittings of Drum

The steam drum shall have a steel dry pipe, perforated on its upper side with saw cuts aggregating one and one-half times the area of the pipe. Dry pipe shall be supported by two straps and a standard cast iron tee, and shall be held in place with 1/2-inch set screws. Tee shall be secured to the drum shell by an expanded nipple and will have 1/2-inch drip hole, as shown.

The boiler feed connections shall be arranged as shown with an internal feed pipe having drilled holes of an aggregate area of 50 percent in excess of the area of feed pipe. The end of pipe will be capped and supported by a bracket, as shown.

There shall be 1 1/2-inch surface blow connection fitted with a scum pan, as shown. Both internal feed and blow pipes will be expanded in the holes of their supporting pads.

The drum shall have two swash plates and a hinged baffle plate built in sections, all located and arranged as shown.

Zinc Plates and Baskets

Sixteen zinc plates, 12 by 6 inches by 1/2 inch thick, or of such size that they may be cut from standard rolled plates with the minimum loss, will be fitted in the drum as shown. They will be contained in a steel plate basket for catching disintegrated zinc, having perforated sides, as shown. Each zinc plate will be supported by two 5/8-inch bolts filed bright and forced in plate to secure proper metallic contact. Supporting bolts and metal, where they come in contact with basket, shall be also filed bright before zincs are secured in position, after which the joints shall be well painted.

Manholes and Handholes

The manhole plate shall be faced and turned to a true oval to fit manhole and shall be dished, as shown. Each plate shall have two forged steel studs with pressed steel yokes and handle, as shown. The manhole in the drum head with reinforcing ring will be seated for manhole gasket of approved material.

Each handhole in outside header plate will be closed with a conical, forged steel plug, held in place by a

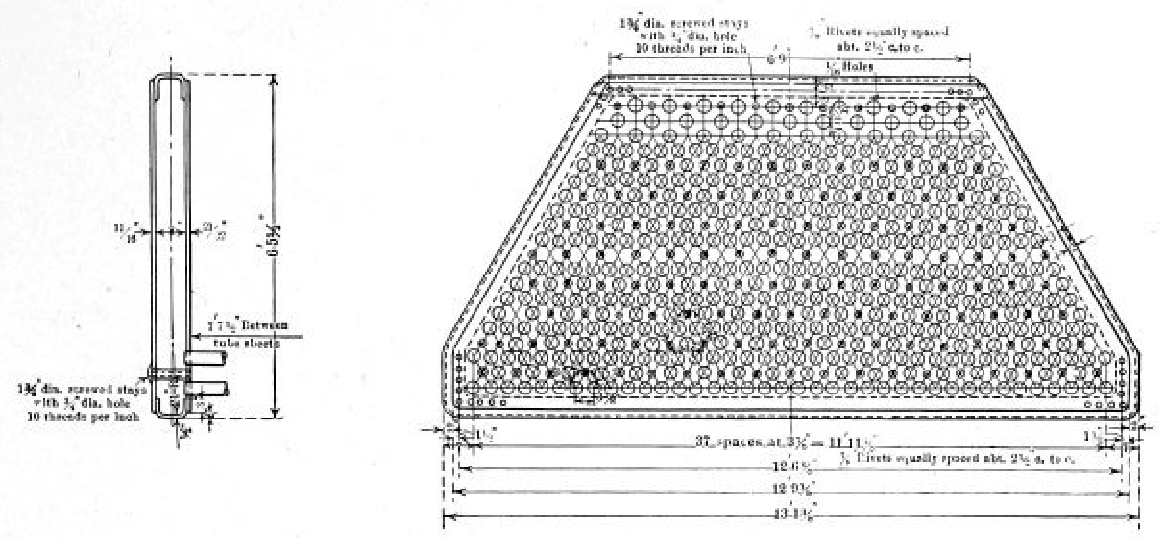


Fig. 2.—Back Header

threaded stem, and cup-shaped yoke plate and forged steel nut. The joint will be made tight on the inside by means of a copper ferrule. The inner edge of the handhole shall be rolled with a special expander to allow flaring of the copper ferrule. The plug will be accurately finished to fit the ferrule and will be properly milled out to allow its being inserted from the outside.

Furnace

The furnace shall be constructed of steel plates and angles, designed to be readily disassembled for shipment.

The firebox and casing shall part along a plane parallel to the inclination of the tubes and be so formed as to provide a support for the lower part of the front and back headers, as shown.

The ashpan shall be built of steel plates made in sections for easy removal, with edges of plates flanged for bolting together.

The furnace shall be lined with special fire bricks, 9 by 6 by 4½ inches, which shall have continuous grooves on one end, as shown, to receive ⅝-inch square head bolts for fastening to casing. These grooves shall be completely filled with approved high pressure cement. A thin coating of the same cement shall be interposed between butts and successive layers of fire bricks. There shall also be 2½ inches of approved insulating material between the brick lining and the casing.

Casing

The boiler casing shall be made of steel plates and shapes arranged as shown. The sloping sides of the boiler shall be lined with 2½-inch standard fire bricks resting on the outer tubes and 2½ inches of approved insulating material.

The casing shall be built in panels, bolted together as shown on drawings. All bolts for assembling on ship-

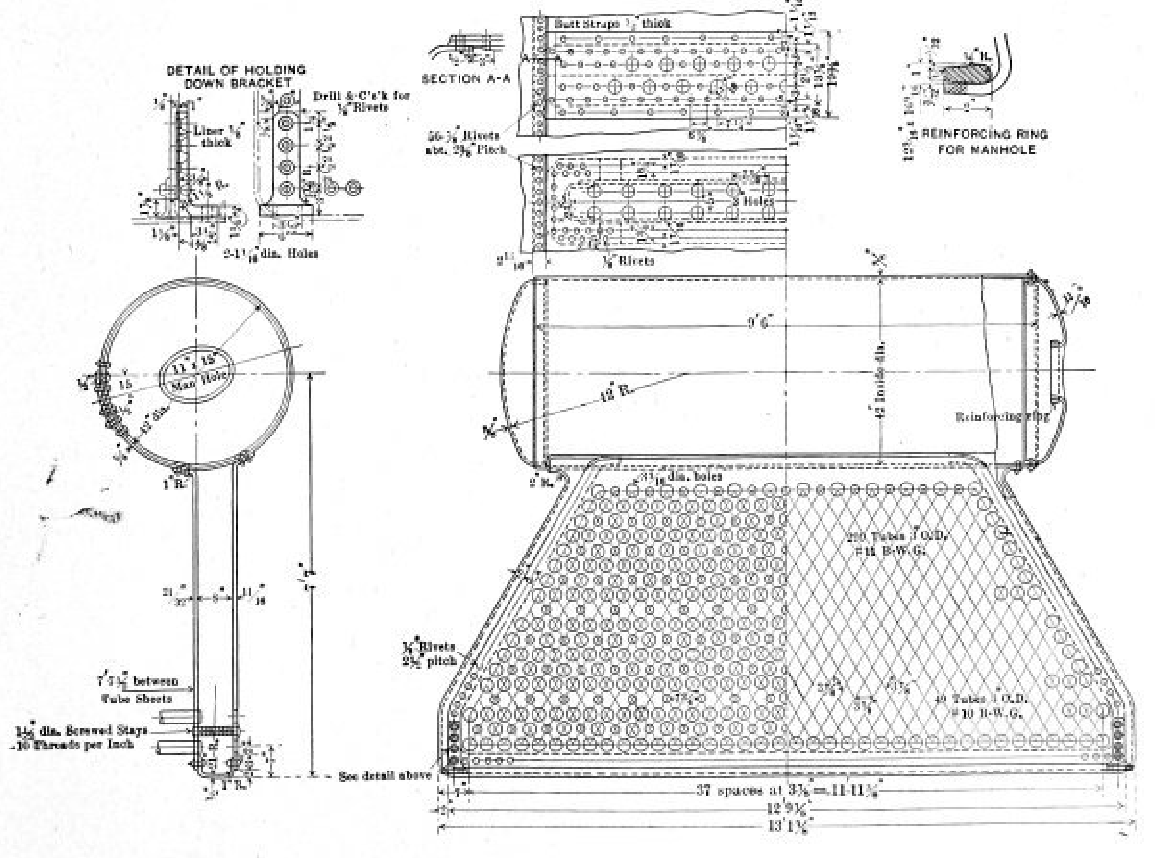


Fig. 3.—Drum and Front Header

board shall be shipped with the plates. The top of the casing shall be built of double steel plates properly supported with angles and brackets, as shown, and insulated with 2½ inches of approved material.

The steam drum shall have 2 inches of approved insulating material held in place by poultry wire, with a ½-inch lining of plastic magnesia on the outside and neatly worked around all pads and manhole opening.

Furnace Front and Doors

The fire front of the boiler will be of steel plates reinforced by angles, as shown, and will contain fire and ash doors. There shall also be four steel plate firing doors, 15 by 18 inches, of the inswinging, counterbalanced type, provided with holes for air circulation. The door frames will be of cast iron in removable sections, bolted to the furnace front.

The ashpit doors will be of cast iron, also of the inswinging counterbalanced type.

Both ashpit and fire doors will be balanced in such a way as to close automatically in case of sudden outrush of steam, such as would follow the bursting of a tube.

Portable lazy bars with hooks for supporting when in use will be provided for furnace doors.

The dead plates shall be of cast iron and so fitted as to be easily removed and replaced.

Front and Rear Tube Doors

Front and rear tube doors will be made of steel plates, riveted to a bar steel frame stiffened by gussets and lined with ⅜-inch asbestos milled board and be hinged for proper access to headers for cleaning, repairs and renewal of tubes, as shown. These doors will be fitted with forged steel latches to hold doors tightly in place.

Access and Inspection Doors

Doors for inspection and renewal of baffle tile shall be provided and located in accordance with the design shown.

Baffles

Baffles shall consist of 2 by 12 by 7½-inch special tile, except the top baffle, which shall consist of ¼-inch steel plates properly held in place.

The lower baffle tiles shall be held in place, at a distance of about 6 inches from the front header, by cast iron distance pieces. The middle baffle tiles shall be prevented from sliding by a cross bar of cast iron about 5 by 1¼ inches, fastened to the casing at both ends.

Boiler Fittings

Each boiler shall have the following fittings of approved makes:

One 3-inch duplex type safety valve with rocker shaft levers, marine type, cast iron body, wicket-seated, brass-fitted, exposed spring.

Two 2-inch stop valves for main and auxiliary feeds.

One 1½-inch valve of the sliding piston type for bottom blow.

One 1-inch standard globe valve for surface blow.

Two composition heavy pattern quick-closing water gages with ½-inch packed brass cocks, 21 inches between centers, with levers and chains for operating from floor. Gage glasses shall be ¾-inch diameter of best Scotch glass and protected by four brass guard rods. Bottom cock to be provided with ⅜-inch blowout cocks.

Three composition heavy pattern quick-closing weighted gage cocks, with chains for operating from floor.

One double-spring steam pressure gage, 10-inch face, in iron case with brass ring, dial to be graduated from 0 to 400 pounds.

One ¾-inch standard valve for drain at bottom of rear header.

One ½-inch salinometer and drain cock fitted to each front header were shown.

All valves over 1 inch diameter shall be extra heavy flanged type. Size and drilling of flanges to conform to "American Standard" for high pressure.

Name Plate

There shall be fastened to the front of each boiler a brass plate containing the name of the manufacturer of the material, the place where manufactured, the tensile strength, the name of the builder of the boiler, and when and where built. The date of the building of the boiler shall be determined by the month and year of issue of the first certificate of inspection which covers the boiler in question.

Tools and Spare Parts

There shall be furnished for each boiler:

One 3-inch tube expander and mandrel, with extra roll for flaring tubes.

Two wrenches for handhole nuts.

Twelve handhole plugs and yokes complete.

Two hundred 3-inch copper ferrules.

Ten 3-inch diameter tubes, 7 feet 9½ inches long, of No. 11 B. W. G.

Ten 3-inch diameter tubes, 7 feet 9½ inches long, of No. 10 B. W. G.

Four 3-inch diameter tubes, bent, 6 feet 5 inches long, of No. 11 B. W. G.

Six water gage glasses.

Three manhole gaskets.

One 3-inch turbine cleaner of approved make.

Two tube scrapers with handles.

Six cast iron plugs to fit No. 10 3-inch tubes.

Six cast iron plugs to fit No. 11 3-inch tubes.

Two plug extractors.

One set of steel templets of 3/16-inch plate, for manhole plate gaskets.

Hydrostatic Pressure

Each boiler shall be tested hydrostatically to a pressure of 400 pounds per square inch in the presence of the local inspector of the United States Steamboat Inspection Service and the corporation's own inspector.

The pressure shall be carefully increased to the specified amount and kept constant until the inspectors have thoroughly examined every part of the boiler.

Inspection

Facilities for the usual inspection, by the corporation's representatives, during the process of construction, shall be provided by the contractor.

Installation and Supervision

The corporation will build the foundations and do all other work assigned as part of the hull work necessary to accommodate the apparatus furnished by the contractor. The corporation will assemble and install the boilers supplied by the contractor, and will connect up same with steam and water connections and uptakes, as required.

In the event of the corporation requesting it, the contractor shall furnish competent engineers to supervise the work of installation, and the contractor shall separately state the per diem rate required for this service.

Trials and Acceptance

Final acceptance will be made after the boiler has satisfactorily passed the shipbuilder's dock trials and full power sea trial, as directed. Any defects developed within one year from date of acceptance and clearly due to faulty workmanship will be made good by and at the expense of the contractor.

General

Boiler will be erected complete in shop and subjected to thorough inspection by the corporation's representatives, and then dismantled, crated and packed with complete packing lists furnished, and shipped f. o. b. cars at the contractor's works, as directed.

A coating of fuel oil shall be applied to all exposed parts.

Handhole plugs shall be set in place and all openings in drum and headers shall be plugged or closed with bolted flanges to prevent injury to studs.

"Lady McGregor"—the Largest Locomotive Built in Queensland

First of New Class of Locomotives Built by Ipswich Government Railway Workshops for 3-Foot 6-Inch Gage Track

BY JOHN O'TOOLE

The largest locomotive in use in Queensland, Australia, up to the present time, is the "Lady McGregor," built in the Ipswich Government Railway workshops and named after the wife of the Governor of Queensland. This is the first of a new class of locomotives known as the class "C 18" and is of the 2-8-0 type built for a 3-foot 6-inch gage track.

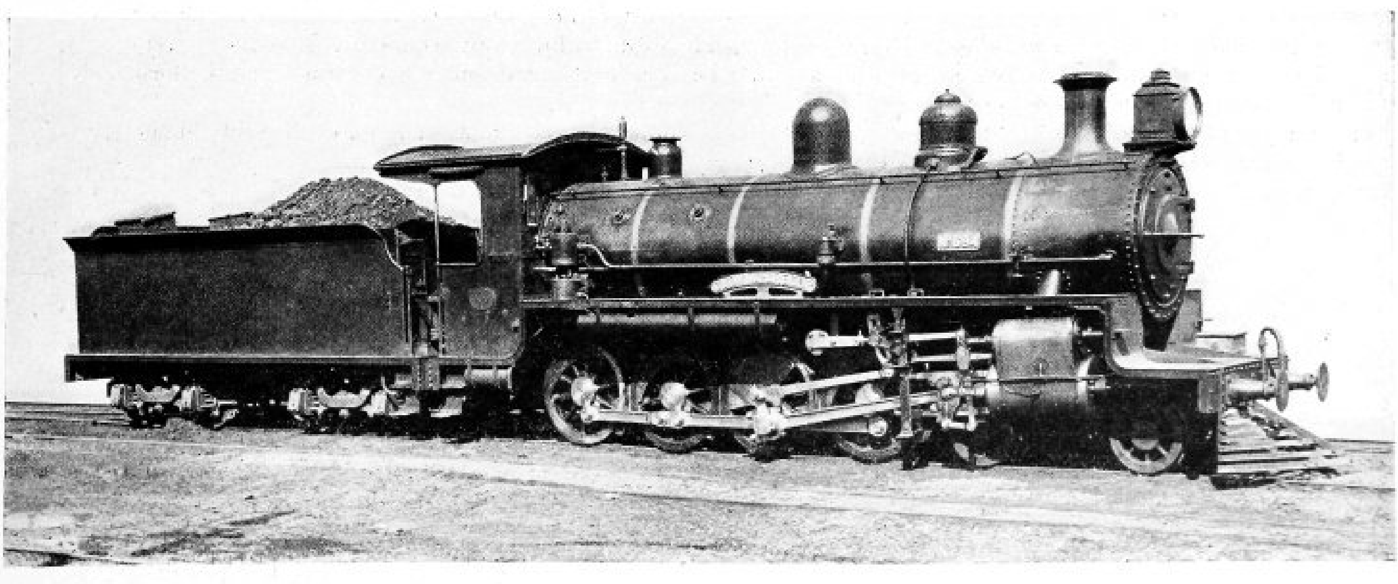
The boiler is of steel with 5/8-inch plates in the barrel and 11/16-inch wrapper plates. The firebox is made of copper and is fitted with 242 copper coated steel tubes 1¾ inches outside diameter. The firebox stays are all of copper.

The boiler is built for a working pressure of 175 pounds per square inch gage and has a total heating surface of 1,043 square feet distributed as follows: 122 small tubes, 601 square feet; 21 large tubes, 295 square feet; firebox, 147. There are also 21 superheater elements having a heating surface of 225 square feet, making the total heating surface, including the superheater elements, 1,268 square feet. The grate area is 21.37 square feet, making a ratio of H. S. to G. A. of 59 to 1.

In running order the engine weighs 52 tons 13 cwt. The weight available for adhesion is 40 tons 8 cwt. The weight of the tender in running order is 40 tons, the coal capacity 7 tons, and the water capacity 3,500 gallons. The weight of the engine and tender complete in running order is 92 tons 13 cwt. The total wheel base of the engine and tender is 48 feet 4¾ inches and the total length over buffers 55 feet 10¼ inches.

The cylinders of the engines are 18 inches diameter and 23 inches stroke. The driving wheels are 4 feet in diameter. At 80 percent boiler pressure the tractive force of the locomotive is 21,735 pounds. These locomotives were the first on the Queensland railways to be fitted with piston valves which have inside admission and are operated by the Walschaerts gears. The steam throttle is of the American balance type, the blow-off cock is operated by pneumatic pressure and the fire bars are of the rocker-bar type.

The ashpan doors, which slide, are also pneumatically driven from the cab. The engine is equipped with the Wakefield mechanical lubricators and two Sellers injectors. The brakes are of the Westinghouse type, two vertical cylinders, 13 inches diameter, one on each side, operating the brake shaft. The sand box is fitted on top of the boiler and is worked by gravity.



"Lady McGregor," Latest Product of Queensland's Government Railway Workshops

Care and Maintenance of Locomotive Boilers and Their Appurtenances—I

System of Inspection—Record of Operations—Rules for Testing and Cleaning Boilers—Methods of Testing Rigid and Flexible Staybolts

BY WILLIAM N. ALLMAN

In the matter of boiler maintenance, to obtain the highest state of efficiency, it is unnecessary to argue the fact that it is required to inspect the boilers at regular intervals; furthermore, various phases of inspection and testing are necessary in order to comply with the rules and regulations issued by the Interstate Commerce Commission.

It therefore becomes necessary to have some system of inspection to bring about the best results. It is also important to maintain a correct record of the various operations in order to know when the boiler is again due for inspection and tests.

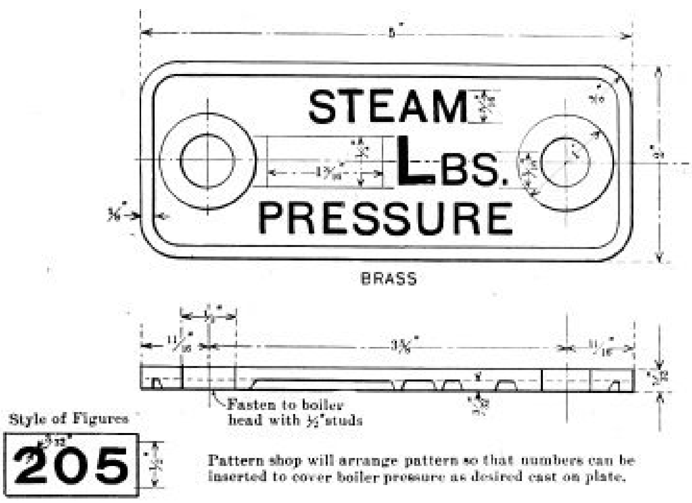


Fig. 1.—Badge Plate

The following rules are therefore submitted, and which are believed to cover good practice.

Rules for Testing, Inspecting and Cleaning Locomotive Boilers

Legal Requirements.—Where laws exist covering and testing of locomotive boilers, the requirements of same shall be fully complied with. Where no laws exist, the following rules must be adhered to. Where laws do exist but do not require tests as rigid as the following, the necessary test must be made to conform to these rules and the law.

Authorized Steam Pressure.—The maximum steam pressure to be carried by locomotive boilers must be in accordance with latest instructions.

Badge Plates.—A badge plate as per Fig. 1, showing the authorized steam pressure, must be applied to the back head of all locomotive boilers in accordance with following instructions:

This plate to be applied to back head of all locomotive boilers in some convenient location.

The lagging and jacketing must be cut away if necessary, in order that plate will be visible at all times.

When placing orders for plates it will be necessary to state what pressure is desired cast on the plates.

The foundries will arrange for the proper numbers indicating pressure desired as ordered.

The pressure as covered by badge plates must correspond with the authorized steam pressure, and should also correspond to the pressure as shown on Federal and State railroad inspection cards posted in locomotive cabs.

No increase in the steam pressure of locomotive boilers will be allowed without written authority from proper officer.

Internal Inspection

Time of Inspection.—The interior of every boiler shall be thoroughly inspected before the boiler is put into service, and whenever a sufficient number of flues are removed to allow an examination.

Removal of Flues.—All flues of boilers in service, except as otherwise provided, shall be removed at least once every three years and a thorough examination shall be made of the entire interior of the boiler. After flues are taken out, the inside of the boiler must have the scale removed and be thoroughly cleaned. Record of removal of flues to be made on Form No. 5 (Fig. 2) and reported on Forms No. 1 and 3 (Figs. 3 and 4).

Removal of Flues—Time Limit.—Removal of flues will be due after three years' service, provided such service is performed within four consecutive years. (Same explanation as covered under hydrostatic test applies to this rule also.)

Method of Inspection.—The entire interior of the boiler must be examined, especially the seams, rivets, braces, staybolts, etc., as far as possible, and all defects found remedied. It must also be examined for cracks, pitting,

BOILER AND FIRE BOX

Line No.	Station	Flues Removed			Crown Stays and Stay Bolts		Condition of								Date of						Date Form Applied		Inspectors
		All	Number	Date of Previous Removal	Condition of	Renewed	Fire Box Sheets and Flues	Arch Tubes	Interior of Boiler	Exterior of Boiler	Sling Stays and Crown Bars	Throat Braces	Back Head Braces	Front Tube Sheet Braces	Boiler Washed	Hydrostatic Test: Date	Hydrostatic Test: Pressure	Removal of Caps from Flexible Stay Bolts	Removal of Lagging: From Barrel	Removal of Lagging: From Fire Box	1047 Revised	1047-A Revised	
1																							
2																							
3																							
4																							
5																							
6																							
7																							

Fig. 2.—Form No. 5, on Which Record of Removal of Flues is Made

MONTHLY LOCOMOTIVE INSPECTION AND REPAIR REPORT.

Month of......................................, 191.... LOCOMOTIVE { Number .... Initial............................

The Railroad Company.

In accordance with the act of Congress approved February 17, 1911, as amended March 4, 1915, and the rules and instructions issued in pursuance thereof and approved by the Interstate Commerce Commission, all parts of locomotive No.................. including the boiler and appurtenances, were inspected on........................., 191 , at.. and all defects disclosed by said inspection have been repaired, except as noted on the back of this report.

1. Steam gauges tested and left in good condition on ...., 191
2. Safety valves set to pop at .... pounds, ... pounds, ... pounds on.........................., 191
3. Were both injectors tested and left in good condition? ....
4. Were steam leaks repaired? ....
5. Condition of brake and signal equipment, ...
6. Condition of draft gear and draw gear, ...
7. Condition of driving gear, ...
8. Condition of running gear, ...
9. Condition of tender, ...

I certify that the above report is correct

...., *Inspector.*
...., *Inspector.*

10. Was boiler washed and gauge cocks and water glass cock spindles removed and cocks cleaned? ....
11. Were steam leaks repaired? ....
12. Condition of stay bolts and crown stays, ...
13. Number of staybolts and crown stays renewed, ...
14. Condition of flues and firebox sheets, ...
15. Condition of arch and water bar tubes, if used, ...
16. Were fusible plugs removed and cleaned? ....
17. Date of previous hydrostatic test, ..., 191 .
18. Date of removal of caps from flexible staybolts, ..., 191 .

I certify that the above report is correct.

...., *Inspector.*
...., *Inspector.*

STATE OF .... }
COUNTY OF .... } *ss:*

SUBSCRIBED AND SWORN TO before me this .... day of ...., 191 , by { .... }

inspectors of the...Company.

...., *Notary Public.*

The above work has been performed and the report is approved.

...., *Officer in Charge.*

Fig. 3.—Form No. 1

grooving or indications of overheating, and for damage where mud has collected or heavy scale formed. The edges of plates, all laps, seams, rivets and points where cracks and defects are likely to develop must be given an especially minute examination. It must be seen that braces and stays are taut and that pins are properly secured in place, also that each is in condition to support its proper load. The interior of shell should be thor-

ANNUAL LOCOMOTIVE INSPECTION AND REPAIR REPORT.

...., 191... LOCOMOTIVE { Number .... Initial............................

The Railroad Company.

In accordance with the act of Congress approved February 17, 1911, as amended March 4, 1915, and the rules and instructions issued in pursuance thereof and approved by the Interstate Commerce Commission, all parts of locomotive No..................., including the boiler and its appurtenances, were inspected on........................., 191 , at.., and all defects disclosed by said inspection have been repaired, except as noted on the back of this report.

1. Date of previous hydrostatic test, ...191
2. Date of previous removal of caps from flexible stay bolts. ...., 191
3. Date of previous removal of flues, ..., 191
4. Date of previous removal of all lagging, ..., 191
5. Hydrostatic test pressure of .... pounds was applied.
6. Were caps removed from all flexible stay bolts? ....
7. Were all flues removed? .... Number removed ....
8. Condition of interior of barrel, ...
9. Was all lagging removed? ....
10. Condition of exterior of barrel, ...
11. Was boiler entered and inspected? ....
12. Was boiler washed? Water glass cocks and gauge cocks cleaned? ....
13. Condition of crown stays and stay bolts, ...
14. Condition of sling stays and crown bars, ...
15. Condition of firebox sheets and flues, ...
16. Condition of arch tubes, ... Water bar tubes, ...
17. Condition of throat braces, ...
18. Condition of back head braces, ...
19. Condition of front flue sheet braces, ...
20. Were fusible plugs removed and cleaned? ....
21. Were steam leaks repaired? ....

I certify that the above report is correct.

...., *Inspector.*
...., *Inspector.*

22. Were steam gauges tested and left in good condition? ....
23. Safety valves set to pop at .... pounds, ... pounds, ... pounds.
24. Were both injectors tested and left in good condition? ....
25. Were steam leaks repaired? ....
26. Hydrostatic test of .... pounds applied to main reservoirs.
27. Condition of brake and signal equipment, ...
28. Were drawbar and drawbar pins removed and inspected? ....
29. Condition of draft gear and draw gear, ...
30. Condition of driving gear, ...
31 Condition of running gear, ...
32. Condition of tender, ...

I certify that the above report is correct.

...., *Inspector.*
...., *Inspector.*

STATE OF .... }
COUNTY OF .... } *ss:*

Subscribed and sworn to before me this ...... day of ...., 191 , by { .... } inspectors of the

....Company.

...., *Notary Public.*

The above work has been performed and the report is approved.

...., *Officer in Charge.*

Fig. 4.—Form No. 3

YEAR	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1917												
1918												
1919												
1920												
1921												
1922												
1923												

Fig. 5.—Reverse Side of Forms Nos. 1 and 3

oughly cleaned and scale removed. Special report to be made of any unusual conditions found.

Repairs.—Any boiler developing cracks in the shell which will impair the safety of the boiler shall be taken out of service at once and repaired before it is returned to service, proper report being made on Form No. 19 (Fig. 6), as required by order of the Interstate Commerce Commission issued under date of June 9, 1914.

It is therefore desired that all concerned be particularly careful to report any changes under the following headings on Form No. 19, and it is to be understood that such information must be absolutely correct, as it is necessary that Form No. 19 be sworn to by the person under whose supervision the work is performed and executed by a notary, which must then be forwarded to the mechanical engineer for approval:

A—Application of new barrel sheets or domes.

B—Application of patches to barrels or domes of boilers or to portion of wrapper sheet of crown bar boilers which is not supported by staybolts.

C—Longitudinal seam reinforcements.

D—Changes in size or number of braces, stating location of braces in boiler.

ALTERATION REPORT FOR LOCOMOTIVE BOILERS

The following alterations were made on the boiler of locomotive No............owned by..............................

Company and operated by..................................Company, on..........................., 191.., at.................

.... The builder's or assigned number stamped on the dome of this boiler is............

Note.—Describe below what alterations were made. When blue prints or drawings accompany report, state same below or on back of report.

State of.................................. }
County of................................ } ss:

.... being duly sworn says that he inspected the above-mentioned alterations and certifies that the above report is correct.

....
(Name of affiant)

Subscribed and sworn to before me this................day of......................................., 191..

....
Notary Public

The above alterations have caused the following changes in calculated maximum stresses for this boiler:
Note.—If stresses are not affected by the alterations, insert the words, "Stresses not changed."

[SEE INS]TRUCTIONS ON REVERSE SIDE

....
Mechanical Engineer

Fig. 6.—Form No. 19

E—Initial application of superheater, arch or water-bar tubes, giving number and dimensions of tubes.

F—Changes in number or capacity of safety valves.

When reporting changes on Form No. 19, it must be understood, in addition to the locomotive number, the builders or serial number stamped on the dome of the boiler must be shown, and in all cases the latter must be taken directly from the dome of the boiler itself and not from any existing records. This is to be done in order that a check can be made on the boilers each time forms are filed.

Where patches or seam reinforcements are applied to the barrels or domes of boilers or to wrapper sheet of crown bar boilers, it must be understood that a complete sketch covering the application should be made on Form No. 19 in the space provided for, or a blue print sketch attached to the form if same cannot be legibly shown on the form proper. These sketches to be made on a sheet 8 by 10½ inches or multiples thereof, and must cover the patch or reinforcement complete in every detail, showing all dimensions, including the thickness of the plate used in the patch, diameter of rivets, diameter of rivet holes, pitch of rivets, distance from center of outer holes to edge of plate, and whether iron or steel plates and rivets are used in making such repairs.

INSTRUCTIONS ON REVERSE OF FORM NO. 19

Extract from Rule 54 of the Rules and Instructions for Inspection and Testing of Locomotive Boilers and their Appurtenances:

When any repairs or changes are made which affect the data shown on the specification card, a corrected card or an alteration report on an approved form, size 8 by 10½ inches, properly certified to, giving details of such changes shall be filed within thirty days from date of their completion. This report should cover:

A. Application of new barrel sheets or domes.

B. Application of patches to barrels or domes of boilers or to portion of wrapper sheet of crown-bar boilers which is not supported by staybolts.

C. Longitudinal seam reinforcements.

D. Changes in size or number of braces, giving maximum stress.

E. Initial application of superheaters, arch or water-bar tubes, giving number and dimensions of tubes.

F. Changes in number or capacity of safety valves.

Report of patches should be accompanied by a drawing or blue print of the patch, showing its location in regard to the center line of boiler, giving all necessary dimensions, and showing the nature and location of the defect. Patches previously applied should be reported the first time the boiler is stripped to permit an examination.

INSTRUCTIONS FOR PREPARING FORM

Describe accurately what alterations were made.

The location and extent of cracks, pitting, corrosion and grooving must be shown and dimensioned unless the defective plate is removed.

Drawing must show whether the plate underneath patch was removed.

Report must state whether iron or steel rivets were used.

The sizes of rivet holes must be given, as well as the size of the rivets.

If authentic records of the tests of material used in making repairs can be obtained, the lowest tensile strength as shown by test must be given; otherwise 50,000 pounds for steel and 45,000 pounds for wrought iron will be allowed as provided by Rule 4.

In case of patches applied prior to July 9, 1914, if there is no authentic record of the date or the shop where the alteration was made, insert the word "Unknown" in the proper blank spaces.

It is not necessary to report patches on surfaces supported by staybolts.

All changes in the design of boilers, such as changing from crown bar staying to radial staying, etc., as well as the transfers of boilers, must be shown.

The original and two copies of this form must be forwarded to the office of the Mechanical Engineer for approval, within ten (10) days after such changes have been made.

The extent and nature of the defect covered by such patches must also be shown on the sketch—that is, when the defect be a crack the length of same must be indicated on the sketch, and its location with reference to some fixed point on the boiler, as well as its location with reference to the center line of the boiler; where holes are cut in shell, this must be also indicated on sketch, giving size of such holes. If the boiler be pitted, grooved or corroded, the extent of such defects must be indicated on the form. Where irregular patches are applied, the exact location and spacing of all rivet holes must be clearly indicated.

In all cases where single plate patches are applied, the thickness must never be less than the thickness of the plate to which it is applied.

In case of patches applied prior to July 1, 1914, if there is no authentic record of the date when or the shop where the alteration was made, insert the word "Unknown" in the proper blank spaces. It will not be necessary to report application of patches on surfaces supported entirely by staybolts.

Where old patches have been removed from boilers and replaced by new ones, a complete sketch of the new patch must be shown on Form No. 19, and a notation shown thereon stating that it replaces an old patch.

Where authentic records of the tests of boiler plates used in making repairs or constructing new boilers exist, the lowest tensile strength as covered by test reports must be shown on Form No. 19.

It will also be necessary to indicate on Form No. 19 transfers of all locomotive boilers from one locomotive to another when such changes are made, giving the builder's numbers, or boiler serial number in conjunction with the locomotive number with each and every case.

It is extremely important that all concerned in the repairs of boilers be thoroughly acquainted with the manner in which the application of patches are to be handled, and it must be further understood that three (3) copies of Form No. 19 are to be forwarded to the office of Mechanical Engineer as soon as possible, after such changes have been made, as they must be filed with the Interstate Commerce Commission within thirty days after completion of the work.

External Inspection

Time of Inspection.—The exterior of every boiler shall be thoroughly inspected before the boiler is put into service, and whenever the jacket and the lagging are removed.

Lagging to be Removed.—The jacket and the lagging shall be removed once every five years to permit inspection of the exterior of the boiler, or whenever the firebox is renewed, or whenever the Federal, State or railroad company's inspectors consider it desirable or necessary to thoroughly inspect the boiler.

Hydrostatic Test

Pressure for Test.—All locomotive boilers must be subjected to a hydrostatic pressure of 25 percent above their rated working pressure, before being placed in service.

Frequency of Test.—This test must be made not less than once each twelve months.

Maximum Test Period.—Hydrostatic test will be due after twelve month's service, provided such service is performed within twenty-four consecutive months. For example: If a boiler receives a hydrostatic test and is placed in service for a period of six months and then placed in storage for fourteen months, and then again placed in service, it would be due for the next hydrostatic test in four months, at which time the twenty-four months' period has expired; in other words, the maximum period between hydrostatic tests for a boiler placed in service is twenty-four months, provided the boiler has not had more than twelve months' actual service.

Preparation for Test.—The water must be heated to about the boiling point immediately before pressure is applied.

Removal of Dome Cap.—The dome cap and throttle stand pipe must be removed at the time of making the hydrostatic test and the interior surface and connections of the boiler examined as thoroughly as conditions will permit. In case the boiler can be entered and thoroughly inspected without removing the throttle stand pipe, the inspector may make the inspection by removing the dome cap only, but the variation from this rule must be noted in the report of inspection.

Witness of Test.—When the test is being made, an authorized representative who is thoroughly familiar with boiler construction must personally witness the test and thoroughly examine the boiler while under test.

Reporting and Recording of Test.—A report of each hydrostatic test must be made on Forms 1 or 3, as well as record being made on Form No. 5.

Repairs and Steam Test.—When all necessary repairs have been completed, the boiler shall be fired up and a steam pressure raised to not less than the allowed working pressure and carefully examined for all defects in the boiler, seams, rivets, bolts, cocks, valves and appurtenances, which must be remedied before placing boiler in service.

Staybolt Test

Frequency of Test.—All rigid staybolts of locomotives in service must be tested not less frequently than once each fifteen days. Staybolts must also be tested immediately after each hydrostatic test.

Preparation for Test.—When these tests are made, there must be not less than 50 pounds of steam pressure on the boiler, which will produce sufficient strain upon the staybolts to cause separation of the parts of broken ones. If the boiler is not under steam the examination may be made after drawing all the water from the boiler.

Method of Testing Rigid Staybolts.—An inspector especially trained for the service must tap with a hammer each staybolt and crown sheet stay accessible on the firebox end, and those not accessible must be tapped whenever possible on the outside end and judge if any are broken. Staybolts having telltale holes must in addition to the hammer test be carefully tested, to insure that all of the telltale holes are open, using a drill for this purpose when necessary.

Method and Frequency of Testing Flexible Staybolts.—All flexible staybolts having caps over the outer ends shall have the caps removed at least once every eighteen months, or whenever the United States or railroad company's inspector considers the removal desirable, in order to thoroughly inspect the staybolt. The firebox sheets to be examined carefully at least once a month, to detect any bulging or indications of broken staybolts.

