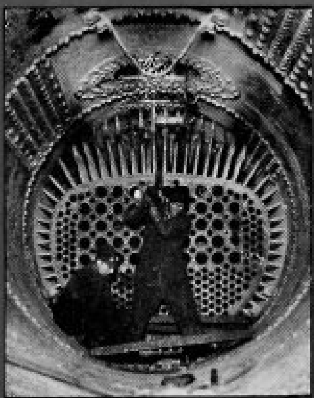
Boiler Maker *and* Plate Fabricator



1937 Outlook Bright for Boiler and Plate Fabricating Industries

DURING 1936, the boiler and plate fabricating industries showed spectacular improvement. The steady expansion of activity in these fields, month after month, makes the outlook particularly bright for 1937.

Steel boiler orders for the first 10 months of 1936 jumped 54.5 per cent over the 1935 period and 114 per cent over the 1934 period. The number of boilers ordered totaled 9,048 against 5,858 in the 1935 period and 4,231 in the 1934 period. Orders for fabricated steel plate practically doubled the 1935 volume, aggregating 390,629 short tons for the first 10 months of 1936, compared with 203,615 tons in the 1935 period, and 199,338 tons in the 1934 period.

Equally impressive is the increase in steam locomotive orders—the 1936 orders aggregating over 400, which was the greatest total since 1929. The manner in which the railroads are attending to their equipment requirements makes the outlook in the locomotive boiler field most encouraging for 1937. Sharply increased railway activity is further indicated by the increase in maintenance of equipment programs. In the first 10 months alone, the railways spent $647,167,808 for this purpose, an increase of $85,619,754 over the like 1935 period.

This expansion of activity emphasizes the growing need for attention to plant facilities and tools, and points to increased demands for boiler and plate fabricating materials during 1937.

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Boiler Maker and Plate Fabricator

Annual Index

The annual index of BOILER MAKER AND PLATE FABRICATOR for the year 1936 will be mailed without cost to each subscriber who sends a request for it to our New York office before February 15 and before the supply is

Purchasing Power

Purchasing power of average weekly earnings of wage-earners in manufacturing industries in November, 1936, was 5.6 percent higher than the average for 1929, while the average work-week was 14.5 percent shorter than in 1929.

These facts are brought out in a comparison of conditions of labor in 25 manufacturing industries in 1929 and 1936 made public January 9, by the National Industrial Conference Board.

The current higher purchasing power of wages is accounted for chiefly by the fact that weekly money earnings have advanced more rapidly than the cost of living. In November, 1936, weekly money earnings had recovered to 90.5 percent of the 1929 level. The cost of living, however, stood at 85.7 percent of the 1929 level of living costs.

Average hours worked per week in November, 1936, were 41.3, as compared with 48.3 in 1929. The number of workers employed in these 25 manufacturing industries in November was 95 percent of the average number employed in 1929.

Boiler Manufacturers' Mid-Winter Meeting

An important meeting of the American Boiler Manufacturers' Association and Affiliated Industries will be held at the Cleveland Hotel, Cleveland, on January 20. Formerly the mid-winter meeting was held in February, but this year due to the necessity of discussing vital problems in connection with the business of the industry it was decided to advance the date of the meeting.

The American Boiler Manufacturers' Association and branch meetings have been scheduled to eliminate conflict in so far as possible. The time for each session is naturally limited because of the brief duration of the meeting. The committee has arranged a definite time schedule to which those in attendance should conform. Beginning at 9:00 a.m., the general meeting will be held, followed by luncheon at 12:30 p.m. In the afternoon, the Horizontal Return Tubular Boiler Branch will meet at 1:30 p.m.; the Stoker Branch will convene at the same time; the Pulverized Fuel Equipment Branch at 2:30 p.m.; and the Watertube Branch at 3:30 p.m.

Reports of all activities since the last annual meeting will be given, but most important, policies for the coming year will be discussed and plans for activities drawn up.

Locomotive Boiler Accident Record Improves

The first annual report of Chief Inspector John B. Hall of the Bureau of Locomotive Inspection to the Interstate Commerce Commission marks the twenty-fifth anniversary of the Bureau and notes the decrease in the number of injuries and fatalities resulting from accidents due to locomotive failures.

While the number of accidents occurring to locomotives in 1936 increased to 209 from the 1935 figure of 201, the number of persons killed decreased from 29 to 16 and the number of persons injured from 267 to 215. Of the total number of accidents, boiler failures accounted for 75 or 35.9 percent in 1936, as compared with 68 or 33.8 percent in the previous year. The number of casualties caused by such accidents were 10 killed and 80 injured, which represents 62.5 percent and 37.2 percent respectively of the total persons killed and injured by locomotive failures.

This record is much better than that of the previous year, particularly so when the considerably greater volume of traffic that has been handled this past year is considered. On the whole, the record speaks well for the efficiency of railway operating and maintenance men in their efforts to keep, in a safe operating condition, a large quantity of railway power, which is just beginning to be replaced.

Crown-sheet failures continued to be the chief source of serious accidents and accounted for 50 percent of the total fatalities. However, compared with 1935, the number of crown-sheet failures decreased by 3, the number of persons injured by 52 and the number of persons killed by 13. This is a commendable improvement but its price of continuous surveillance, proper construction and careful maintenance must continue to be given if the record is to be equalled or improved during 1937. The continuance and possible increase of heavy traffic movements over American railroads will place an even greater burden upon railway shopmen and enginemen to observe these precautions.

This year will see the entrance into active service of many new locomotives which were ordered in the final months of 1936. The arrival of this new, up-to-date equipment, featuring in many cases new ideas and developments in locomotive design, will no doubt bring about the retirement of a considerable amount of obsolete and wornout equipment. On this count, we look forward to even greater improvements in the report of the Bureau of Locomotive Inspection for 1937.

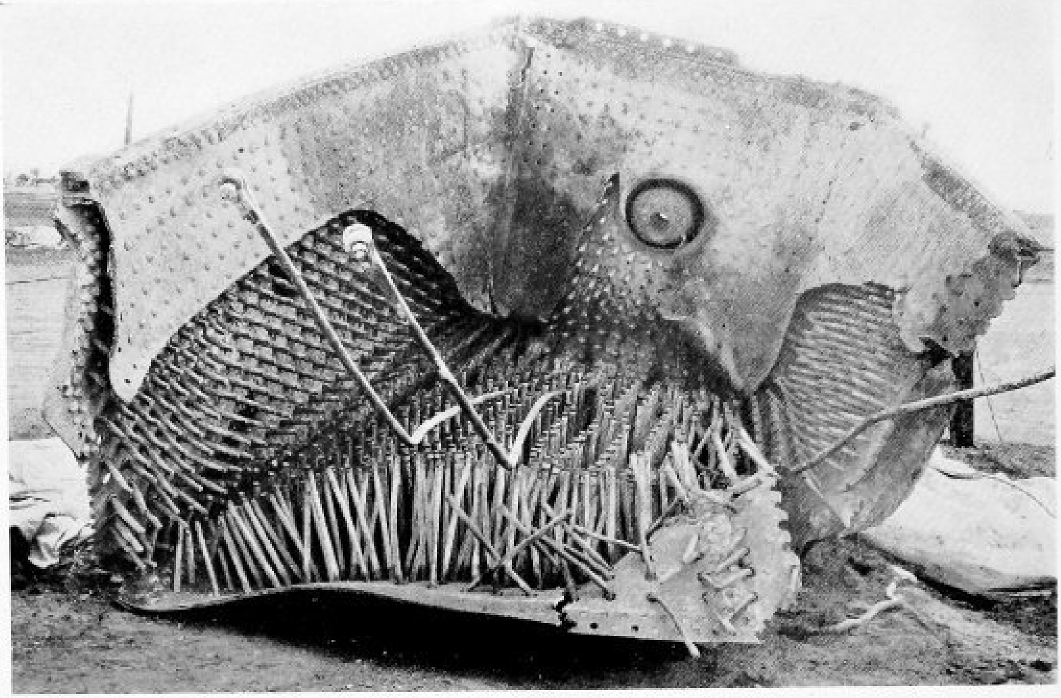


Fig. 1.—Drastic result of a crown sheet failure

Bureau of Locomotive Inspection in Operation Twenty-Five Years

Annual Report of the Chief Inspector

In his annual report to the Interstate Commerce Commission Chief Inspector John B. Hall of the Bureau of Locomotive Inspection points out that the past fiscal year marked the completion of a quarter of a century of Federal locomotive inspection, and gives a brief statement of the reasons for the law and the accomplishments during that period.

Because of frequent explosions and other accidents due to the use of defective locomotive boilers and appurtenances thereto resulting in loss of life and injuries to employes and others, there was a movement among the railway employes toward the enactment of a Federal law requiring that the railroads maintain their locomotive boilers in safe and serviceable condition.

The Locomotive Boiler Inspection Act was approved on February 17, 1911, after having been given consideration by committees of the Senate and the House for a period of 2 years.

The act, which became effective on July 1, 1911, set up a general safety standard and made provision for formulation and promulgation of rules and regulations which, after a specified procedure, became obligatory upon the carriers.

Authentic records as to the number of casualties caused by defective boilers and their appurtenances prior to the enactment of the Locomotive Boiler Inspection Act are not available, but Table A shows a comparison of the number of persons killed and number of persons injured as a result of failure of some part or appurten-

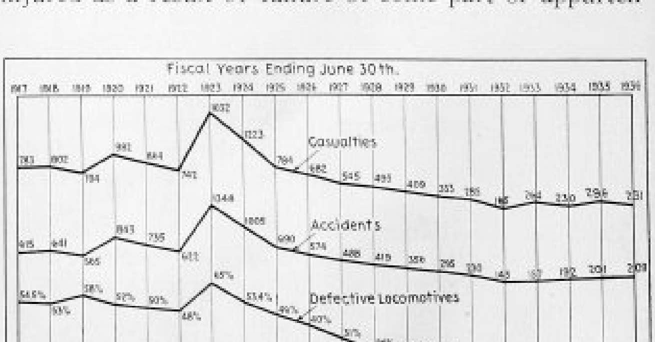


Fig. 2.—Relation of defective locomotives and accidents resulting from failures of some part or appurtenance of locomotives

ance of the locomotive boiler for the first year in which the act was operative and for the year ended June 30, 1936.

TABLE A

Boiler and its appurtenances only	Year ended June 30— 1912	1936
Number of persons killed	91	10
Number of persons injured	1,005	80

The total number of persons killed as a result of failures of locomotive boilers and their appurtenances in the period shown was 717, and the total number of injured was 8771. If the casualties had occurred at the same rate throughout the period as they occurred in the first year in which the act was effective, there would have been 2275 persons killed and 25,125 injured.

The defective condition in which many locomotive boilers and their appurtenances were being operated when the act became effective was disclosed by our inspections. Cracks in boiler shells; improperly designed patches which greatly reduced the strength and safety of the boiler; excessive pitting and grooving; broken, loose, and defective braces; numerous broken and defective stay bolts and crown stays; firebox sheets cracked and leaking; and excessive accumulations of mud and scale on crown sheets and in firebox waterlegs due to improper washing of the boilers were some of the existing conditions.

During the first year there were 3 boiler shell explosions in which 27 persons were killed and 41 injured and 94 crown sheet and firebox failures in which 54 persons were killed and 168 injured. The number of locomotives ordered from service by our inspectors for necessary repairs was 3377. In addition, the following locomotives were required to be strengthened or changed to comply with the requirements of the law or permanently removed from service:

Number having pressure reduced to insure a proper factor of safety	699
Number having seams reinforced by welt plates to insure a proper factor of safety	327
Number permanently removed from service on account of defective condition	698
Number having lowest reading of water glass raised to comply with the law	992
Number having the lowest gage cock ordered raised to comply with the law	408
Number ordered strengthened by having braces of greater sectional area applied	351
Number requiring additional support for crown sheet	116

It will thus be seen that during the first year a total of 6968 locomotives was either held out of service for repairs or changed and strengthened to conform to the requirements of the law or permanently removed from service.

Due to the necessity of maintaining their boilers and appurtenances in better condition than heretofore the railroads thereafter concentrated their efforts on conditioning their boilers, with resultant neglect of other parts of the locomotives. Accidents caused by failures of parts of the locomotive other than the boiler and its appurtenances began to increase, with resultant loss of life and injury to employes and others. The employes, through their various organizations, again appealed to Congress for relief, and the Boiler Inspection Act was amended to include the entire locomotive and tender and later was amended to include all locomotives regardless of the source of power.

When the machinery rules became effective, the need was apparent. These rules are almost an exact copy of the rules filed with the Commission by more than 170 of the leading railroads of the country who certified that they were the rules then in force on their respective roads.

The general attitude was to subordinate the making of needed repairs to the requirements of convenience. Although the railroads had inspection rules that were adequate for the purpose, little if any attempt was made to make immediate repairs if any inconvenience would be caused thereby, and as with the boiler, locomotives

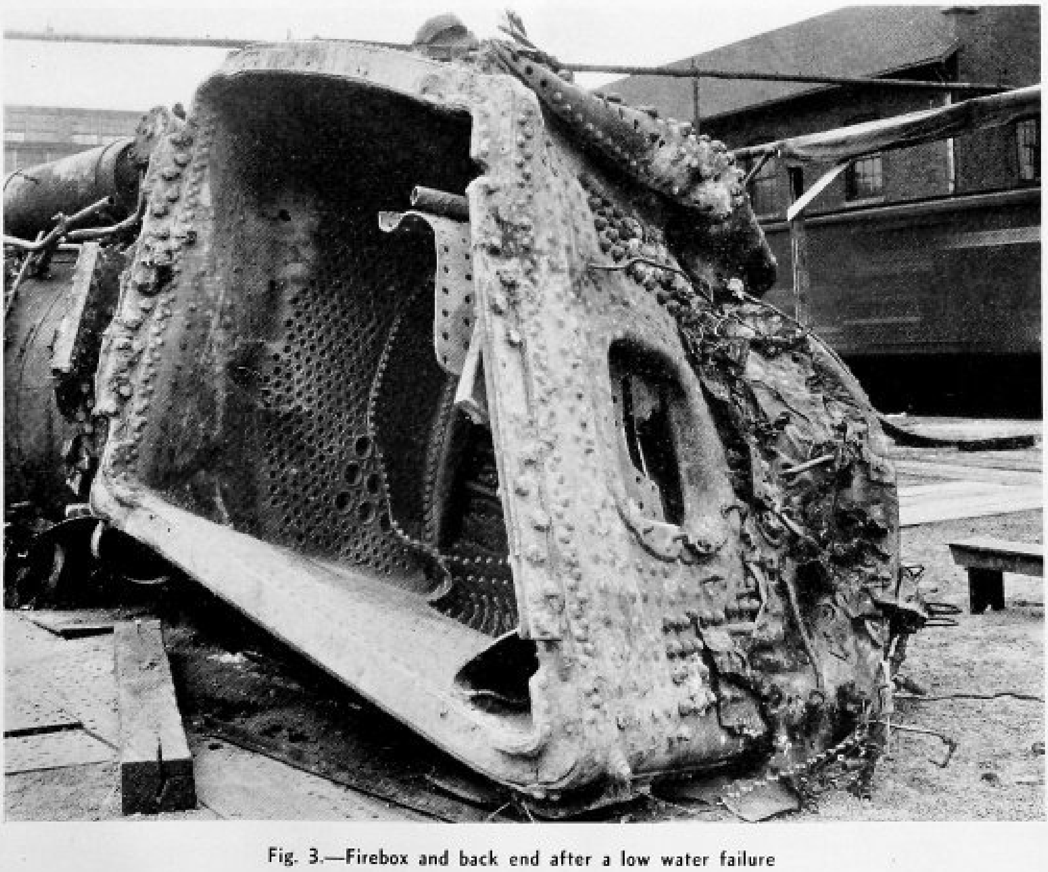


Fig. 3.—Firebox and back end after a low water failure

in known bad condition were continued in use until application of needed repairs seemed to be more convenient, or until failure occurred which often resulted in deaths or injuries.

The expressions "That's good enough," "Hurry up and get her out," "We will get that next trip," and kindred expressions were very common at that time and were responsible for many accidents caused by defects in the locomotives.

Our endeavor has been to have necessary repairs made promptly and properly, and the wisdom of this policy is illustrated in the improved condition of the locomotives, enabling them to make longer runs, reduction in the number of killed and injured due to failures, and greatly increased mileage per engine failure.

During the fiscal year 1917, the first full year after the law was extended to include the entire locomotive and tender, there were 616 accidents resulting in 62 killed and 721 injured while in the fiscal year ended June 30, 1936, there were 209 accidents resulting in 16 persons being killed and 215 injured.

The results obtained by this Bureau in the quarter of a century of its existence in promoting the safety of the employes and travelers on the railroads, due largely to regular and more thorough inspection and repairs, speaks well for the framers of the law and the insight of those who secured its enactment. Due credit is also given to the tireless and conscientious attention to their duty of our corps of inspectors throughout the life of the locomotive boiler inspection law and amendments.

Abstract of Annual Report

Summaries are given, by railroads, of all accidents, showing the number of persons killed and injured due to the failure of parts and appurtenances of locomotives, as reported and investigated under section 8 of the locomotive inspection law, and those reported to the Bureau of Statistics under the Accident Report Act of May 1910 and not reported to this Bureau in accordance with the requirements.

The tables showing the number of accidents, the number of persons killed, and number injured have been arranged to permit comparison with previous years as far as consistent. These tables also show the number of locomotives inspected, the number and percentage of those inspected and found defective, the number for which written notices for repairs were issued in accordance with section 6 of the law, and the total defects found and reported. The data contained therein cover all defects on all parts and appurtenances of locomotives found and reported by our inspectors, arranged by railroads.

Summaries and tables show separately accidents and other data in connection with steam locomotives and tenders and their appurtenances and accidents and other data in connection with locomotives other than steam.

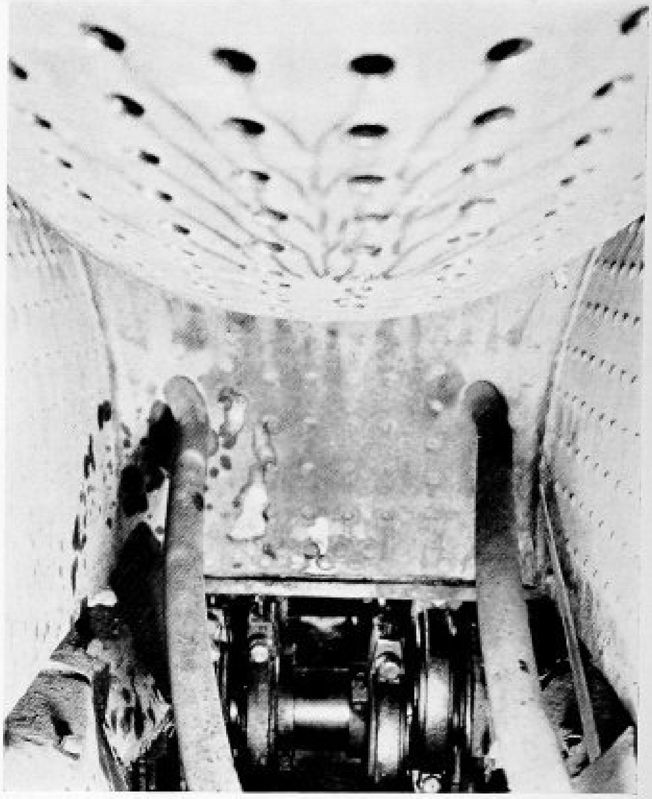


Fig. 4.—Another low water failure

Accidents and Casualties Caused by Failure of Some Part or Appurtenance of the Steam Locomotive Boiler*

	Year ended June 30: 1936	1935	1934	1933	1932	1931	1915	1912
Number of accidents	75	68	63	53	43	91	424	856
Number of persons killed	10	24	4	3	8	15	13	91
Number of persons injured	80	119	77	55	46	122	467	1,005

* The original act applied only to the locomotive boiler.

Condition of Locomotives, Found by Inspection, in Relation to Accidents and Casualties

Fiscal year ended June 30	Percent of locomotives inspected found defective	Number of locomotives ordered out of service	Number of accidents	Number of persons killed	Number of persons injured
1923	65	7075	1348	72	1560
1924	53	5764	1005	66	1157
1925	46	3637	690	20	764
1926	40	3281	574	22	660
1927	31	2539	488	28	517
1928	24	1725	419	30	463
1929	21	1490	356	19	390
1930	16	1200	295	13	320
1931	10	688	230	16	269
1932	8	527	145	9	156
1933	10	544	157	8	256
1934	12	754	192	7	223
1935	12	921	201	29	267
1936	12	852	209	16	215

Reports and Inspections—Steam Locomotives

	Year ended June 30: 1936	1935	1934	1933	1932	1931
Number of locomotives for which reports were filed	49,322	51,283	54,283	56,971	59,110	60,841
Number inspected	97,329	94,151	89,716	87,658	96,924	101,224
Number found defective	11,526	11,071	10,713	8,388	7.724	10,277
Percentage inspected found defective	12	12	12	10	8	10
Number ordered out of service	852	921	754	544	527	688
Total number of defects found	47,453	44,491	43,271	32,733	27.832	36,968

Accidents and Casualties Caused by Failure of Some Part of the Steam Locomotive, Including Boiler, or Tender

	Year ended June 30: 1936	1935	1934	1933	1932	1931
Number of accidents	209	201	192	157	145	230
Percent decrease from previous year	4.0*	4.7*	22.3*	8.3*	36.9	22
Number of persons killed	16	29	7	8	9	16
Percent decrease from previous year	44.8	314.3*	12.5	11.1	43.7	23*
Number of persons injured	215	267	223	256	156	269
Percent decrease from previous year	19.5	19.7*	12.9	64.1*	42	15.9

* Increase.

Investigation of Accidents and General Condition of Locomotives

All accidents reported to the Bureau as required by the law and rules were carefully investigated and appropriate action taken to prevent recurrence as far as possible. Copies of accident investigation reports were furnished to parties interested when requested, and otherwise used in our effort to bring about a diminution in the number of such accidents.

There was an increase of 8 in the number of accidents occurring in connection with steam locomotives, a decrease of 13 in the number of persons killed, and a decrease of 52 in the number of persons injured compared with the previous year.

The chart on page 2 shows the relation between the percentage of defective steam locomotives and the number of accidents and casualties resulting from failures thereof, and illustrates the effect of operating locomotives in defective condition.

During the year 12 percent of the steam locomotives inspected by our inspectors were found with defects or errors in inspection that should have been corrected before the locomotives were put into use; this percentage has remained the same during the past 3 years. There was a reduction of 7.5 percent in the number of locomotives ordered withheld from service by our inspectors because of the presence of defects that rendered the locomotives immediately unsafe.

Boiler explosions caused by crown sheet failures continue to be the source of most of the fatal accidents. There was a decrease of 3 accidents, a decrease of 13 in the number of persons killed, and a decrease of 52 in the number of persons injured from this cause, as compared with the previous year. Eight persons were killed in such failures; this represents 50 percent of all fatalities that occurred during the year. Eight persons were injured in accidents caused by crown sheet failures; this represents 3.7 percent of all injuries that occurred during the year.

Other boiler and appurtenance accidents, including the failure of a side sheet due to overheating caused by negligence in not washing the boiler as often as water conditions required, resulted in the death of 2 persons and the injury of 72 persons.