All flexible staybolts without caps shall be tested once each month in the same manner as rigid bolts, and in addition shall be tested each time the hydrostatic test is applied while the boiler is under a hydrostatic pressure not less than the allowed steam pressure, proper notation of such test being made on Forms No. 1 or 3.

Removal of Caps—Time Limit.—Removal of caps from flexible staybolts will be due after eighteen months' service, providing such service is performed within thirty consecutive months. (Same explanation as covered under hydrostatic test applies to this rule also.)

Broken Staybolts.—No boiler shall be allowed to remain in service when there are one or more staybolts broken in the top row of firebox, nor two or more adjacent broken or plugged staybolts in any part of the firebox, nor three or more broken or plugged staybolts in a circle 4 feet in diameter, nor when five or more staybolts are broken in the entire boiler.

Removal of Staybolts.—Precaution must be taken to insure the removal of all defective staybolts, and a careful examination made of bolts adjacent to broken ones.

Telltale Holes.—All telltale holes and staybolts must be thoroughly cleaned by drill before hydrostatic test is ap-

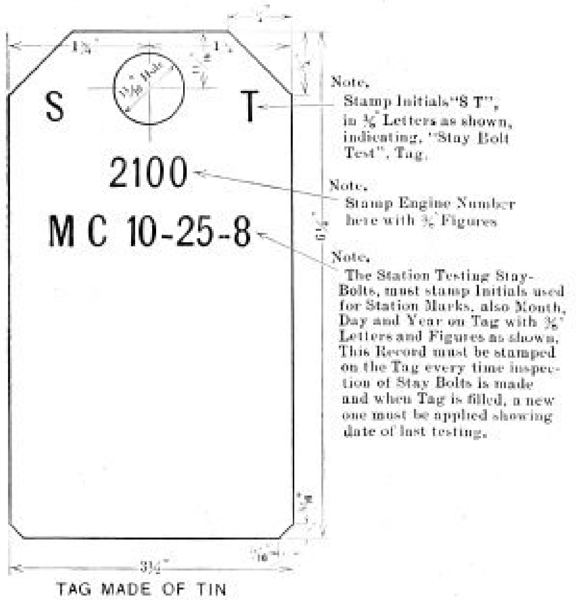


Fig. 7.—Metal Tag Showing Date of Staybolt Test

plied and also when locomotives are in shop for classified repairs.

Reporting of Test.—The staybolt inspector must make a record of staybolt test on Form No. 5 and reported on Forms 1 or 3.

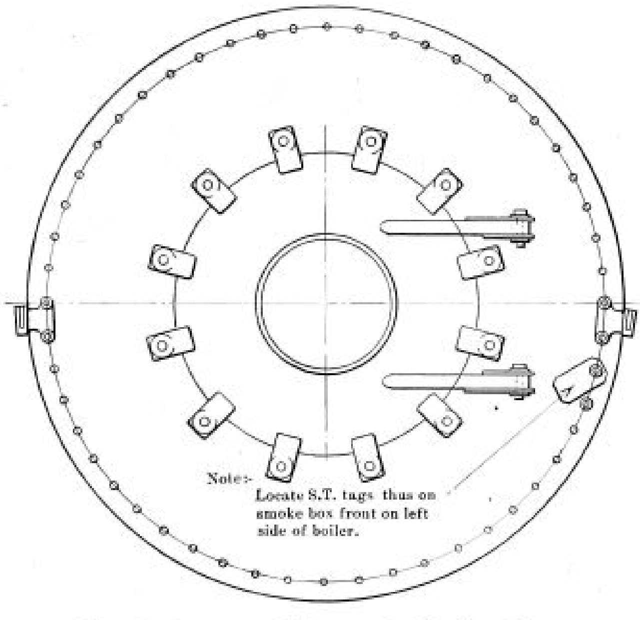


Fig. 8.—Location of Tag on Smoke Box Front

A metal tag must also be attached to the smoke box front as per Figs. 7 and 8, showing date of staybolt test.

INSTRUCTIONS FOR THE TESTING AND EXAMINATION OF STAYBOLTS

First. The boiler inspector at each station must keep a book record of the date of the examination and test of staybolts of each locomotive, in addition to the individual record kept on the smoke box front tag.

Second. The inspection and test should be made in accordance with general rules governing the renewals, repairs, testing and inspection of locomotive boilers, fireboxes, flues and staybolts, and also the report of staybolt test and firebox inspection, Form No. 5.

Third. Where locomotives assigned to one division may be in temporary service on another division, the master mechanic of the division on which the locomotive is assigned shall take up with the master mechanic of the division on which the locomotive is in service, in order to see that the staybolt test and examination is performed at the proper time.

Fourth. The boiler inspector at each station should make up daily a list of locomotives that are due for staybolt test and examination. This list should be brought to the attention of the engine dispatchers, leading hostlers, boiler washers and all others concerned. The leading hostlers and others employed at the ashpits should also make an examination of the tag record on the smoke box front of incoming locomotives, and keep informed as to whether the fire should be knocked on account of the staybolt test being required. They should also notify the boiler inspectors and others concerned when they find home or foreign engines for which test is due.

(To be continued.)

Unusual Experiences with Pipe*

Ordinary pipe is used in various industries and some peculiar experiences are encountered. We mention below some unusual or "freak" incidents in which the inherent qualities or "punishability" of pipe are demonstrated—for the most part by unusual accidents. As will be noted, it would be practically impossible to duplicate the circumstances involved in connection with many of the various pieces shown.

The piece of 5 3/16-inch steel casing shown in Fig. 2 was originally about 18 feet long and was stuck in an oil

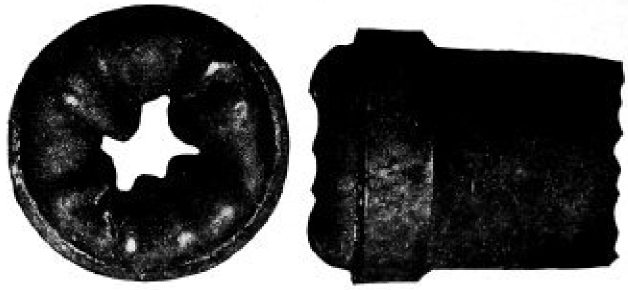


Fig. 1.—Bottom Section of 10-Inch Oil Well Casing After Crushing

well. One hundred and seventy quarts of nitroglycerine had been placed in the well and same was shot off with the idea of blowing this piece out, at the same time "shooting" the well. Instead of blowing it out, however, the casting was reduced in length from about 18 feet to approximately 6 feet. It was drawn to the surface after great difficulty and was crushed, twisted and distorted, but no fracture was shown. This happened in the Ohio field.

A string of 340 feet of 10-inch, 32.515-pound South Penn oil well casing fell 236 feet when an elevator let go. Fig. 1 shows what happened to the bottom length when the casing hit the bottom of the well. The thread protector was forced over the threads and up over the pipe approximately 12 or 13 inches, and the pipe was bent backward and inward. As will be noted, however, the material shows no fracture. This happened in the Oklahoma field.

Fig. 3 shows "3 in 1" section of casing. There was a string 1,440 feet long of 8¼-inch, 24-pound steel casing;

* Information supplied from files of Research Department, National Tube Company, Pittsburg, Pa.

Fig. 2.—Eighteen-Foot Length of 5 3/16-Inch Steel Casing Crumpled to Length of 6 Feet Without Fracturing

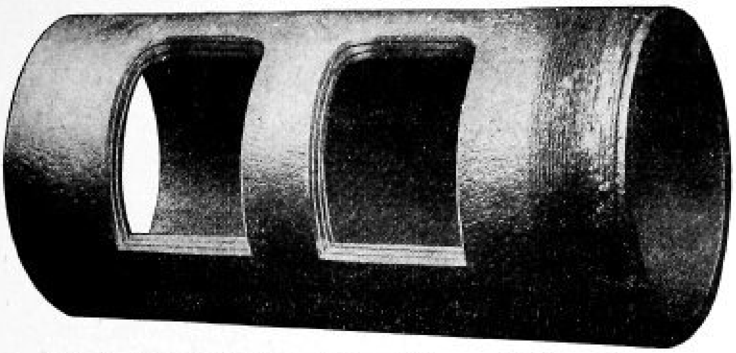


Fig. 3.—Three Sections of Pipe Telescoped Without Fracture

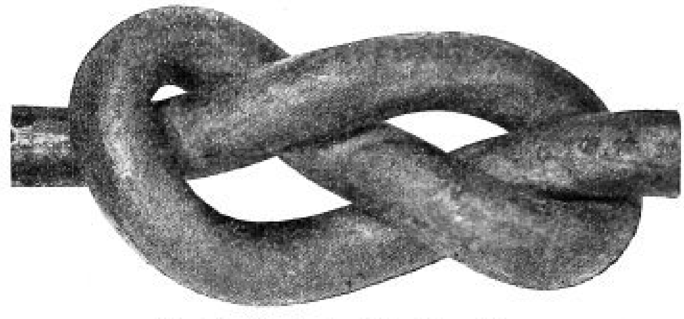


Fig. 6.—Bowknot Made from Pipe

the elevator let go and the string, weighing something over 34,000 pounds, dropped 200 feet to a bottom of limestone. The three sections on the bottom were telescoped—one inside and one outside. It will be noted there was no failure in the weld, and the three lengths telescoped without a crack. The exterior apparently shows a straight length of casing. The particular piece shown was machined to show the three separate sections as telescoped. Note the circumstances are substantially the same as Fig. 2, but the results radically different. This happened in the Ohio field.

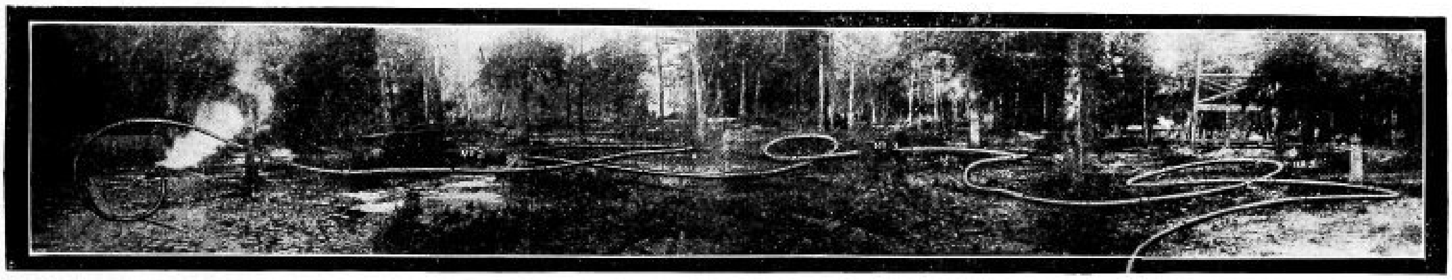


Fig. 4.—Twenty-six Lengths of 4-Inch Rotary Pipe Blown Out of Well Without Breaking a Single Joint

Fig. 4 shows twenty-six lengths of 4-inch rotary pipe, about 500 feet long. The well was about 2,000 feet deep and all of the pipe was out of the ground excepting this particular twenty-six lengths, when the gas began to show up and blew the pipe completely out of the well—*without making a sign of a break in a single joint of the twenty-six lengths*. One of the operators well said that this pipe was "flexible as a giant whiplash." This happened in the Texas field.

Fig. 5 shows a piece of 8-inch line pipe subjected to a twisting strain of 713,000 inch-pounds. In appearance this looks almost like a piece of rubber, and yet when it is remembered that this pipe has a thickness of about one-third of an inch and weighs about 29 pounds per foot, the enormous twisting strain can be appreciated. No sign of fracture appears in the material.

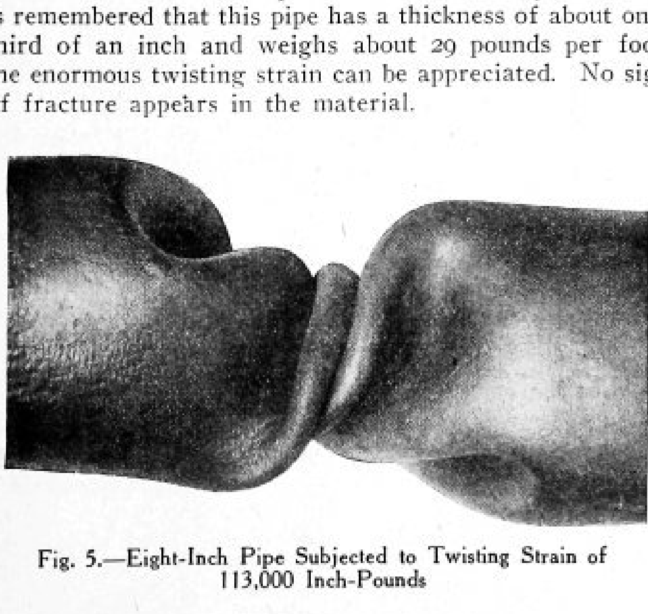


Fig. 5.—Eight-Inch Pipe Subjected to Twisting Strain of 113,000 Inch-Pounds

Fig. 6 shows a bowknot made from pipe and is self-explanatory.

These unusual pieces of pipe tend to show the inherent reserve strength of tubular material.

A few years ago it would have been impossible to secure pipe with physical properties such as shown, and these specific examples reflect the advance and improvement in metallurgical methods and practice in the manufacture of steel for pipe.

Davis-Bournonville Company Enlarges its Facilities

The Davis-Bournonville Company, with general offices and factory at Jersey City, has taken over the plant and factory of the Davis Acetylene Company at Elkhart, Ind. The Davis Acetylene Company has been dissolved and the manufacture of acetylene lighting generators and accessories discontinued. The plant will hereafter be operated under management from Jersey City for the manufacture of acetylene pressure generators for the oxy-acetylene process, and for special products. The Canadian factory at Niagara Falls, Ont., which has been jointly occupied by the two companies, has also been taken over, and will be operated exclusively for the manufacture of oxy-acetylene apparatus for the Canadian trade. The Davis-Bournonville Company has also purchased the H. G. Kotten Company factory and grounds opposite its Jersey City property. This gives the purchaser half of the city block running through Van Wagenen to Corbin avenues, and half of the block from Corbin to West Side avenues. The Kotten factory will be used for manufacturing electrolytic oxygen apparatus and accessories, releasing considerable space in the company's new factory building for increased output of oxy-acetylene welding and cutting apparatus. A four-story warehouse, 60 by 100 feet, of brick and mill construction, will be immediately erected on the Kotten property, still leaving ground for a five-story factory, 60 by 150 feet, corresponding to the company's No. 3 factory, recently completed, which may be erected the coming year.

The Davis-Bournonville Company has recently opened a Government sales office in the Colorado Building, Washington, D. C., with Henry R. Swartley, Jr., resident manager. The company's products are being used extensively by both the army and navy.

Among Railroad Boiler Shops—II

The Long Island Shops—Electric Welding Bench and Screen—Oxy-Acetylene Welding—Drilling and Reaming Tube Sheets

BY JAMES F. HOBART

Last July it was my pleasure and privilege to visit the Long Island shops again. It was twenty years since my previous visit, but the shops appeared about the same, with a new tool here and there, new faces at the machines and new methods almost everywhere.

The most striking innovation was that of welding. Oxy-acetylene and arc welding are both used a good deal in these shops, and a good deal of work is also done with Prest-O-Lite and oxygen instead of acetylene. The former gas is found to be a bit cheaper than the latter, but does not make as hot a flame. Still, it is used a good deal for cutting, in which case the oxygen gas seems to be about the whole show.

Mr. G. C. Bishop, Superintendent of Motive Power, stationed at Morris Park, near Jamaica, Long Island, N. Y., very kindly turned the writer over to Foreman Boiler Maker C. Redmond, who, after a walk all around the boiler shop, turned the writer loose to make his notes and discover the "kinks," which he did—lots of 'em!

The Long Island Shops

"We have to handle the men with gloves now," said Mr. Redmond. "We can't get nearly as many men as we want and they know it, and if we say a word to them they are off to some other shop where they think things are different or better than here. Why, we have to use boys at 31 or 32 cents per hour to do some pretty close work, just because we can't get boiler makers, whom we pay 41 cents per hour—when we can get 'em, which is not often.

Boys Run the Welding Machines

"We have boys almost altogether running the welding and cutting torches. A boy can break in very quickly to do cutting in good shape, but it is different with the welding. But luckily we have a good arc welder who has been with us for many years, and he attends to all the particular jobs, such as welding in new tube sheets, firebox plates and the like.

"This welder lets the boys do all the work possible. Most of the 'putting on' is done by boys with the electric arc. Much of this work is not strictly boiler work, but it is done in this shop by the boiler crew, therefore it may possibly interest boiler makers in other railroad shops.

"We frequently build up thin or wasted spots on all kinds of engine pieces. Wasted places in firebox or water legs are easily thickened to more than their original weight by means of the electric arc. Sometimes they build up the flat places on car wheels, but not very often. Usually, the wheels are turned down until the flat spots disappear, but in case of a single flat spot, metal is sometimes built over the flat place and a light file finish given to the built-up spot. If a wheel be built up very much, it will be necessary to put the wheel in a lathe, and once there the metal which would be removed in turning a new tread on a wheel would hardly pay for building up one or more flat places on the wheel, particularly as then the wheel must needs also be turned to make a good job."

Around the locomotive frames and other portions of the structure where worn spots develop, metal is frequently built on by the electric arc and broken frames, or rods, or levers, which are of almost daily occurrence, are quickly welded by means of the electric arc and very frequently without removing the parts from the engine.

Electric Welding Bench and Screen

Very naturally, there is a whole lot of work which may easily be carried to the welding machine, while other welds require the machine to go to the work. To take care of the large amount of small work, there has been provided a raised platform, or bench, about two feet high, upon which the work may be placed before, during and after welding.

Fig. 1 shows the manner in which one of these benches was arranged. The bench itself, as shown at *A*, needs

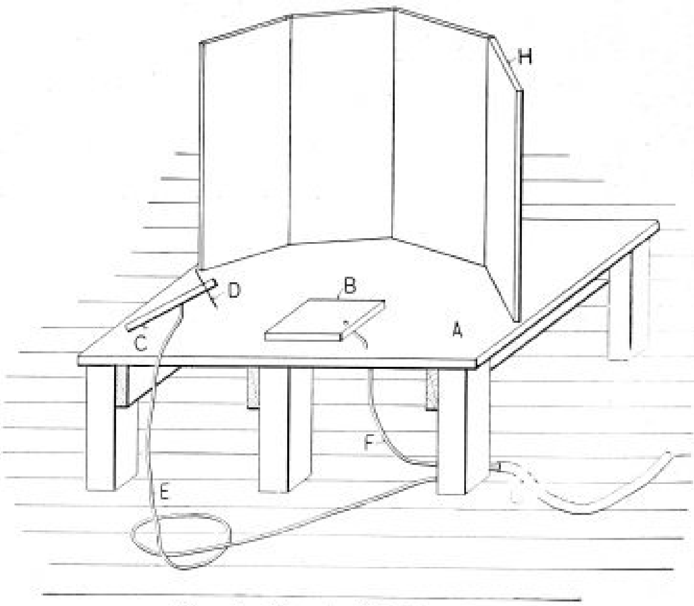


Fig. 1.—Electric Welding Bench

very little description. A metal plate, *B*, about 12 inches by 20 inches in this case, was placed upon the bench and connected with one wire leading to the source of electricity, which, as shown at *G*, is a heavy insulated double conductor, containing the two wires *E* and *F*, which are attached to the torch and to the "cathode," respectively, which latter is the metal plate above described.

The torch shown at *C* has in it, all ready for use, the "welding stick" *D*, which may be termed the "anode" and which is melted and dissolved by the intense heat developed by and in the electric arc formed between the stick *D* and the work which is laid upon plate *B* while being welded, in order that the work might have proper connection with wire *F*.

The workman wears the usual hood over his head—"gas helmets" the boys in the shop call them. But the one great improvement which is always in use in these shops is the screen *H*, which prevents other workmen from being annoyed or injured by the intense light thrown out during the welding operations.

The screen as shown at *H* was evidently made up in the woodworking section of the shop and closely resembled one of the ordinary screens used in dwellings, offices and hospitals, with the exception that screen *H* was made perfectly plain and without legs. In fact, the screen was used whichever end upward it happened to stand, both ends being alike for this purpose.

In many shops which the writer has visited, pieces of canvas or old gunny sacks are hung up around the welder in a half-hearted desire to screen the men in the shop from the welding glare. But usually the attempts at screening were pitiful in their inefficiency. There would be large spaces between the sacks through which the intense light easily found its way, to the discomfort of many workmen who chanced to be within range of the light.

The writer was advised that the use of the screen prevented many cases of eye trouble caused by the electric glare, and since the screen *H* was put in use the time lost by men with eye troubles had greatly decreased.

The electric welding current had a switchboard all of its own and several torches could be operated from the same switchboard, different currents being controlled by separate switches. Several resistances were connected with the switchboard and the service switches in such manner that current could be delivered to the welding torch at 44 amperes, 22 amperes and 10 amperes, according to which switch was thrown. In delivering current in this manner there is, of course, a considerable loss of efficiency while using the smaller currents, for the reason that so much energy is consumed in the resistances that it costs just as much to run the 10 ampere circuit as it does the 44 ampere one, the energy not used at the torch being lost in the resistances through which the current necessarily passed. Where a good deal of electric welding is to be done it surely would prove profitable to install little motor generators which would yield exactly the amount of current required and thus do away with the great waste of current, or rather of energy, which now takes place whenever resistance is used for controlling electric welding currents.

Oxy-Acetylene Welding

While these shops are well equipped with first class oxy-acetylene welding outfits, that system of welding is very seldom used on boiler sections which are subject to steam pressure. The locomotives cared for in this shop, at least several of them, can show fire and tube sheet repairs made by oxy-acetylene which have been in use for as much as five years and which to this day have never shown the least sign of stress or of failure.

It appears that, while perfectly sound and strong welds can be and are made by the oxy-acetylene process, at present there is no means of knowing that the welds are as good and as strong as they look. It has been found that the metal deposited during the welding process *may* be soft and of the same nature as the plate to which it has been united. It has also been found that, on the other hand, the deposited metal *may* be as hard as flint and possessed of very little, if any, ductility, and ready to break short off whenever working conditions cause certain stresses in the deposited metal.

Again, it has been found that the deposited metal may be very soft and yet have little tensile strength, and be ready to go to pieces at any time. In the one case, the steel had been carbonized until its flanging properties had nearly all disappeared. In the other instance the steel had received treatment from an oxidizing flame from the welding torch, and the steel accordingly had lost nearly all its strength and appeared, as one man aptly stated the matter, "rotten"!

When, in the future, means are found for determining, at the time of welding, the character of the metal deposited, so that the foreman may *know* without a doubt whether the weld is normal, hard or soft, then oxy-acetylene welding will come into its own and be used much more frequently than now on steam pressure work and on objects subject to vital stresses.

The electric arc, when anyway decently handled, will not change the nature of the metal in the "welding rods," therefore arc welding can be depended upon; hence its use on steam boilers and in places where the safety of life depends upon the strength out of the weld thus made.

Cutting Out Bad Blow-Offs

In the Long Island shops, when a blow-off, down at the bottom of the water leg, gets wasted away and leaky where it is screwed into the water leg, no time is lost in trying to patch either pipe or the hole into which it was screwed. Instead, the cutting torch is brought into use and a piece cut from the side of the water leg, say 6-inch by 9-inch, close down to the mud ring and containing the leaky blow-off connection. Then a new piece of metal is fitted into the hole in the leg thus made, the blow-off hole located, drilled and tapped, and the piece is then arc-welded right into the water leg, a new blow-off pipe screwed in and the whole job is completed in less time than it would require to take out and bush the bad bit of pipe. By thus renewing the sheet around the blow-off pipe, the renewed life given to that part of the boiler is exactly the same as when the boiler was new.

Removing Rusted-In Pipes

Not only are firebox sheets cut in all manner of shapes and new pieces welded in as above described for the blow-off, but new fire door holes are welded in, provided the technical editor will pass so glaring a statement as the "welding in of a hole"! But it is done, as will be described later. The oxy-acetylene torch—the Prest-O-Lite torch usually—is also used for removing rusted-in pipes and fittings.

One or two 24-inch Stillson wrenches, possibly with pipe extensions, would be hooked to the piece of pipe to be removed. A couple of "boys" played a tattoo around the pipe with riveting hammers, and when all were ready the gas-oxygen torch would be played on the sheet around the pipe or fitting for a minute or two, then with an "all-together" the pipe was started from its rusted hole in a jiffy!

Inserting Door Frames

In the Long Island shops door frames are no longer riveted in. This job, an ill-looking one at best and hard work under the best of conditions, has been made a pleasing task by welding in the frames by means of the electric arc. The frames are simply fitted and laid in place, "tacked" in two or three places, then the welder works once around and the frame seems to be a portion of the solid sheet.

When a new door frame is needed, either on account of the wearing thin of the old frame or the cracking of some corner thereof, the cutting torch makes one sweep right around the frame, the old one falls out, a new one is fitted in its place, which, instead of being "like new," really "is new" and has the life of a new frame.

Changing Shape of Fire Doors

The writer saw one interesting operation, where the old fire door was removed and a new and larger frame put in its place. It appeared that the fireman had great trouble in stoking the fire on the rear corners of the grates on account of the great width of firebox, the thickness of door frame, which, of course, was that of the water leg, prevented the handling of the fire in the corners referred to, thereby causing the loss of two or three square feet of effective grate surface.

The old fire door was cut right out with the cutting torch and a door very much wider was welded into the firebox, thus enabling the fireman to get at the extreme corners of the grates. The wider door also allowed easier and quicker spreading of coal over the fire, thereby adding to the efficiency of the engine to a marked degree. This job would have been a hard one save for the cutting and arc-welding torches and methods.

Cutting Out Tube Sheets

The operation of changing a tube sheet when it has become thin or worn is a very easy one in this shop. The cutting torch quickly separates the tube portion of the sheet from its flange, a new sheet is fitted into the opening thus made and is quickly arc-welded into place as solid as the old sheet and to all appearances exactly as good and as strong as the original tube sheet.

One sheet I saw in process of construction had a flange turned on its lower end, the sides being left blank. This sheet—the old one—had been cut out above and on the sides just outside of the tubes, but the old flange at the bottom of the sheet had been taken out, hence the flanged end on the bottom of the new sheet.

It was noted in this shop that when a sheet was made as above an entire new sheet was used, the flange being turned on one end, the holes drilled as required in the middle of the sheet for the tubes, then the portion of sheet not required was sheared off as soon as the dimensions of the cut-out in the old tube sheet were known. It was claimed that this method of making the new tube sheet, or a portion thereof, saved a considerable amount of plate which would have gone into scrap had a small piece of plate been flanged and then trimmed to fit the hole that the cutting torch had made in the tube sheet. When a whole sheet was used, the pieces cut off were found to be larger and more capable than smaller pieces of being all worked up to advantage.

Drilling and Reaming Tube Sheets

It was noticed that every precaution possible had been taken to make sure that no mistake occurred when work was sent from one section of the shop to another for various operations; for instance, the drilling of the holes for tubes in the new piece to be welded into a tube sheet.

The holes were laid off in the boiler shop and small holes about 15/16 inch, or 1 inch in diameter, were punched in the center of what was to be a hole for a boiler tube. In this condition the new sheet was sent to the machine shop, that the small holes might be enlarged to the diameter required by the boiler tubes.

Upon the sheet the foreman had marked all the information necessary to make just right the drilling or reaming of the tube holes. With a can of nice white paint and a dinky little marking brush an irregular ring was drawn around the sheet, the line of white enclosing in a body each and every hole to be reamed in the sheet. Thus the machinist never needs look for any holes to be drilled outside of the ring of white paint.

Just above the ring above described is painted the shop order number in figures about 4 inches high, so there is no danger of charging up the work to the wrong order. Then the holes to be enlarged are all counted carefully and their number painted likewise upon the sheet. In this case, it was "252 holes" and each was to be 1 15/16 inches in diameter.

Next, the diameter of holes required was painted on the sheet in three places, thus making pretty sure that all the diameter markings could never be accidentally defaced or destroyed through careless handling of the plate.

Overhead Traveling Crane and Drop Pits

This shop was fitted with both drop pits and overhead traveling crane, but, owing to the age of the shop and the construction then employed, the shop walls are not heavy enough to carry a modern heavy-duty traveling crane, hence a light one was installed and the wheel-changing effected by means of the time-honored drop pits with a truck in the bottom of each pit, and each truck was fitted with a pressure cylinder and piston—a small elevator, in fact—for the purpose of raising wheels and axle up into their bearings under the engine.

An overhead traveling crane which could pick up an entire locomotive is one of the time-savers in some shops, but it could not be used here for the reasons stated, and they rub along with the old drop pits.

Locomotive Inspection Rules Modified During War

The Interstate Commerce Commission on September 20 issued an order at the request of the carriers, making modifications, for the period of the war, in certain of the rules and instructions for the inspection and testing of steam locomotives and tenders. The order is as follows:

"Whereas, at a conference held in the office of the chief inspector of locomotives on September 5 and 6, 1917, to consider modifications of the rules and instructions for the inspection and testing of locomotives and tenders and their appurtenances, which were prepared jointly by the mechanical advisory sub-committee of the American Railway Association's Special Committee on Relation of Railway Operation to Legislation and the sub-committee on military equipment standards, Special Committee on National Defense, American Railway Association, and proposed by the committee representing the carriers, on account of the present international crisis, certain modifications were agreed upon by the representatives of the carriers, the representatives of the employees and the chief inspector; therefore,

"*It is ordered*, That effective at once and to continue in force during the period of the war, except where otherwise specifically stated, rules 2, 10, 16, 23, 110, 112 (b), 128 (d), 142 (c) and 150 (a) shall be modified as follows, except where conditions are such that the safety of operation is adversely affected thereby:

Rule 2.—The lowest factor of safety for locomotive boilers which were in service or under construction prior to January 1, 1912, shall be 3.25.

"Effective six months after the close of the war the lowest factor of safety shall be 3.5.

"The dates on which factors of safety from 3.5 to 4, as provided in rule 2, become effective, shall be advanced for a period equivalent to the duration of the war.

"*Rule* 10: *Flues to be removed.*—All flues of boilers in service, except as otherwise provided, shall be removed at least once every four years, and a thorough examination shall be made of the entire interior of the boiler. After flues are taken out the inside of the boiler must have the scale removed and be thoroughly cleaned. This period for the removal of flues may be extended upon application if an investigation shows that conditions warrant it.

"*Rule* 16.—The date for removal of lagging for the purpose of inspecting the exterior of locomotive boilers as provided by rule 16, except where indication of leaks exist,

Are Fire Box Sheets Welded With The Oxwelding Process Efficient?

Answer:

The tensile strength of a single lap riveted seam is approximately 52% to 60% of the strength of the metal itself.

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shall be advanced for a period equivalent to the duration of the war.

"*Rule* 23.—*Method of testing flexible staybolts with caps.*—All flexible staybolts having caps over the outer ends shall have the caps removed at least once every two years and also whenever the United States inspector or the railroad company's inspector considers the removable desirable in order to thoroughly inspect the staybolts.

"The firebox sheets should be examined carefully at least once a month to detect any bulging or indications of broken staybolts. Each time a hydrostatic test is applied the hammer test required by rules 21 and 22 shall be made while the boiler is under hydrostatic pressure not less than the allowed working pressure, and proper notation of such test made on form No. 3.

"*Rule* 110.—*Time of cleaning.*—Distributing or control valves, reducing valves, triple valves, straight-air double-check valves, and dirt collectors shall be cleaned as often as conditions require to maintain them in a safe and suitable condition for service, but not less frequently than once each six months.

"*Add to Rule* 112.—On E. T. or similar equipment where the brake cylinder pressure is maintained regardless of piston travel the maximum piston travel for driving wheel brakes shall be 8 inches.

"*Rule* 128 (*d*).—*Locomotives in road service.*—The total of side motion of rods on crank pins shall not exceed 1/4 inch.

"*Locomotives in yard service.*—The total amount of side motion of rods on crank pins shall not exceed 5/16 inch.

"*Rule* 142 (*c*).—Top leaf broken or leaves in top half or any three leaves in spring broken. (The long side of spring to be considered the top.)

"*Rule* 150 (*a*).—The minimum height of flange for driving and trailing wheel tires, measured from tread, shall be 1 inch for locomotives used in road service, except that on locomotives where construction will not permit the full height of flange on all driving wheels may be 5/8 inch."

Making the Business Earn a Profit—VI

Bookkeeping—What the Books Should Show—Description of the Various Books and Their Functions—The Double Entry System

BY EDWIN L. SEABROOK

Bookkeeping is the confidential advisor of the business man about his business affairs. It should give information on every subject in which he is vitally interested. It should show something more than how much is owing the business or owed by it. That system of bookkeeping which does only this falls far short of its real purpose. If this were its only object, a few loose leaf sheets with the various accounts on them would answer the purpose.

Real Object of Bookkeeping

The real object of bookkeeping is to measure and show the operating results and current status of the business. Any system that does not show the gains or losses does not meet the requirements of modern business conduct. Briefly, bookkeeping consists in recording the history of each business transaction concisely, to show the date and terms of the transaction, *and the results of the transaction* as they relate to the business for which they are kept. It is possible to record the history, date and terms of the transaction, yet not show the *results* of it. By results is meant that which is obtained or secured. If a boiler maker has two thousand transactions in the course of the year, will his books show what has been obtained from these—the results—gain or loss?

It is at this point that many fail with their bookkeeping; it is not carried far enough. They keep accounts with firms or persons from whom they buy or to whom they sell, and perhaps a record of cash received and disbursed. But there is nothing in these to show in which direction the business is going, whether it is being conducted at a gain, just breaking even, or at a loss.

It is not possible to cover in one short article the important subject of bookkeeping in all its details. An outline of some of the most essential features is all that will be attempted at this time.

What the Books Should Show

The books of the boiler maker should show:

The amounts due from others.

The amounts owing by him and the nature of these.

Cash received, from whom, from what source and for what purpose.

Cash disbursed or paid out; to whom and for what purpose.

The amount paid for material.

The amount paid for productive labor.

The amount paid for salary of the proprietor or what he draws from the business.

The amount paid for rent, office help, telephone, insurance, printing, postage, taxes, car fares, freight; hauling, including upkeep of hauling equipment; interest and discount, whether given or taken; accounts that are uncollectible; shop supplies, every item and amount of same that is spent for the cost of conducting business, or overhead.

Depreciation of tools, etc.

The total amount of business (which will be orders received and merchandise sold, if any) during the year.

The inventory which shows the amount of material and value of working equipment, such as tools, etc., on hand.

Finally condensing these accounts into one, which will show the total transactions for the year, what it costs for the material, labor, expense, etc., to produce the business of the year. The difference between the total amount of business and what it costs to produce it will be the profit or loss.

No doubt to many this may seem like a big bookkeeping programme; some of it needless, involving a lot of books and requiring much time. Those holding this view are entirely wrong. Only a few books are necessary. Every account mentioned is absolutely essential to an intelligent knowledge of the business. The time required is simply

		January 1917				5
		12				
	6	Chas. McGear Dr.				
		To Repairs, 244 Broadway,				
		1 new section for boiler,	$50	00		
		18 nipples & connect. rods, at 1.30	23	40		
		Fittings, etc.	10	00		
		Carfares and hauling,	4	00		
		36 hours time, mechanic, at 0.90	34	40	119	80

Fig. 4.—Day Book

		February 1917				11
		12				
	6	Chas. McGear Cr. By Cash			$119	80

Fig. 5

a matter of giving attention to the various details as they arise in the daily routine.

THE NECESSARY BOOKS

The three essential books are: Day book or journal, cash book, ledger. While the size of the business must determine in some degree the number of books used, these three are the principal ones and show the transactions and results. Some others are necessary, such as an order book, time book for the mechanics, and some method of keeping the cost of contracts and other work. These are helps, and not essentials, as they do not show the state of any account, nor the results.

THE DAY BOOK

This is so called because the transactions are, or should be, entered the day they occur; it shows the daily business transactions, hence the term "day book." The entries in this book are of prime importance from a legal standpoint. As this is the first record of the transaction, it is termed the original or historical entry, and is so important that generally it alone can be put in evidence in a disputed account. Even then it must have been made at or near the time of the transaction. The record in the day book is the most important of all entries made of the transaction. The entries in the other books merely classify the results growing out of the original entry. If this entry is wrong the results derived from it must also be wrong.

ENTERING TRANSACTIONS

Owing to the importance of the original entries several features should be strictly followed.

Use a uniform style in describing or making entries of the same kind of transactions.

Describe the transactions briefly, but plain enough to be intelligent.

The quantity and price of each item should be given in merchandise, sales on account, repair work, etc.

Enter the transactions in the original book of entry the day they occur, or as soon as the work for which the charge is made is completed.

To illustrate an entry in the three principal books a transaction in the ordinary course of business of the boiler maker will be used.

Wm. Jonas is called in to make some repairs for Chas. McGear, at 244 Broadway, as follows:

One new section, $50. 18 nipples and connecting rods, at $1.30, $23.40. Fittings, etc., $10. Car fares and hauling, $4.00. 36 hours' time, at $.90, $32.40—$119.80.

When the work was completed the entry in the day book would be made as shown in Fig. 4.

A month later Mr. McGear pays the bill, and the entry shown in Fig. 5 is made.

Between these two entries it may well be assumed that many others were made. It would be possible for Mr. Jonas to keep only one book—the day book—but it would be inconvenient. He would have to go over numerous entries to determine the state of any particular account. A summary of the account (debits and credits) is therefore sought. This is done in the ledger.

LEDGER

The above day book itemized record is entered in the ledger as one sum. This is termed "posting" to the ledger.

The ledger is not an original book of entry. As the items of the transaction are given in some other book, these do not usually appear in the ledger. The numbers in the column next to the amount columns refer to the page in the original book of entry (day book—journal or cash book), from which the entry is posted. Reference to this page will give all the necessary items or explanations.

CASH BOOK

Mr. Jonas, the boiler maker, wished to keep an accurate record of all the cash he receives and disburses. When the payment was received from Mr. McGear this entry was made in the cash book.

It should be noted that the receipt of this payment has been entered twice—in the day book and in the cash book. It is not necessary to make the cash receipt entry in the day book. The cash book entry is sufficient and it can be posted to the ledger. When this is done the cash book becomes an original book of entry.

The above order is small and its record on the books of Mr. Jonas quite simple, yet in it are involved practically all the important transactions of the entire business for the whole year. In the course of a year he may have 400 orders aggregating $50,000, but these do not change, add to or take from the various transactions or results involved in performing the order of Mr. McGear.

An analysis of this order will show the four elements of a price; i. e., material, labor, expense, profit. The material costs something; productive labor was required; the salary of Mr. Jonas, rent, bookkeeping, telephone, hauling, etc.,

											6
Dr.				Chas. McGear						Cr.	
1917 Jan.	12	To Repairs	5	$119	80	1917 Feb.	12	By Cash	11	$119	80

Fig. 6.—Ledger

		February 1917	Dr.		Cr.	11
		12				
	6	Chas. McGear	$119	80		

Fig. 7.—Cash Book

and profit (if there was any) are all in that charge of $119.80. But how much were these different items; how much was the profit? There is nothing in any entry that Mr. Jonas has made so far that shows this. Suppose he has 400 orders during the year, charging the party for the work and crediting them with the payments; will his bookkeeping show the *results* of these transactions?

The question is raised not that it needs an answer, but because this is just as far as many boiler makers go with their bookkeeping, simply keeping a record of who owes them and how much. Others go a step further and enter

		January 1917		Dr.		Cr.	5
		12					
		Chas. McGear		$119	80		
		To Orders				$119	80
	6	For Repairs, 244 Broadway,					
		1 new section for boiler,	$60.00				
		18 nipples & connect. rods at $1.30	23.40				
		Fittings, etc.	10.00				
		Carfares and hauling,	4.00				
		36 hours time, mechanic, at $0.90	32.40				

Fig. 8.—Journal

the amounts due others. Some keep a cash book. These are accounts with persons or personal accounts, and show nothing except the standing of the account. Mr. Jonas may buy a dozen articles from five different firms, employ labor, assemble and erect, and make a charge of $500 for the transaction. There is not, however, the slightest thing in the record of the personal account to show how much it cost. Somewhere Mr. Jonas may set down how much the material and labor cost, but this does not show the correct cost nor the *result;* neither is it a part of the personal account record. Something is lacking; merely charging Mr. McGear for the work and crediting the payment are not sufficient; some other accounts are necessary.

Representative Accounts

Material represents something for which money was spent. The same of rent, salary, labor and other items. These are not accounts with persons, hence not personal, but are representative accounts, because they are accounts with things. An account can be opened with rent, productive labor, material, telephone, etc. These can be charged with what is paid out for them and credited with what they produce. Someone may ask: "What do these accounts produce by which they can be credited? Not being personal, how can they pay anything back?" Without attempting a complete explanation in this article, it can be stated in passing that they do produce something, although it is *representative*. Material and labor produce profit and loss, and can be credited to this. Rent, etc., produce expense. In order to thoroughly understand representative accounts it is necessary to know something about the double-entry system of bookkeeping.

Double Entry System

The name "double entry" seems to frighten many who have had little or no bookkeeping experience. They associate it with intricate, complicated forms and entries and much clerical work. There is nothing complicated about double entry bookkeeping. It is as simple as the alphabet when once the nature of debits and credits (buying and selling) is understood. If the single entry system were not put forward first in teaching bookkeeping, or abolished altogether, the double entry would be used by every one conducting a business.

The term "double entry" comes from the fact that every account is entered twice—once as a debit and once as a credit. Practically every business transaction relates to two things—selling by one and buying by another. Where there is a sale there must be a buyer. If the Safety Boiler Company buys a boiler for $300 from the Eastern Boiler Company one is a debtor and the other a creditor for equal amounts. Where there is a debit there must be a corresponding credit. Double entry makes use of both in every transaction to produce the *result*.

When the Safety Boiler Company bought the boiler, suppose it used several other articles of material purchased from different firms for $77, and labor amounting to $50 was used to install it, and it was finally charged to B. C. D. for $580. There is still something lacking to determine the results—profit or loss. Suppose some representative accounts are opened; let the first be called material, and to this is charged $377. Let the next be labor, which is charged with $50. Then *expense account,* into which finally go all items of overhead. This account is found to be charged with various expense items of $89. An *orders account* is opened, which is credited with all the orders, contracts, sales, etc. In this instance it is credited with B. C. D., $580. (Note that B. C. D. has been charged with this in the personal account and is credited with it in the orders account, making a double entry.)

The last account to be opened is profit and loss. This account is charged with material, $377; labor, $50; expense, $89; total, $516. It is credited with orders, $580. The balance, $64, shows the *result* of the transaction, which is profit. If the debits and credits were reversed (the cost being $580 and the selling price $516) the loss would be $64.

While a single transaction is used, it illustrates the method of keeping representative accounts for the entire business, the procedure and entries would be no more difficult if there were 300 orders or sales instead of one.

In double entry each transaction being debited and credited these two entries must be properly made in some book before they can find their way into the ledger. This book is called the journal, and can be used to take the place of the day book, so that it can be discarded and the journal become the original book of entry. All that has been previously said about the necessary care in making the historical or original entry in the day book should be observed in the use of the journal. The journal is ruled different from the day book, and the amount of each entry placed in both the debit and credit columns.

The sale to Mr. McGear would be made as shown in Fig. 8.

As Mr. McGear is debtor for $119.80, something, or somebody, must be credited for an equal amount. Something has given value, so a representative account termed *orders* is opened. It should be borne in mind that the word "orders" in this connection is the name of an account. As all orders, sales, contracts, etc., will be credited to such an account, no other word should be used in the journal to designate that account. Mr. McGear is debited and orders credited for the amount, $119.80 of the sale, both being entered in the ledger.

Cash receipts and disbursements need not be entered in the journal. As these are entered in the cash book they become original entries and can be posted to the ledger direct.

Any business beyond the vest-pocket size deserves up-to-date bookkeeping. A little study and every-day practice will qualify the boiler maker to keep an intelligent system.

(To be continued.)

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NOTICE TO ADVERTISERS

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 25th of the month, to insure the carrying out of such instructions in the issue of the month following.

Conforming to a resolution adopted at a recent meeting of manufacturers with the National Chamber of Commerce, requesting each line of business to appoint a war service committee to act as a "point of contact" between its industry and the United States Government during the period of the war, the American Boiler Manufacturers' Association has appointed as its war service committee: W. C. Connolly, president of the D. Connolly Boiler Company, Cleveland, Ohio, chairman; George W. Bach, manager of the Union Iron Works, Erie, Pa., and G. S. Barnum, president of the Bigelow Company, New Haven, Conn. Anyone having business pertaining to boilers should address the chairman at once.

The importance of the boiler making industry in war service can be realized when it is understood that the United States Shipping Board Emergency Fleet Corporation has already placed contracts for the construction of something like 700 boilers for the emergency fleet of merchant ships alone. The facilities of practically every boiler shop in the country are needed to meet the requirements of the Government for this work, and in addition to the emergency merchant marine fleet now being built, the Navy Department has under construction 787 naval vessels, most of which are designed for high speed and require enormous boiler capacity.

While the quantity of the output of marine boilers is in itself sufficient to tax the resources of the boiler making industry to its utmost capacity, the further necessity of speeding up this work and securing the earliest possible deliveries of these boilers means that every boiler manufacturer in the country must double his efforts in increasing the efficiency of his plant. On the humble boiler maker, it may be truly said, rests largely the success of our overseas war transportation service.

The opportunity for skilled workers in the United States army has forcibly been brought to our attention by the demands of several branches of the service.

Major E. J. Atkisson, corps of engineers, U. S. army, is organizing the first battalion of a "gas and flame" regiment, the Thirtieth Engineers, at Camp American University, D. C. The new unit, which will be under the command of Col. A. A. Fries, who is now in France, as chief of the gas service, needs chemists, chemical workers, machinists, men experienced in gas manufacture, pipe fitters, boiler makers, automobile repair men, electricians, etc. Men with the proper qualifications between the ages of eighteen and forty, who have not been actually called by a local board in the draft, are urged to enlist.

Similarly, Major E. Z. Steever, signal corps, U. S. army, advises that the Army Air Service needs many more skilled workmen behind the lines abroad. The air fighters need the backing of skilled men to keep each airplane ready for instant and constant service, to bring up supplies, ammunition, food, clothing—without which the men in the air are useless—to construct and maintain the airdromes for housing the planes and quartering the men. For this service a great variety of skilled workers is needed, including metal workers, welders, machinists, plumbers, blacksmiths, molders, tool makers, etc. Here again the age limits for recruits are from eighteen to forty years.

The country needs the services of every skilled worker. If your services are not now indispensable to the war service, go to the nearest recruiting station, or U. S. District Engineering Office, state fully and clearly your qualifications and you will have no difficulty in finding a place where your past experience, training and skill will count for the most in bringing victory and peace to your country.

Many younger boiler makers have already heard the country's call and are now serving as boiler makers on our naval vessels. Many others doubtless will follow their example, and for their benefit there will be published in our next issue not only a description of the principal types of boilers installed in the ships of the navy, but also many useful pointers regarding their care and repair.

Engineering Specialties for Boiler Making

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

Relief at Last for Riveters

R. H. Smith, 1840 Castro street, San Francisco, has patented a device to provide means whereby the strain and fatigue of holding pneumatic tools to their work will be greatly reduced. The device consists of a steel spring trap ⅛ inch thick by 1 inch wide, formed as shown in Fig 1, which is clamped to the pneumatic tool and held against the body of the operator as shown in Fig. 2. It is claimed that much greater force can be produced against the tool than by pressing it with the hands or knees. It is claimed that the vibration and, therefore, the wear and tear on the operator, is greatly lessened and that more work and better work can be performed with less likelihood of broken air hose and connections.

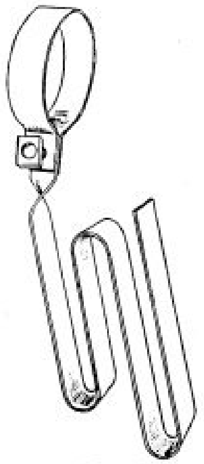


Fig. 1

Fig. 2

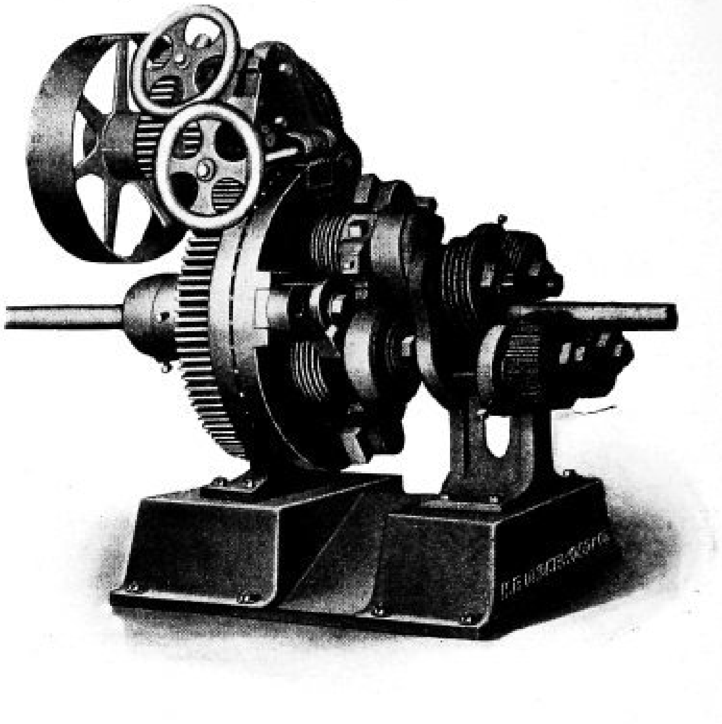
Rotary Flue Cleaner

H. B. Underwood & Company, Philadelphia, Pa., has placed on the market a machine designed for removing the hard adhering crust of lime from boiler flues, which will clean from 8 to 10 feet per minute, removing all scale, and without injury to the flue.

Three revolving shafts, provided with circular blunt-edged steel cutters, are set obliquely in adjustable boxes, the central line of the flue passing between them; these boxes are connected with a movable ring, governed by a worm screw, which is operated by the lower hand-wheel, and each of them is provided with a small adjustable circular assisting cutter with cross teeth, which cuts the line lengthway; after being cut crossways by the circular piece on revolving shafts, the scale is consequently reduced to square particles; the same process is repeated by four circular finishing cutters revolved by the flue, two of them being provided with length teeth and two with cross teeth, and placed adjustable on the same incline plane to the extending plate. Having the circular cutters on the revolving shafts on the same incline plane, the first and second cutters on each shaft will not come in contact with the flue, but will afford an easy entrance, acting like a mill, preventing the machine from choking; there is no sticking, as the cutters are all revolving.

To overcime oval places or uneven diameters the cutters are arranged to give a little, and when this place is passed, immediately come back to the original position, and by slight movement of top hand-wheel, the machine can be reversed (or stopped) and the uneven place cleaned by passing back and through again. Many flues are not perfectly straight, but as any part of them within the machine is held central in line, the projecting ends are at liberty to swing.

The platform is shaped in part like a saddle to allow the loose lime to fall off freely. The speed of the machine is optional with user; the pulley can be run as high as 400 revolutions per minute, when about 8 to 10 feet per minute will be cleaned.

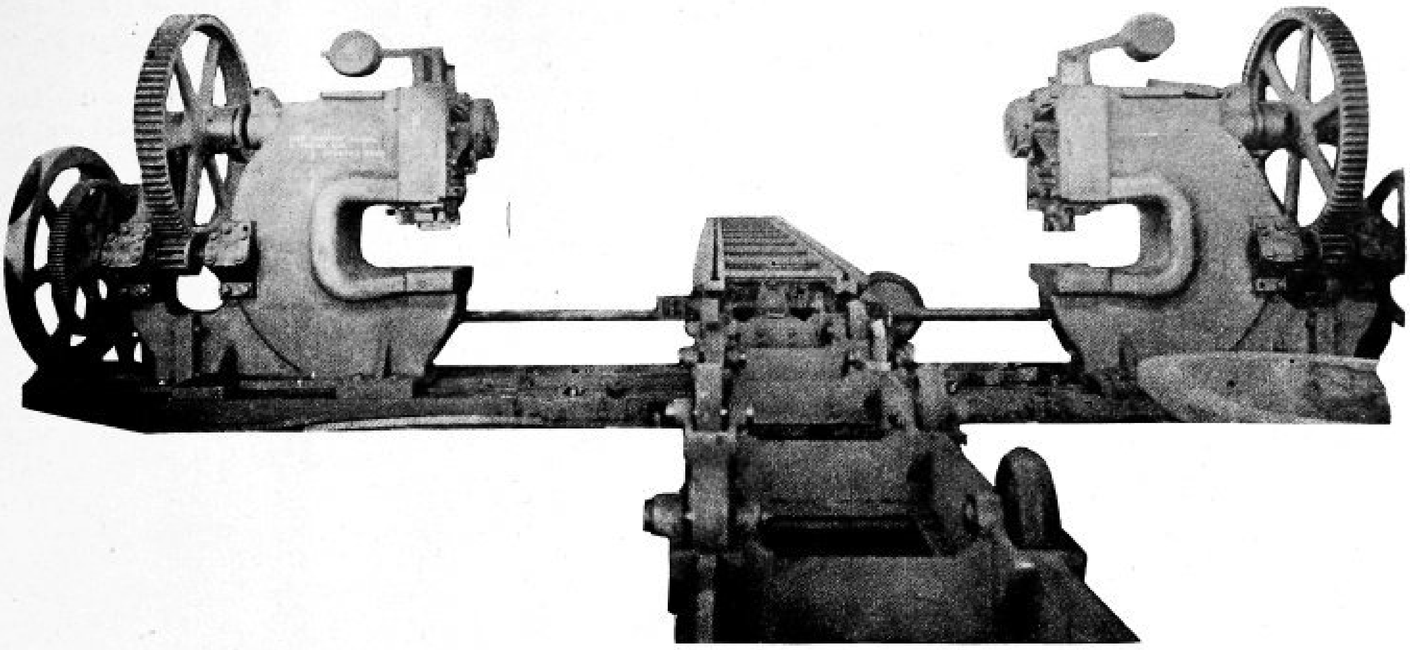


Rotary Machine for Removing Hard-Adhering Crust of Lime from Boiler Tubes

Successful Method of Welding Flues in Back Tube Sheets

A successful method of welding flues in the back flue sheet has been developed by the Hodges Boiler Company, 327 S. La Salle street, Chicago. Fig. 1 illustrates the method now in general use. By referring to Fig. 5 it will be noticed there are no copper ferrules, no swaging of flues, no necessity for prossers or rollers, and no beads at all. By this method it is possible to use ⅜-inch instead of ½-inch sheets, which is advantageous not only in producing a good weld, but also adds greatly in performing the work rapidly. This thickness of plate is a greater heat conductor, and hence a fuel saver.

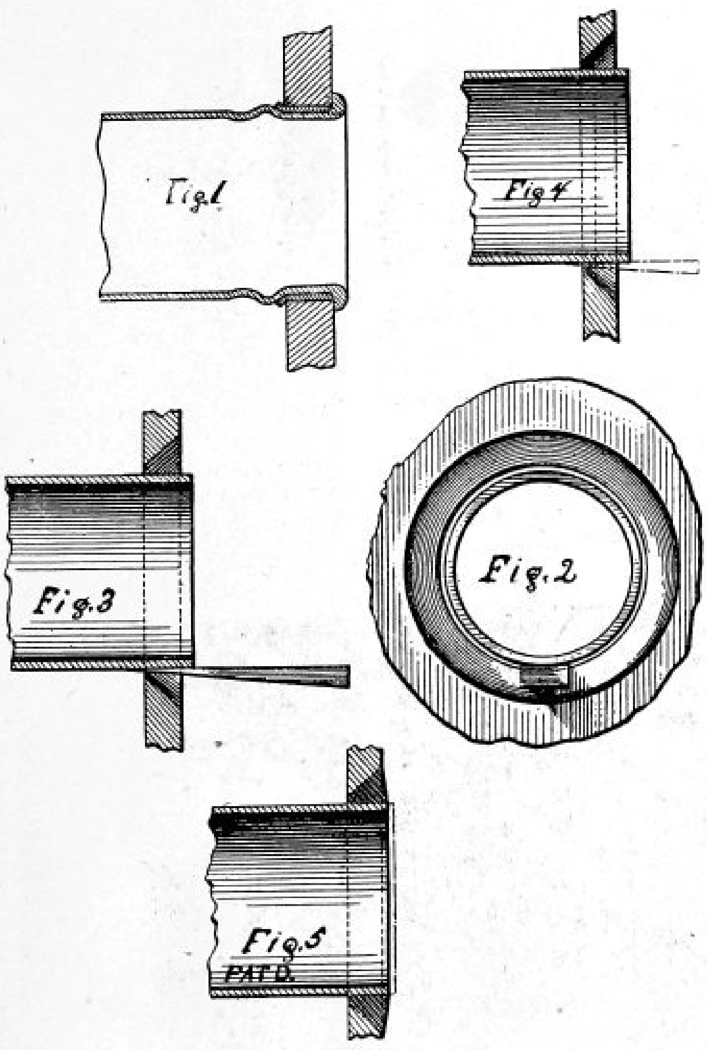
By this method of applying flues the flue hole is drilled ⅛-inch larger than the diameter of the flue. The hole in flue sheet is countersunk or beveled, as shown in Fig. 2, to about 45 degrees on the fire side to a depth equal to the thickness of the plate. Then the tube is inserted until it penetrates ⅛-inch past flush. Now insert the thin wedge beneath the flue to centralize the flue in hole, Fig. 3, then tack the flue to the sheet with welding torch, at



Double Punches, with Spacing Table, Arranged for Punching 1⅜-Inch Holes in Opposite Ends of 1⅜-Inch Plate Simultaneously

the top, Fig. 4, remove wedge and proceed to weld the tube around its entire circumference, fusing the metals, at the same time filling up the groove with added metal until it is past flush, Fig. 5. This will produce a good, substantial weld.

The question readily suggests itself, "How would you remove these flues when necessary?" The answer is: By cutting them out with a cutting torch in a beveled way, remove the flue and smoothing up the bevel with a rose bit, the sheet is ready for another application of tubes.



Method of Welding Tubes in Tube Sheet

Large Double Plate Punching Machine

The Ironton Punch & Shear Company, Ironton, Ohio, has just completed for the Jones & Laughlin Steel Company a large double punching machine. It has some features which are said by the manufacturers to be different from anything of the kind heretofore built. The machine is a double punching machine, each one arranged to punch in unison a 1⅜-inch hole through 1⅜-inch soft steel plates.

Each machine is mounted on a bedplate and can be adjusted so that centers ranging from 5 to 14 feet can be obtained. The shaft shown in the center drives both machines through gears and its revolutions automatically space the work to be punched. Power for the shaft is supplied by a 20 horsepower motor through rawhide spur gears and motor pinion.

The spacing table is 3 feet wide and long enough to accommodate a 30-foot plate. The rollers upon which the spacing table operates are 12 inches in diameter. They are 3 inches wide and are flat on one side of the table and V-shaped on the other.

Seventy-Fifth Anniversary of Joseph T. Ryerson & Son

On November 1 the corporation of Joseph T. Ryerson & Son celebrated the seventy-fifth anniversary of its establishment in Chicago. For two hundred years the Ryerson family has been associated with the iron industry. One branch of this family has carried on this record from father to son for five generations, covering the period since 1750. As early as 1760 the family was manufacturing pig iron, and in 1790 Thomas Ryerson started in business as a wholesale dealer in finished iron and steel products of imported and domestic manufacture in Philadelphia. His son, Joseph T. Ryerson, came out to Chicago and established the present firm of Joseph T. Ryerson & Son in 1842.

His son, Edward L. Ryerson, continued the business, which since 1888 has been a corporation, of which he was president until 1911, and is now chairman of the board of directors. His sons, Joseph T. Ryerson, Donald M. Ryerson and Edward L. Ryerson, Jr., have entered the firm during the past fifteen years and are now vice-presidents, thus making the sixth generation in line of descent associated with interests of this character.

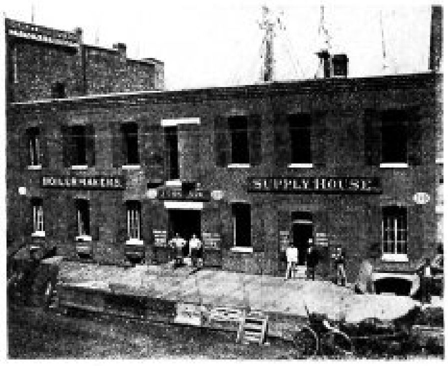


Fig. 1.—Ryerson's South Water Street Store (1852)

The founding of the firm of Joseph T. Ryerson & Son in 1842 was based on the recognition of the advantage of being able to supply customers with their iron and steel requirements promptly without the delays ordinarily attendant upon mill shipment; to afford them a source of supply where small and mixed specifications might be shipped to them immediately with the same attention to detail as would be given if the order embraced a considerable tonnage. During the last seventy-five years this idea has been carried out and improved upon with the one purpose in view of being able to supply the user of steel with his requirements immediately from stock; to study his interests so that material, fittings or equipment might be furnished which would represent the latest and most modern type of construction and practice; to carry in stock sufficient quantity and assorted sizes so that prompt shipment may be made of the large order or the small order, or the order for unusual sizes, as the case may be.

Thus throughout these many years of business this successful firm has built up and perfected an unusual organization. Special consideration has been given to speed and accuracy. Speed is as important as the steel itself, and accuracy must be had without question. To fully appreciate the methods employed one should visit one of the several plants and personally follow orders through to shipment.

The main plant of the firm in Chicago, at Sixteenth and Rockwell streets, is of tremendous size and fully supplied with modern equipment. During the last five years large branch plants have been erected at Jersey City, N. J., and St. Louis, Mo. This year the fourth unit is being opened at Detroit, Mich.

When Edward L. Ryerson retired from the position as president in 1911 and was elected chairman of the board of directors, Clyde M. Carr succeeded as president. The officers to-day are: Edward L. Ryerson, chairman of the board of directors; Clyde M. Carr, president; Joseph T. Ryerson, vice-president and treasurer; Donald M. Ryerson, vice-president; Edward L. Ryerson, Jr., vice-president; George G. Moody, second vice-president; E. L. Hartig, secretary and assistant treasurer.

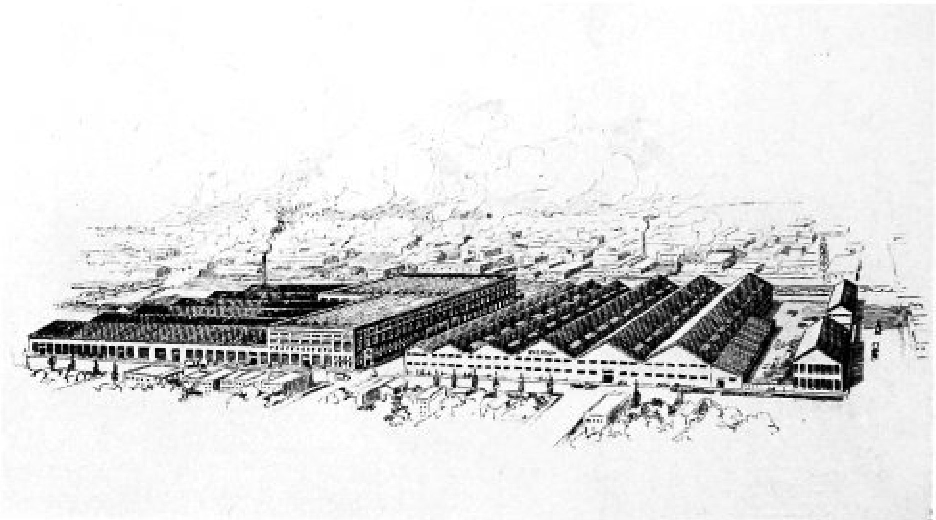


Fig. 3.—Chicago Plant of Joseph T. Ryerson & Son

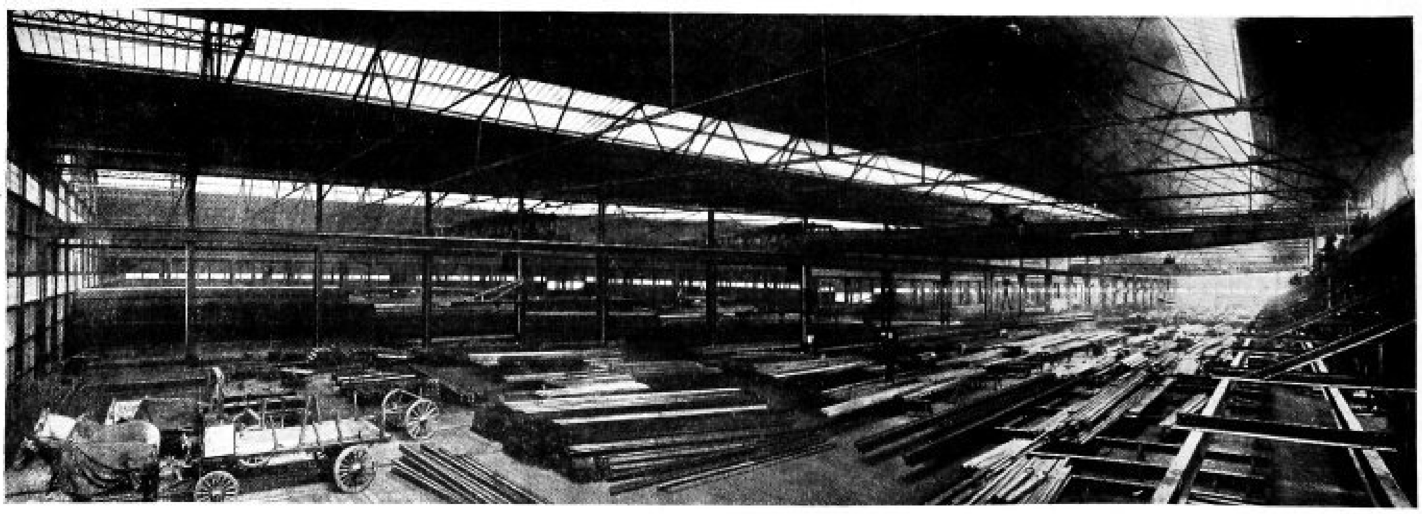


Fig 2.—Interior of Ryerson Structural Warehouse, Chicago

Questions and Answers for Boiler Makers

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

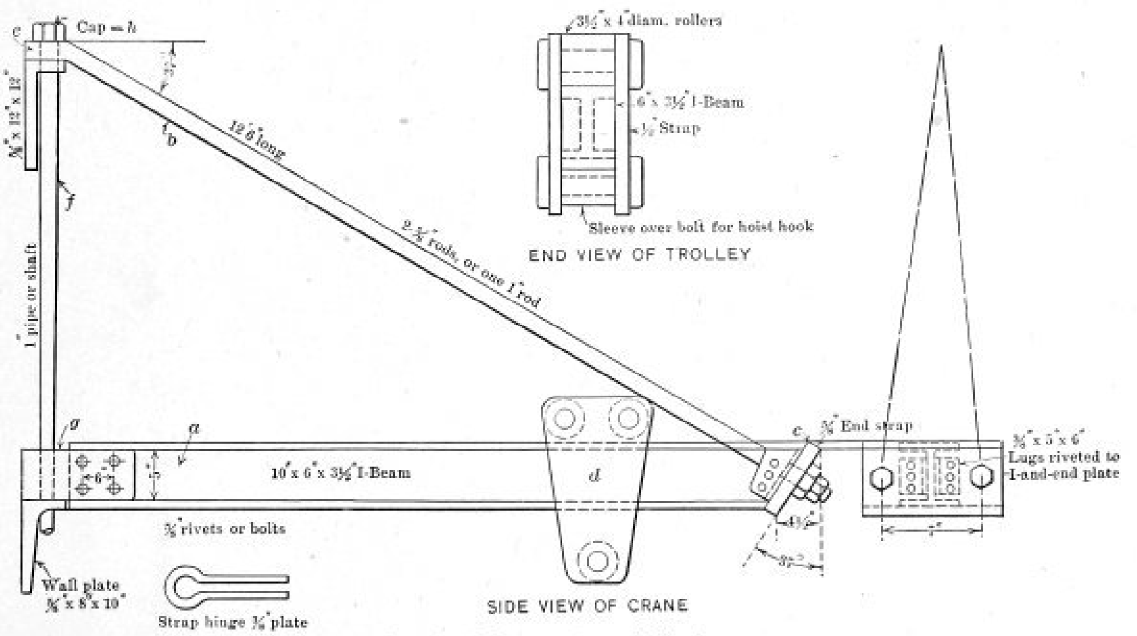
This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary.*

Address your communication to the Editor of the Question and Answer Department of THE BOILER MAKER, *461 Eighth avenue, New York city.*

Making a Jib Crane

Q.—Please give a description of how to build a jib crane that can be fastened to the shop wall, and that will carry about 1,500 pounds.
R. A.

A.—There are so many ways of constructing a home-made jib crane that the giving of directions without our knowing more of your requirements leaves a great deal to guesswork. However, we give one method with the sketches herewith, and it will be easy for you to modify the details to suit yourself.



Details of Construction of Jib Crane

This jib crane is the wall-bracket type, and it is intended to swing through an angle of 180 degrees and to cover a radius of 10 feet. A trolley is used to carry the hoist, which may be either of the chain or air variety.

The horizontal arm *a* is made of a 6-inch I-beam 10 feet long. The 6-inch I-beam flanges are about 3½ inches wide.

For a length of 10 feet, the height of the brace rod *b* should be about 7 feet 6 inches, and its length about 12 feet 6 inches. This gives it an angle or slope of 37 degrees with the horizontal. One end of the beam is cut to this slope, which means cutting back the lower edge 4½ inches. Rivet on an end piece, *c*, of boiler plate to receive the tie rods *b*. In order to clear the trolley *d*, running on top of the rail, the tie rods should be placed 7 inches between centers. The end plate may be made of ⅝-inch boiler plate and riveted to the I-beam, using two angle plates or lugs with three ⅝-inch rivets in each end, as shown.

Use two ⅝-inch rods or one 1-inch rod, modifying the end plate to suit either case. The rods should have good fitting nuts and check nuts. The upper end *e* of the tie rod should be forged into a closed eye without a weld, and one that will fit over a 1-inch pipe or shaft to be used as a vertical arm. The eye should be bent to about 37 degrees from a straight line, so as to seat fair.

The vertical arm *f* should be fitted with a heavy strap hinge *g*, made of ⅝-inch plate. The strap should be 5 inches wide and 6 inches long on the web. Use four ⅝-inch rivets.

The wall brackets may be made of ⅝-inch boiler plate. Set the pivot arm *f* as close as possible to the wall and allow a large area of plate against the wall or post. Use four ¾-inch bolts in each plate.

If a 1-inch pipe be used for the arm *f*, a cap *h* screwed on the top will hold it in place. Short pins could be used instead of the pipe, or use a piece of shafting.

The trolley should have two rollers 3½ inches long and 4 inches in diameter. Use large pins—1 inch in diameter—for the roller shafting. Make the hanger strips *d* of ½-inch plate.

Special care should be taken in making the structure. Give strict orders against anyone overloading it. Grease holes should be provided in the bearings and these filled with stiff graphite grease, which will last for many months without attention.

Is Oxy-Acetylene Welding of Patches and Tubes Permitted?

Q.—Would you consider that oxy-acetylene welded boiler patches and boiler tubes, properly welded, should be acceptable to insurance boiler inspectors.
O. X.

A.—The steam boiler insurance companies each have their rules pertaining to repairs, but in general they accept and approve the A. S. M. E. boiler code as their standard. Hence the inquiry may properly be answered by the Code, of which Bulletin No. 14, Department of

Labor, State of New York, is the very latest issue to date. Paragraph 186, on welded joints, beginning second clause reads: "Autogenous welding may be used in boilers in cases where the strain is carried by other construction which conforms to the requirements of the Code, and where the safety of the structure is not dependent upon the strength of the weld. Autogenous welding shall not be used in place of calking in longitudinal or girth seams."

The above covers the inquiry as respects autogenous welds in *tension* as on the shell plates, but, on the other hand, welding where the plate is supported by tubes or staybolts, as in a locomotive firebox, is acceptable, but not so for a wrapper plate on the outside, since the former is in compression and the latter in tension. As regards such welding for tubes, the question should be divided into fire tube and water tubes.

No welding by any process is advisable as respects power boiler *water* tubes, since the stresses on such tubes are more severe and different from fire tubes. Autogenous welding of fire tubes depends so much on the intelligence and skill of the operator that one cannot approve in a general way, while he might approve of such welding when he personally saw it done in a first class manner. Also what may be done in good shape on a small tube of good material might not pass a larger tube of poorer material.

Again, the stress load on the fire tube must be considered. For example, consider a 4-inch tube supporting a rectangle 5 inches by 7 inches (as in the top row of an H. T. boiler), the area $= 5 \times 7 - 12.56 = 22.44$ square inches. Let the pressure equal 150 pounds, then the stress equals 3,366 pounds. Under such loads and considering that at best an autogenous weld is practically cast metal at the weld, it follows boiler inspectors hesitate to approve of autogenous welds in general for fire tubes, since he would be personally responsible, in event of failure of the tubes, to his company.

Pitch of Tubes

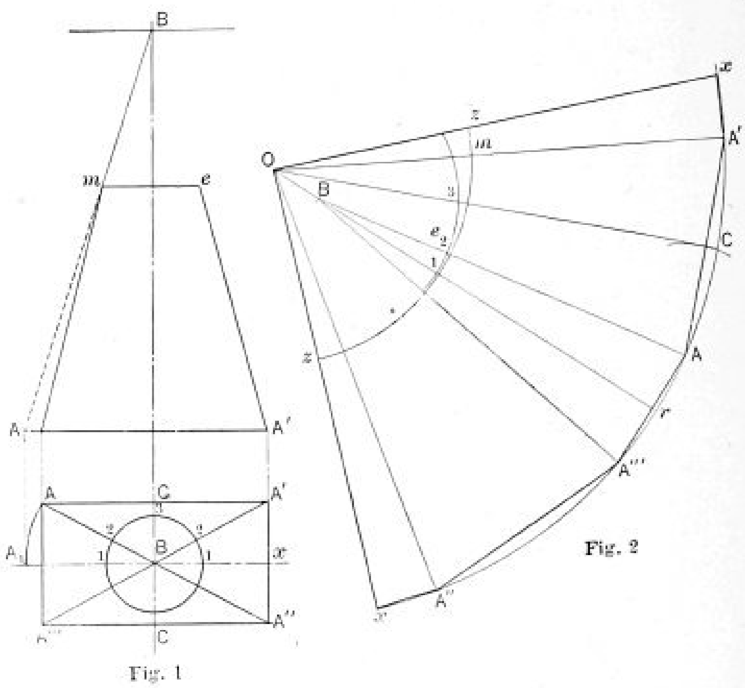
Q.—For any given working pressure, please give rules or formulas for the pitch of tube holes for a flue sheet 1/4 inch thick, containing 2-inch flues. Also please give formula for various size flues and thicknesses of flue sheets. My experience has been that in locomotive boilers the pitch of the tubes is by no means uniform. In old boilers there are many cases where the flues have been worked over and renewed so often as to cause the holes to be enlarged so much that there was very little metal or only a small portion of the ligament left between the flues. Would you consider it a serious matter if you found in a boiler two-thirds of the holes so close that when the flues were renewed they could not be beaded? What load is a flue capable of sustaining when beaded over at one or both ends?