Compared with the first year in which the Boiler Inspection Act was effective there was a reduction of 91 percent in the number of accidents, a reduction of 89 percent in the number of persons killed, and a reduction of 92 percent in the number of persons injured.

One thousand one hundred and fifteen applications were filed for extensions of time for removal of flues, as provided in rule 10. Our investigations disclosed that in 92 of these cases the condition of the locomotives was such that extensions could not properly be granted. Seventy-five were in such condition that the full extensions requested could not be authorized, but extensions for shorter periods of time were allowed. One hundred and twenty-four extensions were granted after defects disclosed by our investigations were required to be repaired. Twenty-eight applications were canceled for various reasons. Seven hundred and ninety-six applications were granted for the full periods requested.

Under rule 54 of the Rules and Instructions for Inspection and Testing of Steam Locomotives, 164 specification cards and 3732 alteration reports were filed,

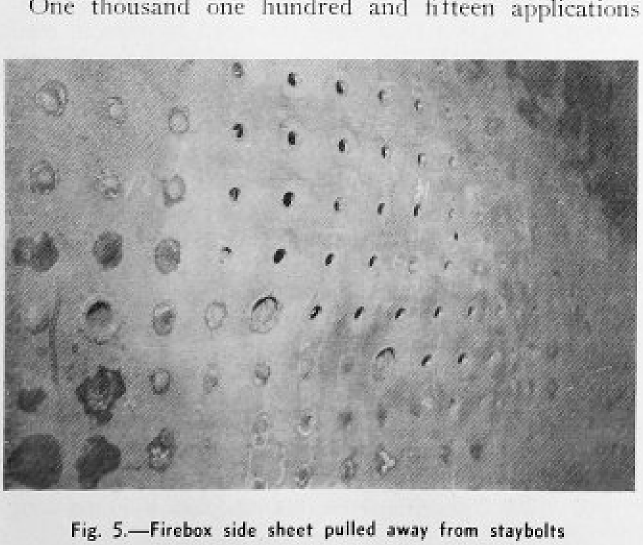


Fig. 5.—Firebox side sheet pulled away from staybolts

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

Parts defective, inoperative or missing, or in violation of rules	Year ended June 30—1936	1935	1934	1933	1932	1931
1. Air compressors	740	733	660	474	417	481
2. Arch tubes	74	74	127	51	54	60
3. Ashpans and mechanism	79	94	87	40	69	81
4. Axles	13	10	6	21	13	10
5. Blow-off cocks	236	283	289	210	144	191
6. Boiler checks	356	413	407	293	214	263
7. Boiler shell	383	396	372	296	220	430
8. Brake equipment	2,480	2,449	2,326	1,696	1,645	1,923
9. Cabs, cab windows, and curtains	1,638	1,273	1,342	1,183	851	1,484
10. Cab aprons and decks	450	368	343	309	262	415
11. Cab cards	166	142	129	121	162	211
12. Coupling and uncoupling devices	65	73	54	67	85	98
13. Crossheads, guides, pistons, and piston rods	1,056	1,086	1,100	773	763	856
14. Crown bolts	63	75	77	67	50	96
15. Cylinders, saddles, and steam chests	1,717	1,547	1,491	1,084	841	1,265
16. Cylinder cocks and rigging	605	627	654	374	376	411
17. Domes and dome caps	114	94	105	76	45	83
18. Draft gear	513	423	401	318	325	568
19. Draw gear	451	414	480	357	371	640
20. Driving boxes, shoes, wedges, pedestals, and braces	1,712	1,573	1,472	1,080	821	925
21. Firebox sheets	295	343	356	246	235	341
22. Flues	178	173	203	150	120	187
23. Frames, tail pieces, and braces, locomotive	997	1,006	951	669	611	740
24. Frames, tender	113	124	128	80	86	105
25. Gages and gage fittings, air	257	275	212	145	156	192
26. Gages and gage fittings, steam	350	320	289	258	214	324
27. Gage cocks	579	480	384	388	330	415
28. Grate shakers and fire doors	400	394	404	245	288	410
29. Handholds	502	464	377	363	382	562
30. Injectors, inoperative	40	39	33	20	31	55
31. Injectors and connections	2,085	2,035	1,909	1,357	1,168	1,815
32. Inspections and tests not made as required	9,005	8,344	8,173	6,358	3,801	4,862
33. Lateral motion	404	389	351	269	237	289
34. Lights, cab and classification	78	81	79	76	55	77
35. Lights, headlight	251	257	218	169	119	180
36. Lubricators and shields	255	191	215	157	119	176
37. Mud rings	237	241	247	232	166	318
38. Packing nuts	508	527	491	419	402	523
39. Packing, piston rod, and valve stem	1,133	906	833	592	444	706
40. Pilots and pilot beams	178	152	174	123	145	160
41. Plugs and studs	236	167	242	151	176	182
42. Reversing gear	463	414	390	254	202	299
43. Rods, main and side, crank pins, and collars	2,093	1,826	1,670	1,327	1,256	1,520
44. Safety valves	125	100	108	53	63	61
45. Sanders	678	779	697	376	289	314
46. Springs and spring rigging	3,008	2,765	2,854	2,122	1,851	2,161
47. Squirt hose	134	113	107	93	96	184
48. Staybolts	279	240	285	219	181	293
49. Staybolts, broken	520	512	455	368	552	938
50. Steam pipes	526	463	489	338	285	512
51. Steam valves	227	212	267	193	143	226
52. Steps	615	640	567	498	622	676
53. Tanks and tank valves	877	913	862	600	587	732
54. Telltale holes	127	102	93	90	108	151
55. Throttle and throttle rigging	760	733	639	448	434	574
56. Trucks, engine and trailing	861	811	898	664	648	714
57. Trucks, tender	1,108	1,120	918	747	766	1,059
58. Valve motion	824	799	784	640	520	497
59. Washout plugs	714	679	776	623	599	815
60. Train-control equipment	6	4	8	4	13	9
61. Water glasses, fittings, and shields	1,118	951	907	716	676	955
62. Wheels	790	697	734	580	603	750
63. Miscellaneous—Signal appliances, badge plates, brakes (hand)	608	563	572	423	325	418
Total number of defects	47,453	44,491	43,271	32,733	27,832	36,968
Locomotives reported	49,322	51,283	54,283	56,971	59,110	60,841
Locomotives inspected	97,329	94,151	89,716	87,658	96,924	101,224
Locomotives defective	11,526	11,071	10,713	8,388	7,724	10,277
Percentage of inspected found defective	12	12	12	10	8	10
Locomotives ordered out of service	852	921	754	544	527	688

checked, and analyzed. These reports are necessary in order to determine whether or not the boilers represented were so constructed or repaired as to render safe and proper service and whether the stresses were within the allowed limits. Corrective measures were taken with respect to numerous discrepancies found.

Under rules 328 and 329 of the Rules and Instructions for Inspection and Testing of Locomotives Other Than Steam, 578 specifications and 96 alteration reports were filed for locomotive units and 538 specifications and 182 alteration reports were filed for boilers mounted on locomotives other than steam. These were checked and analyzed and corrective measures taken with respect to discrepancies found.

No formal appeal by any carrier was taken from the decisions of any inspector during the year.

Locomotive Boiler Failures

Fig. 1 shows the result of a crown sheet failure. This accident caused the death of an engine watchman who was in charge of the locomotive at the time of the explosion. The boiler was torn from the frame and a part of the back end of the boiler was torn from the shell. Both frames were broken at the rear deck casting; the tender, together with the deck casting and attached draw gear, was forced backward 96 feet and the running gear was forced ahead 27 feet.

Fig. 3 shows a view of a back end and firebox that failed due to overheating of the crown sheet. This accident caused the death of three employes. The force of the explosion tore the boiler from the frame and hurled it forward a distance of 261 feet from the point of the explosion.

In Fig. 4 is shown the interior of the firebox of a locomotive on which the crown sheet failed while the locomotive was in use, as a helper coupled to the rear of a caboose. Two employe occupants of the caboose were killed practically instantly, one was injured fatally and died on the fifth day after the accident; another employe occupant of the caboose and one of the occupants of the locomotive cab were severely injured.

Fig. 5 shows a firebox side sheet that pulled off the staybolts due to overheating, caused by accumulation of foreign matter in the water leg. This accident caused the serious injury of two employes. The water supplied to locomotives at the point where this accident occurred had been the cause of repeated complaints from the enginemen due to boiler foaming, at times causing air compressors to stop operating and loss of time on high-speed passenger trains.

Appraisal of the Welding Art

*By O. A. Tillon**

The year 1936 has seen the actual preparation for a sound prosperity in which low manufacturing costs—and then higher profits and certainly greater volume of sales—are being made possible by a more extended and more intelligent application of welding. Perhaps there is an analogy between industry and the individual, in that periods of adversity cause each to take account of his assets, determine his previous errors of judgment or practice, and lay out a new plan for the future—avoiding the pitfalls of earlier experience. The depression from which we are now emerging has, it appears, reacted similarly upon industry. It has forced a search for other, more economic ways of doing things.

In the early years of reduced business activity, industry as a whole began to consider seriously, almost for the first time, those economic opportunities offered by the use of welding. As a result there followed a period of transition. Now, however, things seem to have settled down. Where the pendulum had swung too far, it has been reset to a saner amplitude; where it had not been given sufficient impetus, the required additional forces have been applied.

A few examples of stabilized welding practice are:

1. A realization that machine welding is an economy over hand welding only when a proper balance results between the labor and material cost and investment.

2. High welding speeds must be balanced against quality of weld material.

3. High welding currents and large-sized electrodes often accomplish nothing but increased power and material consumption and frequently impair quality.

4. The chief advantage in the use of alternating current for welding is the practical elimination of magnetic blow rather than a differential in first cost that sometimes exists in the welding units themselves.

5. There are still many entirely proper applications for bare or lightly coated electrodes. The heavily coated electrode can frequently justify its greater cost by providing a very necessary improvement in quality as well as increased welding speed but this is by no means universal.

6. Each welding process has its distinct advantages. Many of these processes overlap as to possibility but usually not as to economy of application.

Of these perhaps the most important that 1936 has seen realized is that high welding currents and large-sized electrodes are generally not an economy. Perhaps a peak has been reached in these factors, which will not be exceeded until new welding processes not now known are brought forth.

* Electric welding engineer, Industrial Department, General Electric Company, Schenectady, N. Y.

Welding Robot Uses Standard Rods

New impetus was given to the development of arc welding in all kinds of metal fabrication work with the announcement of an entirely new automatic welding head; the first of its kind to use standard coated rods. This new automatic welding machine, developed and perfected by the Harnischfeger Corporation, Milwaukee, Wis., is a true robot operated by remote control. By eliminating the hand-operated electrode holder, this automatic machine makes it possible to use a higher current with welding heats as much as 60 percent higher, increasing tremendously the speed of producing welding pieces.

Up to 50 standard welding rods are loaded in a magazine and then fed automatically to the welding position. As one electrode is consumed, the remaining butt is ejected and a new full-length rod is fed into place. The renewing operation takes less than a split second. During this feeding operation, the work table stops and then starts again automatically as the new electrode makes the electric contact. The action is so swift that no break in the welded bead is evident. This new machine can be used on flat work of any length, on circular pieces and, with pantograph attachment, to any shape. It is adaptable for use on lathes, planers, rotating tables, boring mills and with wall cranes, for welding long girders, etc.

Work of the Boiler Code Committee

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information on the application of the code is requested to communicate with the Secretary of the Committee, 29 West 39th Street, New York.

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

Case No. 831 (*Interpretation of Par. P-325*)

Inquiry: May double hanger brackets be attached to welded horizontal-return tubular boilers by fusion welding provided; the lower ends of such brackets are not more than 20 degrees above the horizontal center line and extend over an arc of not less than 20 degrees for shells of any diameter; the bracket plates to be spaced at least 2½ inches apart, thickness of each bracket plate to be not less than 1 percent of the shell diameter, the hanger pin to be located on the vertical center line over the center of the welded contact surface; the distance from the center line of the hanger pin to the edge of the bracket to be not less than 1½ times the hole diameter; and the welding and stresses to meet the requirements of Par. P-325c? Fig. 33 indicates the construction described above.

Reply: It is the opinion of the committee that the construction outlined in the inquiry meets the intent of the code requirements.

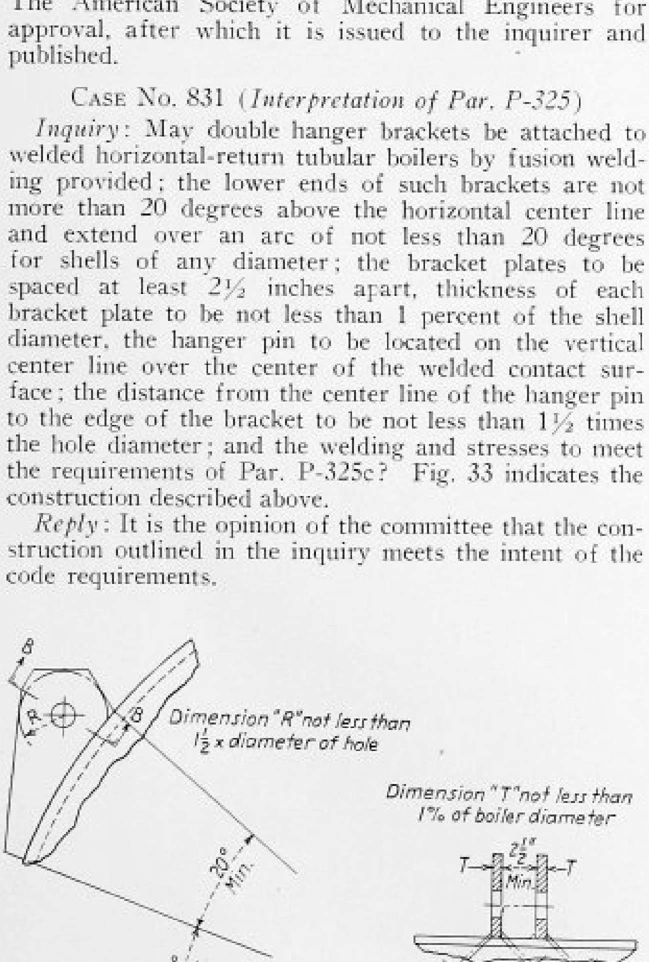


Fig. 33.—Welded bracket connection for horizontal-return tubular boiler

Case No. 832 (*Interpretation of Par. P-329*)

Inquiry: Is it the intent to require hydrostatic test of the completed boiler unit, if the drums are of fusion-welded construction in accordance with Par. P-109*b*?

Reply: Pars. P-101 to P-111, inclusive, are, as titled, "rules for the fusion process of welding" drums or shells of power boilers and apply only to such individual parts. The hydrostatic test pressure of a completed boiler unit should not exceed that provided for in Par. P-329.

Case No. 833
(In the hands of the Committee)

Case No. 834
(In the hands of the Committee)

Case No. 835
(*Interpretation of Pars. P-268 and U-59*)

Inquiry: In welding an inserted type nozzle as shown in Fig. 34, should the joint be radiographed?

Reply: Whereas Figs. P-6 and U-6 show some types of acceptable nozzles which need not be X-rayed under

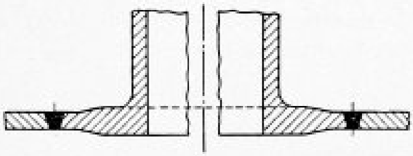


Fig. 34.—Inserted type nozzle

Pars. P-268 and U-59, it is the opinion of the Committee that when an inserted type nozzle as is shown in Fig. 34 is used, the welded joint shall be radiographed.

Electrode Makes High-Tensile Welds

Welds with tensile strengths of approximately 100,000 pounds per square inch can be made with the new "Shield-Arc 100" electrode just announced by The Lincoln Electric Company, Cleveland.

"Shield-Arc 100" electrode is a heavily coated electrode of the shielded-arc type. It is designed for welding steels having somewhat higher ultimate strengths than those ordinarily welded with Lincoln "Shield-Arc 85" electrodes. Welds produced by the new electrode in the higher tensile steels possess ultimate strength of 100,000 to 105,000 pounds per square inch as welded. In the as-welded condition, ductility of welds is from 12 to 18 percent elongation in 2 inches.

It is obvious that the chemical composition of the plate being welded will affect the tensile strength and ductility of the weld. When deposited in mild steel plate, the weld metal will have a tensile strength of approximately 100,000 pounds per square inch, yield point of 85,000 to 95,000 pounds per square inch, and ductility of 12 to 18 percent elongation in 2 inches in the as-welded condition. When stress relieved, the welds possess ultimate strength of 110,000 to 115,000 pounds per square inch, yield point of 95,000 to 105,000 pounds per square inch, and ductility of 18 to 22 percent elongation in 2 inches.

"Shield-Arc 100" electrode is suitable for flat, vertical and overhead welding and is available in ⅛-inch, 5/32-inch and 3/16-inch sizes. For most vertical and overhead welding the ⅛-inch and 5/32-inch sizes are preferred. However, the 3/16-inch size may be used for making vertical welds in thick plate.

Copper and Brass.—A bulletin issued by the Copper and Brass Research Association, New York, in December 1936, describes the many uses of copper and its alloys in industry, house construction and equipment, dishes and cooking utensils, railway rolling stock and large commercial buildings.

Velox as a Marine Steam Generator*

By Dr. Adolphe Meyer†

Velox stands for velocity and refers to the high velocity of the flue gases, used in the Velox steam generator to obtain exceptionally high heat transmission, as well as to its property of producing steam in a few minutes from cold and of adapting itself to widely varying loads in a few seconds.

In most of the new boilers recently introduced for use on board ship nothing has been done to improve materially the combustion itself or the rate of heat transmission, whereas these two points are the main characteristics of the Velox boiler, which has the following special features:

(1) Combustion takes place under a pressure far in excess of that generally employed.

(2) Partial transformation of the above pressure into velocity, in order to obtain high flue-gas speed. This speed may reach the velocity of sound.

(3) The use of a turbo-blower, worked by an exhaust-gas turbine, in order to produce the pressure in the combustion chamber referred to in (1).

(4) Disposition of the gas turbine between two heat-absorbing parts of the boiler, in order to reduce the temperature of the flue gases so that cooling of the turbine is unnecessary, but also permitting of sufficient heat being left in the gas to provide the necessary energy for driving the turbo-blower. The heat which remains is passed on to the feed water by an economizer following the gas turbine.

(5) A special device for separating steam from water which consists of a centrifugal separator without moving parts, in which the mixture of steam and water is injected tangentially on to the cylindrical wall of a container at such a velocity that it rotates with sufficient force to separate the steam and water by centrifugal action.

(6) The very small weight of steel and water involved in the heat transmission which, together with the entire absence of fire bricks and the small amount of water

* Abstract of paper presented at the annual meeting of The Society of Naval Architects and Marine Engineers, held in New York in November, 1936.

† Managing director, Brown, Boveri & Company, Baden, Switzerland.

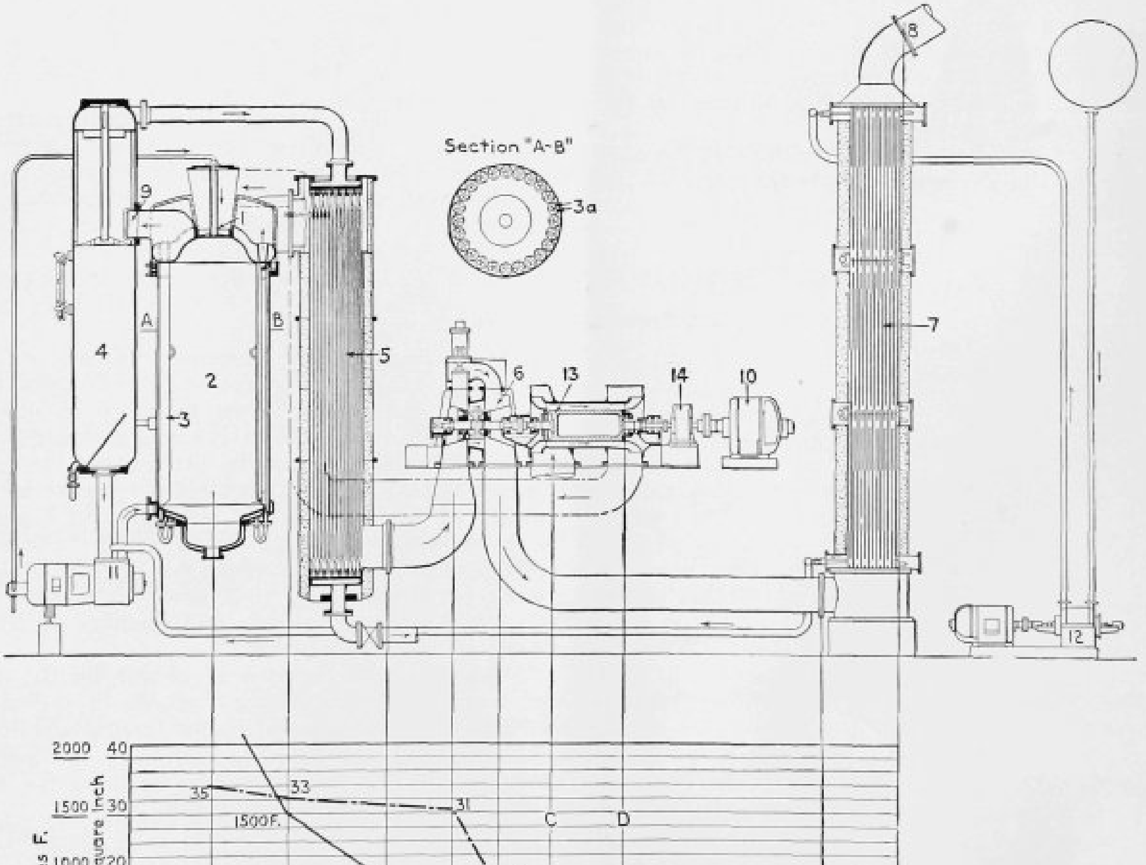


Fig. 1.—Diagram of Velox steam generator showing pressures and temperatures

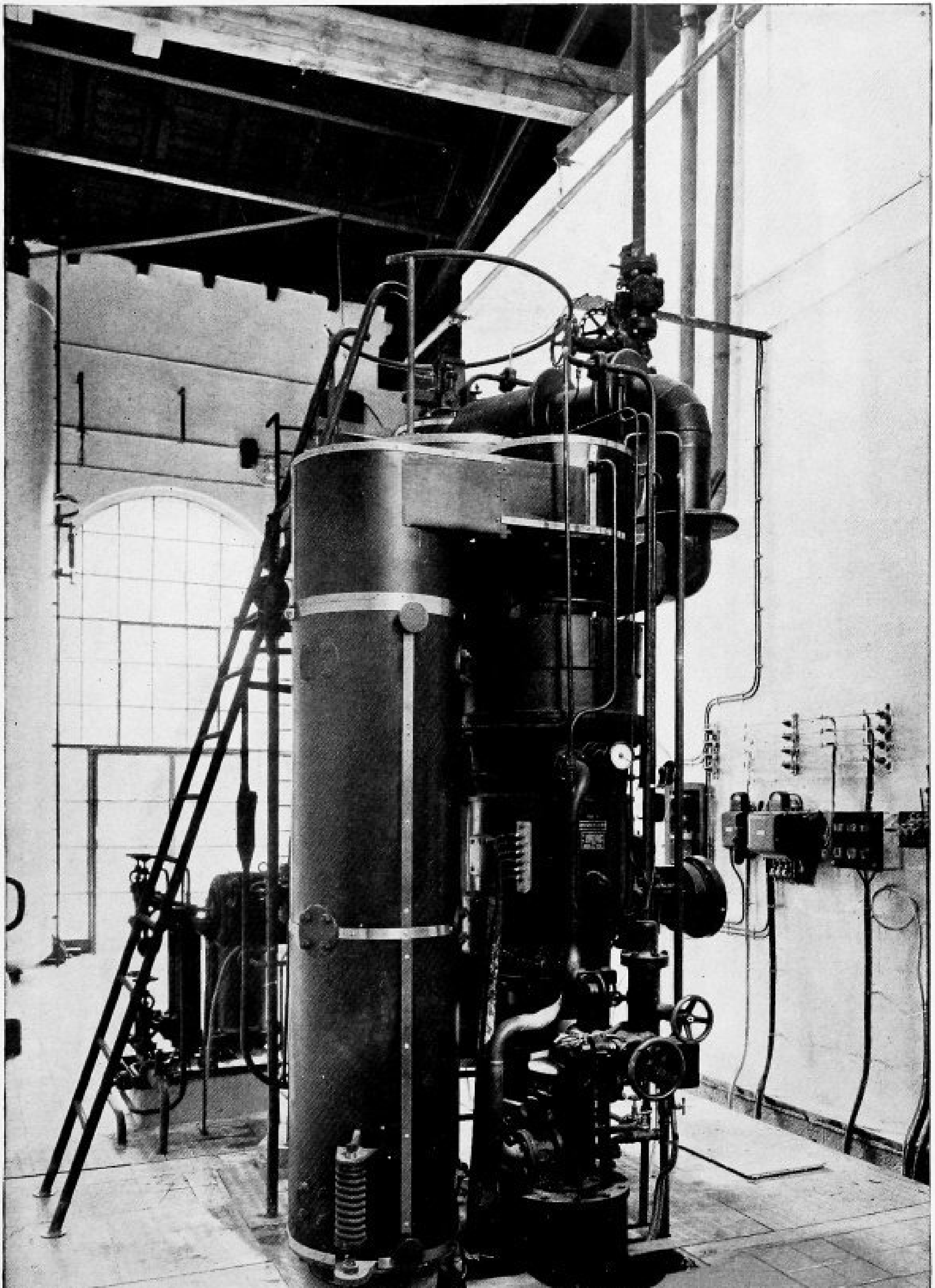


Fig. 2.—Five-ton Velox generator supplying steam at 1150 pounds per square inch and 900 degrees F.

necessary, permits rapid starting of the boiler and gives flexible operation under variations of load. The abovementioned small quantity of water is nevertheless ample for governing by hand.