A.—The pitch between the tubes depends on the diameter of head, number and size of tubes and their arrangement. The size and number of tubes depends on the required heating surface area and draft area that they must provide. The pitch should not under ordinary conditions be less than the product of 1.4 times the diameter of tube used. The general practice by some engineers in spacing tubes 3 inches in diameter and smaller is to allow a bridge equal to 3/4 inch between the holes in the tube plate. Experiments have shown that expanded tubes in circular holes can safely carry a load equal to one-fourth the tensile strength of the tubes. With conical holes the strength is increased. It is, therefore, evident that the holding power of tubes expanded, even if not beaded or wedged out, is ample support for the tube sheet. By beading the tubes, the holding power is greatly increased. In marine practice stay tubes are sometimes employed; tubes of this kind are made heavier than the ordinary tubes. The ends of such tubes are threaded and fitted with nuts, or are threaded and beaded over in the usual way. It is advisable and the best practice, in cases where the holes are expanded so much as to reduce the bridge or ligament between them, as you state, to renew the tube sheet.

Approximate Method for Laying Off a Transition Piece

Q.—Please give a method of drawing and tapering piece from a square or rectangular base to round. L. B.

A.—Draw a plan and elevation, Fig. 1, about the center line *B-B*. Fnd the true length of the diagonal line *A-B* by first revolving its horizontal projection about *B* as a center to position *B-A* in the plan. Project A_1 to the position A_1 in the elevation and draw the line B-A_1. Lay off the line *B-r* in the pattern, Fig. 2, and draw *A-A'''* at right angles to it. Make *A-B* and *A'''-B* equal in length to A_1-B of the elevation, Fig. 1. With *B* as a center, draw an arc with a radius *B-m* of Fig. 1. On this arc set off



Layout of Tapered Connection

the arc length 1-2, 2-3, etc., of the plan view, Fig. 1. From *A* in pattern as a center and *A-C* of the plan as a radius, draw the arc *c*. Through point 3 in the pattern and tangent to arc *c*, draw the line *C-c*. The point *O* is a center used in describing the arc *x-x* at the base of the pattern. It is an approximate center, but by its use practical results are obtained. With *O-A* as a radius and *O* as a center, arc *x-x* is drawn. *A m* equals A_1-m of Fig. 1. With *O* as a center and *O-m* as a radius, draw the arc *z-z* for the upper circular base of the object. On the arc *x-x* the straight edges *A-A'*, *A''-A'''* equal the corresponding lengths of the plan. Having laid off the stretchout lengths on both arcs, draw the edge lines connecting with point *O*.

PERSONAL

Frank J. O'Brien, formerly layerout at Ames Iron Works, Oswego, N. Y., has resigned and accepted a position as assistant foreman and layerout at J. D. Cousins & Sons Boiler Works, Buffalo, N. Y.

A. Anderson, formerly boiler shop foreman for the Gulf Coast Lines at DeQuincy, La., has been appointed boiler shop foreman for the Denver & Rio Grande Railroad at Alamosa, Col.

John H. Harriss has recently been promoted to the position of assistant boiler foreman of the Ames Iron Works, Oswego, N. Y.

The many friends in the boiler making fraternity of Mr. Joe B. Holloway, chief engineer, Hotel Hollywood, Los Angeles, Cal., will regret to learn of the death on October 8 of Mr. Holloway's wife.

Letters from Practical Boiler Makers

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

Tool to Set Motor Against for Drilling Staybolts

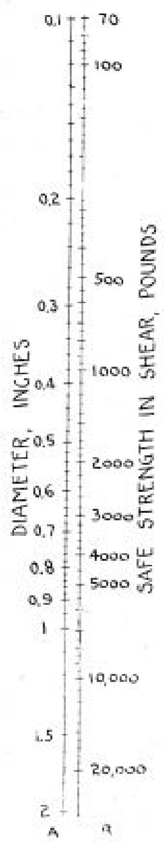
Take a piece of flat iron ½ inch thick, 3 inches wide and about 4 feet long. Cut a V out of one end. This makes a very handy tool to set the motor against when drilling broken staybolts in a roundhouse, as the end with the V cut can be placed in the grates or in a couple of flues, and with a man pushing against the other end it is very easy to drill staybolts, as there is no time lost in tightening bolts as there is in using an old man.

Denver, Col. Arthur Malet.

Handy A. S. M. E. Rivet Chart

Inasmuch as the shearing strength of rivets as specified in the A. S. M. E. Boiler Code is 44,000 pounds, and inasmuch as the factor of safety for new boilers is 5, the allowable stress per square inch is 8,800.

With this constant in mind it is easily possible to determine any area of rivet necessary to hold any load, or it



Rivet Chart

is a simple matter to determine the load a given rivet will hold in shear. However, as long as the value is a constant there is no reason why the strengths of the various sized rivets cannot be charted to advantage, and that is why the accompanying simple chart was constructed.

Scale *A* lists diameters ranging all the way from 0.1 inch to 2 inches. Directly opposite in scale *B* are to be found the safe strengths corresponding with the diameters using 8,800 pounds per square inch as the basis.

For example, What load will a rivet ¾ inch in diameter hold in single shear?

Find the 0.75 point in column *A* and glance across. The answer is, 3,900 pounds.

Again, what diameter of rivet must be used in order to hold a load of 2,000 pounds in single shear?

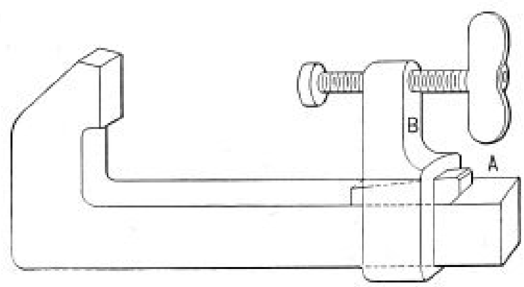
Find the 2,000 in column *B* and glance across to the left. The answer is, 0.54 inch.

It will be found, therefore, that this chart may be kept "on tap" to good advantage by the man who has much rivet figuring to do in connection with boiler design.

N. G. Near.

Adjustable Clamp

The sketch shows a form of quick adjustable clamp that is of real value about the boiler shop. The movable jaw permits the use of a heavy rigid screw. A smart blow of



Quick Adjustable Clamp

a hand hammer at *B* will loosen the jaw, and another on the wedge *A* will tighten it.

This is an original idea with the writer. The clamps can be made in a variety of sizes.

Concord, N. H. C. H. Willey.

Hand vs. Power Riveting

It appears to me that my letter on the above subject in the July issue of The Boiler Maker has been misunderstood or misconstrued, for in that letter I distinctly stated that the shops mentioned were modern in every sense of the word and equipped with the latest and most powerful machinery for the manufacture of boilers. The writer's intention was to convey to the readers of this magazine facts, and only facts, that can be verified at any time, the writer being willing to take the editor of The Boiler Maker, or anyone he will appoint, through one of the most modern boiler shops in western Pennsylvania and show him that the word-picture drawn really does exist, and that the methods used are the very best that science, in design and good workmanship, in the layout and fabrication of the work, can produce.

As stated in my letter, the material used was 13/16-inch plates in tank shells and 1¼-inch in dished heads. For the information of Messrs. Haas and Crombie, I will say that holes in shell sheets are punched 1 inch in the flat sheet and *drilled* 1 inch in the dished heads, and reamed to proper size after parts are fitted together, a practice that can hardly be improved upon unless it is the actual drilling in position spoken of by Mr. Haas (and which was drawn to the attention of the readers of this magazine some time ago during the discussion on punched and drilled holes). There were no distorted holes or mis-shapen plates, the rivets were heated uniformly in gas furnace, girth seams tacked on the quarters. The quantity of rivets driven was of secondary consideration. Quality was what we wanted and did not get. Let us see what constitutes a leaky rivet. It is not necessary that a rivet be loose in the hole and that the water be squirting all over the shop to qualify a leaky rivet. A rivet that weeps, or sweats, or shows a drop of water is a leaky rivet, to all intents and purposes, and will not pass muster until made dry. Therefore I say that a boiler that *weeps or sweats* all over is *leaking all over* and requires calking. I have seen such boilers passed by inspectors, and I am well aware that many of such leaks will take up, but when a job is for your Uncle Samuel he will have the *goods delivered dry* or not at all. Mr. Haas says that a diversity of opinion exists upon every conceivable subject. It is a good thing that it is so, for if it were not so there would be no progress; things would come to a dead standstill.

Hand riveting is not a superstition to me, for I know by years of experience with hammer riveting, away back in the bad old days of boiler making, when decent workmanship simply did not exist, that hand work is good. I would like to ask Mr. Haas if he ever heard of such men as Samuel Nichols, Robert Knight or John Courtney? English boiler makers, men who have devoted their lives to the advancement of the boiler maker's craft and whose works are in the hands of our best engineers and boiler makers, works that are authorities on boiler making and iron shipbuilding in Great Britain to-day, and whose works (original) have never been surpassed by any writer on the same subject. Yet they were men of the bad old days. You surely do not expect the readers of this magazine to understand that they were not decent workmen.

Let us look a little further into the darkness of the bad old days. Who was Sir Daniel Gooch, Superintendent of Motive Power of the Great Western Railway of England; Messrs. Ramsbottom and Webb, of the London & North Western Railway, and Mr. Kemp, of the Caledonian Railway of Scotland; Brunell, of Great Eastern Steamship; Stevenson and Trevethick, of early locomotive fame—all engineers of the early days of steam engines and boilers, men that the mechanical world looks back at with wonder and pride, men that we have to thank, not only for the locomotive, but for its development, and who made the modern locomotive possible. Am I to understand that those great men would allow anything but decent mechanics to work in the shops under their supervision? Again, do you suppose the Richey & Grant Locomotive Company, Killmarnock-Dubbs Locomotive Company, Clyde Bank Shipbuilding Company, of Scotland; Byers & Peacock, Daniel Adamson, and Galloway, of Manchester, England; the Old North Abby Engineering Company, the Taff Vale Railway, Rhymney Railway, and the Marquis of Bute's interests at Cardiff, Wales—firms and companies that were in existence in the bad old days when decent workmanship simply did not exist. Yet those same people have a world-wide reputation for good work, and where the superstition of hand riveting existed to an alarming extent, from my earliest recollection it was impossible for an inferior workman to land a job at any of the works or shops of the above-named firms.

Let us come a little nearer home. In the spring of 1884 (long before Mr. Haas had entered the profession, according to his own statement) I visited the shops of the Pennsylvania Railway at Meadow Land, Newark, N. J., and there in the corner of a building I saw a small locomotive and was told that it was the John Bull, the pioneer locomotive of the company, and upon examination I found that the rivets were all hand driven. Of course we cannot compare the John Bull with the present-day monsters for power; but we can compare the workmanship, and when we make allowance for the difficulties that the boiler makers had to contend with, *they compare* very favorably with the present-day mechanic, who has modern machinery of all kinds to help him. During the World's Fair at Chicago—1893, I think—the John Bull was taken there, and passed through Pittsburgh under her own steam over the P. F. W. & C. Ry., and came back over the Panhandle Railroad in charge of Engineer James McCollough, the present superintendent of the Panhandle Railroad, who told the writer at that time that he had made thirty-five miles per hour over the road. Now, just think of that—a machine that was built in the bad old days of boiler making, when decent workmanship simply did not exist, yet after years of service in the bad old days and years of idleness afterwards, this same product of the poor, unskilled mechanic was able to cover some two thousand miles and attain a speed of thirty-five miles per hour! I think that speaks well for the poor, unskilled mechanic of the *bad old days.*

The Silent Boiler Shop

My fellow craftsmen, just think of what we have missed by getting on to this old earth sixty years before our time! Now that we have lost our hearing, or nearly so, we are told that the modern shop is a silent one. Shall we go seek it? It must be on the other side of the—Jordan, I was going to say—herring pond. It certainly is not on this side, for the only silent boiler shops that I know of are the ones shut down for want of work, and there is none of that kind in this country at the present time. The modern American boiler shop has Hades skinned a mile for noise. In that silent boiler shop across the pond they must use Maxim silencers, rubber cushions or pneumatic shock absorbers—tools that the nerve-racked American boiler maker has been looking for for years.

Mr. Haas says there is some unconscious humor in Mr. Harrison's remark that the rivets given the least attention were the ones that did not leak. Naturally, the less attention with a calking tool the tighter the seam. Now, let us look over that part of the letter leading up to that paragraph which reads: While discussing this subject (hand-driven rivets) with an old friend of ours, and a foreman of high standing, the above facts were mentioned, and he recalled a case similar to this. He had built some stationary boilers for foreign shipment which, *when completed, would be cut in half.* There very little attention was paid to the way the center seams were *driven*, other than that the *rivets* were well plugged into the holes without finish. When the test took place it was found that these rivets that were given the least attention were the ones that did not leak, proving again that the hand-driven rivets are superior to the machine-driven rivets for perfect work.

It was necessary to cut those boilers apart for shipping, therefore the middle seams were hand-driven and no particular attention given in making a finished job. But the simple plugging of the rivets in the holes with light mauls accomplished what the *hydraulic riveting machine failed to do*—drive a tight rivet that did not require calking. Now, where is the unconscious humor spoken of? I fail to see it, therefore I am inclined to think that Mr. Haas was trying to ridicule me.

He also says that I unsparingly condemn modern machinery. Wrong again, sir! Read again the last sentence but one of my letter of July and you will find it reads as follows: "We do not contend that modern machine riveting is not good, and that larger *quantities* of work can be turned out by their use than can be done by any form of hand work; also that cheaper labor can be employed in doing so." Now, is that condemning modern appliances? I think not.

I regret very much that in analyzing my letter Mr. Haas has seen fit to resort to sarcasm and ridicule. There is no reason why the proper meaning of any part of that letter should be distorted and its meaning changed in any way by the free use of high-flown words. My object, in the first place, was not to discredit Mr. Travers' word, but to bring to the notice of this magazine facts and conditions that the writer has deplored for many years past. I am not in any way advocating the return to hand riveting. Far from it, although the practice is frequently resorted to in certain kinds of work. We all know the power of the hydraulic riveter, and many of us know when it was first introduced into the boiler making trade. Yet there have been calls for hand-driven rivets since then. For instance, some sixteen years ago there was built at the yards of the Clyde Bank Shipbuilding Company, Glasgow, Scotland, two battleships, one for the English navy and the other for the Japanese navy. The one for the Japanese navy, the *Mikado*, had her boilers—some thirty-seven or more—all hand driven, according to the specifications of the Japanese Government, and the H. M. S. *Terrible* had the girth seams all hand driven. Now, is it possible that the British and Japanese admiralties did not know what they were about when they specified hand-driven (hammered) rivets? The above particulars were given me by a gentleman who spent nearly two years in the drafting office of the Clyde Bank Shipbuilding Company at the time those ships were building, and who spent seven weeks at sea in the engine room of H. M. S. *Terrible* during the maker's trials, and must be taken by the readers of THE BOILER MAKER at its face value, for at this writing I have no means of verifying it, only to say that my informant holds a very responsible position with the same company that I work for, and I have no cause to doubt his word.

I do not doubt Mr. Haas' word that there are shops that turn out work that can compare with the best, and that boilers made under his supervision were drop dry, but Mr. Haas must remember that conditions that prevail in England do not prevail here. You have your board of trade inspectors that see to it that nothing gets by them that is not right. We have some kind of Federal supervision which, up to the present time, does not amount to much. When the American manufacturers are willing to abolish the punching machine and position drill and are willing to take more time about their work, then and not until then it *may* be possible to get a boiler that does not require calking under test.

Pittsburg, Pa. G. H. HARRISON.

Bottom Plate and Manhole Corrosion

There is no question but that the accumulation of damp ashes in contact with a boiler shell is deleterious. Under such circumstances the invitation offered to speedy corrosion is cordial and could scarcely be more direct in its effects. The fire bar level, in relation to the floor, limits the height at which a boiler can be raised clear, and so avoid piling ash when cleaning fires or raking ashpits. Otherwise it would be easy to insure that, short of willful neglect or culpable negligence, the irreducible content of fuel would be kept clear of the boiler itself.

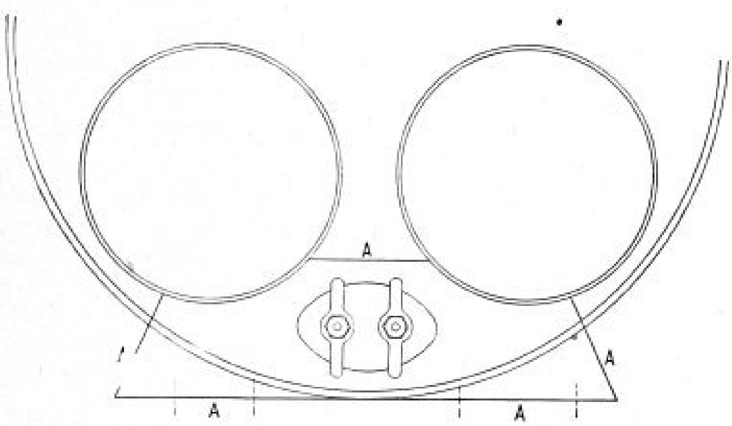


Fig. 1

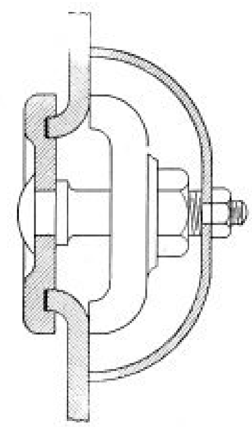


Fig. 2

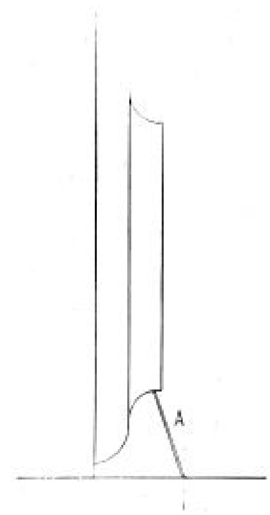


Fig. 3

Some boilers are fitted with grid openings in front to provide a receptacle, but normally the necessity for handling the ash on a level precludes such provision. The trouble would be minimized if the ash and clinker were kept dry, but slaking is a necessity. Alternate damp and drying out, together with the sulphur and other chemical contents of the wetted mass, provides an ideal culture in which the microbes of corrosion rapidly breed and multiply.

Necessity of design imposes upon the boiler maker that in a twin flue firetube boiler the bottom manhole shall be at the front in the center line of boiler at the bottom. Obviously this is the exact position where the heap of wet ash and clinker accumulates when fires are cleaned or ashpits raked out. The heap lies covering the manhole door and is there slaked without removal. If any proof be needed of the effect of the practice it can be found in the condition of the nuts and studs of the door. The lodgment afforded by the fact of the door face forming a recess, and the position of studs, dogs and nuts, insures adherence of the wet ash. Virtually it is impossible to keep the door fittings free even if a broom be frequently used.

Removal of the heap does not mean that the door is freed from adhering material. With all the desire in the world on the part of the stoker or attendant, the normal condition of affairs is ideal for corrosion. While the shell plates are themselves affected in the course of time by the ash heap, the fittings of the manhole door suffer more severely.

Now, it is not difficult to make suitable provision and so avoid the worst effects caused by the universal practice in firing. In fact, the method of so doing is so simple that, like many other obvious things, it is usually overlooked. *Provide the manhole door with a suitable shield or cover.*

The sketch, Fig. 1, shows a typical instance of the worst possible case. If a single furnace only is fitted, there is no room for a manhole door below the flue. In this instance the door must be at the wing, or most probably is underneath barrel of boiler. If more than two furnaces are fitted the structures already cited apply.

The sketch, Fig. 2, gives rough detail of the fitting of a suitable shield at a trivial cost. If the practice becomes usual in any shop the additional expense is really negligible. A light casting is easily procured, but where a boiler shop does its own hot flanging, a couple of cast iron blocks of requisite shape will serve to make a neat and light shield from 3/16-inch material in the press. As will be seen, the manhole studs are made extra long and turned down to ⅝- or ¾-inch threads, the shield being provided with punched or drilled holes to suit. The device is effective and cheap, while its value is so obvious that once seen it should become usual.

Moreover, it neatens off the manhole orifice, and its removal to inspect condition of door joint or take up main nuts is a matter of a couple of minutes. It is preferable, perhaps, that the smaller threads should not be integral with the dog studs, but be smaller studs tapped into the ends of the large studs securing the door. This provides for easy renewal of the shield studs, while the application to an already existing door can be made in this way very readily.

An extension of the idea embodied is that the entire front plate of boiler at floor level should be protected by a light shield plate, shown as *A A* in sketches 1 and 3.

Where the furnaces are riveted by hydraulic means the flanging of shell plate projects outward and a light plate cut to the double curvature of both furnaces and resting on floor seems an easily made job. The projection of furnaces secure it at top while the slight inclination needed to clear the manhole door nuts also allow it to be securely wedged. A couple or more stop pins in firing plate of floor will secure it mechanically. Sketches 1 and 3 are self-explanatory.

It is hoped that by drawing attention to the remedies, both of which are cheap and effective, that such protection may become general.

London, England. A. L. HAAS.

Don't Buy Inefficient Machinery*

Sometimes buyers complain about their machines being inefficient after it is too late. They say that they were "stung." I know of a case of this kind in which the machine used was guaranteed to render a certain performance, but from the start it failed to do so. The guarantee was good for one year only. Both the manufacturer and user were to blame, I contend, because the machine certainly wasn't "as represented" and the buyer was too lenient. The manufacturer insisted that after a time, when the machine was properly "worn in," it would come up to the prescribed mark. But it never did, and the owner is still waiting. The year has passed and the guarantee is no longer active. The owner can't hold the manufacturer any more.

This does not happen often nowadays, because most reliable manufacturers are willing to make good even after several years, guarantee or no guarantee. The point I want to make is that there is seldom any excuse for buying inefficient machinery of any kind, unless one sets out to buy something cheap. One can hardly expect a cheap product to be efficient. Before buying expensive machinery, though, one has several ways of determining beforehand whether or not that machinery will be efficient. Manufacturers are generally willing to make tests before the machine leaves the factory, and at these tests the buyer is allowed to have as many representatives as he wishes. After such tests are made to the full satisfaction of experts, there is seldom any chance that the machines will go wrong or fall below guaranteed performance. It often pays to employ competent experts for the selection of machinery. Lastly, if the machine doesn't fulfill the guarantee, don't be afraid to ask the manufacturer to make good. Present-day manufacturers are anxious to make good, because they know that any case of poor or unsatisfactory performance means a "black eye" for the manufacturer.

W. F. SCHAPHORST.

* Copyright, 1916, by W. F. Schaphorst.

A Welding Job

About a year ago I was working in a back shop when an engine came in with a welded box patch on each side sheet. The patches extended from the flue sheet to within about ten rows of staybolts from the door sheet and about eight rows high. The welded seam on the back end of these patches had been breaking out, so the foreman decided to take the box out on the back and pull the edge of the patch down flush with the other sheet and then weld it.

I was placed on the job, and after taking out the first three rows of staybolts in the back end of the patches, I chipped the weld loose and cut the piece of the side sheet away that was turned over to make the box. After getting this done I put ¾-inch bolts in each staybolt hole in the second row from the end of the patches and pulled them down flush. When the sheets were pulled down flush there was an opening about ¾ of an inch wide between them. I then chipped the edge of each sheet on a forty-five degree angle, tapered out the staybolt holes and run in the bolts.

After the bolts were all in the patches and cut off the welding machine was brought on the job, and placing some strips of 3/16-inch iron against the sheets on the water space side and over the opening between the two sheets, then the opening was welded up. The staybolts were drove up then and the engine sent out.

This engine ran about five or six months before it came in for new side sheets, and the patches never gave any more trouble after being fixed this way.

Denver, Col. ARTHUR MALET.

CONVENTION OF THE INTERNATIONAL ACETYLENE ASSOCIATION.—The nineteenth annual convention of the International Acetylene Association was held at the Congress Hotel in Chicago on October 29 and 30 and was largely attended by representatives of concerns interested in the use of acetylene in welding, cutting and lighting. The members discussed the many changes in industrial conditions that are due to the war and the consequent expansion of the industry in many unexpected directions.

Selected Boiler Patents

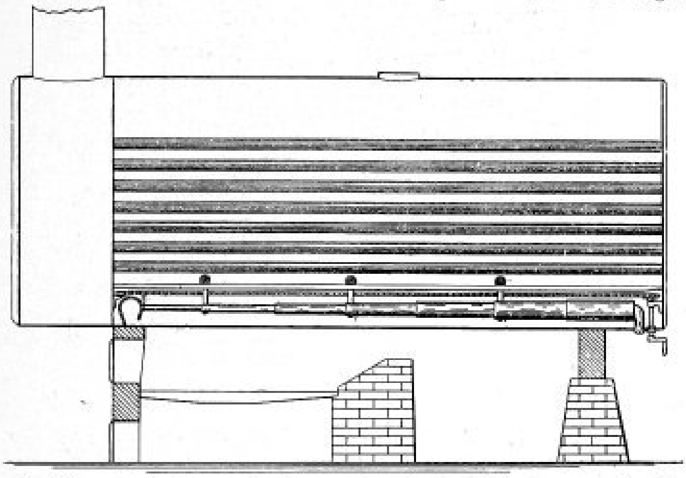
Compiled by

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

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

1,233,776. STEAM BOILER SCRAPER. FRANK S. HAMMOND, OF MEDFORD, MASS.

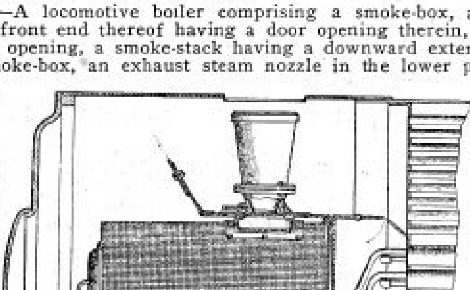
Claim 1.—A boiler scraper comprising a scraper blade fitted to the interior of a boiler interior, a plurality of telescoping tubular sections the smallest of which is attached to the scraper blade, and the largest



of which communicates with the exterior of the boiler at one end of the latter, and externally operative means for retracting the smaller sections into the larger and thereby cleaning practically the entire length of the bottom of the boiler. Two claims.

1,234,235. LOCOMOTIVE SMOKE-BOX. WILLIAM JAMES TOLLERTON, OF CHICAGO, ILL.

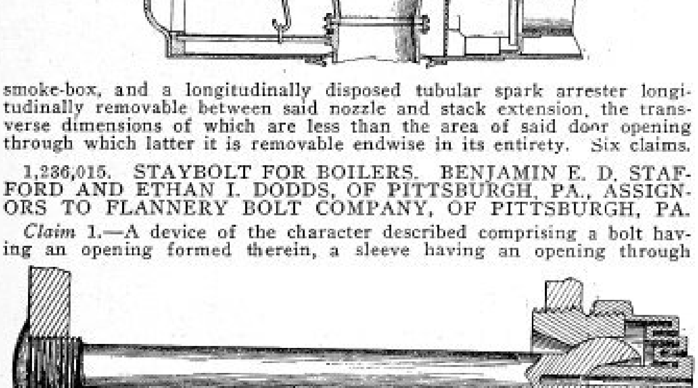
Claim 1.—A locomotive boiler comprising a smoke-box, a plate for closing the front end thereof having a door opening therein, a door for closing said opening, a smoke-stack having a downward extension entering said smoke-box, an exhaust steam nozzle in the lower part of said



smoke-box, and a longitudinally disposed tubular spark arrester longitudinally removable between said nozzle and stack extension, the transverse dimensions of which are less than the area of said door opening through which latter it is removable endwise in its entirety. Six claims.

1,236,015. STAYBOLT FOR BOILERS. BENJAMIN E. D. STAFFORD AND ETHAN I. DODDS, OF PITTSBURGH, PA., ASSIGNORS TO FLANNERY BOLT COMPANY, OF PITTSBURGH, PA.

Claim 1.—A device of the character described comprising a bolt having an opening formed therein, a sleeve having an opening through



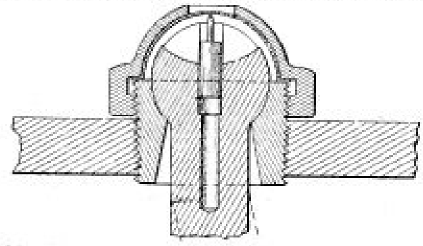
which said bolt passes, a cap on said sleeve, said cap being provided with an opening, and a fillet arranged between said cap and said bolt, said fillet being provided with an opening in the bolt and cap. Eleven claims.

1,235,317. BOILER TUBE CLEANER. SAMUEL J. HERMAN, OF DETROIT, MICH., ASSIGNOR TO DIAMOND POWER SPECIALTY COMPANY, OF DETROIT, MICH., A CORPORATION OF MICHIGAN.

Claim 1.—The combination with groups of tubes arranged in adjacent rows with baffle plates intermediate the adjacent groups at one side of the row, of a blower tube extending between rows transversely of said groups and parallel to said baffles, jet nozzles upon opposite sides of said blower tube dissimilarly distributed, the nozzles on one side covering the area of each entire group of tubes and the nozzles on the opposite side being limited to a portion of each group and avoiding the baffles, and means for rotatively adjusting said blower tube limited to a partial revolution thereof. Two claims.

1,236,065. STAYBOLT FOR BOILERS. ETHAN I. DODDS, OF PITTSBURGH, PA., ASSIGNORS TO FLANNERY BOLT COMPANY, OF PITTSBURGH, PA.

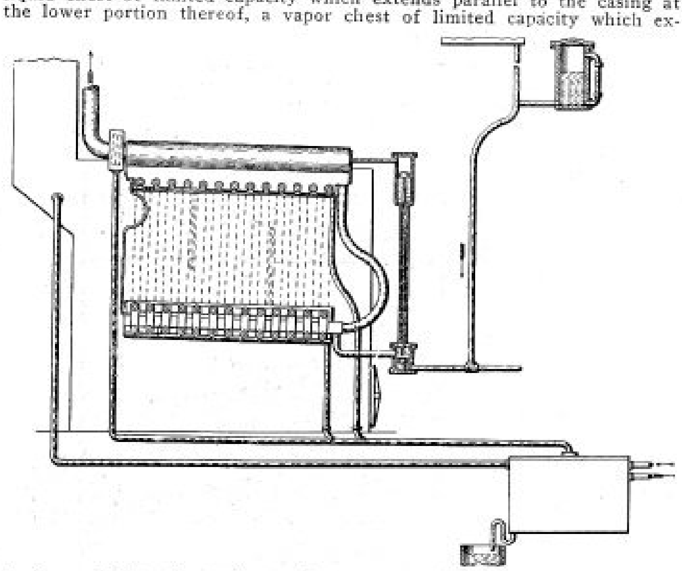
Claim 1.—A staybolt having a telltale bore, a cap covering the head of the bolt and provided with an opening, a breakable covering for the



opening in said cap, and a plunger within the bore of the bolt and in line with the opening in the cap. Six claims.

1,236,155. BOILER. WILLIAM L. R. EMMET, OF SCHENECTADY, N. Y., ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

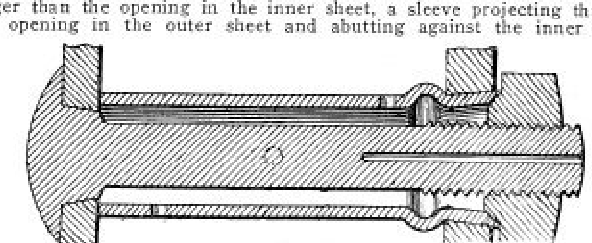
Claim 1.—In a mercury boiler, the combination of a boiler casing, a liquid chest of limited capacity which extends parallel to the casing at the lower portion thereof, a vapor chest of limited capacity which ex-



tends parallel to the casing at the upper portion thereof, a curved flattened tube connecting said chests, headers connected to said chests and projecting into the boiler casing, and flattened tubes which are attached at their ends to the headers, each of said tubes being provided with a curved portion between its ends to reduce strains at the points of attachment due to expansion. Nine claims.

1,236,231. BOILER STAY. CHARLES A. THOMAS, OF BIRMINGHAM, ALA., SSIGNOR OF ONE-HALF TO FRANK A. MAYER, OF WASHINGTON, D. C.

Claim 1.—In a boiler stay the combination with spaced apart inner and outer boiler sheets having axially alined oppositely tapered or flared openings therethrough, the opening in the outer sheet being larger than the opening in the inner sheet, a sleeve projecting through the opening in the outer sheet and abutting against the inner sheet



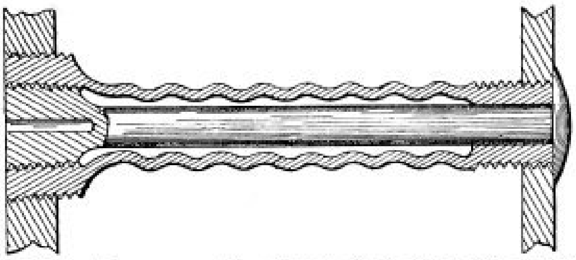
about the opening thereof, said sleeve having an expanded outer end seated against the tapered wall of the opening of the outer sheet, a bolt passed through the opening in the inner sheet into said sleeve and having a head seated flat against the inner side of the inner sheet, with an annular tapered enlargement binding in the opening of said sheet, and against the tapered wall thereof to hold the bolt rigidly in the inner sheet, said bolt having a threaded outer end projecting through and beyond the outer end of the sleeve, and a binding nut threaded upon the outer end of the bolt beyond the sleeve and having an annular wedging extension on its inner side which fits within the expanded outer end of the sleeve and extends inwardly beyond the outer face of the outer sheet. Two claims.

1,235,228. FURNACE DOOR DEVICE. JOHN L. MOHUN, OF BROOKLYN, N. Y., ASSIGNOR TO THE FRANKLIN RAILWAY SUPPLY COMPANY, OF WILMINGTON, DEL., A CORPORATION OF DELAWARE.

Claim 1.—In a furnace door device, the combination with a metal frame adapted to be bolted to the back head of the boiler, and having a curved wall portion extending inward through the firing opening, said curved wall portion terminating in an edge having its face inclined from the top outwardly toward the bottom, of an inwardly and upwardly swinging door normally seated against said face in its closed position, brackets on said frame above the door opening, a horizontal shaft having bearings mounted in said brackets, and a supporting arm rigidly attached to the lower part of the door and extending outwardly and upwardly to said shaft. Five claims.

1,236,224. STAYBOLT FOR BOILERS. BENJAMIN E. D. STAFFORD, OF PITTSBURGH, PA., ASSIGNOR TO FLANNERY BOLT COMPANY, OF PITTSBURGH, PA.

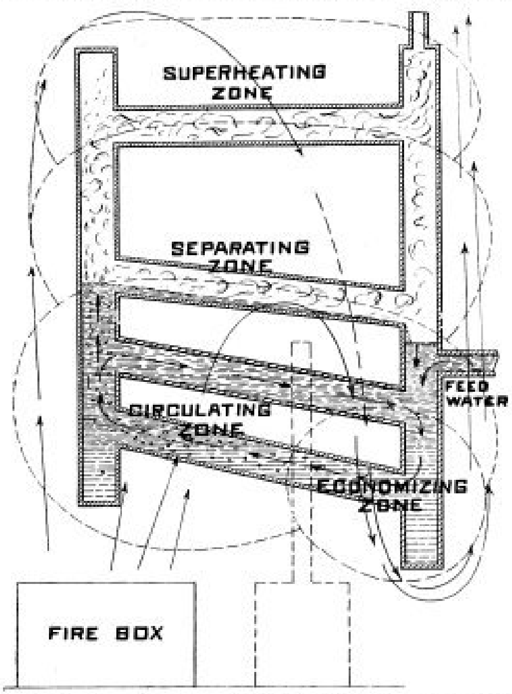
Claim 1.—As a new article of manufacture, a flexible staybolt composed of an outer corrugated tube, and a bolt within the tube, the



tube and bolt being connected adjacent their ends, and disconnected at intermediate points so as to permit the bolt as whole to give or yield laterally. Three claims.

1,236,641. STEAM BOILER. WILLIAM H. WINSLOW, OF CHICAGO, ILL., ASSIGNOR TO WINSLOW SAFETY HIGH PRESSURE BOILER COMPANY, OF CHICAGO, ILL., A CORPORATION OF ILLINOIS.

Claim 1.—The method of treating water to generate steam which consists in applying heat unevenly to a body of water and selectively causing the hottest portion thereof to separate by thermal action, pro-



jecting said hottest portion in a thin sheet having a free steaming surface across a flash surface and supplying heat at substantially furnace temperature to said flash surface in sufficient quantity to supply the necessary heat of vaporization to form steam from a considerable portion thereof, and returning the remainder of said heated water which is not formed into steam to said body of water. Twenty-nine claims.

1,234,924. WATER GAGE. ALBERT W. MORSE, OF NEW YORK, N. Y., ASSIGNOR TO THE NATHAN MANUFACTURING COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

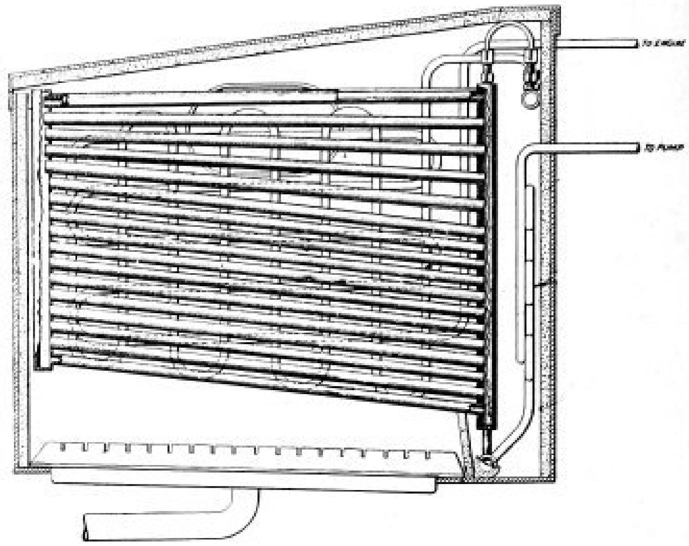
Claim 1.—A water gage comprising a sight glass, a casing adapted partially to surround the same and having a wall on each edge of the sight glass, and rearwardly extending beyond the same, each wall having in front an inturned flange, a packing interposed between the glass and each wall and means bearing against the packing at the rear to compress it against such inturned flange. Twenty-one claims.

1,236,574. WATERTUBE BOILER. GEORGE KINGSLEY, OF NUTLEY, N. J.

Claim 1.—In a watertube boiler the combination of an inner and an outer shell spaced part and connected together at their opposite ends and constituting therebetween a water and steam compartment, said shells being convexed at their top and bottom portions and forming an upper steam chamber and a lower settling chamber, the sides of said shells being upwardly and inwardly inclined and forming oppositely disposed side water walls communicating with said upper and lower chambers, a series of inwardly extending tubes secured to the inner shell of said side water walls and communicating therewith and having their inner ends closed, front and rear frames secured to said shells and inclosing said tubes, fuel-burning means disposed between said side water walls and above said lower settling chamber, baffle plates carried by said tubes and forming gas passages leading adjacent said upper steam chamber, and a smoke connection leading from said passage. Four claims.

1,237,233. BOILER. WILLIAM H. WINSLOW, OF CHICAGO, ILL., ASSIGNOR TO WINSLOW SAFETY HIGH PRESSURE BOILER COMPANY, OF CHICAGO, ILL., A CORPORATION OF ILLINOIS.

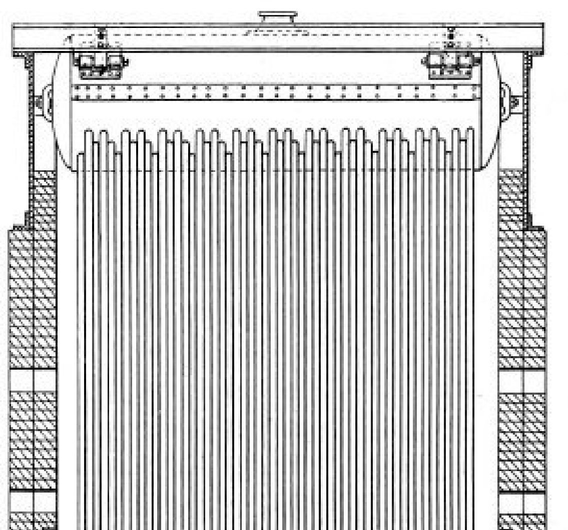
Claim 1.—In a boiler, the combination of two substantially vertical headers, and a plurality of pipes extending between such headers, the lower one or ones of such pipes being substantially horizontal, and the



intermediate pipes having inclinations gradually changing from the inclination of the lower pipe or pipes to a horizontal position, each header affording direct communication between the corresponding ends of all of said pipes. Twenty-nine claims.

1,238,530. VERTICAL WATERTUBE BOILER. GEORGE T. LADD, OF PITTSBURGH, PA.

Claim 1.—In a boiler, the combination of an upper drum, tubes extending downwardly from the upper drum, a lower drum connected to and supported by said tubes, beams arranged substantially parallel with



the axes of said drums, and on opposite sides of the upper drum and adapted to rest at their ends on the boiler setting, and means for connecting the upper drum to said beams which form the sole support of the boiler whereby the boiler is free to move in its setting. Five claims.

1,236,066. STAYBOLT TESTING DEVICE. ETHAN I. DODDS, OF PITTSBURGH, PA., ASSIGNOR TO FLANNERY BOLT COMPANY, OF PITTSBURGH, PA.

Claim 1.—A testing device for staybolts in boiler structures, comprising a shell having a head at one end, a non-magnetic plate secured to the other end of said shell and having a hole therein, a core secured to the head of the shell and passing through the hole in said non-magnetic plate, the free end of said core having a recess to conform approximately to the contour of the cap of a staybolt structure, a coil within said shell encircling the core, and a handle secured to the head of said shell. Two claims.

THE BOILER MAKER

DECEMBER, 1917

Naval Watertube Boilers

Description of Common Types Installed on American Warships—Care and Repair

BY C. H. WILLEY

Many of our younger boiler makers have heard the country's call and responded to the Navy's need. To some of these boys a description of the types of boilers used on board ships of the Navy, along with a few points on their care and repair, may be found helpful. The writer will attempt to cover the subject from a practical

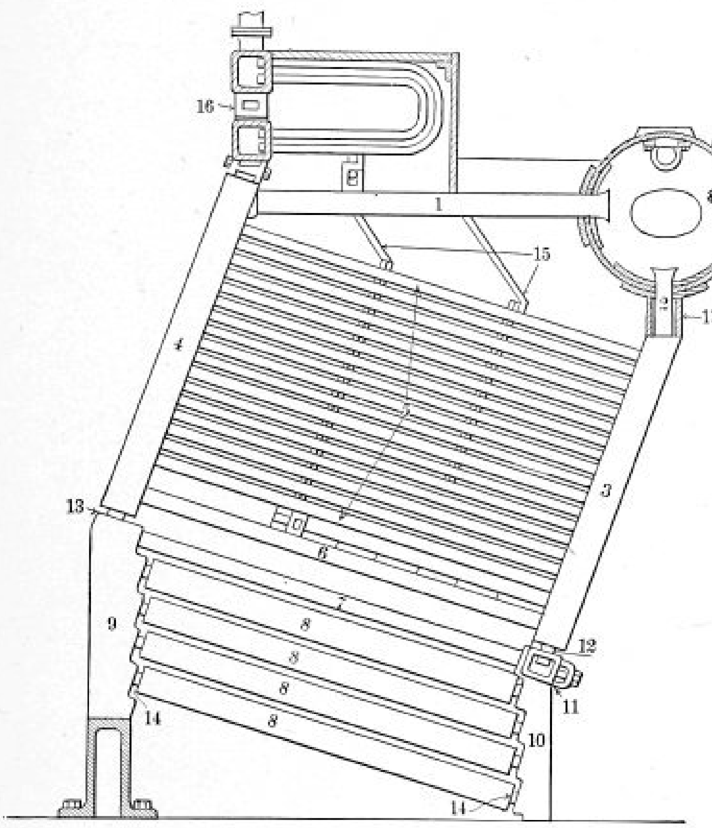


Fig. 1.—Diagram of Babcock & Wilcox Watertube Boiler

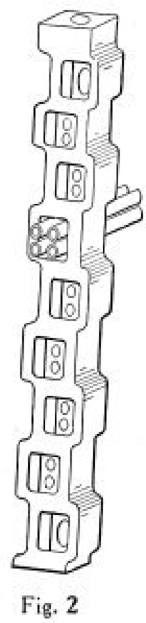


Fig. 2

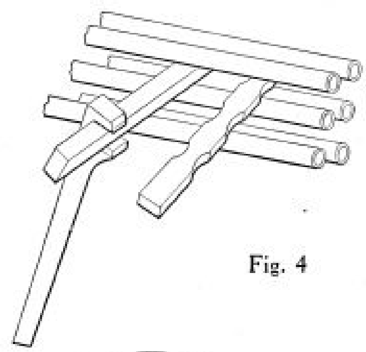


Fig. 4

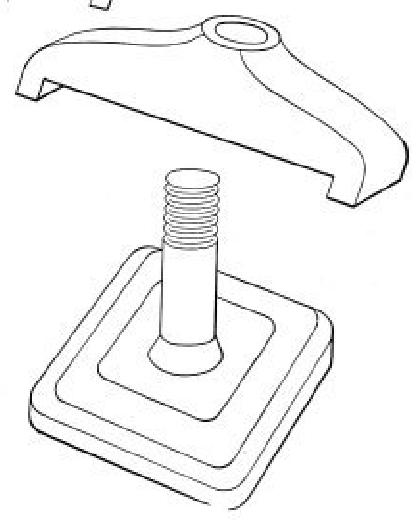


Fig. 3

Navy boiler maker's viewpoint, as if he were describing and giving pointers to a new shipmate.

Where methods of repairs are given, the reader is asked to bear in mind that when this class of work is done on board ship we are not as well equipped with tools, etc., to do the work as it would be done in a boiler shop.

Watertube Boilers

These boilers are classified after the manner in which the circulation of the water takes place, into three classes: Free, accelerated and limited.

Limited circulation implies just sufficient circulation to replace the water being evaporated. Hohenstein and Ward are prominent in this type.

Free circulation means that nothing impedes or obstructs the flow; that the velocity is free to gather speed; that the water is supplied plentifully to the generating tubes. Boilers of this class have straight generating tubes, or nearly so, and set horizontal, or at an incline of fifteen degrees. The water space of the main boiler drums feeds these tubes through headers at the front, and the headers at the back receive the admixture of steam and water, from which it passes upward to the return or circulating tubes to the steam space of the drum, the steam rising and the water returning for recirculation and evaporation.

The chief, or better known and most extensively used, of this class is the Babcock & Wilcox. Formerly some of our ships were fitted with Niclausse boilers; these were of this class, but due to the discontinuance of their manufacture in the United States and the impossibility to obtain any renewals of parts for those we had, the Niclausse boiler is no longer used, and all of the old ones have been converted as they needed repair into a combination of Niclausse and Babcock & Wilcox type.

Accelerated circulation: Boilers grouped under this class are those designed to have their generating tubes almost vertical and connected to horizontal reservoirs or drums at various heights; also those equipped with the "Field Tube," in nearly vertical position. Acceleration of the circulation is accomplished as follows:

The water flows from one drum or reservoir to the other in the nearly vertical generating tubes, and the

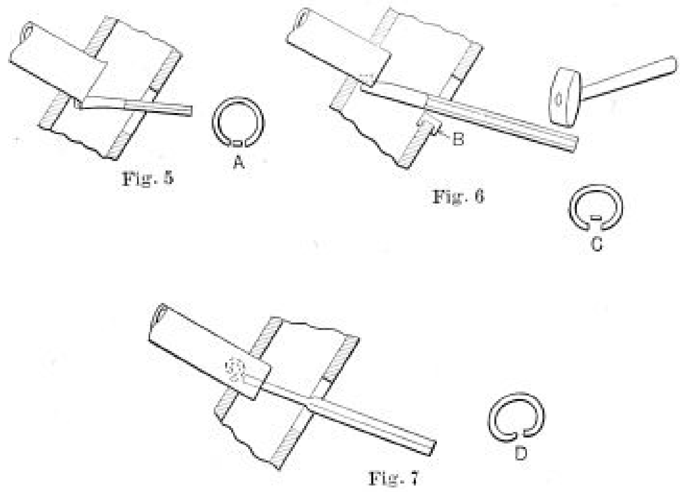


Fig. 5 Fig. 6 Fig. 7

Figs. 5, 6 and 7

bubbles of steam are able to free themselves more rapidly and with greater ease than in the boilers of the limited or free circulation class. The water, when heated in these nearly vertical tubes, rises and is replenished by the cooler supply from the downcomers; this causes the acceleration of circulation.

The Mosher, Normand, Thornycroft, Seabury, Almy, White Forster, Ward, Yarrow and Fore River are of this class, some of which are used in the Navy.

Babcock & Wilcox Marine Boiler

The Babcock & Wilcox marine watertube boiler is the one that has been almost entirely adopted for use in our Navy, nearly all of the latest and largest craft being fitted with these, and it has been the policy of the Bureau of Steam Engineering to replace the firetube type of boiler when it becomes in need of extensive repairs with the watertube type. Some of our late colliers, however, were fitted with firetube boilers.

Referring to the numbers on the structural parts shown in Fig. 1, the names of each part are: No. 1, 4-inch circulating tube; No. 2, 4-inch downtake nipple; No. 3, front header; No. 4, rear header; No. 5, 1-inch generating tubes; No. 6, 4-inch bottom row generating tubes; No. 7, 4-inch side and center water leg tubes; No. 8, 6-inch square section side and center water leg boxes; No. 9, rear upright; No. 10, front upright; No. 11, cross box; No. 12, header to cross box or mud box, 4-inch nipple; No. 13, header to upright 4-inch nipple; No. 14, side box to upright 4-inch nipple; No. 15, baffle and flame plates; No. 16, superheater; No. 17, drum supporting sleeve; No. 18, horizontal steam drum.

The 2- and 4-inch generating tubes which form the main bulk of the heating surface are divided into separate vertical elements or headers. The tubes are expanded into these at their ends. Fig. 2 shows one of these forged steel headers, and Fig. 3 the type of handhole plate and dog that is used in them. The side boxes, or square tubes, as some call them, take the place of brickwork and insure cool side casing and eliminate adherence of clinkers. These boxes are of 9/16 inch thickness, wrought steel with welded seam.

Extending across the front of the boiler beneath the headers are forged steel 6 inches square section cross boxes or mud boxes.

All the front headers except the side and center ones are connected to these cross boxes by 4-inch nipples; the ends of cross box in turn connect by 4-inch nipples to the uprights.

The upper ends of the rear headers are connected to

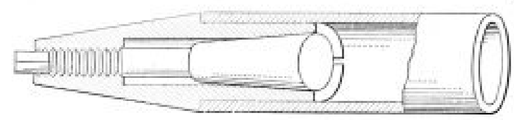


Fig. 8

the horizontal steam drum by the 4-inch circulating tubes.

The 4-inch downtake nipples connect the drum to the tops of the front headers, and around these nipples are steel supporting sleeves that take the weight of the drum.

The superheater consists of two steel headers which

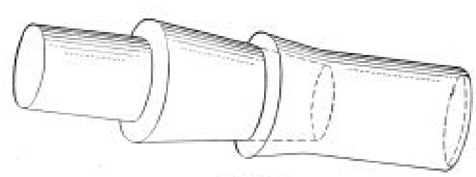


Fig. 9

receive the tube in groups of four to a handhole. All tubes are of seamless drawn steel and extra heavy.

Repairs

The boiler maker's work of repair consists mainly of renewing defective tubes, nipples, side boxes, flame plates, and keeping the boiler casing patched and tight.

Renewing Flame Plates

Fig. 4 shows how the flame or baffle plates are put in. It is necessary to remove a part of the boiler side casing

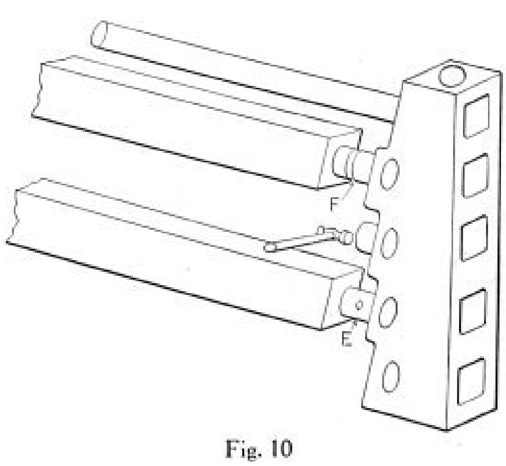


Fig. 10

to renew some, but with patience they can be renewed through the large side panel tube cleaning doors. The section of flame plate is inserted flat on the row of tubes, then a long, square bar of tough steel is inserted, as shown, and this twisted with a large wrench so the corners spread the tubes. The flame plate is then turned on edge and put in place, the square bar turned back flat and withdrawn. The edges of the flame plate must then be secured.

RENEWING TUBES

Perhaps as quick, safe and easy a method of cutting out a tube is that shown in Figs. 5-6-7. The tools re-

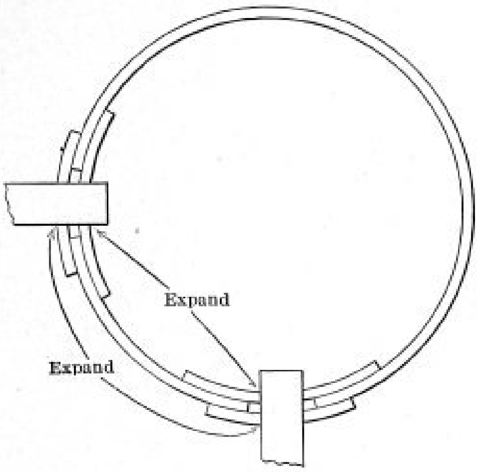


Fig. 11

quired are preferably a pneumatic hammer, a ripper, chisel and bar, and sledge hammer.

The ripper is shown cutting two slots in the lower edge of a 4-inch tube; this leaves a tongue as shown at *A*. A

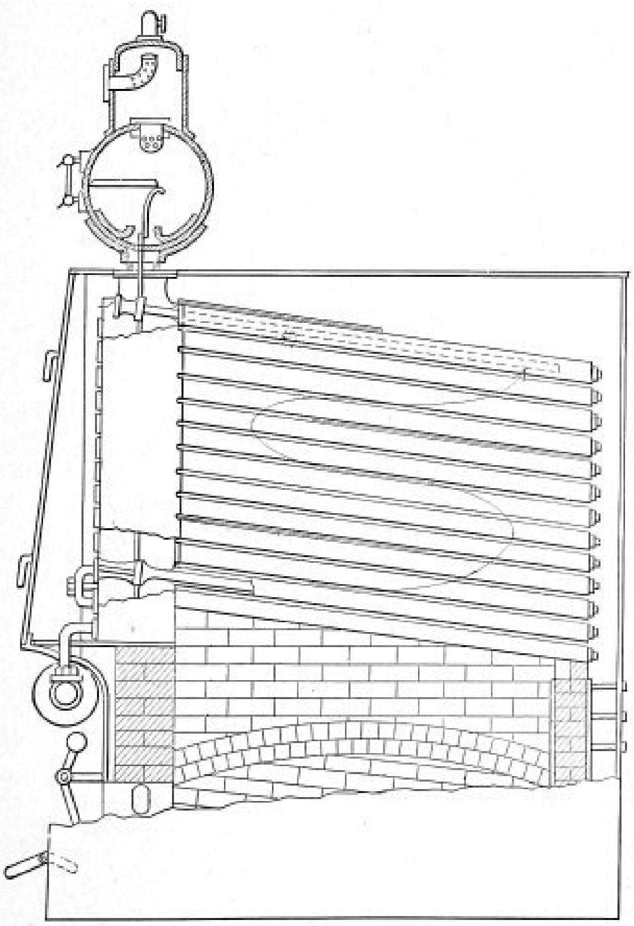


Fig. 12.—Niclausse Boiler

short bar is used, as in Fig. 6, to bend this tongue upwards, using a piece of metal to protect the seat of the handhole, as shown at *B*; the tongue is then in the position shown at *C*. Now the ripper chisel is used broadside against this tongue as in Fig. 7 to curl it back; this rips the tube open across the seat, where it is expanded into the header with absolutely no danger of injuring the seat. The tube is then collapsed, as at *D*, and is ready to come out by driving from the rear header with a tube drift.

Fig. 8 shows a very handy tube pilot that is secured in the end of a 2-inch tube by tightening the center tapered mandrel; this spreads the split end inside the tube. One of these can be easily made in the ship's machine shop. A pilot is needed to steer the end of the tube through the holes in the baffle or flame plates, and if one such as shown in Fig. 8 is used there is no danger of it getting loose and falling down among the nest of tubes.

The 4-inch tubes should be belled or flared in one end with a bell mandrel, as shown in Fig. 9, and the other end should be flared with the straight expander rolls.

RENEWING SIDE BOX

This is accomplished by working from the furnace. Take out such grate bars as are in the way, and with a diamond point chisel punch through a hole, as in *E* in Fig. 10, then place the heel of a ripping chisel in this hole and cut the nipples in half, as indicated at *F*. A hand hammer will drive the halved nipples out when the box is taken out. The new box is put in place and new nipples that have one end flared are put in and expanded, it being seen that the nipple is divided over the seats properly.

DOWNTAKE NIPPLES

When the downtake nipples or circulating tubes are renewed, care must be taken that the seat is rolled by the expander on both the inner and outer butt straps, as shown in Fig. 11. A special extension piece for the expander is provided in the tool outfit. The supporting sleeve of the boiler drum that surrounds the downtake nipple should be in place when inserting new nipples.

Fig. 12 shows a side elevation view of the former Niclausse boiler, which have now been converted into B. & W. design.

(To be continued.)

Are You the Man?

Skilled workers are needed at once in the air service behind the lines in France. Squadrons have been and are now being formed for this service. Picked men are being enrolled from the various workers; these men will be given special training, according to their vocations, in the work required in the air service. They will get actual practice work on airplane motors, trucks, airdome construction and everything that will be done on the other side.

If you operate a lathe, drive a truck, splice insulated wire, fit a joint, or do other skilled work better than the average—perhaps you are the man! Skilled men will be enrolled as non-commissioned officers, ranking as sergeants and corporals, with pay ranging from $30 to $81 per month, according to rank. You will be right up behind the lines—as near the front as the airdromes can safely be taken.

The kind of men wanted includes chauffeurs, auto mechanicians, carpenters, electricians, coppersmiths, sailmakers, machinists, blacksmiths, metal workers, draftsmen, tool makers, welders, plumbers, painters, pattern makers, boat builders and a host of other skilled workmen.

Talk this over with your friends. Team up with your "pal," go to the nearest army recruiting station and enlist in the aviation section of the Signal Corps.

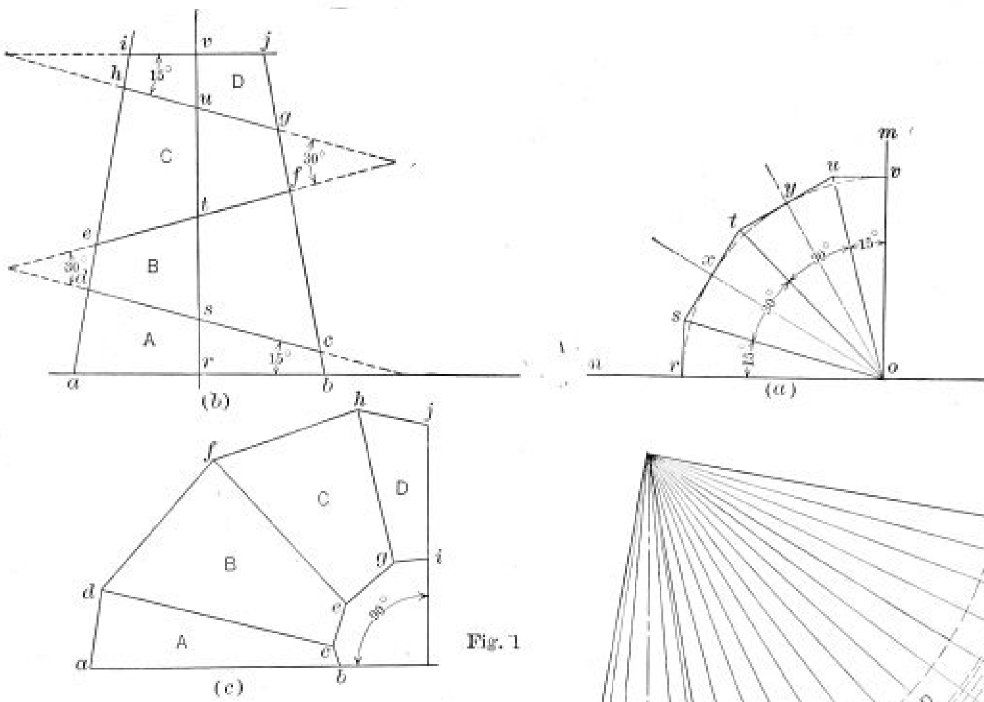


Fig. 1

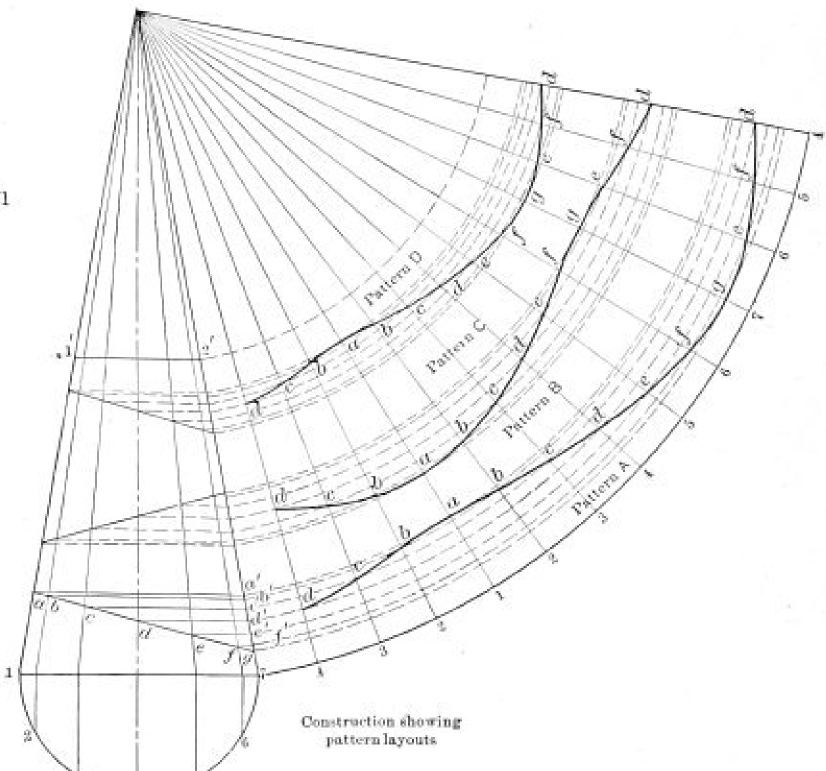


Fig. 2

Layout of Patterns for Tapering Elbow

Tapering Elbow Construction

BY C. B. LINSTROM

Sections of Elbow Fitted Together Form Cone —Radial Method of Laying Out Patterns Used

The layout, Fig. 1, represents the method of laying off an elevation for a tapering elbow having four sections, *A, B, C* and *D*. The preliminary work involved is shown at (a) and (b).

In (a) the center arc *r-v* is drawn first to the required radius of the elbow. Lines *r-s, s-t, t-u* and *u-v* are the axes or center line for the elbow sections; they are determined in this way: Divide the arc *r-v* into one less the number of sections in the elbow, in this case three, as at *r-x, x-y* and *y-v*. Then draw the radial lines *o-x* and *o-y*. At right angles to these lines draw the center lines tangent to the arc *r-v* as shown.

In view *b* a base line *a-b* for the frustum is drawn. A perpendicular line *r-v* to *a-b* is then laid off. Spaces *r-s, s-t, t-u* and *u-v* on this line are equal to the corresponding ones in view *a*.

Lay off the frustum *a-b-i-j* equal to the dimensions of the elbow, so that *a-b* equals the large opening and *i-j* the small opening. Through the points *s, t* and *u* draw respectively the lines *c-d, e-f* and *h-g*, making 15 and 30 degree angles as shown.

The sections *A, B, C* and *D* are now assembled in a frustum of a cone. By reversing the positions of these sections in view *b*, so that the shortest side or throat connections come as shown in view *c*, an elevation of the elbow is completed with the sections shown assembled.

The radial method, Fig. 2, is a practical and quick way of handling this work. The sides of the frustum, view *b*,

Fig. 1, are extended meeting in point *x*, Fig. 2. The object *x*-1-7 is a right cone, and therefore any part of its surface may be developed by the use of its elements.

These are determined by drawing first the semicircle and dividing it into equal parts. Projections are drawn from the points 2, 3, 4, etc., to intersect the base 1-7. Radial lines are then drawn from the points on the base to point *x*.

Before the pattern can be drawn, the true length of the construction lines must be found. This is done, for example, by projecting points *b-c-d-e*, etc., to the outer element *x*-7 of the cone, thus locating points *b'-c'-d'*, etc. With *x*-7 as a radius draw the arc 4-4. Make it equal in length to the circumference around the base of the cone. This is equal to its diameter times the constant 3.1416.

The distance may be laid off by the measuring wheel or by transferring the spaces from the semicircle, Fig. 2. Draw the lines *x*-4, *x*-4 in the pattern layout and also the radial lines, *x*-1, *x*-2, *x*-3. With *x* as a center draw arcs from *a'*, *b'*, *c'*, etc., intersecting radial lines in the pattern.

The layouts in this case do not show any allowances made for laps; this must be taken care of in the work. The idea brought out in Fig. 2 is just to show the use of the radial method. If the taper between the bases of the frustum is small, then the sides will not intersect within a distance suitable for the use of the trammel points; in such cases short approximate solutions are used or the triangular method is applicable.

Among Railroad Boiler Shops—III

The Long Island Shops, Continued—They Make All Their Staybolts—Inserting New Blow-Offs—Butting and Welding "Front-Ends"—Welding and Cutting Appliances—Testing Boilers Over Drop Pits—Cutting Off Rivet Heads—Removing Rusty Pipe and Fittings—Front-End Superheaters

BY JAMES F. HOBART

In this shop they make all the staybolts that are used. The steel is threaded and drilled and one end squared to receive a wrench whereby the bolts are screwed into place. Fig. 1 shows how they square up staybolt ends to receive the wrench. The steel blank, before it has been threaded or drilled, is placed as shown at *A*, upon a female die which is placed in an ordinary punch press, then the male die, *D*, is set to enter between *B* and *C*, the staybolt blank *A* is placed in position, and a single stroke of the press shears off two sides of the blank, which is then turned ninety degrees and another stroke of the punch squares the remaining sides of the stay.

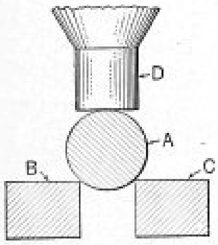


Fig. 1.—Squaring Staybolts

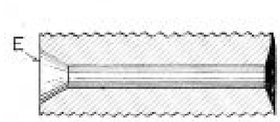


Fig. 2.—Countersunk Staybolt

The squared end of the rod comes in handy when the threads are cut, as the staybolt may be conveniently driven by the squared end. After the holes are drilled, and before the bolts are screwed into place, the hole is countersunk as shown at *E*, Fig. 2. After the other end of the bolt has been cut off, thereby removing the squared portion, that end of the bolt is counterbored also, so that when the riveting is done the hole in the bolt will not be closed up. The riveting, of course, closes the hole to some extent, but if it be closed too much, the application for a second or two of a small pointed reamer, or even a small twist drill, will quickly clean out the hole, leaving the bolt open from one end to the other.

Reaming Staybolt Holes

Staybolt holes, by the practice followed in the Long Island Railroad shops, are reamed by electric drill, or sometimes by the usual air drill as commonly found in the hand and portable sizes. The man who is going from the tool room window to ream a lot of staybolt holes makes a man think that he might be going out for a game of golf. To be sure, the usual golf sticks are not in evidence, but the "golf bag" is to be seen, or at least a pretty good imitation thereof.

The man draws from the tool room a tin or galvanized iron concern, about 4 inches in diameter and 18 inches to 20 inches deep, something as shown by Fig. 3 at *F*. This can has a wire bale, *G*, attached, by means of which the tin can was suspended, while in use, from some convenient portion of the locomotive about which it was being used.

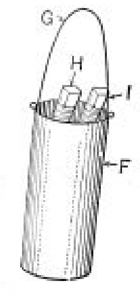


Fig. 3.—Tap Can

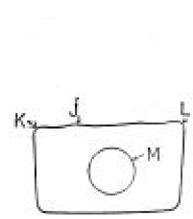


Fig. 4.—Cutting Out Bad Blow-Off

In the tap case, which is nearly full of lubricating oil, the workman places three taps—long reamer taps—made expressly for staybolt work, and each of these reamer taps is capable of cutting its way through two holes which are far too small for the staybolts. The reamer taps are small enough at the entering end to make their way through holes much smaller than the staybolts, so that even when the holes in the inner and outer sheets are out of alinement considerably, the slimly tapered reamer tap can be made to enter both holes and ream and tap them both to the actual size required by a staybolt.

The tap can which the writer saw at work had two taps in it, *H* and *I*. The third tap, which the workman brought out in the can, was in use in the air drill stock. Two of the tap reamers were of the same size, but one was new, the other had seen much service. In finishing a hole, the workman removed the old tap reamer from the bath of oil in which it reposed while in the tap case. He slipped this tool into the air drill stock and then presented the tap, covered with a film of oil, to the hole to be reamed.

The film of oil all over the tap served to provide almost perfect lubrication during the cutting process, and as soon as the old tap had been screwed in as far as the air drill head could carry it the workman reached under the water leg of the boiler, removed the tap from the finished hole and replaced the tap in the oil in the tap can again, where it received another thorough coating of oil in readiness for another hole in the water leg.

Just as soon as the old tap had been returned to the oil bath, the new tap was removed therefrom and sent through the hole which the old tap had threaded. The new tap was, of course, slightly larger than the old one, and removed a very light chip from the threads in both sheets. Thus the bulk of the thread cuttting was done by the old tap, while the new tap was sent through with merely a finishing cut and was consequently able to maintain its full size for a long time, thus standardizing all the holes in the water legs of the boiler.

The third tap was larger than the other two, sometimes being an eighth or a quarter of an inch greater in diameter. The large tap was used for certain of the holes wherein larger staybolts were required in order to carry the greater stress called for by the layout of the boiler, standard stays 1 inch in diameter not being sufficient to carry the stress allowable to the areas which the stays must serve. When the mechanic takes the tap can from the tool room, he obtains the sizes of taps required, be they large or small. But they did not often trouble to send new and old taps for the larger size, as there were so few holes of that size in any one boiler that they simply run one tap through those holes—a full-sized tap —and let it go at that.

Inserting New Blow-Offs

It is a frequent occurrence in locomotive boilers for the threads of the blow-off opening to go bad, so that leakage develops around the blow-off pipe. It is sometimes a serious and vexatious matter to make suitable repairs in such cases. The holes, usually reinforced, require new reinforcing pads to be put in place after the usual remedy has been applied, viz., the reaming of the blow-off hole and the cutting therein of new threads for a larger diameter of blow-off pipe.

But after one or two repairs in this manner the limit has been reached, for it is not practicable to put in 4-inch or 5-inch blow-off pipes into ordinary locomotive boilers; therefore the scheme was adopted of cutting out, with the oxy-acetylene torch, a piece of plate containing the defective blow-off hole and the welding in, by electric means, another piece of sheet of the same thickness which had been drilled and tapped for a standard blow-off pipe.

Fig. 4 shows the manner in which a piece of plate would be cut out, the piece *J* having rounded corners as shown at *K* and at *L*. A new hole would be drilled in a new piece of plate as shown at *M*, then the new plate would be oxy-acetylene cut to exactly the size of the old plate. This was effected by laying the cut-out old piece of plate on top of a new piece in which the new blow-off hole had been drilled and tapped. By thus laying the old piece of plate over the new one, the blow-off hole was located accurately. Then the new plate was trimmed off all around the old piece, leaving the new one just as much larger all around as had been cut out by the width of cut made by the gas jet.

Sometimes the cutting would be done "Johnnie on the spot" by the cutting torch, working right around the piece of old plate but keeping distant therefrom a space equal to the width of cut made by the cutting tool. In this way the new plate was made exactly large enough to fit well in the hole which had been made in the boiler under repairs.

But sometimes a mark was made around the old plate, distant therefrom the amount the new plate was to be made larger than the old one. After thus marked, the plate was sent to the shears and cut to the mark, when it should fit closely and be easily welded by means of the electric arc, which is used in this shop exclusively for steam pressure jobs, the oxy-acetylene method being also used, but not for boiler work. Still, the writer was shown in this shop boiler work done by the oxy-acetylene method which had been in constant use in locomotives for more than five years without once showing the least sign of failure or of distress. But, owing to the impossibility of knowing whether the oxy-acetylene weld was safe or not, whether it had been carbonized or oxidized during the welding operation, for this reason the arc system of welding was used exclusively for pressure welding in these shops.

Butting and Welding "Front-Ends"

In the Long Island shops some peculiar things are done in connection with the setting up of front-ends. Here is a place where there is no steam pressure to be worked against and oxy-acetylene welding may be used to advantage, or, in some cases, the fronts are welded electrically.

The plate composing the front end is sheared and rolled, then the edges are butted together and welded. This, it is found, saves a whole lot of work, for it not only saves punching and riveting, but it also saves the shearing, bending and punching of straps, also the time of a boiler maker "layerout," for no rivet spacing is required.