(7) Forced circulation in the evaporating part of the boiler.

(8) Entirely automatic governing.

(9) Small weight.

(10) Small space requirement.

(11) High efficiencies over large variations in load.

Fig. 1 represents a steam generator of the Velox type, and indicates the temperatures and pressures prevailing in its different parts. The combustion of the fuel takes place in the combustion chamber *2*, where air and

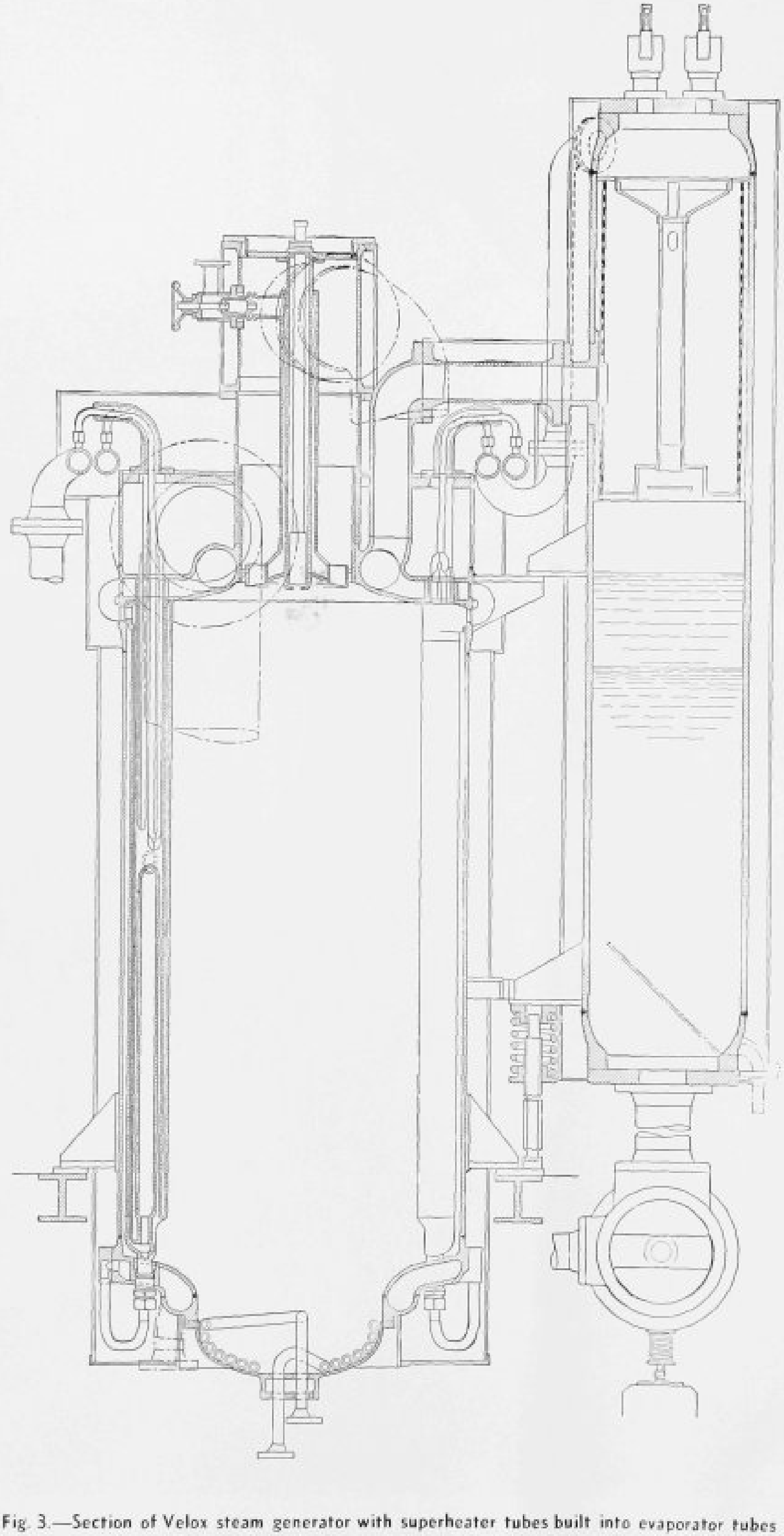


Fig. 3.—Section of Velox steam generator with superheater tubes built into evaporator tubes

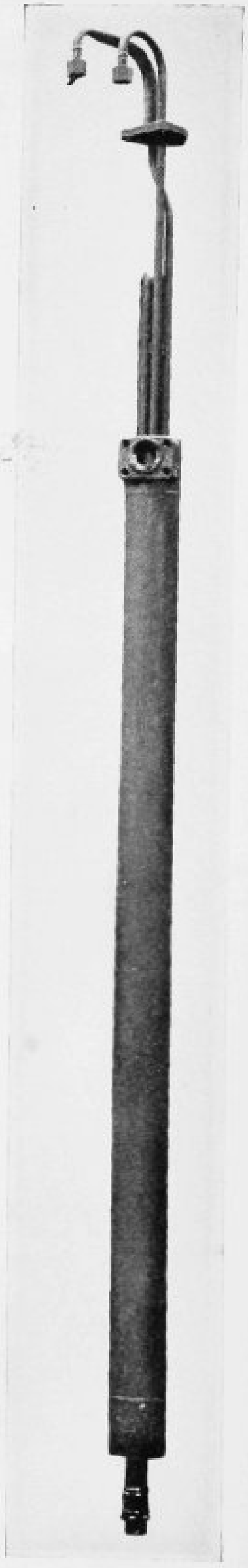


Fig. 4.—Superheater element partially withdrawn from evaporator tube

fuel enter through the burner *1*; the air enters at a pressure of about 35 pounds per square inch absolute and the fuel at about 300 pounds gage. The gases give up part of their heat content by radiation to the external walls of the evaporator tubes *3*, which line the wall of the combustion chamber. More heat is transmitted by convection while the gases pass upward through the internal tubes *3a* of the evaporators to the exhaust flue-gas collecting chamber. Thus the initial temperature of combustion is reduced to about 1500 degrees F., while the

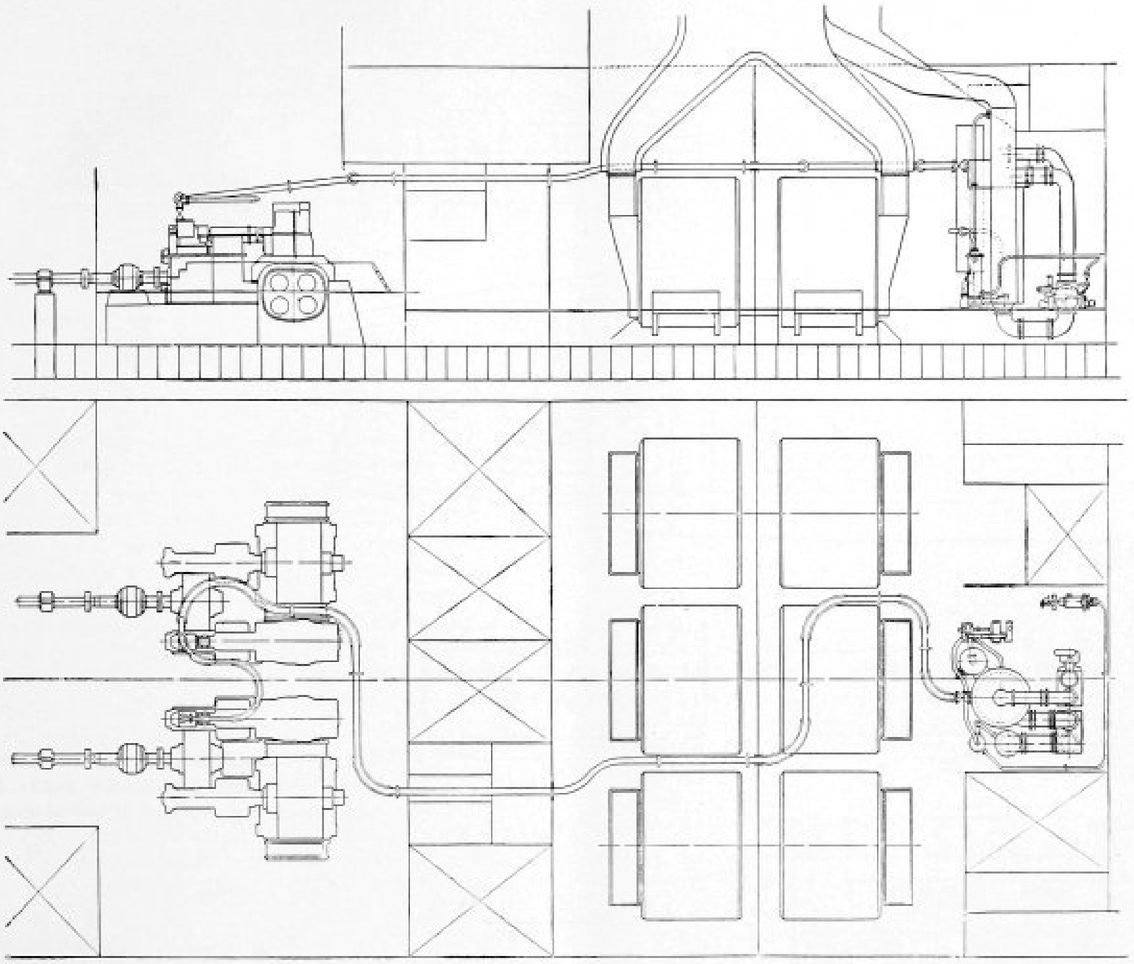


Fig. 5.—One 35-ton Velox steam generator replacing seven Scotch boilers on the East India steamer "Athos II" of the Messageries Maritimes

pressure drops to about 33 pounds absolute. With this temperature and under this pressure the gases enter the superheater *5* to leave it cooled to about 900 degrees F. at a pressure of about 31 pounds. The gas turbine *6*, to which the gases then flow, causes the flue-gas temperature to drop to about 700 degrees F. while the pressure drops to about 16.5 pounds absolute. The corresponding heat drop, apart from small radiation and bearing losses, is entirely converted into mechanical energy and transmitted to the blower where it is reconverted into heat with a corresponding rise in the air temperature. Finally, the gases escape through the feedwater heater *7* which forms part of the flue. Thence they continue, through the flue itself, to the atmosphere, where they leave cooled to about 200 degrees F.

The water and steam circuit is as follows:

The make-up water is fed by the feed pump *12* through the preheater *7* to the separator *4*, where it mixes with the evaporating water. This water is kept in continuous circulation by the circulating pump *11* which pumps it through the combustion chamber *2* and evaporating tubes *3* back to the separator *4* at the rate of about 10 to 20 times the full-load evaporation.

The circulating pump gives the circulating water a sufficient pressure head to impart a high velocity to the steam and water mixture, which is forced through nozzles into a vertical drum, and the steam and water are thus separated by centrifugal action. The separating capacity of this centrifugal separator is about 100 to 200 times greater than that by the difference of specific weight of steam and water in the normal drum. The water then falls through a small gap in the lower partition of the separator, while the steam enters the superheater *5*, where it is superheated to the desired amount for use in a steam turbine. Tests have shown that the amount of humidity of the steam leaving the steam separator is about ½ percent at full load.

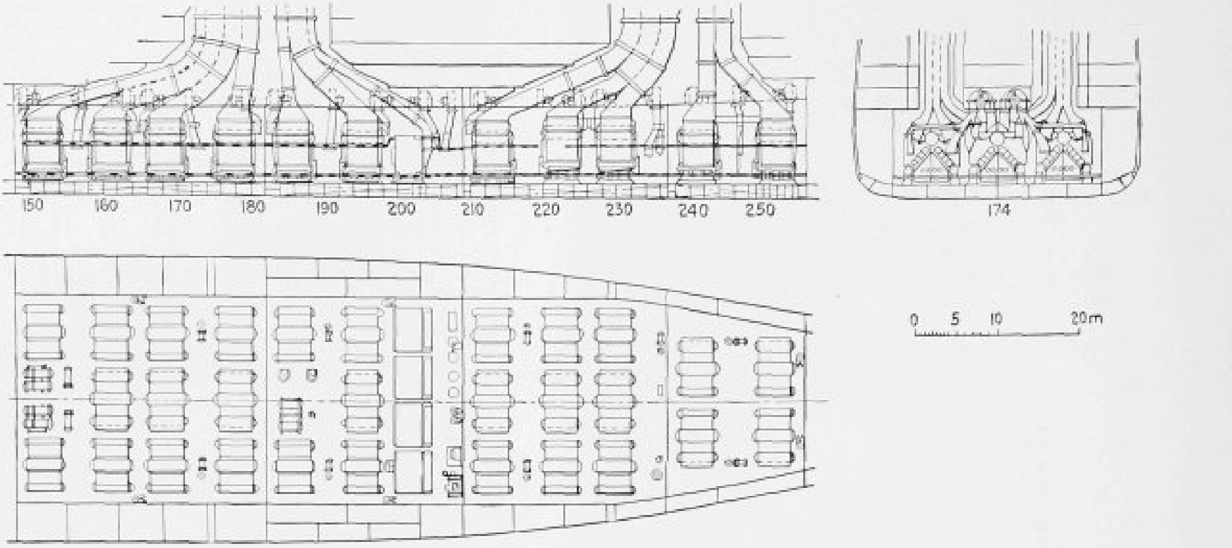
Construction

In modern Velox boilers there is no separate superheater as shown in Fig. 1. The superheater elements are placed inside the evaporator tubes as shown in Fig. 3. Fig. 4 shows an evaporator tube with a superheater element partially drawn.

The boilers are fitted with turbo-blower sets consisting of a reaction turbine with four rows and an axial blower especially developed for this purpose. The overall efficiency of this set is of the order of 83 (turbine) × 73 (blower) = 60 percent.

An automatic governing system is used to control the operation of the generator.

The small space requirements of a Velox, its low weight and high efficiency are of paramount importance for the transformation of existing plants on old ships. It is generally possible to replace one existing boiler with a Velox which equals the output of all the other boilers. By means of such a substitution the power range and economy of old ships can be considerably increased, and even more so if at the same time the steam pressure and



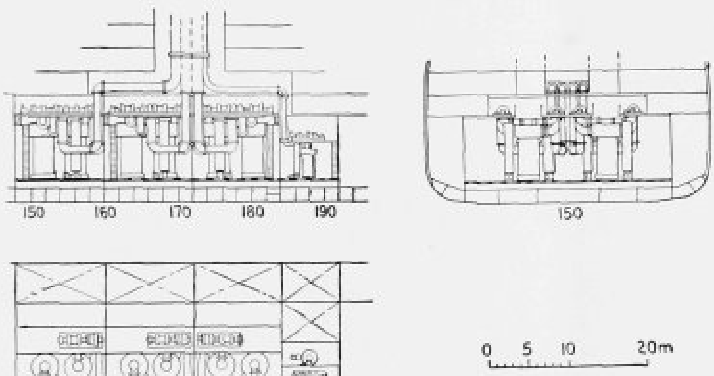


Fig. 6.—Comparison of S. S. "Normandie" fitted with existing watertube boilers and with Velox high-pressure steam generators

superheat are increased and the additional heat drop is used in a supplementary high-pressure turbine which may drive through existing gear.

A transformation of this kind, ordered by the Messageries Maritimes for their East India steamer *Athos II*, is shown in Fig. 5. In this case one of seven existing oil-fired Scotch boilers built for the generation of seven tons of steam per hour at 215 pounds per square inch and 540 degrees F. each is to be replaced by a Velox of 35 tons per hour at 840 degrees F., thus increasing the steam capacity five times and augmenting the power range 6.6 times compared with and within the space taken up by the obsolete boiler.

The excess pressure and temperature of the steam produced by the Velox are taken care of by an additional high-pressure turbine, while a second low-pressure turbine with its condenser works on the remaining heat drop, both these turbines driving through additional pinions on the existing gear.

The power is thus about doubled, the speed of the vessel being raised from 16 to 20 knots.

Replacing existing boilers with a Velox has additional advantages in river craft where the draft may be reduced considerably as well as in vessels which have relatively short periods of service with long intervals in between, as, for instance, channel steamers, ice-breakers, tugs, lifeboats, etc., which hitherto have had to be kept constantly under fire whereas with Velox boilers they could get up steam in five minutes from cold.

In new vessels the effect of substituting Velox for the normal Scotch or watertube boiler may be still greater than in a transformation job, because this substitution may justify the building of an entirely different hull, which may have less displacement and still the same or improved carrying-capacity and speed.

This result clearly shows by comparing the *Normandie*, equipped with watertube boilers, as she now is, with the same vessel equipped with Velox boilers, as she could be (Fig. 6). The reduction of the number of boilers from 29 to 12 and of their weight (without water and air ducts) from 2900 to 900 tons, as well as the reduction of the number of smoke ducts from 2 to 1 and from a section of 3800 to 520 square feet, shows the possibilities of the Velox boiler for high-powered liners.

One may object that the *Normandie*, if built today, would have a more modern boiler plant; but even comparisons made with most modern boilers such as the Johnson on the *Asturias* or the Benson on the *Potsdam* show a reduction in space requirement of 2 to 1 in favor of the Velox.

In smaller vessels much can be gained by assembling the Velox boiler and turbine into a compact unit thus dispensing with long pipe lines, eliminating various fittings and having the same attendance for turbine and boiler.

The description of the application of the Velox steam plant to merchant vessel requirements would not be complete without a comparison with Diesel drive, one of its main competitors. The Velox has the advantage over the Diesel engine that every kind of oil can be used and there is no restriction as to the use of the more expensive gas and Diesel oils. The fuel consumption of the Diesel engine is, of course, lower than that of a Velox steam turbine installation. The difference in price between Diesel oil and bunker oil is, however, greater in many countries than the difference in fuel consumption, so that the fuel costs for a Velox are generally lower than those for Diesel engines. The Velox steam turbine plant is also more favorable in regard to weight, except for long voyages where the excess fuel oil equalizes the difference in weight in about 40 days' steaming.

Care in Handling Small Tools

Experienced railway shop men generally appreciate that small cutting tools, such as reamers, taps, etc., with exposed cutting edges, must be handled carefully if the desired results in the way of smooth, accurate high-production work are to be obtained. In other words, the tools may be correctly designed and ground in the first place, but unless the cutting edges are guarded against subsequent damage throughout the entire period of shop and tool-room handling, they are almost sure to become dulled, nicked, or broken with resultant inferior work, power wasted and time lost.

The unfortunate fact about cutting-tool efficiency is that it may be lost by momentary carelessness on the part of shop men, who, generally speaking, are good mechanics but who have allowed their vigilance to relax in a brief period of thoughtlessness, or just enough to permit tool damage to occur. The result is that all of their good work in being careful nine-tenths of the time is lost.

Many instances may be cited to show the way in which even a careful program for the handling of small tools may be rendered largely ineffective by slighting a single detail. In one shop, for example, the tool foreman took a justifiable pride in his tool room with its modern equipment and well-designed bins where cutting tools could be kept safely and in an orderly arrangement. He even went so far as to line the bins in the tap section with felt to protect the cutting edges of the tools. Much to the chagrin of the foreman who made a surprise check one day, he found taps stacked two and three deep in some of the bins! Needless to say, many were nicked. A further check in the shop showed numerous instances in which machinists tossed individual taps carelessly onto metal-top benches, etc.

Milling cutters of the larger size are usually handled fairly carefully owing to their weight, but small cutters and especially reamers frequently receive even less considerate treatment than taps.

For example, in overcoming reamer trouble one large midwestern railway shop uses expensive ring gages to check the accuracy of reamer taper after grinding and also provides individual rubber protective boots for large reamers to avoid the possibility of damage while handling them about the shop. These boots consist simply of scrap air-brake hose, cut to the proper length and provided with a wooden block in one end, held in place by three or four short nails. By the enforcement of rather rigid instructions requiring that reamers be kept in these protective boots at all times while out in the shop, except when actually being used for reaming holes, much more satisfactory conditions and performance were attained.

One other fact regarding cutting-tool condition should be kept in mind; namely, that while the results of careless handling and resultant tool damage can be corrected by frequent grinding, cutting-tool life is thereby proportionately reduced. It is obviously good economy to exercise constantly the greatest handling care practicable.

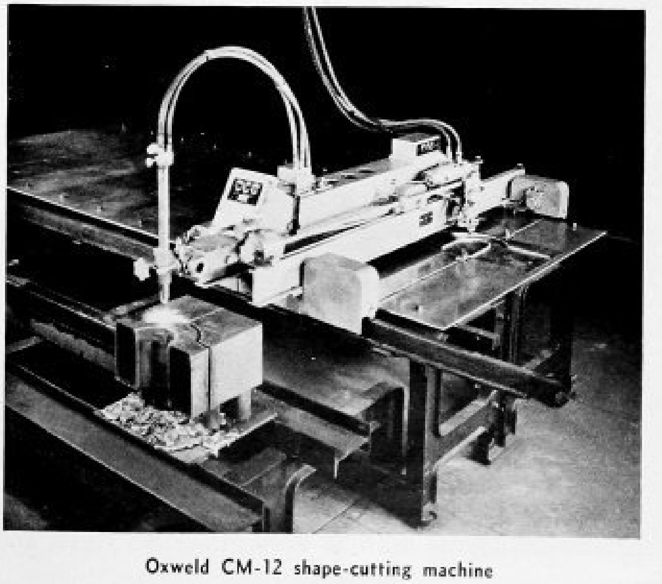
Oxweld Shape Cutting Machine

The Linde Air Products Company, New York, recently introduced the Oxweld type CM-12 shape-cutting machine which is designed to increase the accuracy and range of flame-cutting. The flexibility of this machine is such that any shape, from the simplest to the most complicated, can be flame cut either automatically with templets or guided by hand. The immediate transfer of motion from one end of the machine to the other is an important factor in assuring precision in cutting.

In addition to cutting shapes of all description, the machine will cut straight lines automatically in any direction and at any bevel. Cuts as long as 144 inches are possible and an important feature lies in the fact that straight-line cuts can be made at any desired angle in the horizontal plane. A special circle-cutting attachment is also provided, thus enabling the automatic production of circles from 2 inches to 24 inches in radius. Still another feature is that of multiple cutting. The apparatus is designed to carry from two to five blowpipes which can perform multiple cutting operations under all the conditions possible with a single blowpipe.

The features of design and construction which make possible the accomplishments of this shape-cutting machine typify the trend in modern machine development. Alloys have been utilized to establish an ideal strength-weight ratio combined with the necessary stability and rigidity of construction. The vital working parts are completely inclosed to insure correct lubrication and freedom from maintenance. The motor is rated at $\frac{1}{3}$ horsepower and is more powerful than on any other shape-cutting machine in this class. The speed range of the unit is from $1\frac{1}{2}$ to 75 inches per minute. All important controls have been duplicated.

The blowpipes used have been constructed to give greater flame stability and increased economies in cutting. Material up to 12 inches in thickness can be handled; for heavier cuts a special blowpipe is available. The sensitive tracing mechanism, accurate scale calibrations and freedom from friction and vibration make precision cuts a routine accomplishment.



Oxweld CM-12 shape-cutting machine

Water conditions affecting extension of

Locomotive Washout Periods

At the thirty-seventh annual meeting of the American Railway Engineering Association the subject of water conditions in locomotives was discussed under the above title. The report was prepared by a committee composed of J. B. Wesley, chairman; R. W. Chorley, R. E. Coughlan, B. W. DeGeer, R. N. Foster, O. E. Mace, R. H. Miller, E. R. Morris, Owen Rice, and R. M. Stimmel. An abstract of the report follows:

Operation of steam locomotives over extended washout periods has been demonstrated to be practical and economical under general water conditions found throughout the country. Some roads have operated on this basis for a number of years, while other roads have only recently adopted the custom of washing locomotive boilers only at monthly inspection time. Of 19 roads giving information on this subject, 8 are operating the full 30-day period permitted by law between washouts; 5 are operating part of their locomotives on this basis; and 6 are making no efforts along this line. No road has been reported which, having once established its locomotive operation on the extended washout basis, has returned to frequent boiler washing practice.

A number of factors have united during the past few years to bring this subject to the attention of railroad managements, and considerable interest in the subject is manifest on many roads that still operate with the frequent washout and water change practice. With greater investment in larger and more powerful locomotives it becomes desirable to keep the engine in active service as much as possible; the extension of locomotive runs makes it necessary that the water in the boiler be conditioned without taking the locomotive out of service for boiler washing; and decreased revenues during the depression have centered attention on possible sources of economy, both in operation and maintenance.

Boiler conditions produced by water.—Water, as found in nature, is never pure. It carries various mineral, organic and gaseous substances in solution, with frequently mineral matter in suspension—mud. These impurities in water are present in varying quantities, depending mostly on the nature of the soil over which or through which the water has traveled. Five major adverse boiler conditions are produced by water conditions, namely:

(1) Scale formation on the heating surfaces
(2) Corrosion of boiler metal
(3) Leaking conditions
(4) Mud or sludge accumulation
(5) Foaming

Some of these conditions can be corrected by boiler washing while others cannot be so corrected.

(1) Scale formation is caused principally by the deposition of calcium and magnesium compounds when water containing them is heated or evaporated in boilers. Boiler washing does not prevent or correct this condition, as the scale when once formed in place adheres too tightly to be dislodged by a stream of water. The removal of scale from heating surfaces is effected by mechanical means, such as bombarding the sheets and stays, by scraping and sandblasting, and by rattling the flues—not by washing.

(2) Corrosion of boiler metal is a more complicated phenomenon. Briefly, it is caused by any one of a number of water conditions, metal characteristics, stresses in the boiler assembly, or by a combination of two or more of these conditions. The definite cause in any particular instance is frequently difficult to determine. But boiler washing is not known to be, nor is it advocated to be a corrosion preventive.

(3) Leaking of boilers, so far as pertains to water conditions, is mainly caused by scale deposits and by corroded metal; so its prevention or correction depends on the elimination of its two causes. Boiler washing does not prevent the development of this condition but frequently aids it. Correct application of chemicals to the natural water will reduce scale formation to a satisfactory minimum, and this chemical treatment usually carries the best antidote for that corrosion which is caused by water conditions. So proper chemical treatment of water to prevent scale formation also prevents most corrosion of boiler metal. With these two conditions eliminated the development of leaking conditions also stops. Boiler washing does not and cannot prevent the existence of the above three conditions.

(4) Mud, or sludge, as found in boilers, has two sources. It comes from suspended matter in water—that is, from muddy water—and also from the temporary hardness in solution which precipitates out as sludge when the water is heated in the boiler. A water with high temporary hardness, though perfectly clear, can put as much mud in a boiler as does a "muddy water." The first type of mud—that of muddy water—can be removed from the water either by filtration or by sedimentation. Usually where sedimentation is used the water is also chemically treated for removal of scale-forming matter, thus getting rid of both the suspended mud and the temporary hardness mud. If the mud materials are permitted to enter the boiler they can be drafted out through the blow-off valve or they can be washed out.

(5) Foaming is the term applied to the condition in the boiler when steam bubbles develop to such an extent that the bubble films and entrained water are carried to the cylinders with the steam. Disregarding the mechanical and operating features that affect the occurrence of this condition, it is sufficient to say that foaming is caused by the presence of suspended matter (mud) or alkali salts (foaming salts) in the water, or a combination of the two. In actual operation the combination usually exists. *There is no economic chemical treatment that will remove the foaming salts*, and since these salts remain in solution in the water in the boiler, the prevention of foaming depends on removing all the foul water from the water—that is by washing the boiler or changing the water—or on blowing out at proper intervals a part of the foul water and refilling with fresh water.

These considerations show us that of the five adverse conditions produced in boilers by impurities in water, only two of them—mud accumulation and foaming—can be corrected by boiler washing. Yet these two conditions can be corrected by other means too. If the other methods of correction will permit more continuous operation of the locomotive, making possible longer locomotive runs, and if they produce greater economy in operation and maintenance of the machine, then they merit consideration.

Conditioning water in boilers by systematic blowing.—When water with its impurities is taken into a boiler and evaporated the pure water passes out in the form of steam while the impurities remain inside the boiler. As water continues to be evaporated the impurities accumulate in the water left in the boiler, and when a sufficient degree of concentration has been produced, foaming takes place. The degree of concentration required to produce foaming varies considerably with the different ratios of mud to alkali salts in the waters used, also with the varieties of alkali salts predominant in the waters. But for any one operating district this is a fairly constant condition. The critical foulness to cause foaming usually lies between 100 and 200 grains per U.S. gallon of foaming or alkali salts. The concentration of these salts in the boiler must be maintained below this critical condition if foaming is to be prevented and satisfactory operation secured.

Evaporation of water in a boiler is comparable to burning coal in the firebox. When coal is burned the "pure" part goes out of the stack in the form of gases, the impurities in the coal remain in the firebox as ash. If these impurities are permitted to remain and accumulate in the firebox it will be only a relatively short time until the fire is smothered and the engine fails for steam. In operation the fireman shakes the grates, no accumulation of the impurities is permitted, a good fire condition is maintained, and no failure occurs. Likewise with the water. If part of the accumulated impurities in the boiler are blown out through the blowoff at sufficiently frequent intervals, the concentration of foaming salts that cause foaming is not reached, and no foaming occurs. Keeping the boiler clean by opening the blowoff valve is just as effective as keeping the fire clean by shaking the grates, and there is no more excuse for an engine failure or train delay from the occurrence of foaming than there is from a dirty fire condition.

Fuel losses from blowing.—In the matter of fuel consumption, there is a certain loss of heat units attendant on blowing hot water from the boiler. But this loss is more than offset by the reduction in the terminal handling cost, due to fewer washouts and water changes being made. This is clearly shown in the two 30-day operating test reports comparing the cost of boiler conditioning by blowing with the cost of conditioning by washing the boiler and changing water.

CASE I

Thirty-day operating period—one washout—no water change—52 trips of 170 miles—8840 miles operated

Item	*Per Single Trip*		*170 miles*
Terminal blowing (@ 48¾¢ per M gal.)	82 seconds	451 gallons	$0.23
Road blowing (@ 48¾¢ per M gal.)	292 seconds	1606 gallons	.78
Boiler wash (1 @ $3.07)	—	—	.06
Water change (@ $2.04)	None	—	.00
Anti-foam compound (@ 10.6¢ lb. on eng.)	None used	—	.00
Total boiler conditioning expense per trip			$1.07

CASE I

Previous practice—water change after every odd round trip—boiler wash after every even round trip

Item	*Per Single Trip*		*170 miles*
Terminal blowing	None	—	$0.00
Road blowing (@ 48¾¢ per M gal.)	160 seconds	850 gallons	.41
Boiler wash (14 @ $3.07)	—	—	.83
Water change (13 @ $2.04)	—	—	.51
Anti-foam compound (@ 10.6¢ per lb. on eng.)	4 pounds	—	.43
Total boiler conditioning expense per trip			$2.18

CASE II

Thirty-day operating period—one washout—no water change—28 trips of 490 miles—13,720 miles operated

Item	*Per Single Trip*		*490 miles*
Terminal blowing (@ 40¢ per M gal.)	175 seconds	962 gallons	$0.38
Road blowing (@ 40¢ per M gal.)	775 seconds	4262 gallons	1.67
Boiler washout (1 @ $2.77)	—	—	.10
Water change (@ $1.68)	—	—	.00
Anti-foam compound (@ 10.6¢ per lb. on eng.)	None used	—	.00
Total boiler conditioning expense per trip			$2.15

CASE II

Previous practice—water change every odd round trip—boiler wash every even round trip—foaming controlled by road blowing and use of boiler compound

Item	*Per Single Trip*		*490 miles*
Terminal blowing	None	—	$0.00
Road blowing (@ 40¢ per M gal.)	468 seconds	2574 gallons	1.04
Boiler wash (7 @ $2.77)	—	—	.69
Water change (7 @ $1.68)	—	—	.42
Anti-foam compound (@ 10.6¢ per lb. on eng.)	8 pounds	—	.85
Total boiler conditioning expense per trip			$3.00

Both cases show a lower cost for boiler conditioning when operating under the extended washout plan than with the frequent washout and water change. Also, there was an improvement in the boiler conditions, there being fewer leaks and cleaner heating surfaces, that insures a more economical fuel performance on line.

Use of hard, or scale-forming waters.—Where it is necessary to use unsoftened waters containing hardness ranging from 10 to 20 grains, with frequent washing being done, a scale deposit normal for the water being used is formed. Washing does not remove that scale and the accumulation in any period of time is equally as heavy as if no washing at all were done. The limiting factor in using hard waters is the time required for the scale deposit to become so heavy as to require bumping off the sheets and stays to prevent leaks and metal burns and to maintain economical fuel performance. This time element will vary with the type and degree of hardness in the waters used, being shorter with waters of high hardness than with waters of lesser hardness. In no case will the scale formation be more rapid with the extended washout period than with frequent washing. Observation of boilers operating under these conditions has shown less scale accumulation when operating 30 days between washouts—no water change—than when they were washed often. Two cases of test operation which showed this are given below:

TEST No. 1

Mountain type locomotive—passenger service—170-mile district—8840 miles operated—no washout—no water change

Report on boiler after 30-day operation: "The interior of the boiler of engine—after the 30-day continuous test without boiler wash, water change, or the use of anti-foam compound, was in first-class condition as regards the condition of scale and the absence of mud."

TEST No. 2

Mountain type locomotive—passenger service—490-mile district—13,720 miles operated—no water change—no washout—30 days operation

Report on boiler after 30-day run: "The interior of the boiler of engine—after the 30-day continuous test without boiler wash or water change at terminals was in first-class condition as regards the accumulation of scale and mud. There was no accumulation of mud or sludge and the condition of the water surfaces of tubes and sheets was better than at the start of the test."

These two tests, together with similar tests on other operating districts and on yard engines at different terminals, showed so satisfactory in maintaining good boiler conditions that three years ago the entire system was placed on the 30-day washout period operation. Since that time the boiler conditions have consistently shown improvement over conditions prevailing when boilers were washed at frequent intervals.

Mud and sludge conditions.—When the waters used contain appreciable quantities of mud or they cause the precipitation of considerable sludge within the boiler, this material tends to collect in the waterlegs of the firebox. If these are permitted to accumulate in excessive quantities there is the possibility of blocking water from the sheets and causing them to overheat. However, the experience of roads over a period of years, using waters direct from streams, with only internal type treatment that does not remove mud and which causes the hardness in the water to precipitate as sludge in the boiler, has shown that under normal mud conditions the blowing done to prevent foaming also keeps the mud and sludge drafted from the boiler. When a heavy mud condition does exist in the water used, there must be no hesitancy in washing often enough to prevent the mud from collecting to a hazardous extent.

Alkali salts.—The salts of sodium and potassium, known as "alkali salts" and also as "foaming salts," are extremely soluble in water and a condition of saturation is never reached in a boiler; so these substances do not settle out of the water but remain dissolved in it. Practically all waters contain more or less of these salts, and the extent to which they are present in a water is the usual gage of the water's tendency to cause foaming. For instance, the water supply that contains 50 grains per gallon of alkali or foaming salts will cause foaming more quickly than will a water that contains only 10 grains per gallon. Each boilerful of water evaporated leaves inside the boiler all the foaming salts that were contained in the water, and the concentration of these salts in the water left will be double that of the original feed water. Suppose a boiler of 5000 gallons capacity uses a water of 50 grains per gallon foaming salts. By the time 5000 gallons have been evaporated and the boiler kept filled with more water, the water in the boiler will contain its own 50 grains per gallon plus the 50 grains that were in the water evaporated, making then a concentration in the boiler of 100 grains per gallon. When another 5000 gallons, or 10,000 gallons in all, have been evaporated another 50 grains will be added to the water in the boiler, or there will be a concentration of 150 grains. That is, the evaporation of 10,000 gallons of this water will produce a concentration of foaming salts in the boiler that will likely produce foaming.

When the concentration causing foaming has been reached with any water, either the boiler must be emptied of the concentrated water, which is difficult to do midway between terminals, or a part of the high concentration blowout and the water remaining in the boiler diluted by the addition of fresh water from the tender, otherwise foaming will take place.

A theory has been advanced to the effect that sometimes the concentration of foaming salts in the boiler becomes so great that the water is not able to absorb and carry away heat fast enough to prevent burning sheets and tubes. Such a theory does not appear to be well founded when operating experiences are considered.

Equipment for blowing.—In order to secure operation of boilers for continuous long periods between washouts, arrangements must be provided for blowing out whenever and wherever desired. Blow-off valves must be placed at such locations as to draw out a maximum amount of mud and sludge when the valve is opened. There are differences of opinion as to what location is the most effective for this purpose. Some prefer a location in the middle of the front waterleg; some locate them in the side waterleg near the front corner; others put them in the back corner. Some roads use only one blow-off valve; others use two or more. Some roads connect a perforated pipe across the back mud ring; others run such a pipe along the belly of the boiler; while still others connect flush with the outside sheet. The proponent of each type of installation advises that very satisfactory cleanliness of the boiler is secured.

There are various methods of operating the valves and disposing of the water and steam blown out. Some valves are of the automatic type. One of the most effective of these is electrically operated, controlled by an electrode extending into the boiler steam space and located at a predetermined height above the water line. When foam builds upon the water to reach the electrode the electric current is closed, causing the blow-off valve to open. As soon as the foam drops below the electrode the circuit is broken and the valve closes. Other automatic valves are of the continuous blow type. The valve is operated by steam pressure from the cylinder chest, so that whenever the engine is working the valve is open and a stream of water is being discharged from the boiler. This type of blowing arrangement has an orifice of predetermined satisfactory size set in the discharge pipe to control the amount of water blown out. The continuous type blow can also be used with a manually operated valve. Other systems are operated manually by the enginemen, the valve having a lever connection into the cab for convenience and safety of operation. These valves usually have a discharge of 1½-inch or 2-inch diameter and they are opened at the discretion of the engineman for a few seconds at a time.

The discharge from the boiler can be objectionable if not properly disposed of. In open country it is practical to have a straight side-open discharge, providing discretion is used in operation so that buildings, signal and switch stands, and people are not blown on. Engines operating in switch yards and in passenger service cannot blow this way. The discharge must be controlled so as not to damage structures or injure people. To guard against the occurrence of these conditions, various types of mufflers are used.

At terminal points where boilers are given terminal blow, those with mufflers are usually blown directly into the cinder pit. Various arrangements are made for taking care of boilers having only the straight side blow. If it is desired to recover the blow-down water, toggles are built for connecting to the blow-off valve and then are piped to the boiler washing plant. Otherwise suitable blow-down boxes or plain walls are erected with drainage connection to a sewer.

One feature stands out prominently through all this. Regardless of the location of the blow-off valve, with or without perforated pipe connection inside the boiler; whether the valve is automatic in operation or manually controlled, fitted with a muffler or blows straight out, if suitable attention is given to the operation of the valve the boiler can be kept clean and foaming prevented for periods of thirty days permitted for locomotive boilers and for indefinite periods for stationary boilers.

Supervision required.—To operate boilers with the extended washout period, competent supervision is as necessary as for any other type of work. It is necessary first to know that the blow-off system is in good condition and will work. Then it is necessary to know that the water in the boiler is being maintained in proper condition. Since foaming is the main feature to guard against, water samples are taken from each boiler entering and leaving terminal and tested to determine the concentration of foaming salts in it. There are two types of instruments used for practical determinations of boiler water concentrations. One is a hydrometer, the float being fitted with a thermometer having a scale for making temperature corrections. The other is a "densimeter" having two parts, one a thermometer calibrated to read direct in grains per gallon and the other a glass bulb. Both are placed in the sample being tested and the thermometer is read just at the time the float rises to the top of the sample being tested. While neither instrument is as accurate as a laboratory balance they are sufficiently close for practical operating purposes. Where either of these instruments is used, some one person at the roundhouse should be delegated to test all boiler water samples. The data from inbound boilers are used as a guide to the amount of water to blow from the boilers; the outbound samples are tested to determine that the water is in condition for satisfactory road work.

Objections to blowing.—There are found to be some objections to the blowing of boilers. This is particularly true when the system of operation is first instituted on the road. Some men object to any change from an established practice. If a thing is new they will try to discredit it. Switch stands have been blown down, blow-off valves have been opened so that buildings have been damaged and passenger equipment rendered dirty and unsightly. Some have claimed that discharging the water from boilers onto ties and bridge timbers causes them to rot out very rapidly. This has not been substantiated yet and there is good reason to believe that the claim is not well founded. Also, claims have been made that frequent discharge of boiler water salines on the roadbed produces a condition that shunts and short-circuits signal currents, causing interruption of correct signal indications. While it is possible that this condition is produced, it has not been clearly and definitely established. However, both of these conditions can readily be eliminated by placing the centrifugal separator on top of the boiler and discharging the water outside the track.

Benefits from blowing boilers.—The benefits from blowing boilers and operating with extended washout period are many and very definite. Probably the first benefit noticed is the decrease in engine failures and train delays on account of foaming. This trouble is practically eliminated when terminal and road blowing are properly done. If some abnormal and emergency water condition develops that would normally cause a boiler to foam, the engine crew increases the blowing sufficient to take care of the situation and the train operates without delay. This improvement in operation is an intangible item, but it is of very definite benefit. There is a decrease in the cost of terminal engine handling that will run from 25 cents to 50 cents per engine handled. Engines are turned more quickly, keeping them in more nearly continuous service. Fewer engines are required to handle the business at hand, meaning that a smaller number of engines has to be maintained for service.

The greatest tangible saving comes from decreased boiler maintenance cost. Every time a hot boiler is emptied, the sheets, staybolts, and flues cool rapidly. Even though hot water is used for washing and filling, it is cold to the boiler metal with its temperatures of 250 to 300 degrees F. The rapid cooling of the metal is accompanied by rapid contraction and excessive stresses. There is a corresponding expansion, though slower, when the boiler is reheated. Frequent repetition of this cycle soon produces cracks in flue sheet knuckles, in side sheets, and breaks staybolts. One road that formerly had flue sheet knuckles cracking in five to six months now runs the same engines in the same service for more than twice as long per knuckle patch; side sheets that formerly cracked in ten to fourteen months have had no cracks in the past three years. Another road has a record of less than one broken staybolt per engine per year. One road made a saving in roundhouse boiler maintenance alone of more than $100,000 per year since adopting the operating of boilers on the extended washout period.

Conclusions.—(1) The presence of excessive amounts of mud and the deposition of scale of sufficient thickness to require bombardment of sheets for removal are the only water conditions that affect the period between boiler washouts providing the boilers are properly blown and handled.

(2) Operation of steam locomotives over extended washout periods by proper use of the blow-off valves is practical and produces large economies for the roads that use this method for conditioning water in boilers.

Accident Caused by Embrittlement

Evidence seems to show that when boiler plate has once been in contact with feed water conducive to the development of caustic cracking, the danger from this boiler ailment is never entirely eliminated even though use of the unsatisfactory water be discontinued. For this reason, in any program for the prevention of boiler accidents, it is desirable not only to be sure that the feed water in use has a proper sulphate to carbonate alkalinity ratio, but also to study the feed water history with respect to water used in the past.

The fact that this is good practice and that a lack of full information is dangerous was shown by a recent accident which, only by good luck, escaped being a major explosion. The compensating feature of this accident was that it served as a warning that other boilers in the battery probably were defective, a surmise which was proved true by subsequent investigation.