There is also saved the time of riveters, rivet heaters, rivet fires and the time of the holder-on. Fig. 5, herewith, gives some idea of the manner of doing this work. The sheets are first brought fair with each other, or advantage is taken by commencing work where the sheets chance to be flush, say as at *O*, Fig. 5. The sheet here is welded as far as it is flush and in its proper position. Then the welding operation is transferred to some other part of the seam, say to *P*, and the plate surfaces there are forced into position and "tacked" by welding a short length, or a long one if the surfaces are found fair with each other. Perhaps before the sheets at *P* have been brought flush and fair with each other, a place say, at *Q*, will be observed to be in the proper position for welding.

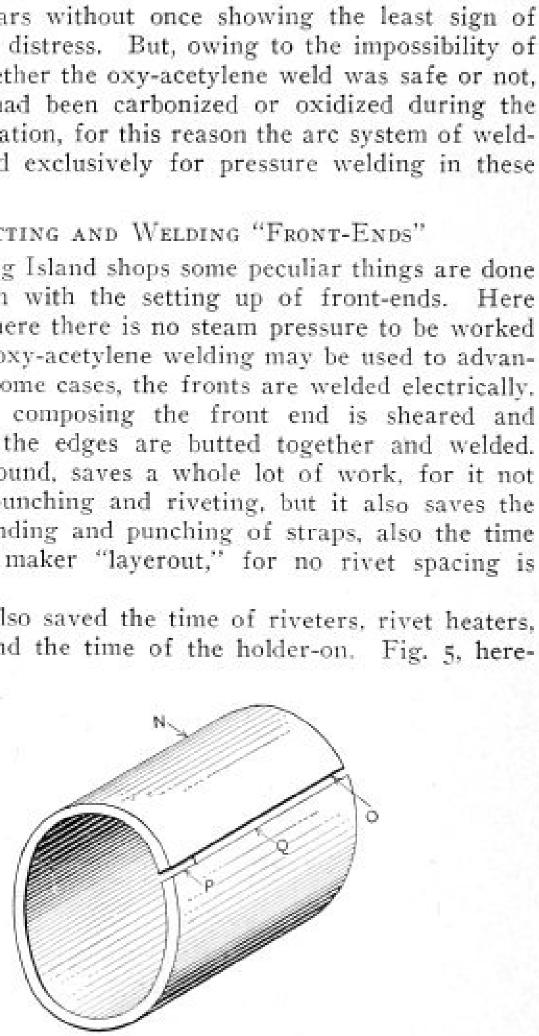


Fig. 5.—Welding Front Ends

Then such place is welded at once, even before the plates at *P* have been forced into position fair with each other.

There was another thing which made the management favor this way of setting up front ends. A welder would be hired for 31 or 32 cents per hour to do the work, while a boiler maker, to perform the same service, would have to be paid 41 cents per hour! Quite a difference, it proved, in a shop where 200 to 300 boilers were kept in repair and rebuilt whenever it was necessary.

Welding and Cutting Appliances

The acetylene generating apparatus used in this shop consists of a four-wheeled truck upon which was mounted a generating cylinder about 30 inches in diameter, with clockwork feeding apparatus by means of which the calcium carbide "cakes" were dropped into water.

Upon the same truck is located a gas storage tank—acetylene—about 16 inches in diameter and 10 feet long. The generator is fitted with a "scrubber" which is supposed to purify the gas as it passes through that appliance. The "scrubber" is merely a tank filled with water to absorb any impurities which might come over with the acetylene gas, said impurities coming from whatever unnecessary chemicals there might be dissolved in the water used, or contained in the calcium carbide.

A word of advice or warning might well be said regarding scrubbers, for, if the water contained therein is not changed at very frequent intervals, it will soon become incapable of thaing up, and of the impurities which may come over with the gas and the workman, finding that the scrubber is ineffective, discontinues its use altogether, letting all the impurities reach the welding torch with the gas, thereby resulting in a low efficiency of the gas and consequent poor or defective welding.

The scrubber at best will contain but a very limited quantity of water, therefore it should be emptied very often and a fresh supply of clean water maintained in the scrubber at all times. Do this, and you or your men will never say that "a scrubber is no good, anyhow."

Testing Boilers Over Drop Pits

The writer saw several boilers under tests while they were right over the drop pits, and portions of the engines were undergoing repairs at the same time.

The "outfit" used consisted of a few pieces of steam pipe, about 1½ inches or 2 inches, and a ball-and-socket connection, two elbows and a flange coupling for 2-inch pipe. By the use of this connection the workmen were able to connect a pressure pipe with the feed pipe or the blow-off pipe of the boiler, no matter in what position the boiler might be located. The pipe could be pushed down under the boiler, made to dodge a wheel or anything else which happened to be in the way, and to bring up fair against the end of the pipe to which connection was to be made.

Cutting Off Rivet Heads

A few years ago it used to be a game of skill among the "boys" in a shop to get at a boiler with a twelve-pound sledge and see how many rivets heads each one could knock off with a hundred blows. And a pretty high degree of skill was developed by the young fellows while playing that game, and the way in which the rivet heads were kept flying through the air might be likened to machine gun bullets above a set of French and German trenches!

But there is no more rivet head pounding in the Long Island shops. The oxy-acetylene cutting torch has changed all that, and now a man slips off a bunch of heads in one, two, three order, without a sound being heard save the sizzle of the gas as it escapes from the acetylene cutting tool.

Other riveted parts are as quickly cut loose when necessary, and the cutting tool has proved itself to be one of the best rivet-removing tools that ever came down the pike in a boiler shop.

Removing Rusty Pipe and Fittings

I saw a gang of men making mighty good time removing pipe and fittings from a boiler which was to be thoroughly overhauled. Some of the fittings were pretty badly rusted in, but that didn't seem to make a bit of difference about said fittings "coming off" in double quick time.

In the stripping gang, two men used Stilson wrench and hammer, respectively, the hammer man loosened up everything which he could play the hammer on, then have a hand with the wrench man starting everything which was not rusted in too tightly. Two other men worked with the gang. One of these men carried a piece of steam pipe about 4 feet long, the other man was equipped with an oxy-acetylene cutting torch.

When two men could not remove a pipe or a fitting with the stout 36-inch Stilson wrench, then the man with the pipe would slip that on over the end of the wrench handle and all three men would surge against the wrench handle extension, and usually the obstinate fitting came out "pronto."

Occasionally, however, a very obstinate fitting or pipe would be met with and the three men could not start it out. Here the fourth man came into action, limbered up his cutting torch and directed a heating stream of gas against that obstinate pipe or fitting. Then a surge or two against the pipe wrench "extension" started out the rusty pipe in a pea-green hurry.

Front-End Superheaters

The boilers on the Long Island Road are fitted with superheaters and front ends have to be built to receive them. This makes a whole lot of welding work and little riveting is required. The fronts are brought to shape and the oxy-acetylene torch quickly fastens them together without lap or visible joints.

I was told by a feller what knows, that a biler what exploded recently had been carried by one insurance company and they had dropped th' risk like a hot iron; it was refused by another and was then taken up by a third company. Now, if that is so, what protection does biler insurance give mor'n that it insures th' owner against loss of property in case th' dinged biler does explode? It don't protect him against damage suits due t' killed and injured people what had nothin' t' do with th' biler. I take it that most biler owners don't take this last proposition int' consideration until it is t' late.

Now yer Uncle Bill believes in biler inspection and insurance when it's carried on with common sense, but there ain't any sense for one company t' insure a biler after another has canceled th' risk because of th' condition it was in or because of th' abuse it was gittin'. It ain't honest business no matter haw yer look at it.—Bill B. Banger in *Power*.

Personal.—H. D. Van Dorn, who for seventeen years has been associated with the American Engineering Company, first as chief engineer and later as sales manager, recently resigned to become manager of the newly incorporated Marine Department of the American Clay Machinery Company, Bucyrus, Ohio.

Making the Business Earn a Profit—VII

How Representative Accounts Are Made up and How They Indicate the Exact Status of the Business

BY EDWIN L. SEABROOK

The November article of this series briefly described Representative Accounts, or accounts with things, such as materials, labor, contracts or orders, expense, etc. This article will show how these Representative Accounts originate and how they are used to determine the exact status of the business, whether it is being conducted profitably or at a loss, how much was received and disbursed for the various items of these accounts.

The preceding article mentioned a number of things that the books of the boiler maker should show. With the exception of the personal accounts and the cash received and disbursed, most of these will be illustrated, with particular attention to keeping a correct account of the various items of overhead expense, material, amount of business, and the combining of all of these into the Profit and Loss Account, to determine the condition of the business at the end of a given period.

In order to do this the business (hypothetically) of a boiler maker will be taken for one month. That period of time will do for the illustrations precisely as well as for a whole year, because all the transactions of buying material, executing contracts, paying mechanics, rent, salaries, and other expense items, are necessarily involved. A longer period of time would simply multiply the various transactions.

During the month of February the business transactions of the boiler maker were:

Received orders, or contracts, from Wm. Jones, $25.76. George McCaull, $368. John Stevens, $518.27. George Andrews, $876.42. John McGear, $178. James Nelson, $57.82. Edward Sampson, $74.90.

Bought material from John Keller, $496.27. Lucas & Company, $127.20. Keystone Company, $243.10. Royal Boiler Company, $194.27. Burton & Company, $252.43.

All of the material was purchased on time, except the second item, which was paid for in cash, and the usual 2 percent discount allowed.

The following amounts were paid for productive labor: $158.60, $162, $166.28, $157.30.

The following amounts were expended for the cost of conducting business, or overhead:

Rent, $30. Insurance—liability, fire, etc., $14.67. Taxes, $3. Telephone, $4. Postage, $1.50. Printing, $3. Shop supplies, $12.50. Light and heat, $14. Depreciation, $7. Allowances, $3.50. Hauling, including wages, upkeep, etc., $80. Collections, $2. Dues, trade association, $1. Office help, $50. Salary of boiler maker, $133.33.

The account of Wm. Jones proved to be worthless and had to be charged off.

George McCaull paid his bill within ten days and took the usual 2 percent discount.

On the last day of the month the boiler maker took an inventory of the material on hand, which had been purchased during the month, and ascertained that it amounted to $193.81.

This is the history of the various transactions for the given period. It remains to determine the exact status of the business at the time the books were closed. The preceding article fully illustrated the personal accounts, cash entries, etc.; these will be eliminated and only the Representative Accounts given. In fact, it is the Representative Accounts that show the operating results. It will be assumed, of course, that the boiler maker has made the proper entries in the Journal and Cash Book, so the Ledger Accounts only will be shown.

The expenses for overhead show sixteen different items. It is perfectly proper to open a Ledger Account with each one of these items. Two illustrations will be sufficient to show how these should be kept in the Ledger. (See Fig. 9.)

These different accounts would be closed by crediting each one with *expense*. The complete expense account would be as shown in Fig. 10.

The amount paid for mechanics can be entered in the Ledger as productive labor, and would be as shown in Fig. 11.

Interest and discount was given and received. This account in the Ledger would be entered as shown in Fig. 12.

An account should be opened with Material, which would appear as in Fig. 13.

The total amount of business transacted would come

Dr. INSURANCE Cr.

Feb	1	To Cash		$14	67	Feb	28	By Expense	$14	67

Dr. PRINTING, POSTAGE, STATIONERY Cr.

Feb	2	To Cash, Stamps		$1	50	Feb	28	By Expense	$4	50
"	"	" " Printing		3	00					
				$4	50				$4	50

Fig. 9

Dr. EXPENSE Cr.

			$	¢				$	¢
Feb	1	To Insurance	$14	67	Feb	28	By Profit & Loss	$352	50
"	2	Printing & Postage	4	50					
"	6	Rent	30	00					
"	"	Telephone	4	00					
"	7	Office Help	12	50					
"	"	Driver	16	00					
"	9	Taxes	3	00					
"	12	Shop Supplies	12	50					
"	14	Auto-truck	8	00					
"	"	Office Help	12	50					
"	"	Driver	16	00					
"	16	Light & Heat	14	00					
"	21	Office Help	12	50					
"	"	Driver	16	00					
"	"	Auto-truck	3	50					
"	28	Allowances	3	50					
"	"	Collections	2	00					
"	"	Dues	1	00					
"	"	Office Help	12	50					
"	"	Driver	16	00					
"	"	Auto-truck	4	50					
"	"	Salary	133	33					
			$352	50				$352	50

Fig. 10

under various heads, such as: Merchandise, Contracts, Orders, etc. In this instance the total amount of business will be designated as Orders, and this account will show the result shown in Fig. 14.

The next account to be opened is Profit and Loss. This should be charged with every item that *cost* the business something and credited with everything that produced something for the business.

The last account to be opened in the Ledger is Deficit, and as the transactions show a loss this account is as shown in Fig. 15.

EXPLANATIONS

It should be noted that Ledger accounts only, and all of these Representative, are shown above. The Double Entry System is used; that is, every account entered twice—Debited and Credited. When George McCaull gave an order for his work he became a debtor, but a creditor was also created for the same amount. When Mr. McCaull was charged personally with the amount of the contract, *Orders,* representing the creditor, or owner of the business, was credited. Wherever there is a credit there must be a debit for an equal amount, and vice versa.

The object of these Representative Accounts is to determine the results of the various transactions. A study of the Expense Account shows what each expense or overhead item cost.

There is one account—Profit and Loss—that combines all the operating accounts and gives the *results* of the

Dr. PRODUCTIVE LABOR Cr.

			$	¢				$	¢
Feb	7	To Cash, Pay Roll	$158	60	Feb	28	By Profit & Loss	$644	18
"	14	" " " "	162	00					
"	21	" " " "	166	28					
"	28	" " " "	157	30					
			$644	18				$644	18

Dr. INTEREST & DISCOUNT Cr.

			$	¢				$	¢
Feb	12	To Cash, Geo. McCaull	$7	36	Feb	11	By Cash, Lucas & Co.	$2	54
					"	28	" Profit & Loss	4	82
			$7	36				$7	36

Figs. 11 and 12

Dr. MATERIAL Cr.

Feb	1	To John Keller	$496 27	Feb	28	By Inventory	$193 81
"	12	" Cash	127 20	"	"	" Profit & Loss	1119 46
"	14	" Keystone Co.	243 10				
"	18	" Royal Boiler Co.	194 27				
"	20	" Burton & Co.	252 43				
			$1313 27				$1313 27

Dr. ORDERS Cr.

Feb	28	By Profit & Loss	$2099 17	Feb	1	By Wm. Jones	$25 76
				"	2	" Geo. McCaull	368 00
				"	7	" J. Stevens	518 27
				"	12	" Geo. Jonas	876 42
				"	18	" John Nelson	57 82
				"	23	" Edw. Sampson	74 90
				"	24	" John McGear	178 00
			$2099 17				$2099 17

Figs. 13 and 14

entire volume of business for a given period. An analysis of the Profit and Loss Account shows, as was stated in the July issue of THE BOILER MAKER, regarding the composition of every price or estimate, that the total volume of business of every boiler maker is (or should be) composed of four elements—Labor, Material, Expense—and if there be a fourth—Profit.

The first two accounts—Insurance; Printing, Postage and Stationery—are simply typical of the different accounts composing the cost of conducting business, or overhead. These accounts should be debited with the amounts expended for them. At the end of the year, or whenever the accounts are closed, they should be credited by *expense* and transferred to the Expense Account.

EXPENSE ACCOUNT

This account is debited for all the expenses of conducting business. The amounts expended for the separate items, when these respective accounts are closed, are transferred to the debit side of the Expense Account.

The Expense Account shows a debit of $352.50, which was spent for conducting the business. This is an expense, chargeable directly to the business. The Expense Account is closed by transferring it into the debit side of the Profit and Loss Account.

Dr. PROFIT & LOSS Cr.

Feb	20	To Wm. Jones	$25 76	Feb	28	By Orders	$2099 17
"	28	" Expense	352 50	"	"	" Deficit	54 55
"	"	" Depreciation	7 00				
"	"	" Productive Labor	644 18				
"	"	" Int. & Discount	4 82				
"	"	" Material	$1119 46				
			$2153 72				$2153 72

Dr. DEFICIT Cr.

Feb	28	To Profit & Loss	$54 55				

Fig. 15

Productive Labor

The Productive Labor Account is debited with the amount, $644.18, paid for mechanics, or productive labor. The account is balanced by crediting it with the same amount and transferring it to the debit side of the Profit and Loss Account.

Interest and Discount

This account is debited with the discount, $7.36, allowed others, and credited with the $2.54 allowed by others. The difference, $4.82, is closed by a credit entry and transferred to the debit side of Profit and Loss.

Material

This account is charged with all the material purchased. If the boiler maker had material on hand at the beginning of this particular period it would have been charged with the amount On Hand, or Inventory. The account is balanced by crediting it with the following two amounts: The amount On Hand at the end of the month, or Inventory, $193.81, and by Profit and Loss for the amount used, $1,119.46; the Profit and Loss Account is debited with the latter amount.

Orders

This account includes all orders, contracts, sales, etc., which are placed on the credit side. The Order Account could be designated *Sales*. Some firms use this term, also *Merchandise*. As this account is credited with all orders for sales, it is quite evident that the total of these will be the amount of business transacted during a given period.

This account must be balanced, or debited, with those items which were an expense to the business in producing the *Orders*. This must necessarily include every item, such as material, labor, expense, etc. The debit side of the Profit and Loss Account shows what these items were. In fact, the identical items on the debit side of Profit and Loss, material, labor, expense, etc., could be transferred to the Debit side of *Orders*, and would show that it cost for everything to conduct the business during the month, $2,153.72, and the amount of orders was $2,099.17, or a loss of $54.55.

Some firms place on the Debit side or Orders (or what other term may be used to designate the account) all items that cost to produce the orders, such as material, labor, expense, etc. As these are the three principal items in the boiler making business, separate accounts should be kept for each of these, and the methods outlined above permit this.

Profit and Loss

This account determines whether the business has been conducted at a gain or a loss, and is therefore the last one to be closed. An analysis of this account will show that it contains the total of all the business transactions (and the results) for the given period. The total sales, orders, contracts, etc., are on the credit side. What it cost in material, labor, expense, etc., to produce these, is on the debit side. By the rule, *Debit the account that costs or receives value, credit the account that produces or gives value*, it is proper to place on the debit side of this account everything that cost the business something, and on the credit side everything that produces something for the business.

An examination of the debit side of the Profit and Loss Account shows that it cost to produce the amount of business secured: Bad debts, $25.76. Expense, $352.57. Depreciation, $7. Productive Labor, $644.18. Interest and Discount, $4.82. Material, $1,119.46. Total, $2,153.72.

As the amount of *Orders* (with which the account is credited) is only $2,099.17, the business was transacted at a loss of $54.55.

The last account in the Ledger is Deficit. It is debited with the balance of Profit and Loss, and the entry being on that side of the Ledger, shows a loss. This account cannot be balanced until the profit equals or exceeds the amount of the deficit. The deficit, however, can be charged off against capital, which would show an impairment of the same. If the income of the business had exceeded the outgo, this account could have been termed "Surplus" and credited with the amount of profit.

Of course, a combination of transactions could have been selected that would have shown a profit instead of a loss. Much of the bookkeeping in use by many trades does not show either the losses or gains, and that is one of the great objects of a bookkeeping system—to determine the operating results of the business and to trace the *why* of the loss. A business man is far more inclined to analyze his losses, and the reasons therefor, than his gains.

The above system is quite simple, requires only three principal books, and will meet the requirements of the average boiler maker. If the set of books is properly opened there should be no difficulty in making the correct entries by anyone who is willing to give the nature of accounts, debits and credits, and the necessary forms a careful study and practice.

(To be continued.)

Production

Increased production, with greatly reduced labor supply, is the problem that many boiler shop executives are wrestling with at present, and, according to the trade press, we are facing a shortage in machine tool output. Such a situation demands that the responsible heads of each department carefully analyze the men, the methods and the machines. While the machines and methods may be considered the foundation of production, if the enthusiasm and co-operation of the men are lacking the output is bound to suffer.

To gain the confidence and co-operation of the men in these stirring times of war that lead the men to believe untold profits are being made and not shared, is no small task. We can expect much unrest, strife and misunderstanding on the part of labor, when we, as executives, fail to get as close to the men as possible, and put forth reasonable efforts to secure their loyalty and co-operation. In dealing with them, we must be completely frank and sincere. They want to understand our methods and objects, and abhor or detest anything that savors of the mysterious.

Do not lose sight of the fact that your success as an executive, and the success of any plan that you may conceive to increase production, will only be accomplished by the combined efforts of the whole organization towards one goal.

Many productive methods that heretofore were considered excellent and conservative will be knocked into a cocked hat by the results of studies of wide-awake, energetic men on improvements, the newly discovered and better methods taking their place at once. C. H. W.

The real problem facing the mechanical departments of the railroads to-day is how can the power and staying qualities of the present locomotives be increased to meet the more severe conditions and the constantly increasing demands.

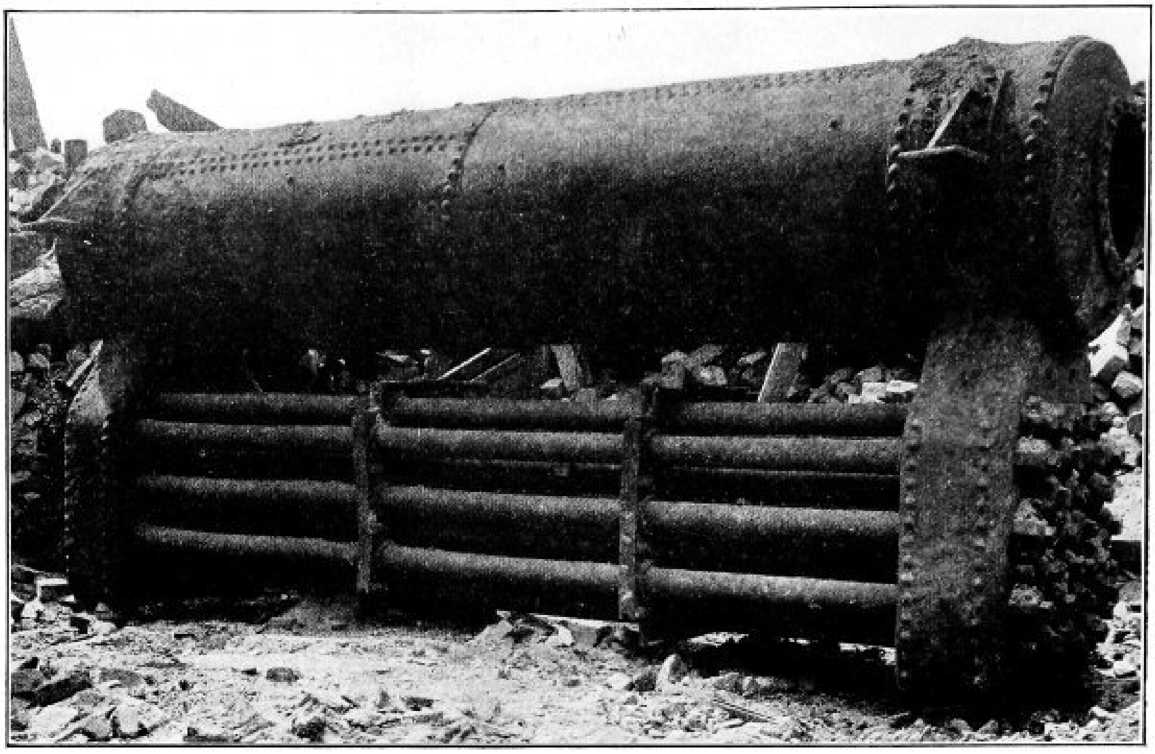


Fig. 1.—The First Heine Boiler Built; Heating Snrface, 250 Square Feet; Horsepower, 25

The First Heine Boiler

After a fire which destroyed the National Guard Armory, Eighteenth and Pine streets, St. Louis, Mo., a few months ago, the Heine Safety Boiler Company, of that city, obtained possession of the first Heine boiler ever built, which was installed at the armory in 1881. This little boiler is shown in Fig. 1, just as it was removed.

It has twenty-four tubes about 10 feet long and the heating surface is approximately 250 square feet, making the rating of the unit 25 horsepower. The boiler was

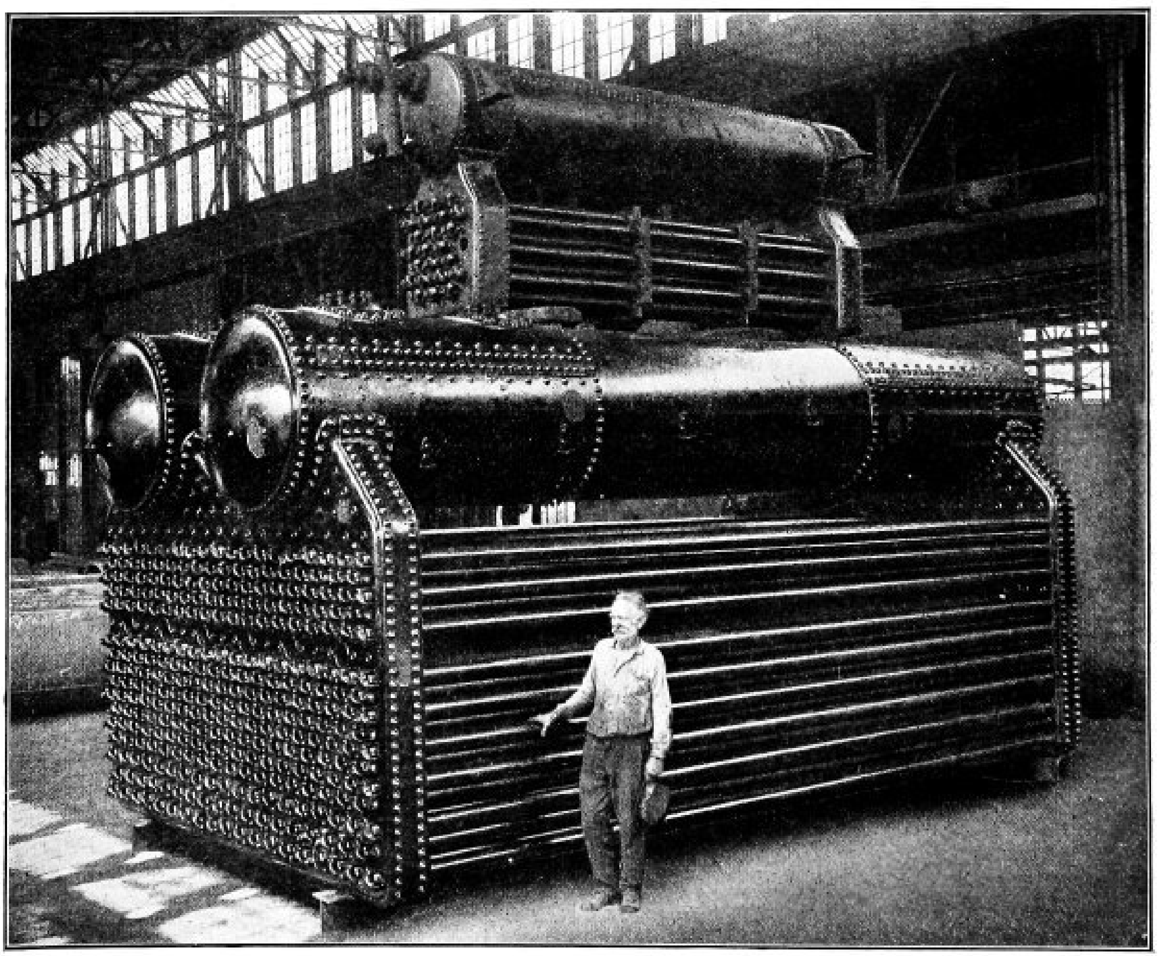


Fig. 2.—First Heine Boiler Contrasted with Modern 500 Horsepower Heine Boiler

built in the shop of Richard Garstang, St. Louis. The original pressure for which it was designed was about 100 pounds, and an inspection certificate from the Fidelity & Casualty Company has been received to the effect that they will certify this boiler to carry 80 pounds pressure at the present time. The report of inspection is quoted below:

Heine Safety Boiler Company,
St. Louis, Mo.

DEAR SIRS:

Our inspector, Mr. W. A. Rutledge, made an *internal inspection* on July 24, 1917, of the first boiler of the Heine type built by the Heine Safety Boiler Company.

The boiler was constructed about thirty-five years ago and has been in continuous service since then, and until the time of its removal to your shop, where it is now located on blocks.

The tubes are pitted, and before the boiler can be used it will be necessary to retube it, also the blow-off flange should be renewed and the boiler completely provided with valves and trimmings if it be installed and used further.

In the event of the boiler being installed, we could allow a working pressure of 80 pounds per square inch, after the above recommendations have been carried out.

Yours very truly,
D. C. HARVEY,
Superintendent.

This indicates a somewhat longer life for watertube boilers than is usually credited them by accountants or engineers when apportioning depreciation changes. However, under modern conditions the heavier loads on boilers would perhaps tend to lessen their life as compared to this little boiler. One odd feature is the casting which forms both the steam outlet and the water column. Another obsolete feature of this boiler is the vertical baffling which was discarded in later designs for the horizontal baffling, now the standard with Heine boilers of both the land and marine types.

The contrast in size between an average watertube boiler of to-day and that of 1881 is shown in Fig. 2. The small National Guard Armory boiler was photographed placed on top of a 500 horsepower unit, which is by no means a large size for present-day practice. Standing alongside of the large boiler is one of the original workmen who helped to build this little boiler thirty-seven years ago, Mr. Joe Garstang, a brother of the proprietor of the shop in which the work was done. This photograph is of particular interest to the student of the history of steam plant machinery, as it shows clearly the evolution in the design of each part of the boiler.

Care and Maintenance of Locomotive Boilers and Their Appurtenances—II

Method of Drilling and Maintaining Telltale Holes in Staybolts—Application of Patches—Steam Gages, Safety Valves and Water Glasses

BY WILLIAM N. ALLMAN

Fig. 9 covers the method of drilling telltale holes in the ends of staybolts, and for cleaning out the holes 3/16-inch drills are to be used, this being adopted with a view of overcoming excessive breakage experienced when cleaning out holes with drills of the same size as the hole. Drills of this size should also be purchased, but special attention should be given that a 7/32-inch drill is used for the drilling of new holes as covered by print mentioned above. In each case the hole is to be countersunk, so as to provide a less liability of the holes being stopped up by the accumulation of sediment or dirt.

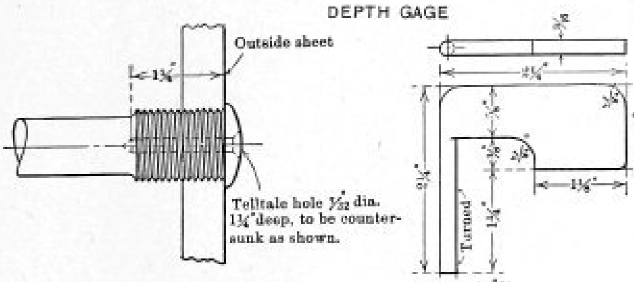


Fig. 9

All staybolts 8 inches long and under (except flexible bolts) must be drilled at the outer sheet ends with telltale holes 7/32 inch in diameter by not less than 1¾ inches deep, and these holes must be kept open at all times. The holes must be full after the ends of the bolts have been riveted over and all bolts drilled more than 1/16 inch out of center must be cut out and replaced. Staybolts located behind brickwork or grate bearer bars to have holes drilled their entire length and kept open as shown in Fig. 5.

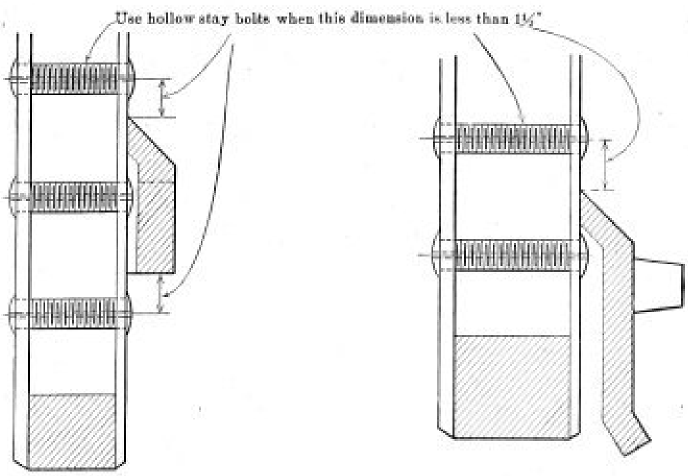
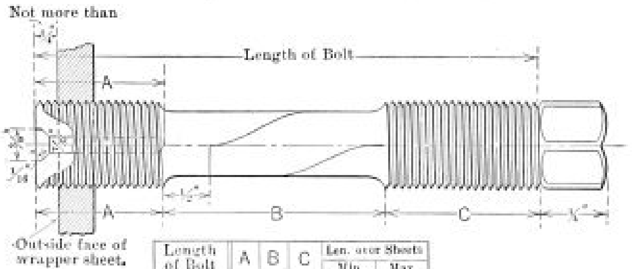


Fig. 10

APPLICATION OF HOLLOW STAYBOLTS BACK OF GRATE BEARING BARS AND DEAD GRATES ON ALL LOCOMOTIVE BOILERS HAVING RIGID STAYS

Fig. 10 covers instructions for applying hollow staybolts back of grate bearing bars and dead grates on all locomotive boilers having rigid stays, also when they are located



Length of Bolt	A	B	C	Len. over Sheets Min	Max
5"	1½"	2"	1½"	3½"	4½"
6"	1½"	2¾"	1¾"	4½"	5½"
7"	1½"	3"	2½"	5½"	6½"
8"	1½"	4"	2½"	6½"	7½"
9"	1½"	5"	2½"	7½"	8½"
10"	2"	5"	3"	8"	9½"
11"	2"	6"	3"	9"	10½"
12"	2"	7"	3"	10"	11½"
13"	2"	8"	3"	11"	12½"
14"	2"	9"	3"	12"	13½"
15"	2"	10"	3"	13"	14½"
16"	2"	11"	3"	14"	15½"
17"	2"	12"	3"	15"	16½"
18"	2"	13"	3"	16"	17½"

Fig. 11

1½ inches or less from center of the stay to edge of bearing bar, to avoid removal of the bearing bars and dead grates to inspect rigid staybolts every thirty days, as required by the Federal law. This does not apply to locomotives having Tate flexible staybolts back of grate bearing bars and dead grates.

Instructions for Ordering American Staybolts

Fig. 11 covers various sizes of American staybolts and when ordering particular attention should be given to the length as shown in table. It will be found that the maximum length overlaps the minimum length for the next larger size bolt in each case, except those from 5 inches to 8 inches, inclusive; therefore in ordering and applying these bolts the length desired is the one having the longest dimension in the body of bolt as indicated by letter *B;* for example, for a length over sheets of 9½ inches, either a 10-inch or 11-inch bolt would be suitable. However, the 11-inch bolt would be preferable, as the body is 1 inch longer (indicated by *B*), which provides for greater flexibility. In applying bolts, same should be screwed into sheets from inside of firebox and must not project beyond outer face of wrapper sheet more than ¼ inch, in order to maintain proper depth of telltale hole; this must be rigidly adhered to, as allowing the bolt to extend more than ¼ inch beyond sheet would mean further deepening of the telltale hole extending into the slotted portion of the body, which would necessitate removal of bolt.

Application of Hollow Staybolts Under Bridge Walls in Combustion Chambers

Fig. 12 covers diagram showing application of hollow staybolts under bridge walls in locomotives having combustion chambers.

All locomotives which are equipped with these bridge walls in combustion chambers should have hollow staybolts applied in the area covered by bridge wall, this being done in order to prevent the removal of bridge wall each month, for the purpose of inspecting staybolts. This will not, however, relieve from making a thorough inspection each time the brick work is removed, nor will it relieve from removing the brick work for an inspection when necessary.

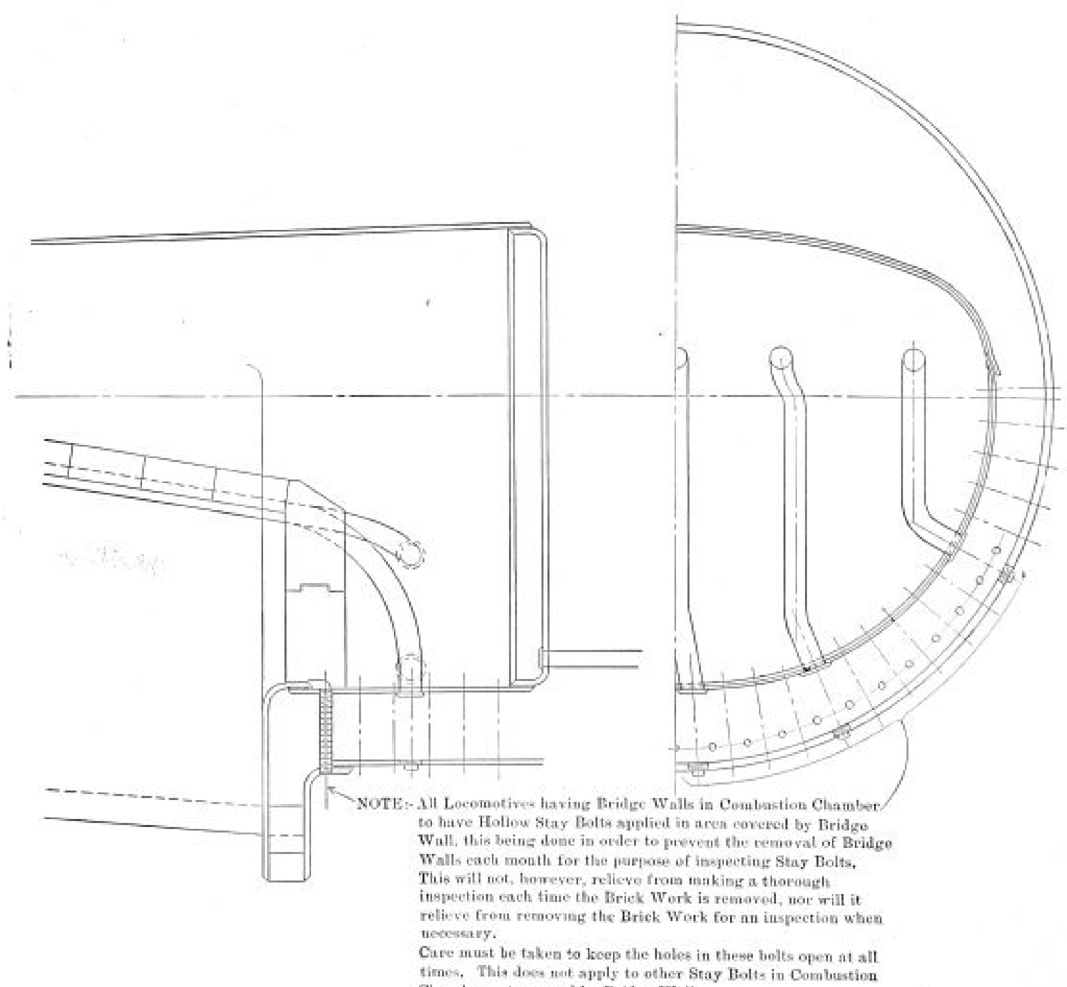


Fig. 12

Are Fire Box Sheets Welded With The Oxwelding Process Efficient?

Answer:

The tensile strength of a single lap riveted seam is approximately 52% to 60% of the strength of the metal itself.

By tests, it has been proven that the tensile strength of a seam welded by the Oxwelding Process is from 80% to 85% of the metal itself.

Why not submit your boiler repair problems to our staff of experts, who are constantly in touch with the application of the Oxwelding Process to the special needs of the steam railroad field?

OXWELD RAILROAD SERVICE COMPANY

Railway Exchange
CHICAGO

30 Church Street
NEW YORK

Care must be taken to keep the holes in these bolts open at all times.

Application of Patches and Reinforcements to Locomotive Boilers

Patches and reinforcements as covered in July, 1917, issue of The Boiler Maker can be used in connection with the application of all patches and reinforcements to locomotive boilers, which develop cracks, pitted plates, grooving, etc., and when necessary to apply plates over cut out portions of sheets.

It has been found in some instances that the practice has been followed of welding up cracks and filling in old rivet holes in the barrels of boilers, and under no circumstances should it be permitted to weld up such cracks or rivet holes. When it becomes necessary to remove an old patch for the purpose of applying a new one, it is desired to use as many of the old holes as possible, leaving open all holes unused and drilling new holes where required. This does not apply to stayed portions of firebox sheets. Roof sheets of crown bar type boilers are considered the same as the barrel of the boiler and no welding is therefore permitted.

In making applications of patches and reinforcements, standard patches referred to above should be used in all cases unless conditions are such that it makes it necessary to depart from same.

Form No. 19 must be forwarded in triplicate to the office of mechanical engineer within ten days after such repairs or changes are made, and these forms must show in detail the patch or reinforcement as applied, giving all dimensions, such as the thickness of plate, diameter of rivets and rivet holes, lap, tensile strength of boiler plate, kind of material in plates and rivets, and the location of patch with regard to some fixed point on the boiler, as well as the extent of the defect covered by the patch.

Stenciling of Patches and Reinforcements Applied to Locomotive Boilers

All patches and reinforcements applied to locomotive boilers should be stencilled with the station initial and date of application. This to be done with ⅜-inch stencils and so located on the patch as to be easily read, and which will provide information as to when and where the work was performed for record.

Steam Gages

Time of Testing.—Steam gages must be tested not less frequently than once every three months, and also when any irregularity is reported. Gages found inaccurate must be corrected before being put into service.

Recording of Test.—Record of test must be made on Form No. 5, as well as reporting on Forms 1 or 3.

A small slip must also be attached to the face of the gage, showing the date and station making the test, viz.: Chicago, 7-22-17.

Method of Testing.—Gages must be removed from the boiler and set with a master gage and all inaccuracies must be corrected before being put into service.

Siphon.—Every gage shall have a siphon of ample capacity to prevent steam entering the gage. The pipe connection shall enter the boiler direct and shall be maintained steam tight between boiler and gage. The siphon pipe and its connections to the boiler must be cleaned each time the gage is tested.

Rules for Setting Safety Valves

Manner in which Safety Valves are to be Handled at Time of Boiler Tests.—At the time of hydrostatic test the working steam gage and safety valves are to be removed from the boiler. The safety valve openings are to be blanked and a test gage used to record the hydrostatic pressure. After the hydrostatic test has been completed the working safety valves are to be applied preparatory to steam tests, and set to authorized pressure, using two steam gages, the working and test gages.

Method of Setting.—When setting safety valves the water level in the boiler shall not be above the highest gage cock. In no case shall safety valves be set to pop at pressure exceeding six pounds above the working steam pressure. When setting safety valves two steam gages shall be used; one gage shall be so located that it will be in full view of the person engaged in setting such valves, and if the pressure indicated by the gages varies more than three pounds they shall be removed from the boiler, tested and corrected before the safety valves are set. If both gages cannot be readily seen by the man engaged in setting the valves, a second man is to assist in comparing the readings of the gages. Gages shall in all cases be tested immediately before the safety valves are set or any change made in the setting, and the siphon pipe and its connections to the boiler must be cleaned each time the gage is tested and inspected for clear opening. Gages located as per Fig. 13.

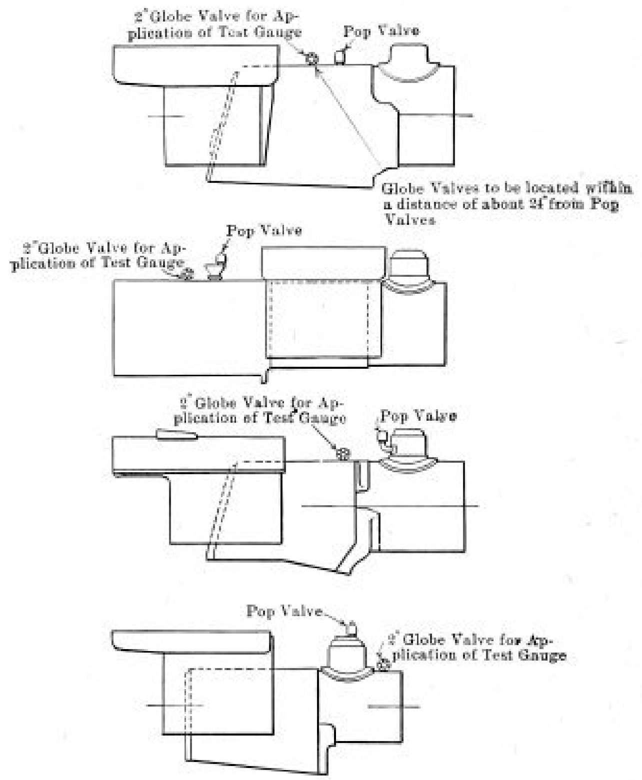


Fig. 13

Pressure at Which Valves Should be Set.—The working valve, which should always be the muffled one (when there is one such on the boiler), must be set at authorized working pressure.

The second valve must be set not to exceed three pounds above the authorized pressure.

The third valve must be set not to exceed five pounds above the authorized pressure, when such a valve is used.

The fourth valve must be set not to exceed six pounds above the authorized pressure, when such a valve is used.

The blow-back should not exceed three pounds.

Working Valves.—If the boiler is fitted with more than one muffled valve, each time the valves are set the muffled one which has been used as the intermediate or maximum, should be set as the working valve and *vice versa.* The same ruling also applies to boilers fitted with valves which are all of the open type.

Number and Capacity of Valves Required.—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 a pressure of more than five percent above the allowed steam pressure.

Order in Which Valves Are Set.—The valve carrying the maximum pressure should be set first and allowed to pop several times in order to insure proper working. The intermediate and working valves should then be set at their respective pressures and checked in the same manner.

located so that the lowest reading of glass will be on a line with the lowest gage cock.

Gage Cocks, Number and Location.—Each locomotive boiler must be equipped with at least three gage cocks, located in accordance with standard drawings. In no case must the lowest gage cock be located less than three inches above highest point of crown sheet.

METHOD OF LOCATING GAGE COCKS ON LOCOMOTIVE BOILERS

Construction of Level.—Two water glasses 9/16 inch by 12 inches, connected by ½-inch rubber tubing of suitable length, both glasses to have scratch marks around glass 3 inches from top. Fill with water level with scratch marks

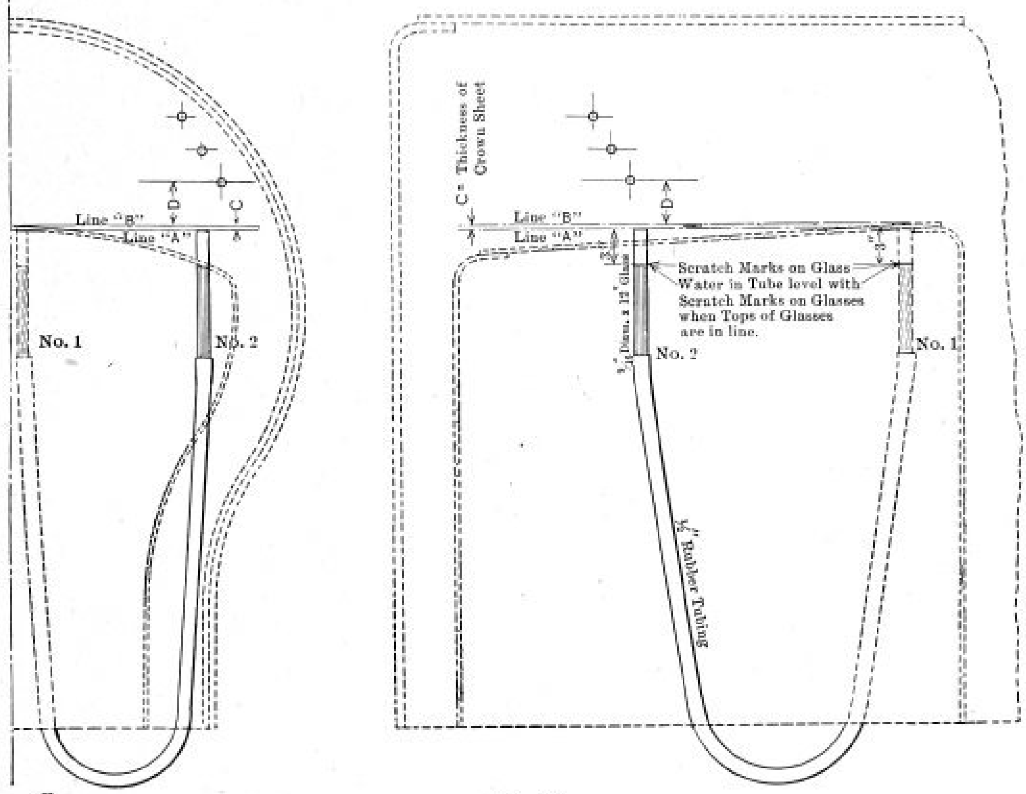


Fig. 14

when tops of glasses are level. Place corks in tops of both glasses when not in use to facilitate handling.

Period for Testing Valves.—Once every three months, or whenever irregularity is reported, the valves must be tested, after the steam gage has been found to be correct. The person engaged in making this test must sign inspection report Form No. 1 or 3 in accordance with Federal boiler inspection laws, after the proper entries have been made on the report showing the results of tests, and also enter the record of inspection on Form No. 5.

Repairs to Valves.—Safety valves must be thoroughly overhauled and put in good condition every time locomotive is in shop for classified repairs, or more often if necessary.

Standard template gages must be used in order to maintain important dimensions as originally designed, so as to get the full efficiency of the valve.

Old springs must be tested as to their deflection under load before being used in repaired valves, as the condition of these springs greatly affects the discharge and working capacity of the valves.

Pressure at Which Valves Should be Used.—Valves should not be used for other pressures than that for which they were designed and marked on each valve by the manufacturer.

WATER GLASSES AND GAGE COCKS

Water Glasses, Number and Location.—Each locomotive boiler must be equipped with at least one water glass,

Directions for Use (See Fig. 14).—The boiler should be approximately level. Remove corks in tops of glasses. Place top of glass No. 1 against highest point of crown sheet in firebox, then raise or lower glass No. 2 on outside of back head or side of shell until water level is equal to scratches on both glasses, then scribe line *A* on back head or shell representing under side of crown sheet, lay off *C* thickness of crown sheet and scribe line *B*, which represents highest point of crown, inside of boiler. Lay off distance *D* from line *B* to locate lowest gage cock. Or to determine *D* measure from line *B* to center line of lowest gage cock.

Time of Cleaning.—The spindles of gage and water glass cocks shall be removed and cocks cleaned of scale and sediment and ground if necessary at each boiler washing.

All gage cocks must be tested and water glasses blown out before each trip and properly maintained.

Water Glass Valves.—All water glasses must have shutoff cocks at top and bottom connection to boiler, and also a drain cock at lower end for cleaning purposes.

Water Glass Lamps.—All water glasses must be supplied with a satisfactory lamp and so located as to enable the engineer to easily see the water in the glass.

SHIELDS

Water and Lubricator Glass Shields.—All tubular water glasses and lubricator tubular glasses must be protected by means of a safety shield in accordance with Fig. 15.

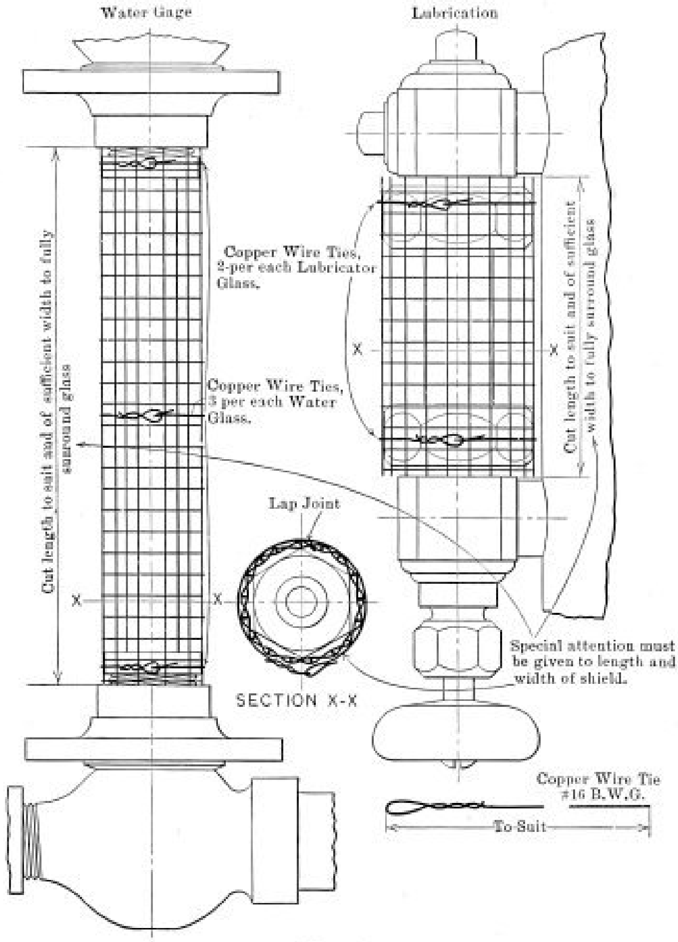


Fig. 15

NOTE.—Each water gage and lubricator with tubular glass applied to locomotive must be equipped with wire shield, here shown, to prevent flying of glass in case of breakage.

The shield should be cut to size to suit and shaped to surround glass, and be held in position by copper wire ties, as shown by diagram.

No locomotive should be permitted in service without these shields, when using the tubular type of glasses. Shields are of No. 26 iron wire galvanized (B. W. G.), 8 by 8 mesh per inch.

These shields must be properly maintained in order to prevent glass from flying in case of breakage.

INJECTORS

Maintenance of Injectors.—Injectors must be kept in good condition, free from scale and must be tested before each trip. Boiler checks, delivery pipes, feed water pipes, tank hose and tank valves must be kept in good condition, free from leaks and foreign substances that would obstruct the flow of water.

(*To be continued.*)

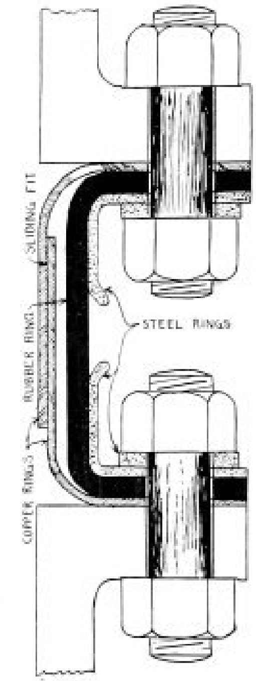
Novel and Successful Rubber Expansion Joint*

Here is a handy kink that the engineer of your plant will be glad to know about. It is a flexible rubber expansion joint. This joint is being successfully used by several large Eastern power companies to replace the corrugated copper and other standard joints, because corrugated copper and other forms of joints had been found lacking in flexibility. There is no reason, therefore, why this joint should not be equally useful in the large power plants connected with industrial establishments. At least, the engineer should know about the latest wrinkles and latest practice.

The principal feature of this joint is the rubber ring shown in heavy black in the sectional drawing herewith. The specifications for this ring are as follows:

"The rubber ring is to be made of five plies. Sea Island duck must be used, each ply weighing not less than 30 ounces to the yard with 45 percent pure Para gum 1/32 inch thick between the plies and 1/16 inch thick on the outside. All must be properly pressed in a mould and thoroughly vulcanized."

This expansion joint is being used in connection with condenser piping to take care of the lengthening and shortening of the pipes during the changes in temperature



Flexible Rubber Expansion Joint

of the condenser water. The diameter of the pipe is about 4 feet, and to give the reader an idea as to the size of this rubber ring it might be well to add that the diameter of the bolts shown in the sketch is 1⅝ inches. Knowing this value, all other measurements may be easily ascertained, as the entire drawing is made to scale. The drilling through the rings and through the pipe flanges shown were made to conform to the standards as established by the American Society of Mechanical Engineers.

As will be noted, the rubber ring is well protected on the outside by means of two steel rings for the purpose of preventing any cutting or wearing action. And on the inside are two copper rings which telescope with a sliding fit. Thus, even though the piping may not be in perfect alinement when installing, the joint will readily care for such inaccuracies in the same way that a self-alining bearing cares for misalinements in shafting.

For handling water of varying temperatures such as is used in condensers this is, therefore, an ideal arrangement. In case the reader has had trouble with his corrugated copper or other expansion joint this might prove to be a happy solution. The joint can be made in almost any size, and for various needs the design might be altered accordingly. To avoid special drilling and special sizes, however, it is usually better to adhere to the American Society of Mechanical Engineers' standards. This will also eliminate a possible source of error.

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NOTICE TO ADVERTISERS

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 25th of the month, to insure the carrying out of such instructions in the issue of the month following.

Boiler makers are needed for early military service overseas. Men in the front line trenches need the help and support of skilled men back of the lines, and boiler makers are wanted at once for the Enlisted Ordnance Corps of the National Army.

Uncle Sam is calling on our trade to come across and help his fighting men. There is a lot of work to be done "over there," and the call has gone out for boiler makers between the ages of eighteen and forty who want to do their bit and who know their job.

Modern war is a tremendous business, and the army that wins is the army which has the best equipment and the best men. The men are at the front now. They are ready to go ahead, but they will need experts in our line to repair and maintain their equipment. There is a fine chance for every man who wants to help. Detailed information can be obtained from the Chief of Ordnance, War Department, Washington, D. C.

A million women, to take the place of a million men soon to go to France, are to be card indexed throughout the country by the National Defense Council Committee. Every woman over sixteen years of age will be asked to register and to check off on a list of 154 occupations those for which she has had training, or those for which she wishes to be trained, expressing her willingness to serve for salary, expenses or as a volunteer.

All this is an emergency measure, but women in America, like those in Great Britain and France, are daily becoming identified in increasing numbers with various industries. Boiler making is no exception. On September 1, the Pennsylvania Railroad Lines east of Pittsburg and Erie were employing nearly four thousand women, two being boiler makers' helpers. In boiler shops in England, according to the Labor Supply Department of the Ministry of Munitions, women are successfully cutting boiler tubes, drilling holes in boiler plates, planing boiler plates, cleaning locomotives, shearing small steel plates, surfacing boiler flue flanges, operating oxy-acetylene cutting torches, driving cranes and taking a part in assembling boilers undergoing repairs.

While in certain departments of railroad work, such as might be designated railroad housekeeping, there seems to be no reason why the services of women should not be generally acceptable, there is little likelihood of an invasion of female labor in the technical or mechanical departments of American railroads.

In order to find the causes of the cracking of boiler plates over riveted seams and the failure of boiler plates in service, due to stresses that occur in riveted joints, an investigation has recently been made by Dr. E. B. Wolff, of Holland. The results of this investigation have recently been presented before the Iron and Steel Institution.

The boilers investigated were of the ordinary single-ended, three-furnace marine type, built of first-class material. Most of the boilers with cracked plates belonged to steamship companies, whose vessels made voyages with a great number of stops, so that the fires were frequently extinguished and relighted. Boilers made of the same material for other companies whose boats had made only long non-stop runs did not fail.

The researches were started after one of the boilers had exploded. An investigation showed that the explosion had been caused by the shell plate of the boiler having burst open in the middle of the double butt-strap joint at the side. It was found that the plate had failed by the forming of a crack in the middle of the length of the boiler, this crack having gradually developed to such an extent that the sound part at the sides could not withstand the boiler pressure and failed suddenly, showing a reduction in area only in that sound part.

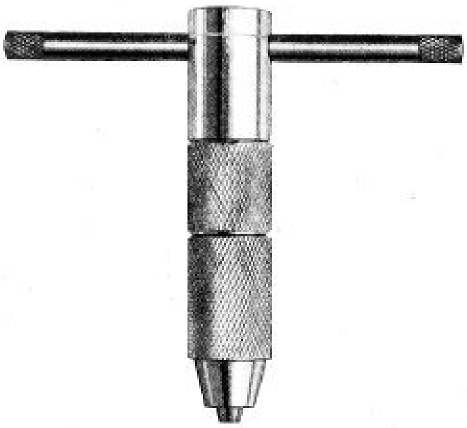
As a result of the investigations, it was proved that a peculiar kind of crack occurs in riveted joints on all kinds of boilers in service. These cracks are in most cases invisible in the beginning, and can then only be observed after etching the plates. They are found either at the inner surfaces of rivet holes or at the surfaces of the plates where these are pressed together. They are found in lap joints, as well as in butt-strap joints; in shell and front plates, as well as in firebox plates. The real stresses in different places on the riveted joints have been measured by a special extensometer, and it has been proved that the supposition that these cracks have been caused by fatigue of the material is probably right. The real stresses that occur in boilers can be even much higher than those in a test piece.

Engineering Specialties for Boiler Making

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

Ratchet Tap Wrench

The Moss-Ochs Company, of Cleveland, Ohio, has recently placed on the market a handy new ratchet tap wrench, in two sizes; No. 1, 0 to ¼ inch, and No. 2, ¼ to ½ inch. It is made with a sliding T-handle, permitting its use in the most difficult corners. The handle may



Rachet Tap Wrench with Sliding T-Handle

be held on center by means of a dog which automatically fits in a milled flat surface of the handle. Adjustment is made immediately to either right or left ratchet or rigid by turning a knurled sleeve. The chuck and ratchet is carefully hardened and all other parts are substantially made, insuring unusual durability.

Machine for Threading Stay Tubes

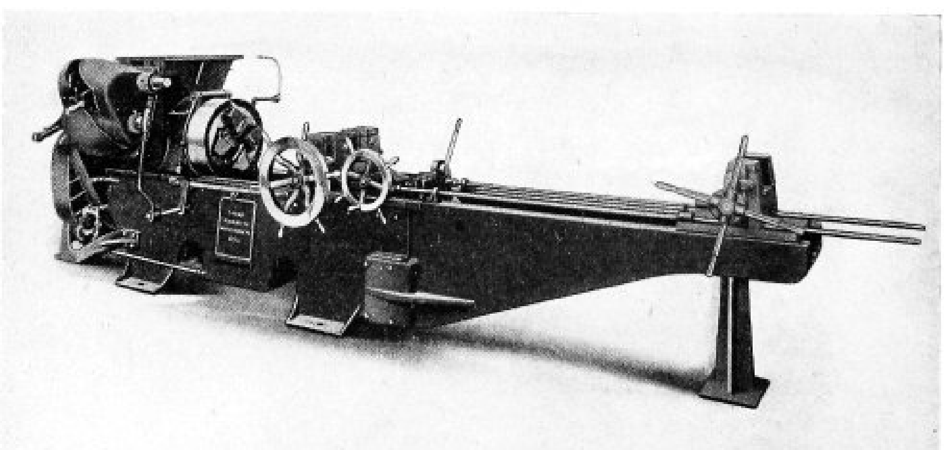
The cut illustrates a Landis threading machine, which was designed and built by the Landis Machine Company, Waynesboro, Pa., for a large shipbuilding plant for threading stay tubes. The tubes vary from 6 to 8 feet in length and from 2¾ inches to 3½ inches in diameter.

The machine is equipped with an auxiliary bed, which is attached to the main bed of the machine. This extension bed supports an auxiliary carriage fitted with threaded grips employed in timing the threads on the ends of the tubes and also in supporting the tubes. The machine is furnished with a lead-screw attachment which insures a high degree of accuracy and a perfect start of the thread, also a pitch indicator which shows the correct position for engaging the lead-screw nut. The illustration shows the machine arranged for an A. C. constant speed motor with mechanical speed change box and silent chain and sprocket drive. The photograph was taken prior to mounting the motor in position.

The method of threading the hollow staybolt tubes on this machine is as follows:

Thread one end of all the tubes which are to be threaded by gripping them in the vise of the regular carriage. Then take a master tube which has both ends threaded and with threads continuous. Place the master tube in the machine, close down the chasers in the threaded portion on one end, that is, make the grooves or serrated surfaces of the chasers fit in the threads already cut on the master stay tube, Grip the other end of the master tube with the threaded grips in the auxiliary carriage. These grips should be sufficiently loose so that they can adjust themselves endwise with the thread on the master tube. After the master tube is gripped in the extension carriage these threaded grips should be securely gripped in the auxiliary carriage vise jaws. Then throw in the lead-screw nut of the main carriage and grip the tubes in the regular vise of the main carriage. The chasers, the lead-screw and the threads on the staybolt tubes then will all be timed. Remove the master stay tube and place the tubes which have already been threaded on one end in the threaded grips of the auxiliary carriage and engage the lead-screw nut when the pitch indicator on the main carriage shows the correct position for engaging this nut. The operation of threading the second end on all the tubes can then proceed and the threads on both ends of the tube will then be continuous.

The machine employs the Landis all-steel rotary die head and long-life chasers which insure a high production of accurate threads.

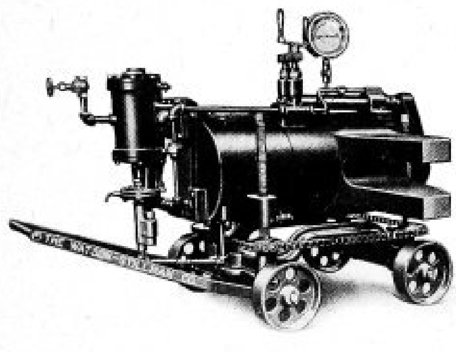


Landis Stay Tube Threading Machine

Crank Pin Press

The Watson-Stillman Company, New York, has brought out a new type of portable press for forcing crank pins into locomotive and engine wheels and for miscellaneous shop and field forcing work. Some unusual features are embodied in this design that should interest every railroad man, especially now that the shortage of labor makes the saving of man power of prime importance.

In this press the hand pump is replaced by one driven by an air engine. To make the power connections it is only necessary to run a rubber hose or other flexible tubing from the shop air main to the pump engine, as is done with pneumatic tools. The operating valves are so placed that the man in charge can operate the press in addition to directing the work of his men. The use of the air pump, therefore, eliminates one man, the hand-pump operator, from the crew, as well as increasing the speed approximately three hundred percent.



Portable Pneumatic Crank Pin Press

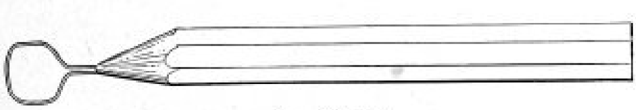
The press is equipped with a gage which accurately indicates the pressure required to seat the pin. By this means it is easy to detect a loose fit, which might seriously endanger the construction of an engine.

The main portion of the press is an open hearth steel cylinder on the sides of which are cast heavy forks which support tie rods. The reservoir is mounted on the rear of the press and the ram operates from the front of the cylinder casting. The whole unit is carried on screws that are mounted on a flat wheel truck. By turning any one of the screws the center line of the ram can be raised or lowered to meet the center line of the pin. Two tie rods and an abutment beam are used in connection with the press. The distance between the rods is adjustable in the forks, so that the rods may be passed through spokes of the wheel at any convenient opening.

The ram is returned by a small hydraulic cylinder mounted on the top of the press, with piston connected to a lug on the end of the ram. All movements of the ram are controlled by a geared screw stem valve. These presses are built in capacities ranging up to 300 tons.

First Aid Kink

All shops possess the handy fellow who can skillfully remove a bit of emery or a steel chip from the eye of his shopmate, but recently the writer met with a new eye doctor. It is shown in the sketch, and is made from a lead pencil and piece of horse hair.



Eye Doctor

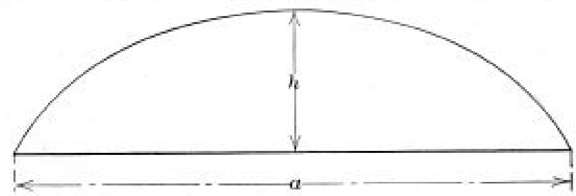
The lead is removed by splitting the pencil, and the groove is filled with shellac or glue. Then the horse hair is made into a small loop and placed as shown and the two halves are put together.

The loop of horse hair is very flexible and does not scratch the eye when probing for the foreign particles.

A Good Formula for Segments of Circles

Boiler makers are still in search for a good formula for determining the area of a segment of a circle, and I suppose the search will be continued until someone happens to hit on one that will give accurate results—as accurate as those obtained by using the well-known formula for areas of circles. There are accurate "complex" formulas, of course; but they are too complex, and, besides, absolutely accurate areas are not always essential. Closely approximate areas generally suffice in boiler design, as is well known, because of the factor of safety always employed.

Here is a formula that I believe will appeal to designers and others connected with the boiler business as a very good one, because of its comparative simplicity and accuracy from the smallest height to a half circle.



Segment of Circle

The formula is:

$$\text{Area of segment in square inches} = \frac{5}{6} h \sqrt{h^2 + 0.64\, a^2}$$

where h = the height of the segment in inches as per the above sketch;

a = the length of the cord in inches as shown.

For example, to check the formula, let us take a case where the radius is equal to 10 inches. What is the area of a half-circle, applying the above formula?

Substituting, we get:

$$\text{Area} = \frac{5}{6} \times 10 \sqrt{100 + 256}$$

$$= \frac{50}{6} \sqrt{356}$$

$$= \frac{50 \times 18.84}{6} = 157 \text{ square inches.}$$

Now, applying the well-known formula for finding the area of a half-circle, it will be found that the area is very close indeed to 157 square inches.

I have not determined the percentage of error of this formula, but it is a fractional part of one percent. We are often satisfied with formulas if they are accurate within two percent, or even more, but this one "hits it on the head" inside of one percent.

Usage of this formula for a time, the writer is convinced, will make it a favorite among boiler designers and computers. It beats anything the writer met with while computing segments some years back.

Further information on this subject will certainly be appreciated. If there is a simpler and better one in existence the writer would like to see it.

New York. N. G. NEAR.

Save your quarters and help win the war. With each quarter saved buy a "thrift stamp." Sixteen "thrift stamps" (worth $4) plus 12 cents now buys a War Savings Stamp.

Questions and Answers for Boiler Makers

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

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

Address your communication to the Editor of the Question and Answer Department of THE BOILER MAKER, 461 *Eighth avenue, New York city.*

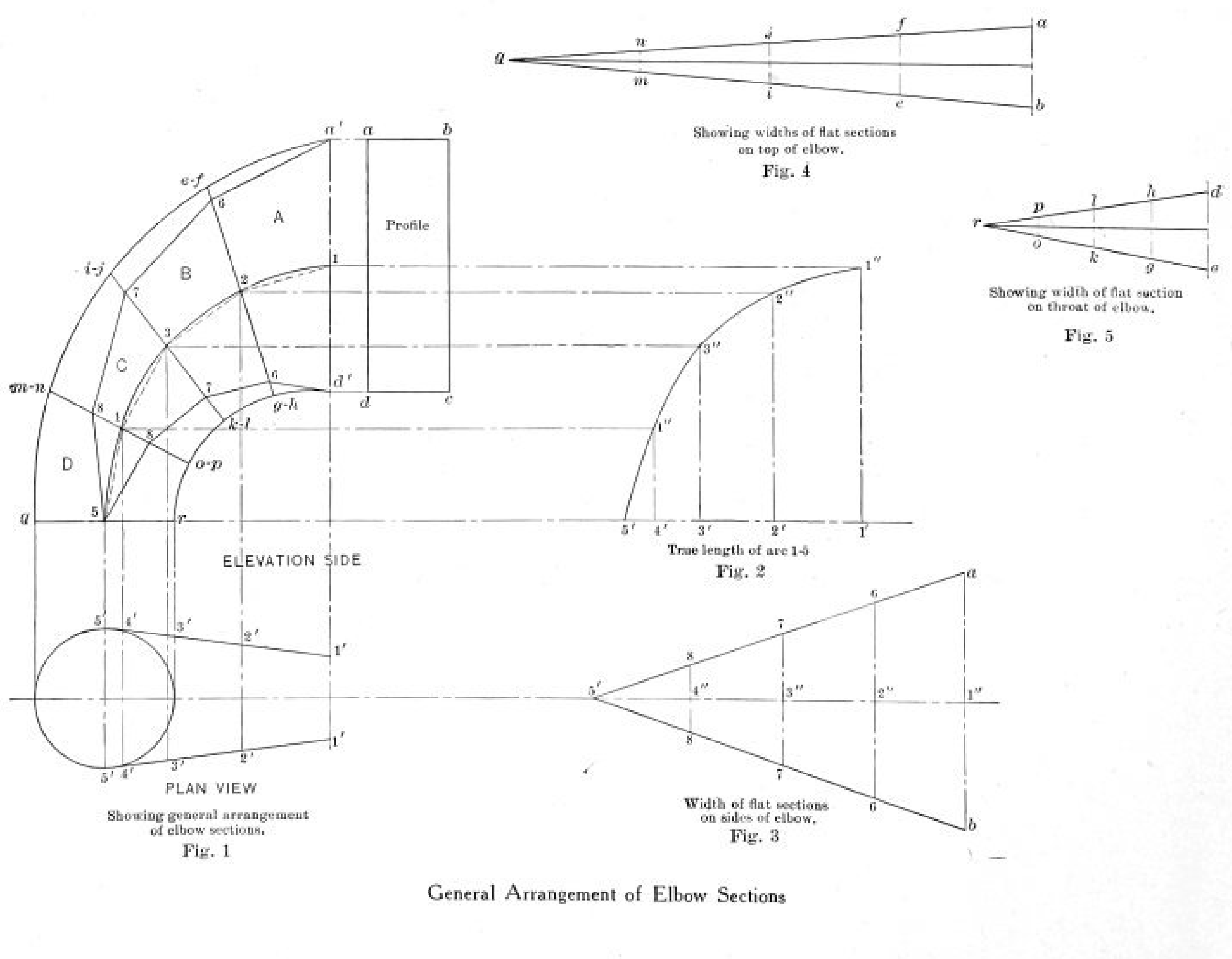
Layout of an Exhaust Fan Elbow

Q.—I made a development of an irregular elbow after considerable trouble, but after the job was finished it did not look good. I would be glad to have this layout fully explained in an early issue.
C. M. L.