In the case under consideration the plant had 8 bent-tube type boilers operating at about 150 pounds pressure. Some of them were rated at 823 horsepower and the others at 324 horsepower, the boiler which failed being of the larger size. The first indication of trouble was a noise such as would be made by the rupturing of a small tube, but the accident obviously was more serious than a tube failure since a sufficient volume of water escaped to put out the fire. An examination of the boiler after the accident brought to light the condition shown in Fig. 1. The metal of the shell plate had separated as much as $1\frac{5}{16}$ inches in places until the rivet holes were actually visible where they had pulled out from beneath the butt strap of the lower or mud drum. This drum was 48 inches by 16 feet 9 inches, and seams were double riveted with $1\frac{1}{32}$-inch diameter rivet holes and 3 inches pitch. The plate had

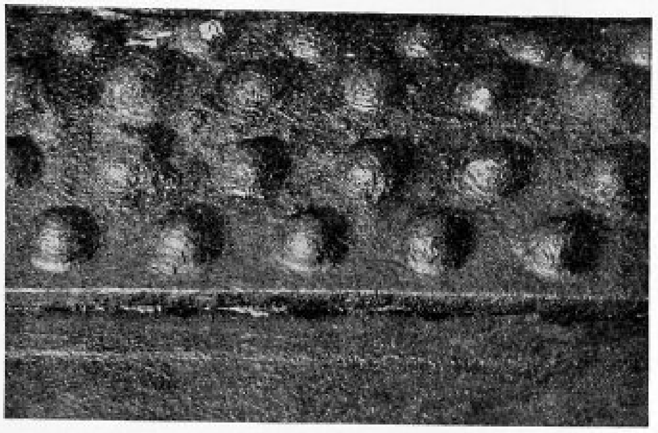


Fig. 1.—Seam which pulled apart for 6 feet after embrittlement had developed to a serious extent

cracked for a distance of 6 feet along the outer row of rivets and there were also cracks in the outer butt strap between the rivet holes in the top row. These cracks were characteristic of embrittlement in its final stages.

Other boilers were examined for traces of embrittlement and the telltale fissures were readily visible when the Hartford Magniscope was used in the rivet holes. Photographs of these fissures in one of the boilers are reproduced in Fig. 2. The serious condition necessitated the purchase of a new boiler.

Several facts of value to all operators of boilers were emphasized by this case. The boilers which were affected had none of the usual symptoms of embrittlement such as broken rivet heads, deposits of caustic or evidences of leakage. Rivet heads did not break when they were hammered. The presence of the ailment could not have been discovered except by an actual Magniscope examination following the removal of rivets in a boiler which apparently was sound. Moreover, the treated feed water had a sulphate ratio higher than that recommended under the A.S.M.E. Boiler Code. The plant was following accepted procedure with respect to the avoidance of embrittlement.

When the history of the boiler was reviewed, however, facts came to light which explained the development of the trouble.

Installed in 1924, the boilers were operated until 1929 with raw well water for make-up, which amounted to about a third of that used. This water had a high carbonate but low sulphate content, and since it was not treated to correct this unfavorable ratio, conditions were right for the metal to be affected. In 1929 a feedwater treating system was installed, but the trouble, while not then evident, had been started. It required only time to cause the progressive weakening of the plate until the failure eventually occurred. *The Locomotive*, Hartford Steam Boiler Inspection and Insurance Company.

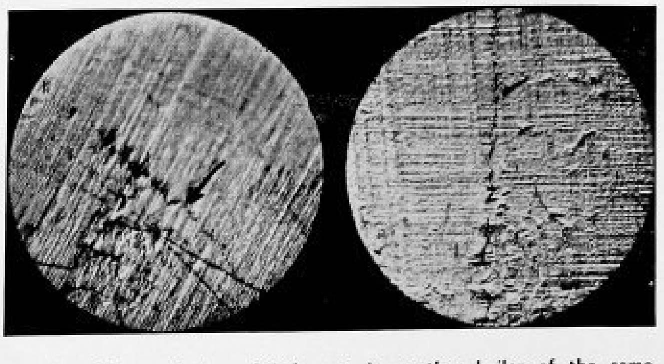
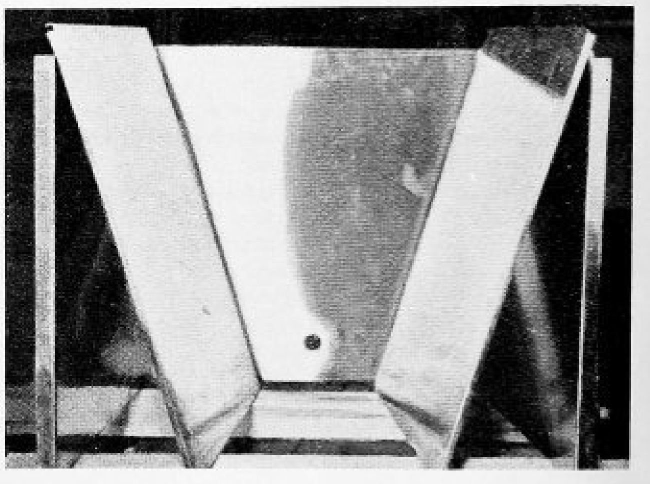


Fig. 2.—Characteristic embrittlement in another boiler of the same battery as the affected vessel

Fabricating a Stainless Steel Tank

Observation of work carried out by fabricators, particularly of work on the newer materials such as the various types of stainless steels, is often well worth while because of the fact that each new job of this kind represents new problems or independently developed methods of handling. Recent work carried out in the fabrication of a stainless steel tank by a company that had but little previous experience with this type of material will be, therefore, of interest to others doing similar work. The company consists of sheet metal workers and has not been equipped for welding for any great length of time. It is now specializing and going after jobs of this kind aggressively.

An order had been received for several sulphur dye tanks to be fabricated by oxy-acetylene welding 16-gage stainless steel of a type known as "disintegration-proof." One of the completed tanks is shown in an accompanying illustration. It will be seen that the sides and bottom are each of one single sheet of material.

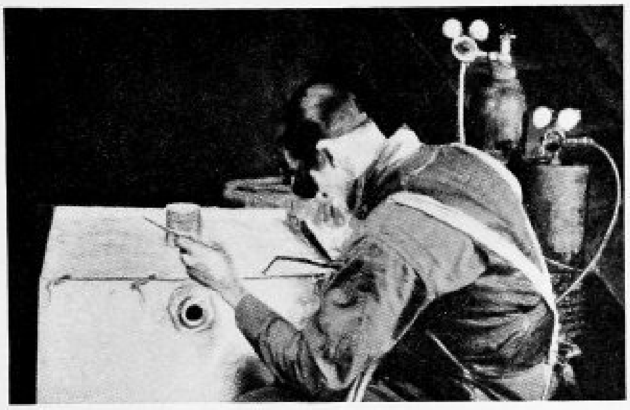


Stainless steel dye tank with edges of sheet flanged before welding

A ½-inch flange was turned up on each edge by a power press to give a good square corner and to stiffen the finished tank. It was also noticed that this type of design helped considerably in keeping the edges in line for welding. Small U-type clamps were used to hold the edges of adjacent sheets together and in place while the sheets were tack-welded. The tack-welds were spaced at intervals of 2½ to 3 inches and made along the edge in one direction only from end to end. Likewise the welding of the seam itself was carried out in one direction only beginning at one end and not stopping until the other end was reached. It is interesting to note that the edges of the material were thoroughly filed clean and free from oxide after tack-welding and then the whole seam painted with Cromaloy flux before the final weld was made.

A blowpipe tip one size smaller than is recommended for working on ordinary carbon steel sheet of the same thickness was used for this work. The oxygen and acetylene pressures recommended by the manufacturer of the welding equipment were used.

When the pieces of sheet metal were tack-welded and



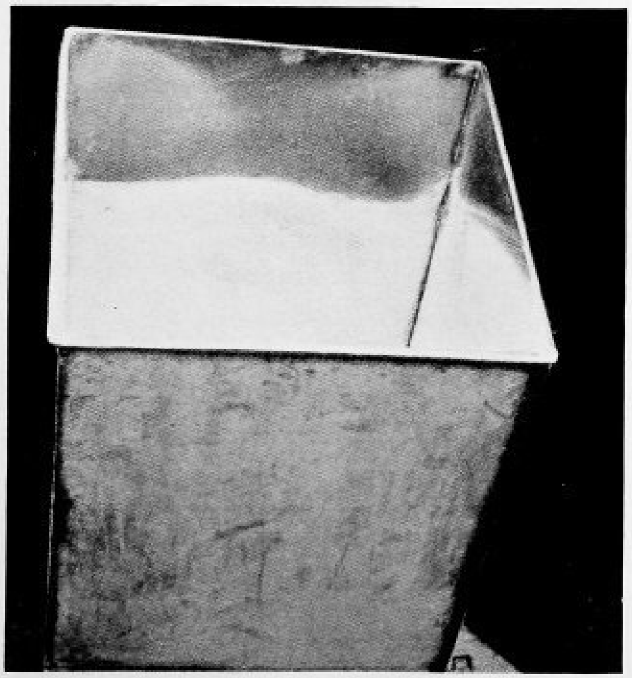
Welding the tank

ready for the next step in assembly, 1/4 and 3/8-inch thick asbestos sheets were laid along the surfaces that would be exposed most to the welding flame and then thoroughly soaked with water. The asbestos was fitted closely into the corner of the edges to be welded. This was found to be a splendid method of practically eliminating possible difficulties from warping of the sheets.

Strips of the base metal were used as welding rod when this was required, although not much was needed as the welding operation consisted simply of melting down about 1/8 inch of the adjacent flanges. This is regular recommended practice for the making of flange type joints in sheet metal of this thickness. In this case, however, it will be remembered that rather wide flanges were turned up in order to leave the reinforcement in the finished tank that this type of preparation would give. The strips of metal used as welding rod served a dual purpose in that they were used to assist the action of the flux by scraping off the viscous oxide slag that formed on the surface of the molten puddle. This particular type of stainless steel does not flow as easily under the action of the welding flame as some other types do, although the welding quality is good.

When the welding work had been completed the heat color marks were readily and permanently removed by the application of a regular type of mechanic's hand cleaner and common household scouring powder.

Some of the ideas used for this job may be found useful in carrying out similar work.



Scouring powder used to remove heat marks resulting from welding operations

Advanced Welding Course Offered

Engineers, designers, architects, production managers, welding supervisors, foremen and operators, and others interested in welding in and around New York City will have an opportunity of obtaining advanced instruction in the practical and theoretical aspects of arc welding the first week of February. This opportunity is offered by a special course in arc welding design and practice sponsored by The Lincoln Electric Company, Cleveland. The course will begin Monday, February 1, and last through Friday, February 5. Meetings will be held in the Port of New York Authority building, 15th St. and 8th Avenue. The course will be under the direction of E. W. P. Smith, nationally known welding authority of Cleveland.

The course will consist of day and evening sessions. Mornings will be devoted to free consultation service on welding problems, offering companies in the New York area the benefit of many years' experience in the practical application of the electric arc process. Practical welding demonstrations will be given in the afternoons. Evening sessions will consist of illustrated lectures and open discussions.

The purpose of the course is to study the arc welding process and its application to design and fabricating problems. The process will be considered from the arc to the finished product. The following subjects will be covered: The shielded arc, its value and use in design; weld inspection; checking fusion and penetration; calculating stress distribution in welded joints; use of rubber weld models and polarized light in studying stress distribution; a practical metallurgical study of the welding of ferrous and non-ferrous metals; determining the most economical section in changing from cast to arc welded construction; organizing the welding department; and estimating welding costs. Characteristics of the welding arc will be illustrated by projecting the arc on a screen with a generator in operation. This will demonstrate the behavior of the arc in a variety of applications.

A small fee will be charged for the complete course.

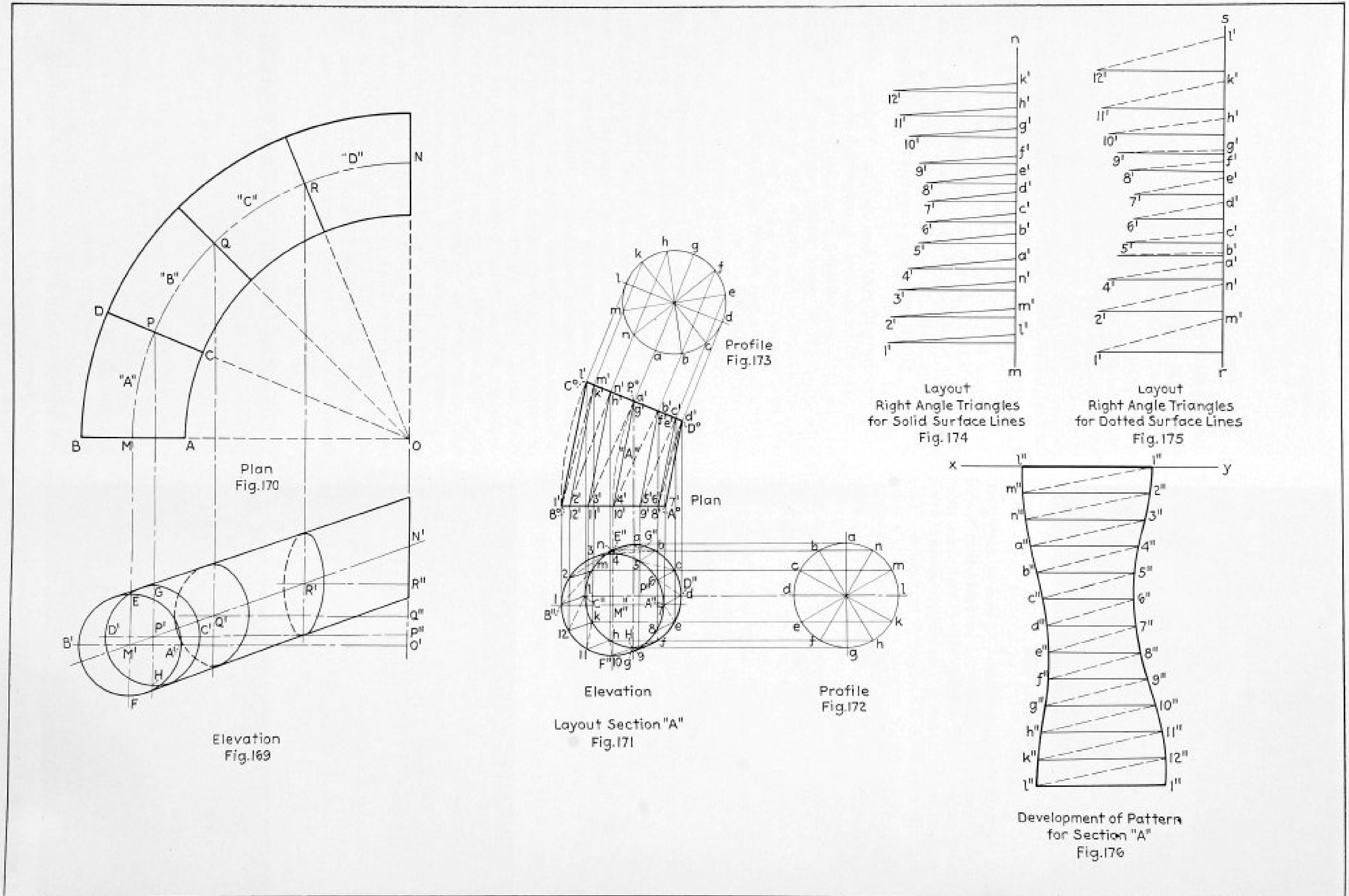
Complete information regarding the New York welding course can be obtained either from the New York office of The Lincoln Electric Company, 330 W. 42nd St., or from the Welding Engineering Department, The Lincoln Electric Company, Cleveland.

Edge Moor Appoints Welding Engineer

Thomas J. Dillon, president, Edge Moor Iron Works, Edge Moor, Del., announced recently the appointment of Russell T. Kernoll as chief engineer of welded fabrication.

Mr. Kernoll has had many years' experience in pressure vessel and welded equipment fabrication. He comes to Edge Moor Iron Works from the engineering department of M. W. Kellogg Company, Jersey City, N. J., and prior to this connection had been for many years associated with Struthers-Wells Company, Warren, Pa., in executive and engineering capacities.

Mr. Kernoll assumed his new duties at Edge Moor, Del., on December 1



Plan, elevation, profile and patterns of offset elbow layout

Practical Plate Development—XX

Layout of an Offset Elbow

By George M. Davies

The offset elbow to be developed is shown in Fig. 169, the elevation, and in Fig. 170, the plan. The elbow is a 90-degree piece with an offset equal to *O'-N'* in the elevation, Fig. 169. For convenience, the thickness of the plate has been omitted and the outline shown has been taken on the neutral axis of the plates. The joints are assumed to be welded, with no allowances being provided on the pattern for fitting or welding.

To develop the patterns of the elbow, it is first necessary to divide the elbow into a number of parts, four being taken in this case. Any number of sections may be selected, depending on the size of the elbow.

Divide the arc *M-N* of the plan view, Fig. 170, into four equal parts and number the divisions *P, Q, R* as shown. Connect the points *P, Q, R* with the center *O* and extend the lines cutting the outside of the elbow. These lines will be the miter lines for the sections "A," "B," "C" and "D."

Then, parallel to *O-N*, draw lines through the points *P, Q, R* and extend them into the elevation, cutting the centerline *M'-N'* at *P', Q', R'*. Erect perpendiculars to *O-N* through the points *P', Q'* and *R'* which locate the points *P", Q"* and *R"* in the elevation. The distance *O'-P"* will then represent the offset of section "A"; *P"-Q"*, the offset of section "B"; *Q"-R"*, the offset of section "C"; and *R"-N'*, the offset of section "D." *O'-P"*, *P"-Q"*, *Q"-R"*, *R"-N'* together equal the distance *O'-N* of the elevation.

The miter lines between the various sections will appear in the elevation as ellipses as shown. The method of determining the miter line between sections "A" and "B" is illustrated in Fig. 171.

Duplicate the layout of section "A" in Figs. 169 and 170 in Fig. 171, with the exception of the miter line between the sections "A" and "B." This is obtained in the following manner: Extend the centerline *C"-D"*, Fig. 171, and on this line draw the profile, Fig. 172, as shown. Divide the profile, Fig. 172, into any number of equal parts, the greater the number of equal parts taken the more accurate the final development will be. Twelve have been taken in this case and the divisions numbered from *a* to *n* as shown. Next, parallel to the centerline *C"-D"*, draw lines through the points *a* to *n*, Fig. 172, and extend same into the elevation of Fig. 171.

Then erect a perpendicular to the line *C°-D°* of the plan, Fig. 171, at the point *P°* and on this perpendicular construct the profile, Fig. 173, and divide this profile into the same number of equal parts as was taken for the profile, Fig. 172. Number these divisions from *a* to *n* corresponding to the same points in the profile, Fig. 172. This is followed by drawing lines parallel to the perpendicular to the line *C°-D°* through the points *a* to *n*, Fig. 173, cutting the line *C°-D°* of the plan of Fig. 171; these latter points being numbered from *a'* to *n'* as shown. Next, parallel to the centerline *P"-P°*, draw a line through the point *a'* on *C°-D°* and extend it into the elevation, cutting the line drawn through the point *a* in the elevation of Fig. 171. In like manner, locate the points *b* to *n* of the elevation of Fig. 171.

Connect the points *a* to *n* of the elevation of Fig. 171 with a line which completes the outline of the miter line between sections "A" and "B." The outline of section "A," Fig. 171, is now finished.

The outline of the miter lines between sections "B" and "C" and "C" and "D" in Fig. 169 is obtained in the same manner.

The next step is to develop the pattern of section "A," and the method used for developing the pattern of section "A" is the same for sections "B," "C" and "D."

Divide the circle *A"E"B"F"*, Fig. 171, into the same number of equal parts as was taken in the profile, Fig. 172, and number them from 1 to 12 as shown. Parallel to *M"-M°*, draw lines through the points 1 to 12, extending these lines into the plan and cutting the line *A°-B°* at the points numbered 1' to 12' as shown.

Connect the points 1'-*l'*, 2'-*m'*, 3'-*n'*, 4'-*a'*, 5'-*b'*, 6'-*c'*, 7'-*d'*, 8'-*e'*, 9'-*f'*, 10'-*g'*, 11'-*h'* and 12'-*k'* of the plan of Fig. 171 with solid lines, and the points 1'-*m'*, 2'-*n'*, 3'-*a'*, 4'-*b'*, 5'-*c'*, 6'-*d'*, 7'-*e'*, 8'-*f'*, 9'-*g'*, 10'-*h'*, 11'-*k'* and 12'-*l'* with dotted lines. These lines represent the surface lines of the object, and in order to develop the object, the true length of these surface lines must be obtained. Connect the corresponding points in the elevation of Fig. 171, and draw the surface lines in the elevation corresponding to the surface lines in the plan of Fig. 171.

To obtain the true lengths of the solid and dotted surface lines in Fig. 171, it is necessary to construct a series of right angle triangles as shown in Figs. 174 and 175.

In Fig. 174 draw any line as *m-n* and erect a perpendicular to it. Step off from the line *m-n* on the perpendicular a distance equal to 1'-*l'* of the plan of Fig. 171, locating the point 1', Fig. 174. Then, from the perpendicular, step off on the line *m-n* a distance equal to the vertical distance between the points 1 and *l* in the elevation of Fig. 171, which locates the point *l'*, Fig. 174. Connect the points 1'-*l'*, Fig. 174, with a line which will be the true length of the surface line 1'-*l'* of the plan, Fig. 171.

Next, erect another perpendicular to the line *m-n* and step off on this perpendicular a distance equal to 2'-*m'* of the plan of Fig. 171, locating the point 2', Fig. 174. From this perpendicular step off on the line *m-n* a distance equal to the vertical distance between the points 2-*m* of the elevation of Fig. 171, thereby locating the point *m'*, Fig. 174. Connect the points 2'-*m'*, Fig. 174, and this line will be the true length of the solid surface line 2'-*m'* of the plan, Fig. 171.

Continue in the same manner, taking the bases of the triangles from the plan of Fig. 171 and the altitudes of the triangles from the elevation of Fig. 171 until the true length of the entire solid surface is obtained.

The true length of the dotted surface lines, Fig. 175, is obtained in the same manner as in Fig. 174. The bases of the triangles are taken from the plan of Fig. 171

and the altitudes from the elevation of Fig. 171. The altitudes are taken as the vertical distance between the different points.

To Construct the Pattern

Draw any line as *x-y*, Fig. 176, and on it step off 1″-*l*″ equal to 1′-*l*′, Fig. 174. With *l*″ as a center and with the dividers set equal to the distance *l-m*, Fig. 172, scribe an arc, and with 1″ as a center and with the trams set equal to 1′-*m*′, Fig. 175, scribe another arc, cutting the arc just drawn and locating the point *m*″, Fig. 176.

Then, using 1″ as a center and with the trams set equal to the distance 1-2, Fig. 171, scribe an arc, and with *m*″, Fig. 176, as another center and with the trams set equal to the distance 2′-*m*′, Fig. 174, scribe a second arc, cutting the arc just drawn and locating the point 2″, Fig. 176.

Continue in this manner by making the distances 2″-3″, 3″-4″, 4″-5″, 5″-6″, 6″-7″, 7″-8″, 8″-9″, 9″-10″, 10″-11″, 11″-12″, 12″-1″, Fig. 176, equal to 2-3, 3-4, 4-5, 5-6, 6-7, 7-8, 8-9, 9-10, 10-11, 11-12, 12-1 of the elevation of Fig. 171, and the distances *m*″-*n*″, *n*″-*a*″ to *k*″-*l*″ equal to the distances *m-n*, *n-a* to *k-l* of the profile, Fig. 172.

The true lengths of the solid and dotted surface lines used in Fig. 176 are taken from their corresponding lines in Figs. 174 and 175.