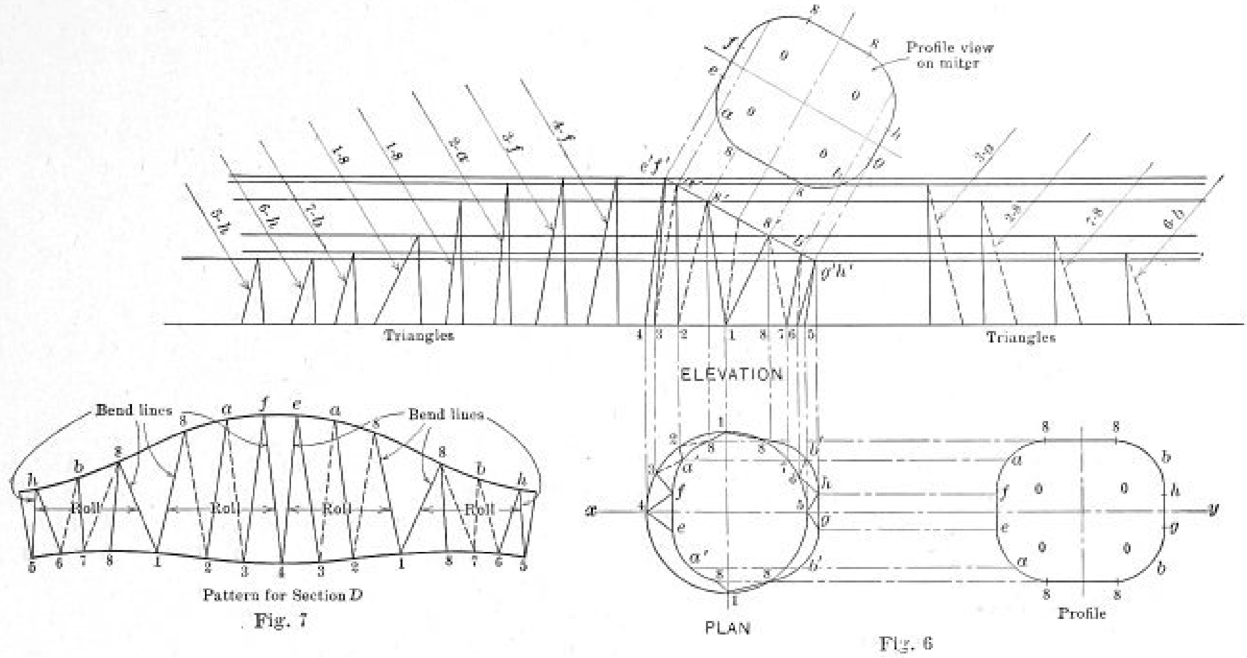
A.—The drawing you provided shows a square opening $17\frac{3}{4}$ inches by $17\frac{1}{4}$ inches, running to a round $7\frac{3}{4}$ inches in diameter. It seems to us that the areas of the ends are not properly proportioned. The square end equals 297.56 square inches and the smaller or circular end $7\frac{3}{4} \times 7\frac{3}{4} \times .7854 = 47.17$ square inches, thus showing a difference of $297.56 - 47.17 = 250.39$ square inches, which is entirely too great. In the Figs. 1 to 8 inclusive are shown the relative position and shape of an elbow similar in form but tapering from a rectangular opening to a round. The development applied in this example is applicable to elbows having different shaped ends. Note the perspective view, Fig. 8, and consider the shape of the two openings. One being rectangular and the other round in shape, the sections must be so proportioned as to produce a symmetrical and well-tapered object. Each section of the object has four triangular-shaped sides connecting with curved sections. These flat sections should taper uniformly from section *D* to a point at the corners of the rectangular section *A*. The shape of the flat surfaces on the sides of the elbow is shown in Fig. 8. The flat surfaces on the top and throat are much narrower and taper from the narrow width of the rectangular opening of section *A* to nothing in the section *D*.

Construction.—Lay off the plan and side elevation of the elbow, showing the general arrangement of the sections, as at *A-B-C-D*, Fig. 1. Locate the miter lines *m-n-o-p*, *i-j-k-l*, etc., in the elevation. The distance 1′-1′ in the plan equals the distance *a-b*, the width of the rectangular profile. The center line 1-2-3-4-5 is laid off midway between the extremities of the miter lines. To obtain a gradual taper in the flat sections on the top, sides and throat of the elbow, the constructions in Figs. 2, 3, 4 and 5 are necessary.

Consider the layout of the flat sections on the sides, the first step being to develop the true length of the center line 1-5, as follows: Draw a horizontal line, Fig. 2, equal in length to the line 1′-2′-5′ of the plan. Locate the points 2′-3′-4′ in Fig. 2 to correspond with their position in the plan, Fig. 1. Erect vertical construction lines from



General Arrangement of Elbow Sections



Layout of Patterns

1′-2′-3′-4′, Fig. 2, and from the corresponding points 1-2-3-4 of the elevation, Fig. 1, draw horizontal projectors to intersect the vertical lines in Fig. 2 at 1″-2″-3″, etc. The arc drawn through these points closely approximates the true length of the arc 1-5 of the elbow. The widths of the flat sections along the sides are now determined by first drawing the horizontal line 1″-5′, Fig. 3, and laying off the distances 1″-2″, 2″-3″, 3″-4″, equal to the corresponding distances between these points of Fig. 2. At right angles to 1″-5′ and through the points 1″, 2″, 3″, etc., draw lines of indefinite length. On the line drawn through 1″ lay off the width *a-d* of the profile view of the rectangular end, as shown in Fig. 1. Connect *a* and *d* with 5′ by drawing straight lines. Distances 6-6, 7-7 and 8-8 are the required widths on the miter lines. The widths of the flat sections at the top of the elbow are shown in Fig. 4, and those along the throat in Fig. 5.

Layout of Views for Developing Pattern of Section D.—Transfer the view section, Fig. 1, as shown in the elevation, Fig. 6. At right angles to the vertical center line draw the horizontal center line *x-y*. Draw a circle in the plan equal in diameter to the circular opening of the elbow. Next draw the profile view of the opening on the miter line *m-n*, *o-p*. This profile view shows the position of the flat sections at *e-f*, 8-8 and *g-h*, and equal respectively the corresponding 8-8, *n-m* and *o-p* of Figs 3, 4 and 5. The arc sections between the points 8-*a*, *f*-8, *h*-8 and *g*-8 may be any desired shape; in this case they are arcs struck from points *o* as centers.

The shape of the sections on the miter line in the plan view is foreshortened owing to the inclination of the miter line to the horizontal plane. To develop the view, simply transfer the profile view to the right of the plan, locating its center on line *x-y*. From the points 8-*a*-*f*-*e*, etc., draw horizontal projectors to the plan, and from 8′-*a*′-*f*′-*e*′ of the elevation draw vertical projectors intersecting the horizontal ones in the plan. Draw in the foreshortened view. The circle is then divided as shown at 1, 2, 3, 4, 5, 6, etc. Dotted and horizontal triangulation lines connect the circular base with the irregular view on the miter in both plan and elevation. The true lengths are shown at the right and left of the elevation in the triangles. The bases of these triangles are transferred from the plan and the heights from the elevation. Their hypotenuses are the required true lengths.

Developments of Pattern for Section D.—Start the layout from any convenient place, in this case from line 4-*f* as illustrated in Fig. 7. From point *f* as a center and *f-e* of the profile view as a radius describe an arc. Then with point 4 as a center and 4-*f* as a radius, describe an arc locating point *e*. From point 4 in the pattern describe arcs with 4-3 of the plan as a radius. With the compasses set to *f*-3 of the triangles and using *f* and *e* in the pattern, describe arcs locating points 3-3. Continue in this manner, using the distances for the stretch-outs at top and bottom equal to the lengths of the arcs and straight lines of the profile views, and then the true lengths of the triangles. No laps are indicated; therefore this part must be taken care of in the layout. The foregoing principles are also used in the construction of the sections *A*, *B* and *C*, so no further directions seem necessary.

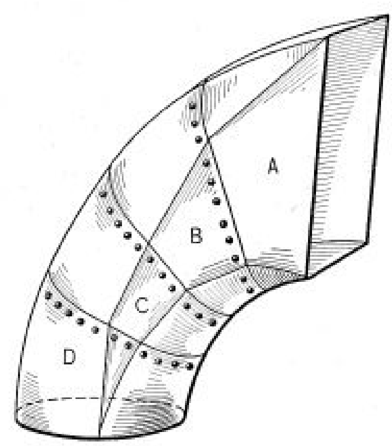


Fig. 8.—General View of Elbow

Tube Holes and Setting

Q.—(1) Why are not outward tapered or flared holes used for tube setting?

(2) Will tapered tube holes not improve tube setting?

A.—Some boiler designers prefer to make the holes for tubes conical or tapering in form, in order to increase the holding power of the tubes. When the holes are so made, the inner sharp edges of the metal around the openings must be rounded off. The ordinary practice, however, is to drill circular holes in one boiler head larger than in the other, as in time it is necessary to replace worn-out tubes. In such cases the tubes may be removed quite easily through the larger tube holes. The holding power of tubes, expanded in circular holes and beaded over, has proved sufficient to support the tube sheets.

Strength of Tank Subjected to Vacuum

Q.—We recently had a problem put before us that has caused more or less discussion pro and con. It has occurred to us that you could give us your opinion as to the matter in question.

We furnished a 7-foot diameter by 30-foot long horizontal mixing or compounding tank for the casing head gasoline trade, this tank having ¼-inch shell, double riveted on the side seams, ⅝-inch diameter rivets, with heads 5/16 inches, standard dish. These tanks are tested in the shop hydrostatically to 75 pounds, and in use contain gasoline with a working pressure of 20 pounds. These tanks are used extensively for the trade in the field, and if the valves are not carefully closed when the tanks are empty and the gasoline pumps are allowed to operate, a vacuum of 26 inches would immediately be produced. As a result, quite a few of these tanks have collapsed, the fault naturally being with the users of these tanks in not providing proper precautions, etc. The tanks are not sold for vacuum.

However, in the case under discussion, one of our tanks leaked in three or four places and we sent a boiler maker to do necessary calking. It developed that the customers were not in position to furnish water or air to make the proper test, and their foreman suggested to our boiler maker that they use steam. Our boiler maker replied that he could, if absolutely necessary, make a test with steam, but he preferred water or air. They therefore furnished 45 pounds steam pressure in the tank and our boiler maker calked the tank tight, and in an hour afterwards, on his return to the tank, found same completely collapsed; in fact, doubled flat upon itself in two or three places, so that only the two heads stood up in practically their original shape.

The statement was made, and still maintained, by our customer's engineer that the condensing of the 45 pounds of steam in this tank created a vacuum necessary to collapse the tank. We assert that this was not possible, and we would appreciate very much your expression regarding this matter. J. F. M.

A.—From the conditions explained in your letter it is evident that the tank collapsed, due to partial vacuum within the tank. It is probable that the partial vacuum was produced in this manner: After the rivets and seams were calked, the steam pressure was brought up to 45 pounds per square inch for testing, but the valves on the tank were left closed to the atmosphere. If this was the case the steam in condensing created a vacuum that would be perfect if no air was in the tank; therefore, a partial vacuum in addition to the weight of the metal is what caused the tank to collapse.

To resist collapsing or external pressure the metal in a tank of this size would have to be heavier than ¼ inch thick. In May's issue of THE BOILER MAKER a description is given on vacuum, and also notes relative thereto for figuring allowable pressure and plate thickness for riveted pipe work. Considering in the case mentioned that the vacuum within the tank is 26 inches, this means that the air within this tank is sufficient to produce a pressure of $4/30 \times 14.7$ equals 2 pounds per square inch at sea level. The pressure tending to collapse the shell equals $14.7 - 2$ equals 12.7 pounds per square inch. Theoretically, according to the following solution, the plate thickness should equal 0.17 inches:

$$t = \sqrt{\frac{12.7 \times 84 \times \sqrt{360}}{692{,}800}} = .17$$

In which t = plate thickness in inches,
84 = diameter of tank in inches,
360 = length of tank in inches.

Owing to the length of the tank and its large diameter the plate thickness must be greater than 0.17 inch. The heads of reinforced ends in pipes or tanks of great lengths are not sufficient to prevent shells from collapsing in their centers. A factor of safety of 4 is, therefore, recommended in calculating the required thickness of plate to resist collapsing pressure. Therefore, in this case to resist a partial vacuum of 26 inches the plate thickness should be 0.17×4 equals .68 inch. By the use of reinforcing rings inside the tank the factor of safety may be less than 4, thereby reducing the plate's thickness.

Hardening and Tempering Rivet Sets

Q.—In "Laying Out for Boiler Makers," there is a chapter devoted to tempering chisels and tools of this kind, but I have not been able to get a line on tempering snaps—that is, ⅝, ¾ and ⅞ dies—and also the rule for hardening the shanks of air hammer tools. Also, what is the best composition to use in hand welding; for instance, in welding broken rivet tongues? L. P.

A.—For hardening tool steel the entire metal is brought to a medium cherry red heat and afterwards chilled by dipping it into cold water, brine or oil. The degree of hardness depends on the rapidity with which the steel is cooled. There are different methods of heating; in forge fires, oil or gas furnaces, molten lead, charcoal, barium chloride and by electricity. The heat treatment should be such that it can be easily controlled in order to maintain a uniform heat and be free from oxidizing elements. Tool or carbon steel treated in this way hardens so that internal stresses arise within the metal; therefore they should be tempered after being hardened, thereby offsetting the danger of the steel cracking. *Tempering* is another heat and cooling treatment of the steel, being done by two different methods, namely, in a tempering bath of oil or lead, or by color.

Hardened steel changes color when reheated, and the color indicates the degree of temperature. In drawing the temper the colors run from the heated end of the metal to the cold end; first appears a pale yellow followed by a darker yellow, then comes purple, etc. For punches, dies and rivet sets the temper should be drawn between a brown and purple color being a range of heat temperature between 490 degrees to 530 degrees F. In tempering by color heat the face end of the rivet tool in a forge or furnace; the tool should be placed on a metal plate so that it can be turned frequently in the fire, care being taken to heat the face of the set uniformly. Owing to the shape of the set the outside edge is liable to overheat before the center is heated to the proper temperature. To prevent this, cool the edge slightly by dipping the tool into cold water, but hold the tool so that only the affected edge is cooled off. Replace the tool in the fire and bring it up to a dull cherry red. Then dip it into cold water so that its face extends about one-half below the surface of the water. Move the tool about in the water a few times with a circular motion, or otherwise the steam will form a pocket around the tool, preventing the required cooling effect of the water. Remove the tool from the water and clean the face with sand paper in order to observe the drawing of the temper to a brown or purple color by the heat that is still in the tool. As soon as the temper color runs into the face end of the tool, plunge the set into cold water to prevent the temper from drawing further. The shank end would be tempered in the same manner.

Experience in this work is the best means of determining the exact temper color suitable for the conditions met with, because tool steel is a variable quantity and what is good practice in handling one grade would not be suitable for a different grade, etc.

Borax and sand alone or in combination are good fluxes for iron and steel welding. Potter's clay mixed with strong water and salt solution (brine) and then powdered, is an excellent flux for welding iron to steel.

Letters from Practical Boiler Makers

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

Renewing Mud Drum Nipples

The feature article in the October issue of THE BOILER MAKER, under the above title, is a well-written article on an important subject. However, the author prescribes a practice and makes a statement further on with which I wish to take issue. He advises the belling of nipples with a mandrel before the nipples are put in place, the belled end being put on the mud drum end, and states that a better job can be done than with the rolls supplied with the expander for this purpose.

I doubt very much if a better job can be done in this way. The flaring of tubes and nipples is done for holding purposes and should be done after the nipple is inserted and the joint made between header and nipple by expanding. In this way only the metal below the expanded joint is affected, where if driven on a mandrel before insertion it appears to me that the metal which later will make the joint will be distorted, making it harder to roll a good joint.

In my experience with the handling of engines and boilers, I have found that first-hand information from manufacturers regarding the care of their products was always the best. They invariably do a lot of experimenting and testing to produce an article of merit, and the method of inserting nipples as prescribed by the maker of these boilers is to flare the nipples after expanding them, with the rolls provided with the expander for that purpose.

Somerville, Mass. G. B. LONGSTREET.

Come Across

The writer has profited considerably, and much enjoyed the privilege of contributing his bits of experiences and ideas to the pages of a worth-while magazine, THE BOILER MAKER, and has felt happy to be able to swap bits of knowledge and kinks with other men in the field. There are undoubtedly many readers of THE BOILER MAKER who have a few valuable notes and kinks jotted down in their note books, and a number of practical experiences that would be appreciated by the rest of us. I, for one, would like to have more of such fellows come across with some of their goods.

It all lies in making the start. Many fellows feel that they cannot express themselves in cold print, but, honest, fellows, it's not necessary to use polished grammar in passing a good idea along to the rest of us boys; we fellows of the shop all talk on the same level. "Hifalutin' words ain't got no place" in our vocabulary when we are trying to pound home a worth-while point.

Lots of fellows get into a rut, and a rut only differs from a failure's grave in appearance. He who only thinks of himself and won't attempt to make a fair exchange of his experiences and knowledge with his fellows in the same line of endeavor eventually becomes a human crab possessed of but two modes of motion, sideways and backwards.

So come on, fellows, come across when you get an idea, a kink, or anything that you feel is worth telling about; write it down, sketch it out, and talk it over with your fellows through THE BOILER MAKER.

Concord, N. H. C. H. WILLEY.

Why Should Butt Straps Be Taken Off and Cleaned?

The general practice in boiler construction is to either drill the rivet holes in the plates or to punch the rivet holes ¼ inch small, and then ream out to size. The law then steps in and tells us we have to take the plates apart and remove all burrs from the rivet holes and all dirt from between the plates, then assemble for riveting. The writer does not object to the above rule, but believes that it should be modified, and desires to have the question freely discussed in these columns by practical boiler makers.

Suppose we have a boiler with the heads a good tight fit and butt straps bolted close up before reaming; we then ream the boiler, and if the reamer is in good condition very little burr should be left in the hole and very little dirt between the plates. We now take this boiler all apart and clean as required by the boiler rules; then comes the assembling, but we must not use the drift pin, as excessive drifting of the holes is dangerous. But can we put this boiler together again without drifting the holes fair? And when we use a drift pin on heavy shell plates it leaves a pretty big, hard hump on the edge of the hole. This hump is worse than the burr that we have just removed.

I have had boilers thoroughly cleaned and carefully reassembled and riveted and tested, and had first-class results. I have also tried this plan, just to loosen up the bolts on the butt straps and blow any dirt from between the straps, then tighten up all bolts, then rivet, and have got exactly the same results, all rivets tight and a first-class job.

I believe in first-class work, and that we cannot be too careful in the building of high pressure boilers; neither do I wish to shirk any good rule that will enable us to make our work as safe as human ingenuity can make it. Neither did I put one over on the boiler inspector, as the boilers that were not taken apart did not call for any inspection. The question in my mind is this, whether it is the better plan to take off the butt straps and then try to bring everything fair again.

Unless a good boiler maker is in the gang, it is so easy for the helper to keep on driving in the drift pins. The helper does not know any better—just maybe wants to get warmed up and hits her up. There is always this chance of starting a fracture.

Or will we just loosen the bolts a little, blow out the dirt with compressed air, and then tighten up the bolts? The burr around the edge of the hole is so small that the pressure of the hydraulic riveter will take care of it, and in the finished work both methods give the same results, every bull-driven rivet tight without calking.

Some will say, "Well, the rule says that we have to take them apart." That is so. Engineers have given us many rules for our guidance, but many rules have been discarded, and many will yet be discarded. Because a rule has been in force for over thirty years and considered good practice, and has been adopted without question by the many boards of boiler rules, does not signify that it is a necessary rule. It might be left to the discretion of the inspector that where there has been careless fitting up and loose heads he should order the boiler taken apart and cleaned, then bolted up close before driving any rivets.

The foregoing has not been written in the spirit of criticism, but rather that we may discuss this subject, and get the opinion of good men in our business.

If we can get good tight work without taking off butt straps, and so destroying the alinement of the newly reamed holes, then it is not necessary to take them apart.

Good labor is scarce and boilers are urgently required, and any rule that creates unnecessary labor and that will hold up the boiler for several hours might be discarded for the duration of the war. We hear efficiency being urged on every hand. Efficiency is the power to do, or the power to produce, and any thought that will increase production should receive earnest consideration.

Paterson, N. J. JAMES CROMBIE.

Boiler Fire Tubes

Again and again attention is invited and criticism passed upon the arrangement and diameter of fire tubes in the Scotch marine and locomotive type boilers. Nearly every critic claims that if certain alterations were made better circulation and increased efficiency would result. If, for instance, one man finds that 2-inch tubes give better results than 2½-inch or 3-inch, for this reason alone he would have all boilers fitted with the tubes which from experience he fancies. In spite of such original discovery, the boiler maker continues to follow his own practice while the critic considers him old-fashioned and conservative.

In this connection the following data obtained from a former resident in Johannesburg, South Africa, on the subject of portable boilers of the locomotive type is of interest.

The conditions are those of fifteen years ago, and at that time the feed water was very bad and the local coal so inferior that two hours' steaming gave eight inches of clinker on the fire bars.

Three rival makes of boilers were in operation and all were of the same nominal horsepower, their price approximately equal, and their makers well-known firms whose reputation is practically world wide.

Terming the makers A, B and C. A and B had fireboxes supported by sling stays from exterior shell. C had semi-circular unstayed firebox roof. The relative proportions (length, height and width) of firebox differed slightly, which would affect the length of the fire bars, but exact data as to this divergence is not available.

The relative steaming capacity was $2A = 3B = 4C$. The diameter of tubes was $A = 2\frac{1}{4}$ inches, $B = 2$ inches, $C = 1\frac{3}{4}$ inches, and to this difference alone is attributed the superiority in steaming power of A by the writer's informant. Doubtless, had the conditions of operation and the remaining divergence in proportion been analyzed in a scientific manner, other factors might have contributed to the difference. The fact remains that the C boiler was less efficient and that the smaller tubes were blamed for the poor results. At the same time, in another place with different coal, it is quite possible that the relative efficiencies might be reversed, and this points to the need for study of local conditions in export trade. If exchange of heat is alone considered, it is possible to obtain a very high efficiency by high capital cost. Actually the divergence in shape and design evident in the boiler field is due to compromise between conflicting claims. Rational design seeks to retain efficient results, while affording a shape for the purpose desired. Each special shape of boiler has virtues as well as drawbacks. That considerable thermal efficiency is obtained under adverse theoretical conditions is to the credit of the trade.

Evaporative efficiency has in many instances to give way to other considerations. There is no best shape of boiler considered as a boiler, only a more particular design for a particular end. In any discussion as to the best type of boiler, several things have to be kept in mind. Capital cost, available water, weight, type of available coal, thermal efficiency, type of operative labor, without exhausting all the considerations involved.

It is an axiom proved by experience that the slower the rate of combustion the greater the thermal efficiency. For rapidity of steam raising and weight of steam generated per weight of boiler, forced draft and a watertube type are best. Where the available water is bad from a boiler point of view the watertube boiler is ruled out and some other form substituted. It is all a question of fitness for a destined end affected by every imaginable factor.

To come to closer grips with the subject of tubes. Crowding as many tubes as can be got into a boiler under a mistaken nation that, "ipso facto," every tube is of the same relative value is one of the commonest of misconceptions. When heating surface is specified the entire superficies of every tube forms part of the total cited.

There exists sufficient reason for extended scientific investigation as to the most effective disposition and arrangement of fire tubes in a boiler. Historic experiments have been made, but these are in the remote past. In 1830 no less a person than George Stephenson found that one square foot of firebox was equal to three square feet of tube surface. In 1840 the barrel of a locomotive boiler was divided by Mr. Dewrance into six compartments; that next the firebox was 6 inches and the remainder each 12 inches in length. The experiments served to show that the first 6 inches of tube surface were equal, area for area, to the firebox surface, the second 12 inches only one-third as effective, while the remaining divisions gave a very small rate of evaporation.

In 1864 further trials were made, the division into six compartments over the 5 feet of tubes. The first division was 1 inch, the second 10 inches, and the other four were 12 inches in length respectively.

The following quantities of water were found to have been evaporated in three hours: (1) 1 inch, 46 ounces; (2) 10 inches, 47 ounces; (3) 1 foot, 30 ounces; (4) 1 foot, 22 ounces; (5) 1 foot, 18 ounces; (6) 1 foot, 17 ounces. In some experiments made at Devonport on a Scotch marine return tube boiler, the temperatures at various points along the tubes were carefully observed, with the following results:

Temperature	Degrees
At center of combustion chamber	1,576
6 inches within chamber from tube plate	1,460
At combustion chamber end of tubes	1,302
8 inches along tube	1,165
1 foot 2 inches along tube	1,115
1 foot 8 inches along tube	1,045
2 feet 2 inches along tube	976
3 feet 2 inches along tube	890
4 feet 2 inches along tube	820
Smoke box end of tube	795
At center of smoke box	740

The normal consumption of boiler under natural draft was 17 pounds of coal per square foot of grate area, tubes 2¾-inch diameter. The relative efficiency of heating surface, taken in order, is furnace crown, top of combustion chamber, sides and ends of combustion chamber, and lastly the tubes. In an experiment made by placing a hot substance inside a rectangular box submerged in water, it was found that the upper face generated steam more than twice as fast as the vertical sides per unit of area, while the lower face yielded none. The poor efficiency of the sides was due to the difficulty with which steam separates from the vertical surfaces to give place to fresh particles of water. By slightly inclining the box, the rate of evaporation of the elevated side was increased, while from the reverse side the steam escaped so slowly as to lead to an overheating of the metal.

The foregoing is condensed from available authorities. It proves that in the early days of steam practice the earliest practitioners were by no means unmindful of relative values and their methods truly scientific.

The tubes, then, play a very second-rate part in steam raising, their principal utility being to conduct away the products of combustion and retard the velocity of the hot gases.

Let us first see what the designer attempts to do in the matter of tube area. Taking actual data of a well-designed Scotch boiler, there are three furnaces 42 inches in diameter, 350 tubes 2½ inches in diameter, each .144 inch thick.

Cross sectional area 3 furnaces = 4,155 square inches.
Cross sectional area 350 tubes = 1,330 square inches.

Grate bars will be at half diameter, thickness of fire layer must be taken into account, also the construction of brick bridge. Allowing for these factors, the result shows that tube area and furnace area balance. The effective cross section of furnaces in operation for passage of combustion products and that of the tubes is roughly equal. The construction of bridge and clinker on bars usually renders the tube area in excess.

Actually the designer considers the more practical data. He is strictly limited by workshop reasons and gets in his boiler a sufficient grate area on an assumed combustion basis, and as many tubes of reasonable size as possible. Obviously the smaller in diameter the tubes, the greater the total cross-sectional area. Design is actually a compromise between conflicting claims and is largely based upon established practical result.

The Operating Side

To consider now another matter with regard to tubes from the operating side. It is clear that, unless very frequent sweeping is practiced, that in the course of a short period all the tubes are partially choked. In a locomotive boiler, tubes are swept daily. In a ship, this is impossible. In a marine boiler, burning reasonable coal weekly, sweeping is the rule. For this reason alone tubes must not be too small, otherwise the draft, which is dependent upon tube area, is speedily checked and the weight of coal cannot be burned.

In practice the result is that, starting with clean tubes and steam easy to maintain, the coal consumption gets proportionately less each watch until after the lapse of a week it is necessary to sweep tubes. The maximum efficiency point is reached about the middle of the period. At the commencement the tube area is in excess, at the finish is less than sufficient.

On short passages the necessity of cleaning tube does not occur, so that opinion may differ as to the adequacy of a given size tube—e. g., short passages at high speed, smaller tubes, and lessened tube area aid economy. The normal general utility heat serves to establish general practice, hence the usual number, disposition and size of boiler tube. It is not uncommon in such a vessel to get increased economy with plugged tubes. A former experience of the writer will, perhaps, bear re-telling. The smoke box end of the tubes in the Scotch boilers of a certain ship were, for the purposes of experiment, fitted each with a thin slip of wood. Twelve days' steaming found numerous tubes with the wood charred but vertically intact. This proved conclusively that the particular tubes were less efficient. About one-third of the tubes were less efficient. Still pursuing economy, the other tubes were then partially choked by grooved taper plugs cast for the purpose. The scheme resulted in marked economy in coal consumption. It is the condition of practice which should fix diameter and number of tubes. Nearly everyone fixes on the tubes of a Scotch boiler as the one point where improvement is possible. As already pointed out, the heating effect provided by the tubes is small, so that rearrangement would not do very much good. In any case, of the total circumferential surface of the tubes, one-half is at the bottom and so valueless, leaving aside the insulation of soot in this portion.

Function of Tubes

The function of the tubes is to provide draft and carry away the products of combustion, and this essential comes before anything else. The tubes are less a thermal exchange than a simple flue. Moreover, natural draft is impossible if the whole of the heat were killed in the gas. Probably the best means of utilizing the waste gas is to be found in superheating the steam by its means. One serious attempt was once made to improve the cerculation of the Scotch boiler. This was the fitting of cross tubes similar to those in the flue of a Lancashire boiler across the combustion chamber. So far as is known the experiment was never repeated. The writer is informed that a vessel with boilers so fitted disappeared, and as a consequence the type was abandoned.

When speculating upon possible improvement some rather extraordinary notions come into the mind. Why not fit the combustion chamber with vertical watertubes, acting also as stays to the crown sheet, or by redesign and for reasons of replacement place them diagonally across the chamber. The scheme, it is admitted, is visionary, and the writer does not propose it, as he sees constructional difficulties in the way. At the same time the heating surface of such watertubes would be considerable and convection currents of some velocity would be induced. Extra heating surface of a valid kind would have been added, premising that redesign made the scheme practicable. However, it was possibly reflections of this kind which originated the first watertube boiler. For one thing, a manhole of fair size would have to be provided vertically over each combustion chamber crown. The interior condition of the tubes could be viewed from the top by a light underneath. The necessity for the manhole is evident from replacement considerations. If at one and the same time the crown stays could be dispensed with and additional heating surface of the most valid kind introduced and quick circulation assured, the introduction of watertubes into the combustion chamber would have many merits.

However, the scheme is too attractive to be without valid drawbacks; otherwise it would doubtless be in service at the present day for naval purposes and so placate the two opposing boiler experts (watertube versus fire tube). The necessity for keeping the thickness of the crown sheet at a minimum is doubtless the most valid objection, tube sheets being vertical and less exposed to direct flame can be thicker to give more security to the tubes when expanded. It would be extremely difficult to arrange for replacement of horizontal watertubes. However, the subject is left purposely open for critics or for some designer to solve.

London, England. A. L. Haas.

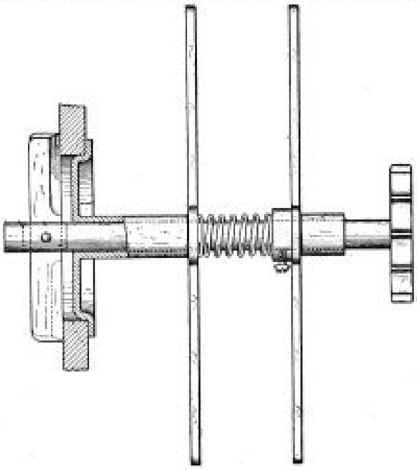
Selected Boiler Patents

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

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

1,239,754. SCRAPER FOR BOILER HAND-HOLES. OTTO BACHE AND CHARLES BERG, OF SAN FRANCISCO, CAL.

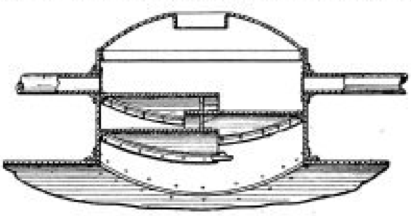
Claim.—In an implement of the class described, the combination of a spindle, means supported thereby for scraping the inner side of an apertured plate, a bearing for the spindle provided with means for en-



gaging the outer side of said plate, handles secured respectively to said spindle and bearing, and each extending in opposite directions from the part to which it is secured, and a coiled spring around the spindle compressed between said handles.

1,239,931. STEAM DOME SEPARATOR AND BOILER SKIMMER. CHARLES C. MILLER, OF PITTSBURG, KANSAS.

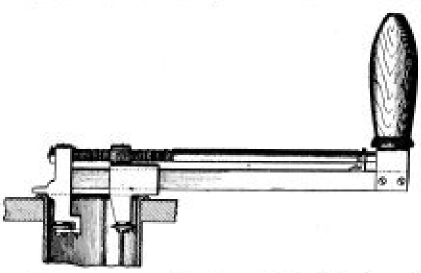
Claim 1.—In steam skimming and separating means, a boiler, a dome carried by the boiler and communicating with the interior thereof and provided with a steam outlet, a plurality of convexed oppositely directed



baffle plates mounted in the dome in superposed spaced relation intermediate said boiler and steam outlet, adapted to separate moisture from steam as it flows through the dome, and means for collecting the moisture separated from the steam by said plates and removing it from the dome. Three claims.

1,240,779. FLUE CUTTER. HERMAN M. POWERS, OF PIERCE CITY, MO.

Claim 1.—A flue cutting implement comprising a stock, a cutter holder fixed to said stock, a cutter holder movable on said stock, cutters carried by said cutter holders, a handle journaled to said stock whereby the stock may be moved in a circular path while the cutters are arranged



within a tube, and means operable by said handle whereby the movable cutter holder may be fed in a direction away from the other cutter holder, the last-mentioned means being co-operable with said handle. Four claims.

1,239,370. LOCOMOTIVE STACK AND DRAFT DEVICE. WILLIAM ELMER, OF BUFFALO, N. Y.

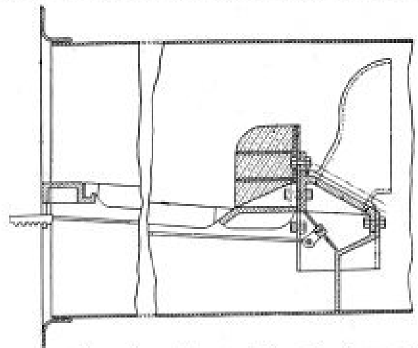
Claim 1.—A locomotive stack and draft device, including a cylindrical stack provided with a plurality of cylindrical conduits nested within the stack with their axes parallel to the axis of the stack. Four claims.

1,238,127. GAGE. WILLIAM L. GEDDES, OF MERION, PA.

Claim 1.—The combination with a boiler of a gage comprising a sight tube, a fixture containing a passage communicating with said tube, a passage communicating with said boiler and said passage first named, a manually operated valve controlling communication between said passages, an automatic valve between said valve first named and said boiler, a by-pass communicating with said first and second named passages, and a valve controlling said by-pass. Three claims.

1,240,971. FIRE BOX. JOHANNES HASSEL JENSEN, OF COPENHAGEN, DENMARK.

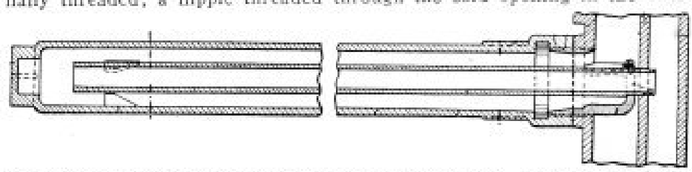
Claim 1.—A mouthpiece for secondary air supply in fire boxes, comprising a flattened trumpet-shaped member corrugated in cross section



forming air passages adapted to direct air issuing from the outlet end in paths crossing one another. Four claims.

1,240,994. PIPE ATTACHMENT FOR TUBULAR FURNACES. EUGENE SOLOMON MANNY, OF MONTREAL, QUEBEC, CANADA.

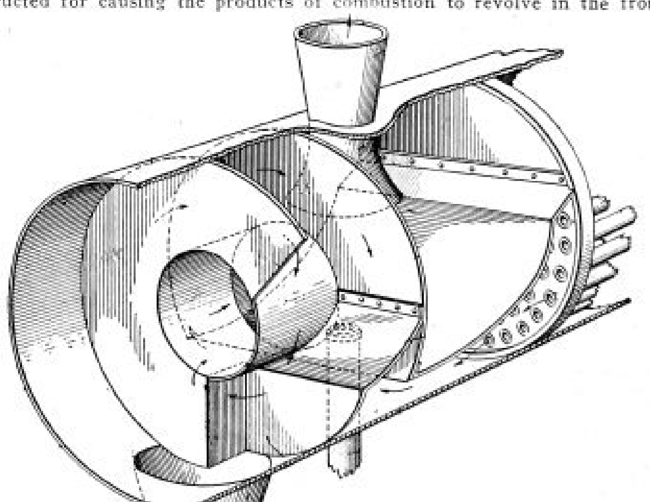
Claim.—In a furnace, the combination, with spaced outer and inner water legs formed with co-axial openings, the opening in the outer water leg being threaded, and the opening in the inner water leg being plain and having a smaller diameter than the first-named opening; of an outer water-circulating tube closed at one end and having its other end disposed in registration with the opening in said outer water leg and internally threaded; a nipple threaded through the said opening in the outer



water leg into the second-named end of said tube, said nipple being formed with a plurality of spaced arms which project into the space between the water legs and are connected at their extremities by an annular supporting member of appreciably smaller diameter than said tube; an open-ended inner water-circulating tube disposed within the outer tube and projecting at one end through said annular supporting member and the plain opening in the inner water leg into the space between the latter and the back wall of the furnace, the other end of said inner tube terminating short of the closed end of the outer tube; and a plurality of supporting members arranged within said outer tube and grouped around the said other end of inner tube, whereby said inner tube is maintained in spaced relation within said outer tube.

1,241,059. SPARK ARRESTER. THOMAS M. VAN HORN, OF CHICAGO, ILL.

Claim 1.—In combination with a locomotive smoke box and stack, and an exhaust nozzle, of a spark arrester device having a passage constructed for causing the products of combustion to revolve in the front



end of the smoke box whereby to separate the solid particles from the exhaust gases, said arresting device arranged on said front end and provided with an outlet for said products of combustion disposed forwardly of said nozzle and stack, and a conduit for conducting the exhaust gases rearwardly to the stack. Ten claims.

1,239,612. FUEL-FEEDING DEVICE. WILLIAM McCLAVE, OF SCRANTON, PA., ASSIGNOR TO McCLAVE-BROOKS COMPANY, OF SCRANTON, PA., A CORPORATION OF PENNSYLVANIA.

Claim 1.—In a furnace, a reciprocating pusher associated therewith, means for actuating said pusher consisting of a drive shaft, an eccentric thereon, a link carried by said eccentric, a furnace shaft connected to the link, means for instantly arresting the reciprocation of the pusher located between the furnace shaft and the drive shaft, comprising a block mounted in a slot in said link, side plates rigidly attached to said block, and a cam lock located between the side plates adapted to lock the block against said link. Three claims.

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