Connect the points 1″ to 1″ and *l*″ to *l*″ with a line, thereby completing the pattern of section "A" of Fig. 176.

The patterns for sections "B," "C" and "D" are obtained in exactly the same manner as was used for section "A."

(To be continued)

Trend in Locomotive Boiler Design

By G. P. Blackall

In his illuminating presidential address to the British Institution of Locomotive Engineers, recently delivered in London, W. A. Stanier, chief mechanical engineer of the London, Midland and Scottish Railway, Britain's largest railroad system, graphically traced the developments which have taken place in steam locomotive design of recent years. Mr. Stanier pointed out that the general practice has been to design locomotives on conventional lines, and, although the working pressure of boilers rarely exceeds 300 pounds per square inch, there has been a marked increase in firebox volume and grate area with an improvement in tube ratios, the cylinders being designed with better steam passages and larger steam pipes, and the valve gear arranged with longer valve travel. The following is a résumé of that part of Mr. Stainer's address devoted to locomotive boilers.

Many experiments have been made with locomotives having ultra high-pressure boilers. In Germany, France, America, and England locomotives have been built with the Schmidt-Henschel type of boiler, having a closed circuit with a pressure of 1600 to 1800 pounds per square inch, and producing steam at from 850 to 900 pounds per square inch, but they have not progressed very far. In America and on the Continent, a number of engines are running successfully with watertube fireboxes.

The Winterthur high-pressure locomotive, which was tried out on the Swiss Federal Railways, has a boiler of a special watertube type. The engine is of a high-speed uniflow type with cam-operated poppet valve. The boiler pressure is 850 pounds per square inch.

In Britain locomotive boilers are still of the conventional design, and the highest pressure is 250 pounds per square inch. A great deal of investigation of boiler proportions has been carried out, and there has been a tendency to build boilers with larger grate areas and bigger fireboxes. Unfortunately, the English load gage restricts the size both of boiler and engine design; a width of 8 feet 9 inches over cylinders and 13 feet 3 inches high limits the proportions, and the weights on axles limit the weights of the various parts to much more modest dimensions than many locomotives on the Continent and in America. In America, many locomotives are running with watertube fireboxes. These fireboxes are made possible by the more generous dimensions of the U. S. load gage.

These developments must be carefully watched, and all locomotive engineers are keenly following the boiler proportions of locomotives that are running or contemplated. The following features deserve particular attention:

1. The grate area should be of sufficient size to insure an average rate of combustion of about 50 pounds of coal per square foot of grate area per hour.

2. There should be ample firebox volume to insure combustion before the gases enter the tubes.

3. Ample free area for both the superheater flue tubes and boiler tubes, and a suitable ratio for the superheated steam required without prejudicing the steaming properties of the boiler.

4. A suitable evaporating heating surface and proportion of length to bore of tubes, so that the passage of gases is not unduly retarded through the tubes.

5. Good air space through the grate; many modern grates have from 48 to 54 percent air space to grate area.

6. Design of smokebox arrangement.

From a close examination of modern boiler design, details of the boiler proportions are very interesting. Fairly wide differences may be noted, which indicate that within certain limits, the steaming and efficiency of a boiler will be quite satisfactory, and this fact is a great help, when it is realized that very often the design has to be modified to meet other important features.

To enable boilers of the largest possible size to be built, it is necessary sometimes to use higher tensile steel plates than are normally used, and a number of railroads have built boilers using a steel containing about 2 percent of nickel with the following analysis:

Carbon	0.2 to 0.25 percent
Silicon	0.1 to 0.15 percent
Manganese	0.5 to 0.7 percent
Sulphur	0.04 percent
Phosphorus	0.04 percent
Nickel	1.75 to 2.0 percent

PHYSICAL TESTS

Tensile	34 to 38 tons per square inch
Yield	17 to 19 tons per square inch
Elongation	22 to 24 percent
Reduction of area	50 percent

This material enables a reduction to be made in the thickness of plates used in the design of the boiler, which results in a net reduction in weight of the boiler (having about 29 to 30 square feet of grate area) of 2000 pounds, and a further reduction of 600 pounds is obtained by using high-tensile longitudinal and roof stays, a total decrease of 2600 pounds. No difficulty is experienced in flanging this material, and no detriment can be discovered as a result of electric arc welding certain parts, provided suitable electrodes are used.

The practice of electric arc welding on boilers has not developed very far in England, although steady progress is being made. Up to the present no chief mechanical engineer has had courage to weld all the seams on a locomotive boiler, although in America it is quite usual for the steel firebox plates to be welded. There is a fruitful field for research, as by eliminating rivets and lapped seams weight can be saved and sources of weakness removed.

On the Continent a great deal of experimental work has been carried out in connection with boilers of the Velox and La Mont type. The Velox boiler has been developed by the Brown, Boveri Company, and advantages are claimed for this generator on account of the small space required, its exceptionally light weight, rapidity in raising steam, and general adaptability to service requirements. The P. L. M. Railroad has under consideration the conversion of a 4-6-0 locomotive to this type of steam unit.

The La Mont generator is also of the watertube, steam unit type, and, roughly speaking, it is claimed that to give the same output as a conventional type of locomotive boiler the La Mont type would be about one-half its weight. Both of these watertube boilers have a very high rate of steam production, and one of the most important auxiliaries is the provision of a pump to insure that satisfactory circulation is maintained.

It may be that the future high-speed locomotive will depart from the simple type originated by George Stephenson, and we shall have a super steam raising unit supplying high-pressure steam to a small totally enclosed multi-cylinder high-speed engine on the lines of the Dobie, or the Swiss Locomotive Company's engine which was tried a few years ago. One of the factors necessary for the success of such a machine would probably be a good water supply.

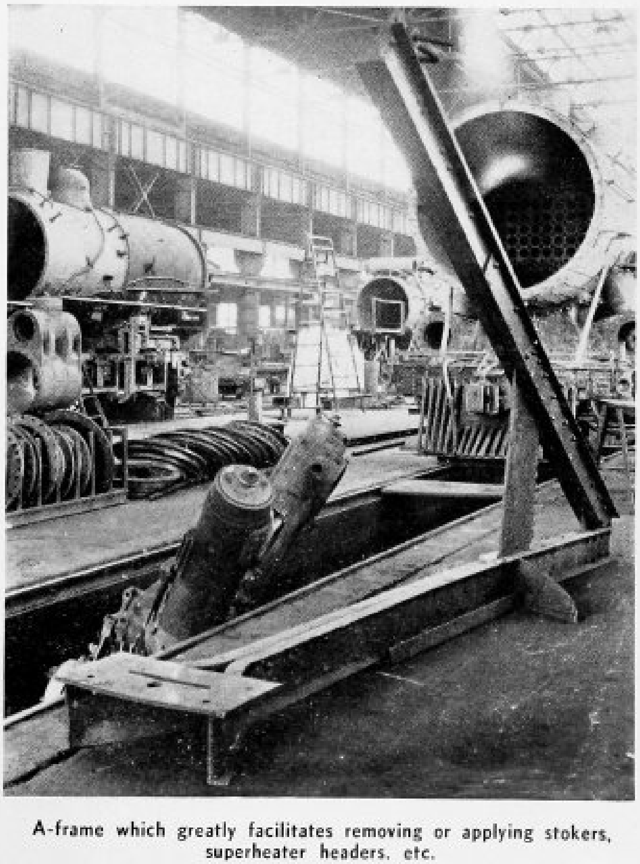
On the London, Midland and Scottish Railway in recent years an endeavor has been made to improve the quality of the water supplied to the locomotives. A large number of water softeners have been installed and are now being brought into service. The introduction of water softening in bulk has its inherent troubles. Many of the waters to be dealt with have a considerable permanent hardness, and this necessitates the addition of soda to remove this very undesirable feature, resulting in a softened water of an alkaline character, which invariably sets up a condition in the boiler causing priming. To avoid the high concentration of priming salts, it is necessary to blow the boiler down frequently, or, alternatively, to fit every boiler with a continuous blow-down so that the concentration of priming salts in solution does not exceed 180 grains per gallon. This means continuously discharging about two gallons of water per minute all the time a locomotive is working.

This system has been introduced very largely in America, and the London, Midland and Scottish is now engaged in fitting a continuous blow-down on all locomotives so that the fullest advantage can be taken of water softened down to zero hardness. It has been proved that unless zero hardness is provided, most of the advantage of water softening is lost, due to corrosion, priming and other troubles.

Device for Removing Superheater Headers

Among other special devices, developed at the Denver shops of the Chicago, Burlington and Quincy, which save time and labor is one used for applying stokers, superheater headers and the like.

This device consists of an A-frame, each leg of which is made of two 9-inch channels bolted together and having the outer ends of the lower channels spread and equipped with a ¾-inch steel plate, 14 inches by 29 inches to which the superheater header can be bolted. The bottom channels are 16 feet long and the angular channels, to the upper end of which the crane hook is attached, are 14 feet long. The steel cross plate of the A-frame is made of ½-inch stock 17 inches wide and the angle at the junction of the 9-inch channels is approximately 35 degrees. The steel plate to which the crane U-bolt is attached is provided with a series of holes drilled 2½ inches apart so that the point of attachment to the shop



A-frame which greatly facilitates removing or applying stokers, superheater headers, etc.

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Reg. U. S. Pat. Off.

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crane may be varied, dependent upon the weight being lifted.

This and numerous other lifting devices used at the Burlington shops are designed not only to permit applying and removing locomotive parts with a minimum expenditure of time and labor, but also to make sure that this work is done with maximum safety. There is always more or less potential danger when applying or removing heavy locomotive parts, but the use of properly designed lifting devices, such as those illustrated, removes most of the physical labor otherwise necessary, prevents the possibility of strained backs and limbs, and avoids the necessity of shop men getting into relatively dangerous positions.

CALENDAR.—The Dearborn Chemical Company, New York, has prepared a calendar extending from December, 1936, to December, 1937.

Ignitron Seam Welder Developed

A new ignitron seam welder control utilizing ignitron tubes has been announced recently by the Westinghouse Electric and Manufacturing Company. This control times power impulses in terms of a definite number of power cycles to a wheel type electrode resistance welding machine. Among its features is an inductive timer, consisting of a synchronous driven disk rotating once per second and containing 120 holes, each corresponding to a half cycle of welding current. Also, the use of ignitron tubes permits a design utilizing no voltages higher than line voltages and eliminating the need of power contractors and transformers. Steel pins are plugged into the holes according to the timing desired. Its use, it is claimed, greatly improves the quality of welds for even very light gage steels, and is especially suitable for welding heavy gage steels, demanding heavy welding currents, and special metal alloys demanding accurate timing.

Trade Publications

AIR COMPRESSOR.—A pamphlet on the single direct-acting air-cooled air compressor, type AN, has been published by the Worthington Pump and Machinery Corporation, Harrison, N. J.

FORGING PRESSES.—The subject of heavy-duty forging presses has been covered in an interesting and illustrative manner in a bulletin recently issued by the Chambersburg Engineering Company, Chambersburg, Pa., called "Chambersburg High - Speed Steam - Hydraulic Forging Presses."

ACETYLENE GAS.—The Air Reduction Sales Company, New York, has published a booklet called "Airco Acetylene" which presents the story of acetylene versus various other fuel gases. The comparative consumption of oxygen by various fuel gases is strikingly shown in the diagram included in this bulletin.

NICKEL ALLOYS.—The International Nickel Company, Inc., New York, has prepared a new booklet entitled "Strength Plus" describing the solution to scores of actual metal problems as encountered by the engineer. It contains 48 pages, completely illustrated, and was prepared primarily to serve as a guide book to Monel and other non-ferrous alloys in various fields of engineering.

RECORDING INSTRUMENTS.—A new catalogue, No. 6703 covering the complete line of thermometers and pressure gages, indicating, recording and controlling, has recently been published by the Brown Instrument Company, Philadelphia. It describes the classes of Brown thermometers and pressure gages, enumerates the wide range of applications and explains outstanding constructional features.

READING IRON.—The Reading Iron Company, Philadelphia, Pa., has prepared an interesting booklet on the early history of wrought iron in the American colonies and during the beginning of the United States as a nation. Illustrations are included showing artistically fabricated wrought iron gates used on early colonial estates and the hand-made wrought-iron nails used in the house construction during those times.

Questions and Answers Pertaining to Boilers

This department is maintained for the purpose of helping those who desire assistance on boiler and plate fabricating problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless special permission is given to do so.

By George M. Davis

Calculation of Shell Plate Stress

Q.—Give an example showing the factor of safety in the staybolted portion of a vertical tubular boiler; that is, does the water space width multiplied by the steam pressure give the stress on the shell plate? A. C. H.

A.—In a vertical tubular boiler, the stress on the firebox wrapper sheet is equal to the width of the water space multiplied by the steam pressure, provided the furnace sheet is adequately stayed to the wrapper sheet, which would permit the entire force acting on the furnace sheet to be transmitted through the staybolts to the wrapper sheet.

The A.S.M.E. Code provides for this in the following manner: The maximum allowable working pressure for any curved stayed surface subject to internal pressure shall be obtained by the two following methods, and the minimum value obtained shall be used:

(1) The maximum allowable working pressure shall be computed without allowing for the holding power of the stays, due allowance being made for the weakening effect of the holes for the stays, riveted longitudinal joint or other construction. To this pressure there shall be added the pressure secured by the formula for braced and stayed surfaces given in Par. P-199 using 70 for the value of C,

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

where:

P = maximum allowable working pressure, pounds per square inch.

T = thickness of plate in sixteenths of an inch.

p = maximum pitch measured in inches between straight lines passing through the centers of the staybolts in the different rows, which lines may be horizontal, vertical or inclined.

$C = 70$.

(2) The maximum allowable working pressure shall be computed without allowing for the holding power of the stays, due allowance being made for the weakening effect of the holes for the stays, riveted longitudinal joint or other construction. To this pressure there shall be added the pressure corresponding to the strength of the stays or braces for the stresses given in Table P-10, each stay or brace being assumed to resist the steam pressure acting on the full area of the external surface supported by the stay or brace.

Table P-10 gives the maximum allowable stresses for staybolts and stays and braces.

(a) Unwelded or flexible staybolts less than twenty diameters long, screwed through plates with ends riveted over—7500 pounds per square inch.

Measuring Semi-Elliptical Heads

Q.—Page 280, 1933, A.S.M.E. Code describes a method of measuring the radius of dished heads. Is there a similar method of measuring semi-elliptical heads and is there any kind of gage available that can be used for this purpose, which could be applied on the outside surface of a head? A. C. H.

A.—The method of determining the radius of a dished head, referred to in the question, is illustrated in Fig. 1, where:

R = radius of dish.

C = chord or distance straight across between two points on the inner surface of the head.

The distance C should be taken as large as practical, but small enough so that no portion of the rounded surface at A which joins the flange and the dished portion of the head will be included in the measurements.

H = distance from the middle point of chord C to the inner surface of the head, measured at right angles to the chord.

then:

$$R = \frac{H}{2} + \frac{C^2}{8H}$$

Theoretically, this method would not be applicable to semi-elliptical heads as a true ellipse cannot be drawn with circular arcs.

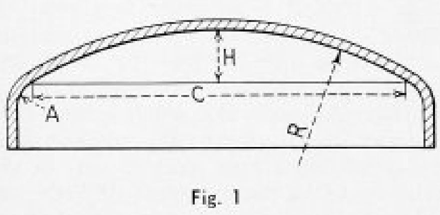


Fig. 1

For practical purposes where the elliptical head is an approximate ellipse constructed with circular arcs as shown in Fig. 2, the radius PF could be determined by the method outlined in Fig. 1.

To construct an approximate ellipse by circular arcs, let *AC* be the major axis and *BN* the minor. Draw the half circle *ADC* with *O* as a center. Divide *BD* into three equal parts and set off *BE* equal to one of these parts. With *A* and *C* as centers and *OE* as radius, describe circular arcs *KLM* and *FGH;* with *G* and *L* as centers and the same radius as previously, describe arcs *FCH* and *KAM*. Through *F* and *G* draw line *FP*, and with *P* as a center draw the arc *FBK*. Arc *HNM* is drawn in the same manner.

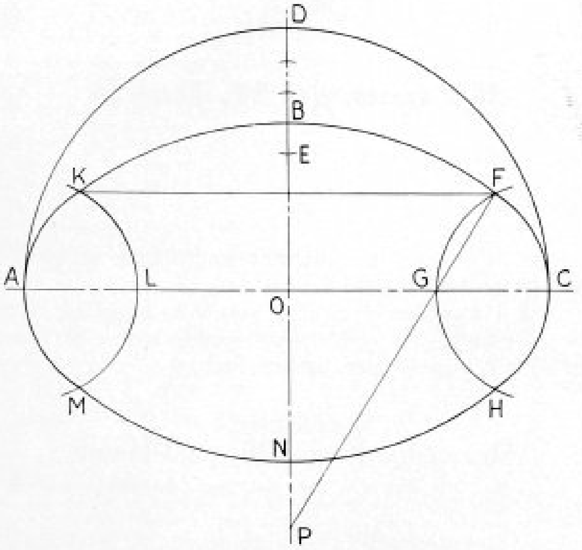


Fig. 2

The radius *PF* of the approximate ellipse *AKBFC*, Fig. 2, is determined by the same method shown in Fig. 1. The distance *C* should be taken as large as practical but in no case larger than *K-F* in Fig. 2.

I do not know of a gage that can be used on the outside surface of the head.

Butt Straps of Vertical Boiler

Q.—I recently became involved in a discussion concerning the construction of an upright firetube boiler and would like to submit it to you for an answer.

It seems to be the custom when constructing this type of boiler with butt and double strap shell joint to omit the inner strap in the portion of the boiler that is staybolted, next to the furnace sheet. I maintain that it is the staybolts that obviate the necessity of the inner strap, but have heard that it is because of some problem in hydraulics caused by the furnace taking the load off of the shell to some extent. If the latter be the case, I cannot quite grasp it and would like you to enlighten me. —A. B.

A.—There are various arrangements employed in riveting the seams and staying the furnace sheet of upright firetube boilers. Without the details of the particular boiler involved no very exact answer can be given. However, the omission of an inner butt strap is usually a matter based on convenience and ease in construction. Boilers may be built with lap joint or single and double butt strap and in each case the joint is designed for the particular conditions. For small boilers the simpler joints are easier and more cheaply made. One reason for not having an inside butt strap in way of the stayed furnace plate would be the increased difficulty of making the joint and the restriction that it would cause in the water spaces which are already restricted. The staying of the furnace plate to the outside sheet of the boiler by means of internal stays tends to stiffen up this sheet to a certain extent but the seam must be designed to take care of the pressure to prevent leakage. This fact and the difficulties of installing an inside butt strap would have an influence in having the joint made with outside strap only.

The furnace plate when heated would tend to expand and this would cause the stays to exert some pressure on the outside plate which to a certain extent would place these stays in compression while the internal pressure in the boiler would place them in tension. Hence under these conditions the load on the stays is lessened. This tends to bring less tension stress on the stays and in this indirect way may have some effect upon the stiffness of the joint.

No problem of hydraulics appears to be involved and it is not sure when the furnace would take the load off the shell except as mentioned above.

It may therefore be said that, as the inside strap is not entirely essential it is in the way and is the cause of additional expense and can be left out.

Plate Layout Books

Q.—I have read with interest your various articles in The Boiler Maker and Plate Fabricator, and I am writing to ask that you recommend some books that will help draftsmen and layout men in making layouts of stacks, bins, tanks, etc., as my company is doing a considerable amount of plate work at present and the knowledge of short cuts for laying out this kind of construction is needed. D. H. W.

A.—"Laying Out for Boiler Makers," fourth edition, published by the Simmons-Boardman Publishing Corporation, 30 Church Street, New York City, is a practical book on laying out and developing all types of plate work, including elementary as well as more intricate problems.

The edition covers smokestacks, various shaped tops and breechings, together with the complete development of a 191-foot self-supporting steel stack.

The section devoted to tanks includes the complete development of an 85-foot diameter tank, 30 feet high, and the development of conical and umbrella roofs and hemispherical tank bottoms.

Various shaped conveyors, hoppers and chutes are also included.

Welding Steel Forgings

Q.—Is it safe to repair cracked or broken steel forgings by means of welding? How can it be determined whether welding should be used? —C. L. K.

A.—Welding can be used to advantage if the weld is properly designed and made. Consideration should be given to the following points: (1) Will the part welded be of adequate strength to take care of the possible stress? (2) With the facilities and operators at hand can a proper strength weld be made? (3) Can the weld be made sufficiently ductile either in making it or by normalizing after it is made? (4) Can the weld be made so that there is a proper distribution of the stress to the various parts so as to avoid stress concentration? (5) Will the making of the weld cause distortion of parts or can such necessary distortion be allowed for?

The main danger in welding strength forgings is that the weld may not be properly made so that there is insufficient adhesion or bond; that the weld metal is too hard and brittle and will not stand shock; that dangerous distortion may take place; and that, if not normalized, locked up stresses may exist.

When a crack or some small part is welded, there is danger that the welded part may not be of adequate strength to take the load that may come upon it. This must be given consideration. If the welds can be properly made and are properly designed and stress relieved, they can be used to great advantage in repairing steel forgings.

Calculation of Staybolt Sizes

Q.—How is the selection of the proper size of staybolt for various plate thicknesses and working pressures arrived at? J. S.

A.—The size of the staybolt to be used is determined by the load that the staybolt will carry and still not exceed the maximum allowable stress for staybolts. The allowable load that a staybolt will carry is determined as follows:

Assume: A one-inch diameter staybolt with V-threads, 12 threads per inch.

The formula for the diameter of a staybolt at the bottom (root) of a V-thread is as follows:

$$d = D - (P \times 1.732)$$

where:

D = diameter of staybolt over the threads, inches.
P = pitch of threads, inches.
d = diameter of staybolt at bottom of threads, inches.
1.732 = a constant.

When U. S. threads are used, the formula is:

$$d = D - (P \times 1.732 \times 0.75).$$

Substituting in the first formula we have:

$d = 1 - (\frac{1}{12} \times 1.732)$
$d = 1 - 0.1443$
$d = 0.8557$ = diameter at root of threads.

The area of the staybolt at the root of the threads would be:

$$\text{Area} = 3.1416 \times \frac{(0.8557)^2}{2}$$

Area = 0.575 square inches.

With an allowable stress of 7500 pounds per square inch, the total load that can be carried by the staybolt would be:

$7500 \times 0.575 = 4312$ pounds, allowable load on staybolt.

The next step is to determine the area that can be supported by this load for a given pressure on the area.

Assume 200 pounds pressure, then:

$4312 \div 200 = 21.56$ square inches, area supported by one staybolt.

The pitch of the staybolts for a given area to be supported is determined as follows:

Area to be supported	21.56 square inches
Cross-sectional area 1-inch diameter staybolt	0.7854
Total area supported	22.3454

$\sqrt{22.3454} = 4.72$ inches pitch.

The next step to be considered is the thickness of the plate that can be supported.

The formula for thickness of plate is as follows:

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

where:

P = maximum allowable working pressure, pounds per square inch.
T = thickness of plate in sixteenths of an inch.
p = maximum pitch of staybolts, inches.
C = constant = 112 for stays screwed through plate not over $\frac{7}{16}$ inch in thickness, with ends riveted over.
C = 120 for stays screwed through plates over $\frac{7}{16}$ inch in thickness with ends riveted over.

Substituting the values already used in this formula we have:

$$T = \sqrt{\frac{200 \times (4.72)^2}{112}}$$

$$T = \sqrt{\frac{200 \times 22.3454}{112}}$$

$$T = \sqrt{39.9}$$

T = 6.3 sixteenths of an inch.

Summarizing the above we find that a one-inch diameter staybolt with V-threads, 12 threads per inch will support a $\frac{6.3}{16}$-inch sheet, having staybolts pitched 4.72 inches apart, with a load on the sheet of 200 pounds per square inch.

The following table gives the maximum allowable pitch, in inches, of screwed staybolts, ends riveted over.

Pressure pounds per square inch	Thickness of plate, inches: 5/16	3/8	7/16	1/2	9/16	5/8	11/16
	Maximum pitch of staybolts, inches						
100	5¼	6⅜	7⅜	...	...	...	...
110	5	6	7	8⅜	...	...	...
120	4⅞	5¾	6¾	8	...	...	...
125	4¾	5⅝	6⅝	7¾	...	...	...
130	4⅝	5½	6½	7⅝	...	...	...
140	4½	5⅜	6¼	7⅜	8⅜	...	...
150	4¼	5⅛	6	7⅛	8	...	...
160	4⅜	5	5⅞	6⅞	7¾	...	...
170	4	4⅞	5⅝	6¾	7½	8⅜	...
180	...	4¾	5½	6½	7⅜	8⅛	...
190	...	4⅝	5⅜	6⅜	7⅛	7⅞	...
200	...	4½	5¼	6⅛	7	7¾	8½
225	...	4¼	4⅞	5⅞	6½	7¼	8
250	...	4	4⅝	5½	6¼	6⅞	7⅝
300	...	...	4¼	5	5⅜	6¼	7

From the above table we can find the correct pitch for a given plate thickness and boiler pressure. From the pitch obtained in the table, the correct size of staybolt can be found by squaring the pitch and multiplying by the boiler pressure which will give the load on the staybolt. After obtaining the load on the staybolt, the size of the bolt to be used can be taken from the following table:

Outside Diameter of Staybolts, Inches		Diameter at Bottom of Thread, Inches	Net Cross-Sectional Area (at Bottom of Thread), Square Inches	Allowable Load at 7500 Pounds Stress, per Square Inch
¾	0.7500	0.6057	0.288	2160
13/16	0.8125	0.6682	0.351	2632
⅞	0.8750	0.7307	0.419	3142
15/16	0.9375	0.7932	0.494	3705
1	1.0000	0.8557	0.575	4312
1 1/16	1.0625	0.9182	0.662	4965
1⅛	1.1250	0.9807	0.755	5662
1 3/16	1.1875	1.0432	0.855	6412
1¼	1.2500	1.1057	0.960	7200
1 5/16	1.3125	1.1682	1.072	8040
1⅜	1.3750	1.2307	1.190	8925
1 7/16	1.4375	1.2932	1.313	9849
1½	1.5000	1.3557	1.444	10830

With the same values as previously used, using the nearest fraction for plate thickness we have:

⅜ inch thickness of plate
200 pounds pressure

and from the table we find that a 4.5-inch pitch should be used.

$4.5 \times 4.5 \times 200 = 4050$ pounds load on the staybolt.

Referring to the table we find that a one-inch diameter staybolt is the smallest diameter staybolt that will carry this load.

Associations

Bureau of Locomotive Inspection of the Interstate Commerce Commission

Chief Inspector—John M. Hall, Washington, D. C.
Assistant Chief Inspector—J. A. Shirley, Washington.
Assistant Chief Inspector—J. B. Brown, Washington.

Bureau of Navigation and Steamboat Inspection of the Department of Commerce

Director—Joseph B. Weaver, Washington, D. C.

American Uniform Boiler Law Society

Chairman of the Administrative Council—Charles E. Gorton, 95 Liberty Street, New York.

Boiler Code Committee of the American Society of Mechanical Engineers

Chairman—D. S. Jacobus, New York.
Acting Secretary—M. Jurist, 29 W. 39th Street, New York.

National Board of Boiler and Pressure Vessel Inspectors

Chairman—William H. Furman, Albany, N. Y.
Secretary-Treasurer—C. O. Myers, Commercial National Bank Building, Columbus, Ohio.
Vice-Chairman—F. A. Page, San Francisco, Cal.
Statistician—L. C. Peal, Nashville, Tenn.

International Brotherhood of Boiler Makers, Welders, Iron Ship Builders and Helpers of America

International President—J. A. Franklin, Suite 522, Brotherhood Block, Kansas City, Kansas.
Assistant International President—J. N. Davis, Suite 522, Brotherhood Block, Kansas City, Kansas.
International Secretary-Treasurer—Wm. E. Walter, Suite 506, Brotherhood Block, Kansas City, Kansas.
Editor-Manager of Journal—L. A. Freeman, Suite 524, Brotherhood Block, Kansas City, Kansas.
International Vice-Presidents—Joseph Reed, 3753 S. E. Madison Street, Portland, Ore.; W. A. Calvin, Room 402, A. F. of L. Building, Washington, D. C.; Harry Nicholas, 6215 S. Benton Blvd., Kansas City, Mo.; Chas. J. McGowan, 220 South State Street, Room 2116, Chicago, Ill.; J. H. Gutridge, 2178 South 79th Street, W. Allis, Wis.; W. G. Pendergast, 1814 Eighth Avenue, Brooklyn, N. Y.; W. J. Coyle, 424 Third Avenue, Verdun, Montreal, Quebec, Can.; A. M. Milligan, 262 Trent Avenue, East Kildonan, Man., Can.; J. F. Schmitt, 28 S. Roys Street, Columbus, Ohio; William Williams, 1615 S. E. 27th Avenue, Portland, Ore.

Master Boiler Makers' Association

President: M. V. Milton, chief boiler inspector, Canadian National Railway.
Vice-President: William N. Moore, general boiler foreman, Pere Marquette Railway.
Secretary-Treasurer: Albert F. Stiglmeier, general foreman boiler maker, New York Central System, West Albany Shop. Address, 29 Parkwood Street, Albany, N. Y.
Chairman Executive Board: William N. Moore.
Executive Board—Three Years: William N. Moore, general boiler foreman, Pere Marquette Railroad; Carl A. Harper, general boiler inspector, Cleveland, Cincinnati, Chicago & St. Louis Railroad; E. C. Umlauf, supervisor of boilers, Erie Railroad.
Executive Board—Two Years: M. V. Milton, chief boiler inspector, Canadian National Railway; Charles J. Kline, locomotive inspector, Interstate Commerce Commission; Sigurd Christopherson, supervisor of boiler inspection and maintenance, New York, New Haven & Hartford Railroad.
Executive Board—One Year: George L. Young, boiler foreman, Reading Company; C. W. Buffington, general master boiler maker, Chesapeake & Ohio Railroad; A. W. Novak, general boiler inspector, Chicago, Milwaukee, St. Paul & Pacific Railroad.

American Boiler Manufacturers' Association

President: Starr H. Barnum, The Bigelow Company, New Haven, Conn.
Vice-President: W. F. Keenan, Jr., Foster Wheeler Corporation, New York.
Secretary-Treasurer: A. C. Baker, 709 Rockefeller Building, Cleveland, O.
Executive Committee (Three years): A. W. Strong, Jr., The Strong-Scott Manufacturing Company, Minneapolis, Minn. R. J. Bros, William Bros Boiler & Manufacturing Company, Minneapolis, Minn. E. R. Stone, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. (Two years): E. E. Knoblock, Union Iron Works, Erie, Pa. A. G. Weigel, Combustion Engineering Corporation, New York. J. F. Dillon, Jr., Struthers-Wells-Titusville Corporation, Warren, Pa. (One year): F. H. Daniels, Riley Stoker Corporation, Worcester, Mass. M. E. Finck, Murray Iron Works, Burlington, Ia. A. G. Pratt, Babcock & Wilcox Company, New York. (Ex-Officio): Starr H. Barnum, The Bigelow Company, New Haven, Conn. Walter F. Keenan, Jr., Foster Wheeler Corporation, New York.

Office of Industrial Recovery Committee,
15 Park Row, New York

Manager—James D. Andrew.
Secretary—H. E. Aldrich.

Steel Plate Fabricators Association

President — Merle J. Trees, 37 West Van Buren Street, Chicago, Ill.

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

States

Arkansas	Missouri	Rhode Island
California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maine	Oklahoma	District of Columbia
Maryland	Oregon	Panama Canal Zone
Michigan	Pennsylvania	Territory of Hawaii
Minnesota		

Cities

Chicago, Ill.	Los Angeles, Cal.	Memphis, Tenn.
Detroit, Mich.	St. Joseph, Mo.	Nashville, Tenn.
Erie, Pa.	St. Louis, Mo.	Omaha, Neb.
Evanston, Ill.	Scranton, Pa.	Parkersburg, W. Va.
Houston, Tex.	Seattle, Wash.	Philadelphia, Pa.
Kansas City, Mo.	Tulsa, Okla.	Tampa, Fla.

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

States

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

Cities

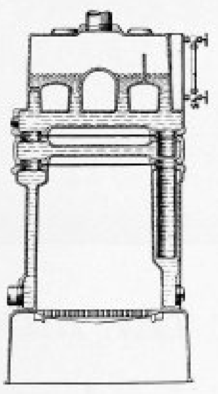
Chicago, Ill.	Memphis, Tenn.	St. Louis, Mo.
Detroit, Mich.	Nashville, Tenn.	Scranton, Pa.
Erie, Pa.	Omaha, Neb.	Seattle, Wash.
Kansas City, Mo.	Parkersburg, W. Va.	Tampa, Fla.
	Philadelphia, Pa.	

Selected Patents

Compiled by Dwight B. Galt, Patent lawyer, Earle Building, Washington, D. C. Readers desiring copies of patents or any information regarding patents or trade marks should correspond directly with Mr. Galt.

1,885,175. BOILER. CHARLES W. BRABBEE, OF BRONXVILLE, AND BERNHARD GOERG, OF MOUNT VERNON, NEW YORK, ASSIGNORS TO AMERICAN RADIATOR COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

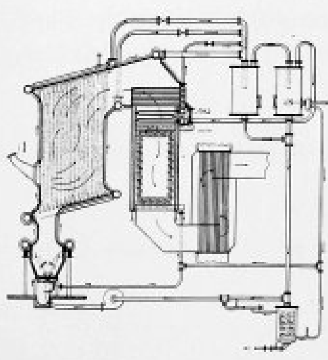
Claim.—A horizontal sectional boiler comprising a relatively-deep fire-pot section, and at least one upper section thereon, nipple ports at opposite sides of boiler in the opposing faces of said sections and a nipple secured



in the ports at one side of the boiler and constituting the sole passage for the ascending currents of heated water, and water-accelerating means disposed in the nipple ports at the opposite side of the boiler; said means comprising a nipple portion uniting said upper section with said fire-pot section, and a tubular portion substantially coextensive in length with the height of said fire-pot section extending from said last-named nipple portion into said fire-pot section and having its free end terminating adjacent the base of said fire-pot section, substantially as specified. Five claims.

1,883,293. BOILER WITH FORCED RETURN CIRCULATION THROUGH FURNACE WALLS. DAVID S. JACOBUS, OF MONTCLAIR, NEW JERSEY, ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

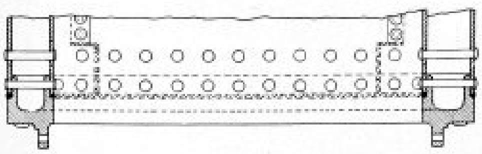
Claim.—The process which comprises positively circulating water only through the steam generating tubes of a boiler during normal operation



and through said steam generating tubes and the economizer of the boiler during the starting up period. Six claims.

1,918,363. BOILER MUD RING STRUCTURE. GEORGE M. WILSON, OF SCHENECTADY, NEW YORK.

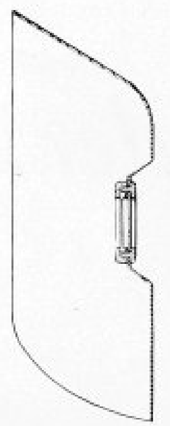
Claim.—In a locomotive boiler, the combination of a mud ring comprising integrally formed U-shaped members extending along opposite sides of the boiler fire box, each member having a base and two spaced walls united with and extending upwardly from the base providing therewith a channel open at the top, said spaced walls each having a longitudinal row of spaced threaded orifices near its upper edge, the orifices on one side being aligned with the orifices on the opposite side providing pairs, and said members having thickened portions on each side beginning at a point between the row of orifices and the bottom of said channel and extending below the bottom of said channel, to reinforce the union between said base and said walls, each of said thickened portions forming a shoulder with the adjacent upwardly extending portion of the wall; a boiler plate adjacent the exterior face of each of said upwardly extending portions and having perforations registering with said threaded orifices and having a



lower edge spaced above the adjacent shoulder, said edge being welded to said shoulder to form an integral jointure between the plate and adjacent thickened portion; and a row of bolts each extending across the channel and having its respective ends threaded through the orifices of one of said pairs, extending through the perforations of the adjacent plates and headed over at its outer ends, whereby said extensions are rigidly held in fixed, spaced relation and said sheets are held snugly against said extensions. One claim.

1,919,927. WELDER'S SHIELD. FREDERICK M. BOWERS, OF CHESTER, PENNSYLVANIA.

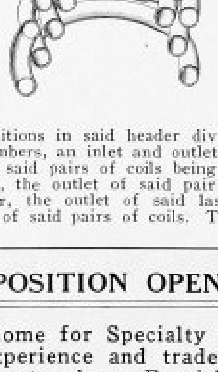
Claim.—A welder's shield having an inwardly extending recess and a hole in the material of said recess providing vertical flanges, a rectangular



visor frame composed of inner and outer parts slidably engaging to embrace said vertical flanges, means on the inner side of said shield for releasably securing said parts together, a glass in said frame and rectangular tension means held by said inner and outer parts for securing the same against movement. Fifteen claims.

1,919,506. WATER HEATER. JOHN C. GLENN, OF CHICAGO, ILLINOIS.

Claim.—In a water heater, a plurality of superposed overlapping conical coils, said coils being connected into pairs at their lower ends, each pair having an inlet and outlet, a header extending into the space in the



center of said coils, partitions in said header dividing its interior into a plurality of separate chambers, an inlet and outlet for each of said chambers, the inlet of one of said pairs of coils being connected to the outlet of one of said chambers, the outlet of said pair being connected to the inlet of another chamber, the outlet of said last named chamber communicating with another of said pairs of coils. Two claims.

Boiler Maker and Plate Fabricator

Boiler and Fabricated Plate Orders in 1936

Not since 1930 has the boiler manufacturing industry enjoyed the level of business which was sustained throughout the year 1936. The complete report of new boiler orders for last year, as compared with the previous six years, appears elsewhere in this issue.

To establish the degree of recovery in this industry, it is sufficient to point out the fact that 10,806 new steel boilers were ordered during the year, a gain of 53.5 percent over the previous year. This record was not approached in any year between 1930 and 1936, and in the former year the figures for production exceeded the 1936 level by only about 15 percent. The difference in total heating surface between the two years amounted only to 11.4 percent.

When this record is combined with that of the heavy plate fabricating field, which is also served by this publication, it is evident that the market for employment, as well as for materials, tools and equipment has kept abreast of practically every other of the heavy goods industries. Nearly 500,000 tons of heavy plate fabricated products were reported by the Bureau of the Census during the year 1936.

Locomotive Orders for 1936 First Large Market Since 1929

Orders for motive power and rolling stock placed in the United States during 1936 showed a big increase over those placed during the preceding year. The 533 locomotives constitute the largest number of orders placed since 1929 when 1212 were ordered in the United States.

Of the 498 locomotives ordered for railway service in 1936, 110 are of the 4-8-4 type, 66 of the 4-6-4 type, 62 of the 0-8-0 type, and 61 Diesel-electric locomotives. This indicates clearly the increase in the demand for the 4-8-4 type for high-capacity passenger service and fast freight service. The table also brings out clearly the renewed popularity of the articulated types to meet the demand for expedited schedules in freight service over difficult lines. Orders for a total of 97 articulated locomotives, with five types of wheel arrangement, were placed last year. These are all single-expansion locomotives.

Among the large orders placed during the year were 50 4-6-4 type for the New York Central and 50 0-8-0 type for the Pittsburgh & Lake Erie. The Chicago, Milwaukee, St. Paul and Pacific ordered 30 4-8-4 type locomotives for freight service, and the Union Pacific 20 4-8-4 type locomotives for passenger service. Numerous orders for 10 or more locomotives of a single type were also placed by other railroads.

Since the first of the year up to February 6, 58 steam locomotives have been ordered as follows:

Chicago & Illinois Midland	2
Delaware, Lackawanna & Western	5
Northern Pacific	9
Pere Marquette	15
Union Pacific	25
Industrial and Miscellaneous	2
Total	58

ORDERS FOR LOCOMOTIVES OF ALL TYPES SINCE 1918

Year	Domestic	Canadian	U. S. Export	Total
1918	2,593	209	2,086	4,888
1919	214	58	898	1,170
1920	1,998	189	718	2,905
1921	239	35	546	820
1922	2,600	68	131	2,799
1923	1,944	82	116	2,142
1924	1,413	71	142	1,626
1925	1,055	10	209	1,274
1926	1,301	61	180	1,542
1927	734	58	54	846
1928	603	98	27	728
1929	1,212	77	106	1,395
1930	440	95	20	555
1931	176	2	28	206
1932	12	1 (Export)	1	14
1933	42	...	7	49
1934	182	...	17	199
1935	83	27	15	125
1936	533	1	22	556

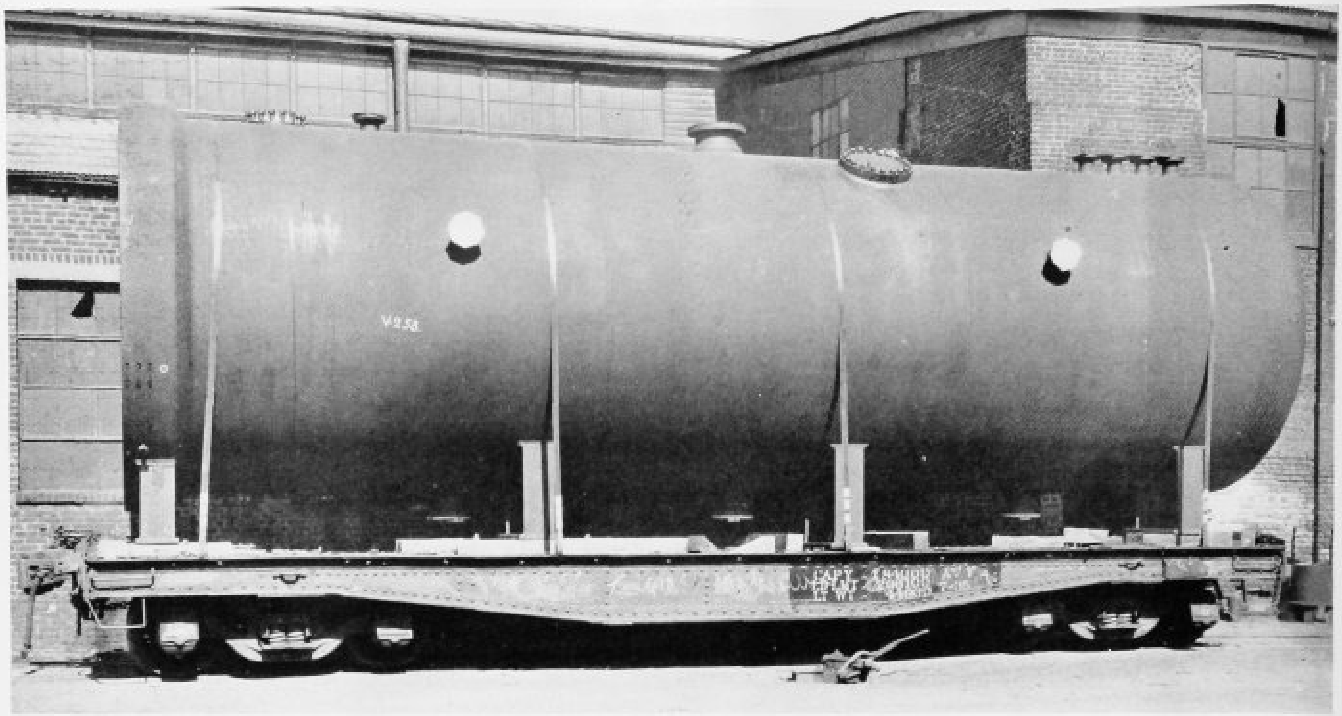
The Changing Mode of Boiler Making

If the old boiler makers to whom many of our present day boiler makers were first apprenticed should return to scenes of their hardy trade in order to survey the work of their erstwhile pupils, these ancient craftsmen would be, without doubt, much disturbed by the liberties that have been taken by their successors. A visit to a boiler shop of the present day would revive but few memories of the past.

Those in close contact with activities in a particular field are prone to accept as a matter of course developments in that field. Each development, if acceptable, holds the interest of the trade but briefly and then is relegated to the commonplace. Consequently, full appreciation of the revolutionary changes that have taken place in the boiler making and plate fabricating industries are seldom reviewed.

The pages of BOILER MAKER AND PLATE FABRICATOR have always served to mirror the changes that are continually taking place in this industry. As the sole publication dealing exclusively with this industry, it has played its part in keeping its readers fully informed. Elsewhere in this issue, products of a modern boiler shop made by modern methods with modern tools are described.

The employment of welding on these vessels and countless others has uncovered opportunities for the application of the boiler making trade which formerly did not exist. The ability to manufacture vessels, the fabrication of which would have been pronounced impossible or impractical under the old methods, has extended considerably the boundaries for the boiler maker.



Large arc-welded evaporator ready for shipment to Ford Motor Company

Foster Wheeler fabricates

Large Arc-Welded Evaporators

Among the many different types of pressure vessels built in recent months at the Carteret, N. J., plant of the Foster Wheeler Corporation were two groups of industrial steam power plant evaporators, both of which were of considerable size and capacity. The vessels were built to conform to the A. S. M. E. Code for Unfired Pressure Vessels and to Class I welding requirements. The quality of all welds was checked by the X-ray and all vessels were annealed and stress relieved upon completion.

The first group consisted of three units which were installed in the new River Rouge power plant of the Ford Motor Company. Each evaporator is designed to evaporate 405,000 pounds of steam per hour at 180 pounds per square inch gage pressure. The heating medium is turbine exhaust steam supplied to the evaporator at 240 pounds per square inch. The designed working pressure for the evaporator shell is 225 pounds per square inch gage, and the vessel, upon completion, was subjected to a hydrostatic test pressure, maximum, of 450 pounds per square inch.

The principal dimensions of this evaporator are length overall, 35 feet 4 inches; inside diameter of shell, 10 feet; thickness of shell plating, 1⅜ inches. The shell structure consists of the usual type of spherical dished head, three uniform shell sections and a heavy cylindrical forging, functioning as a frame for a unique type of removable head.

The spherical dished head was bumped to a radius of 108 inches and is 1⅞ inches thick. Three openings are provided in this head, a 16-inch manhole and two 4-inch nozzles. To this head was welded directly, the first cylindrical shell section, 10 feet 4 inches in length. This section and two others, identical in design and dimensions, were fabricated entirely by an automatic welding machine. The shell plating for both longitudinal and girth welds was recessed along the seam to be welded to a depth of 1¼ inches. The maximum distance between the corresponding upper edges of the recesses along the butts was about ¾ inch and the minimum, at the bottom edges, ⅛ inch. All welds, when finished, were ground down smooth and flush with the shell surface, which made the completed vessel appear to be practically seamless.

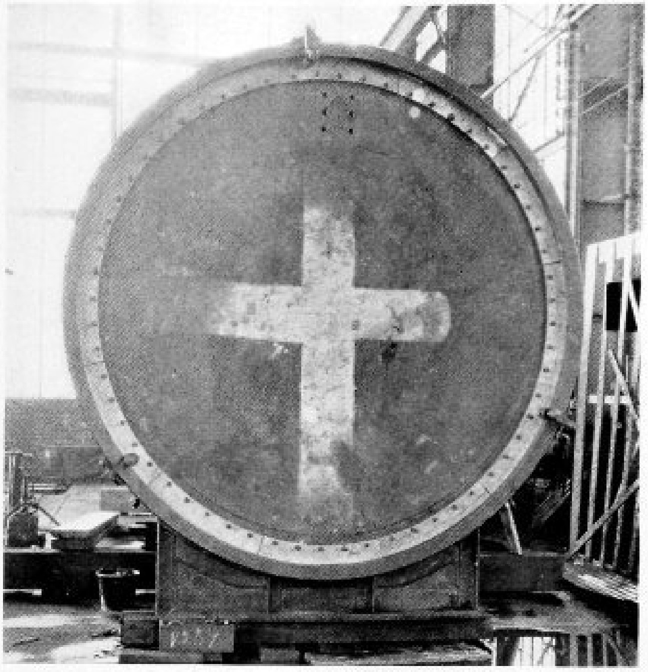
The first cylindrical section from the bumped head was equipped with a number of openings. Four 4-inch inside diameter nozzle connections for safety valves were set on 6-inch holes in the shell, 12 inches apart on centers and welded to the shell. An 8-inch nozzle was also welded to the bottom of the shell of this section for a drain connection.

The second or middle section carried the main vapor outlet which was a 12-inch inside diameter nozzle connection welded over a 15-inch hole in the shell. This section also had an 8-inch drain mounting on the bottom.

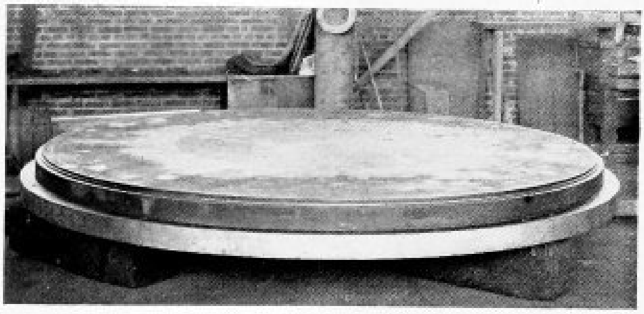
The third section mounted the main evaporating steam inlet connection, 12 inches inside diameter, which was a flange welded into a hole in the top of the shell.

The front end or removable head of this evaporator constitutes the most interesting part of the vessel. Due to the large diameter of the shell and the relatively high internal pressure, the construction and fastening of a bolted-up head would present considerable difficulty. The large number and size of bolts involved in a head secured in this fashion would have taxed the ingenuity of the designer in order to find sufficient room between the nuts for the insertion of wrenches or other tightening tools. Moreover, the process of tightening a head of the size and thickness required would be a rather arduous one when possible deformation of the shell or head is considered. Also due to stiffness of heavy flanges and normally designed bolted covers with rapid temperature changes, it is impossible to keep such heads tight.

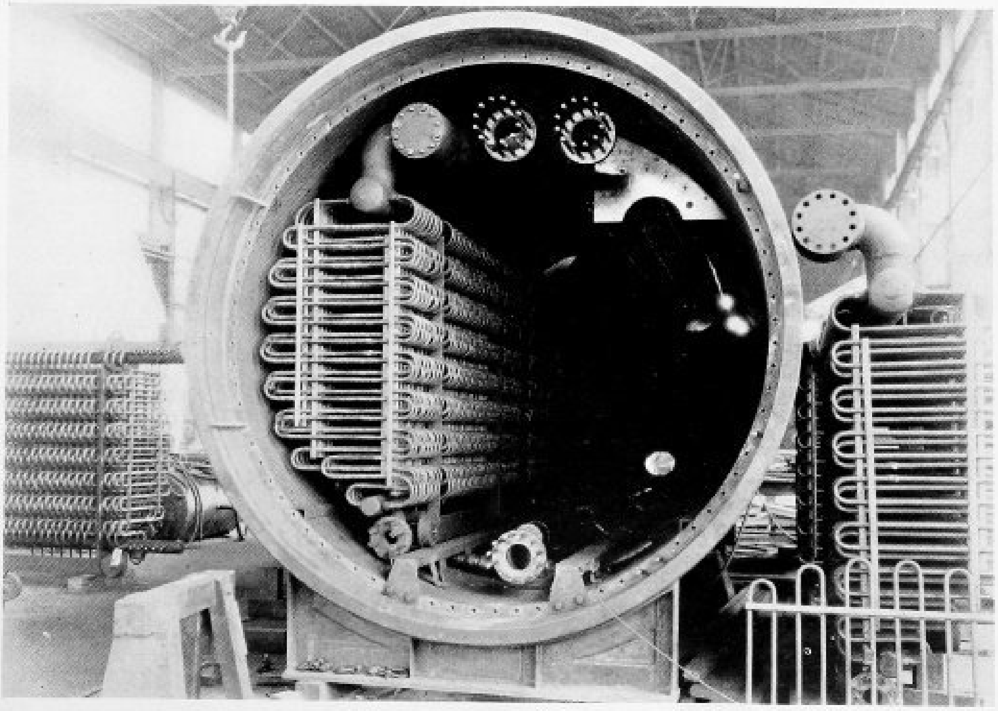
Consequently, a floating head of the lock type of construction was developed. This type of lock head was invented by G. D. Dodd, sales engineer, Foster Wheeler Corporation. It consists of a 9-inch thick steel plate, weighing approximately 30,000 pounds, a steel diaphragm plate, a diaphragm-supporting plate and retaining rings and flanges, set in a heavy steel forged ring. This ring is 2 feet 1 inch in length, welded to the shell, and acts as a frame for the floating head assembly. The construction of the floating head in diagrammatic form is illustrated on page 34. *E* is the lock head ring split into a number of pieces which fit into a groove machined in the ring forging *A* as shown. This lock head ring serves merely to keep the large pressure head *B* in position; *C* is a thin steel diaphragm bolted to the inner wall of the forged ring *A*; *D* is a gasket and *F* is an inside head which serves as a protection for the diaphragm when the evaporator is desealed and a partial vacuum exists inside the evaporator. The load on the diaphragm when the vessel is under external pressure would tend to force the diaphragm inward, resulting in possible damage if the plate *F* were not in place as a reinforcement. The heads built for the River Rouge evaporators were not exactly the same in all details as the head shown in the



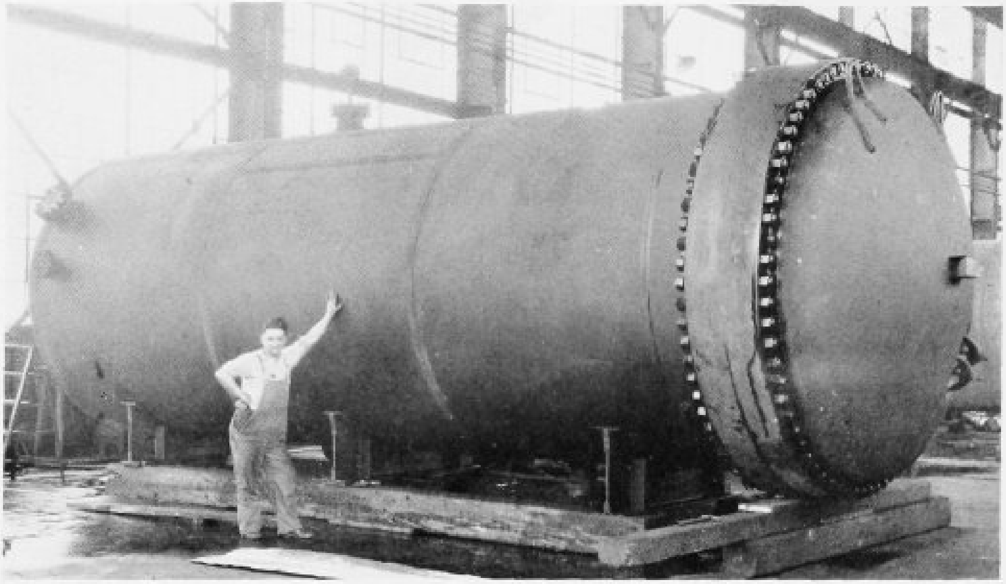
View showing floating head installed in evaporator



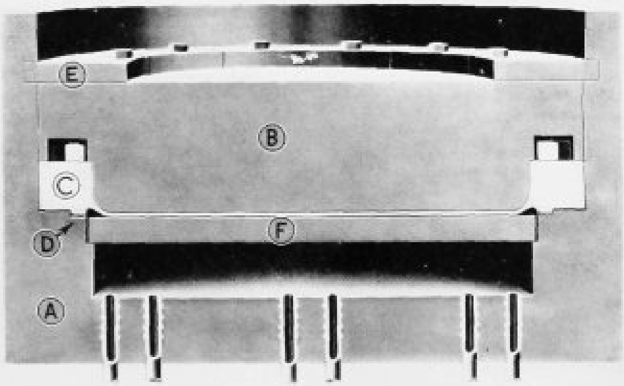
Floating head plate, 9 inches thick and 15 tons in weight



Evaporator tube installation in shell with tracks arranged for inserting or removing tube banks



Firestone evaporator with bolted-up head and all-welded shell and mountings



Diagrammatic view of floating head

illustration on this page, but the same principles of construction apply.

The evaporating tubes inside the evaporator were arranged in three files. Each file is further divided into three tube nests which can be removed separately. The tubes rest upon a wheeled carriage which runs on tracks welded to the inside of the shell. Removal of the tubes for cleaning and repairing is performed by opening the evaporator at the head, breaking the necessary steam connection and rolling the tube files out along the track.

The mountings on the vessel were all welded to the shell as previously stated. The method employed in welding flanges and manholes to the shell was to scarf the edges of the hole in the shell down to a point at mid-thickness, set the flange or manhole into the hole and weld along the notch between flange and plate, top and bottom.

Neck welds were treated in a somewhat similar manner, only the shell plating was not trimmed and a fillet weld filled the right angle between the neck and shell, inside and outside. Nozzles were welded to the shell by running a fillet bead around the foot of the nozzle and the outer surface of the shell and running a second fillet bead in the angle formed by the bottom of the nozzle and the sides of the hole in the shell.

The Firestone Tire & Rubber Company, Akron, O., also accepted delivery recently of five evaporators built by the Foster Wheeler Corporation, which were slightly smaller than those described above. These units were built to handle 260,900 pounds of steam per hour at 180 pounds per square inch gage pressure. Exhaust steam for evaporating purposes was to be supplied at 236 pounds per square inch gage.

Firestone Evaporator

The design of these evaporators provided for a safe working pressure in the shell of 190 pounds per square inch gage and a maximum pressure in the heating elements of 450 pounds per square inch gage. The completed vessels were subjected to a hydrostatic test pressure of double the above values. The weight of each completed vessel, empty, was 85,000 pounds and the normal weight in operation, 145,000 pounds.

The length overall is 28 feet 8½ inches; the maximum inside diameter of the shells 9 feet, and the shell plate thickness 1¼ inches. Like the Ford evaporators, these vessels were built to conform to the A.S.M.E. Code for Unfired Pressure Vessels with Class I welding employed in fabrication. All welding was X-rayed and the completed vessel annealed and stress relieved.

The rear or permanent head was formed from 1⅝-inch plate and bumped to an 8-foot radius. This head was welded directly to the first shell section, of which there are three of approximately equal length. All welding on the girth or longitudinal seams of the shell or heads was by the automatic process.

The mountings on the first shell section from the rear head consist of the safety-valve connection nozzle, shell drains, etc. The second section mounts an 8-inch vapor outlet nozzle and the usual drain attachments. The third section carries the main steam inlet and drain attachments. All these mountings are welded to the shell.

To the third section of the shell is welded the head flange which is a heavy steel forged ring, 12⅛ inches in width, 6¾ inches thick in way of the bolt holes and 10 feet 1½ inches in diameter, outside. A similar flange was welded to a 1⅝-inch plate, bumped to a radius of 8 feet to form the front head. Seventy-two 2⅜-inch holes were bored in each of these flanges to receive 2¼-inch stud bolts, 2 feet 2 inches in length, for fastening the head to the shell.

The evaporators rest in three cradle supports which are welded to the shell and fabricated from steel angles and plate stock.

High-speed, semi-streamlined

Canadian Pacific Locomotive

Within recent months the Canadian Pacific has received from the Montreal Locomotive Works, Ltd., five semi-streamlined locomotives for high-speed passenger service. The locomotives are of the 4-4-4 type and will be used to haul trains made up of new steel passenger coaches, the weight of which has been kept low by careful designing. The total weight of the locomotive is 263,000 pounds, of which 120,000 pounds is on the two pairs of drivers. The driving wheels are 80 inches in diameter, the cylinders 17¼ inches by 28 inches, and, with a boiler pressure of 300 pounds per square inch, the locomotive develops a tractive force of 26,500 pounds.

The boiler is of the conical type with three shell courses of nickel steel. The first course is 68 inches in inside diameter, the second course is conical, and the third 75 inches in outside diameter. The first course is of 23/32-inch material; the second, of ¾-inch material, and the third, of 25/32-inch material. The firebox sheets and staybolts are also of nickel steel. There is no combustion chamber, and the length over tube sheets is 19 feet.

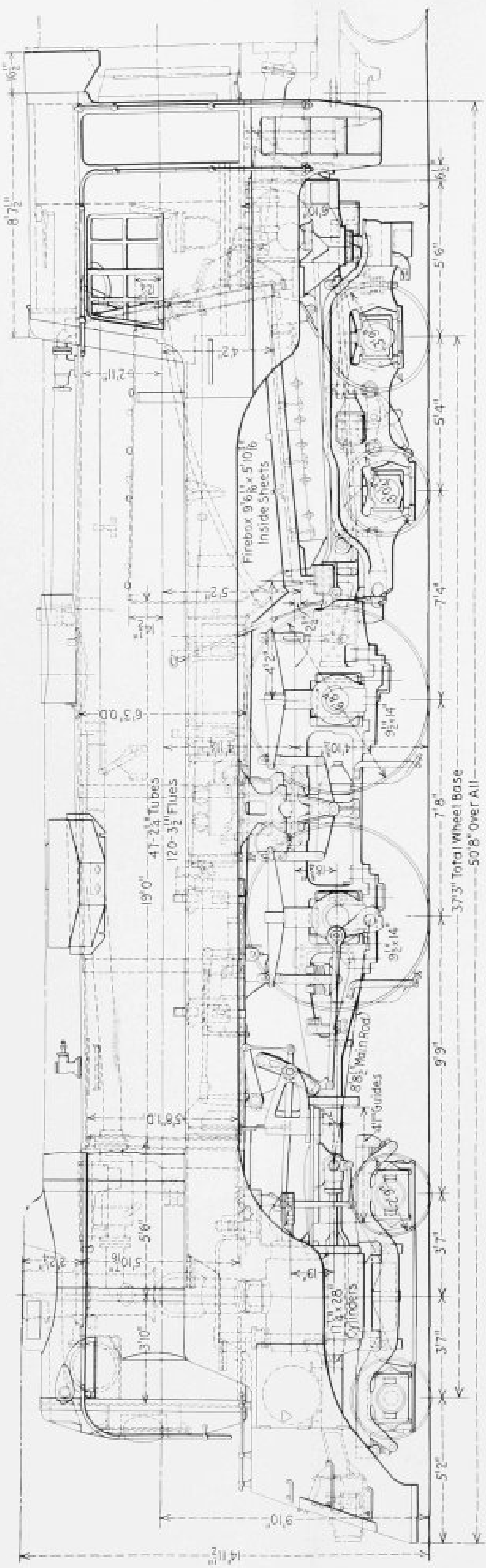
The boiler is built without a steam dome. An inside dry pipe, 8 inches in outside diameter, closed at the rear end and extending back about 2 feet into the third shell course, gathers steam through a series of circumferential slots in the top surface. These slots, the length of which in horizontal projection is 4 inches, have a combined area which is approximately twice the cross-sectional area of the dry pipe. It will be seen from the detailed drawing that the slotted portion of the pipe is enclosed between transverse end pieces, which extend up to and conform with the curvature of the shell courses, and flanged sides, joined to the ends by spot welding, which lie parallel to and rest upon the dry pipe. The effect of the passage thus formed on either side of the dry pipe is to spread the water-surface area over which the steam rises sufficiently to prevent the lifting of the water and to effect a much steadier level of the water in the water glass. This form of dry pipe has been developed as the result of experience during recent years on some of the largest locomotives in use on the Canadian Pacific.

In place of the dome a manhole 17½ inches in diameter is provided through the top of the third course in front of the firebox. A flanged ring provides a seat for a flat cover on which the safety valves are mounted. Threaded safety valve connections have been replaced on this road by bolting flanges with flat ground joints in order to overcome the frequent distortion of the valve seats from too severe use of the wrench. The whistle, which also has a flange base, is studded to the boiler shell immediately back of the manhole ring. The steam connection is by pipe to the side of the whistle base from the superheated steam turret.

In the fabrication of the boiler shell nickel-steel rivets have been used for the first time in order to secure a higher shearing value and in order to provide a better balanced seam in the high-tensile plate. Seal welding is employed on the calking edges around the mud ring corners and 10 inches up the calking edges of the vertical side- and wrapper-sheet seams. Pads for the blow-off cocks are also welded to the wrapper sheets. On the boiler shell, welding is applied at the ends of the outside butt straps of the longitudinal seams. At the front end of the first course the shell seam is butt welded back for a distance of 16 inches.

There are four arch tubes in the firebox. At the throat ends these are rolled and beaded into ported

Canadian Pacific locomotive for light high-speed passenger service



Elevation of new Canadian Pacific 4-4-4 type locomotive

General Dimensions, Weights and Proportions of the Canadian Pacific 4-4-4 Type Locomotive

Railroad	Canadian Pacific
Builder	Montreal Loco. Works
Type of locomotive	4-4-4
Road class	F-2-a
Road numbers	3000—3004
Date built	1936
Service	Passenger
Dimensions:	
Height to top of stack, ft. and in.	14—11½
Height to center of boiler, ft. and in.	9—10
Width overall, in.	128¼
Cylinder centers, in.	77
Weights in working order, lb.:	
On drivers	120,000
On front truck	68,000
On trailing truck	75,000
Total engine	263,000
Tender	198,500
Wheel bases, ft. and in.:	
Driving	7—8
Front truck	7—2
Trailing truck	5—4
Engine, total	37—3
Engine and tender, total	70—8¼
Wheels, diameter outside tires, in.:	
Driving	80
Front truck	33
Trailing truck	36¼ and 45
Engine:	
Cylinders, number, diameter and stroke, in.	2—17¼ × 28
Valve gear, type	Walschaert
Valves, piston type, size, in.	9
Maximum travel, in.	6½
Steam lap, in.	1⅛
Exhaust clearance, in.	¼
Lead, in.	¼
Cut-off in full gear, percent	84
Boiler:	
Type	Conical
Steam pressure, lb. per sq. in.	300
Diameter, first ring, outside, in.	$69\frac{7}{16}$
Diameter, largest, outside, in.	75
Firebox, length, in.	$114\frac{1}{16}$
Firebox, width, in.	$70\frac{9}{16}$
Height mud ring to crown sheet, back, in.	58¼
Height mud ring to crown sheet, front, in.	73
Arch tubes, number and diameter, in.	4—3½
Tubes, number and diameter, in.	47—2¼
Flues, number and diameter, in.	120—3½
Length over tube sheets, ft. and in.	19—0
Net gas area through tubes and flues, sq. ft.	6.03
Fuel	Bituminous
Stoker	Standard Type BK-1
Grate type	Rosebud
Grate area, sq. ft.	55.6
Heating surfaces, sq. ft.:	
Firebox	198
Arch tubes	34
Firebox, total	232
Tubes and flues	2,601
Evaporative, total	2,833
Superheating (Type E)	1,100
Combined evap. and superheat	3,933
Feed-water heater, type	Elesco
Tender:	
Style or type	Rectangular
Water capacity, Imperial gal.	7,000
Fuel capacity, tons	12
Trucks	Four-wheel
Journals, dia., in.	6.2992
General data, estimated:	
Rated tractive force, engine, 85 percent, lb.	26,500
Speed at 1,000 ft. per min. piston speed, m.p.h.	51
Piston speed at 10 m.p.h., ft. per min.	196.1
R.p.m. at 10 m.p.h.	42
Equiv. evap. per sq. ft. evap. h.s. per hr.	13.3
Weight proportions:	
Weight on drivers ÷ weight, engine, percent	45.6
Weight on drivers ÷ tractive force	4.52
Weight of engine ÷ evaporation	6.97
Weight of engines ÷ comb. heat. surface	66.87
Boiler proportions:	
Firebox heat. surface, percent comb. heat. surface	5.89
Tube-flue heat. surface, percent comb. heat. surface	66.13
Superheat. surface, percent comb. heat. surface	27.96
Firebox heat. surface ÷ grate area	4.17
Tube-flue heat. surface ÷ grate area	46.78
Superheat. surface ÷ grate area	19.78
Comb. heat. surface ÷ grate area	70.73
Gas area, tube and flue ÷ grate area	0.1082
Tractive force ÷ grate area	476.61
Tractive force ÷ comb. heat. surface	6.73
Tractive force × diam. drivers ÷ comb. heat. surface	539.02

forged-steel sleeves which extend through the water space and are threaded and welded to the inside and outside sheets. The outer end is closed with square-threaded plugs. These have been used with success for some years on the Canadian Pacific. The grates are of the rosebud or pin-hole type and are of chromite heat-resisting steel. The side bars are closely fitted against the side sheets and the usual deflector plates are applied at the mud ring under the side carriers to deflect cold air currents inward and to prevent them from sweeping directly up along the side sheets. This has prevented trouble from firebox side sheets cracking. The ash-pan hopper and door are of cast steel, while the body of the pan is of plate construction. Drop side doors at the top of the ash pan are provided to facilitate cleaning and inspection.

The boilers are fitted with the Type E superheater, in the header of which is included the American multiple throttle. The Elesco feed-water heater is mounted in a deep recess in the top of the front end of the smokebox. The steam connections between the cylinders and the header are installed with gland-packed slip joints where the pipes are attached to the cylinders. This arrangement has overcome the considerable difficulty formerly experienced with failures of these pipes from expansion and contraction stresses. The front end is fitted with a barrel type of netting, oval in horizontal cross-section. The netting fits into grooved castings at the top and bottom and may be readily removed. This is an arrangement with which the railroad has been experimenting with considerable success during the past few years.

The stack and stack cowling form the only projection above the surface of the cowling over the boiler. The stack is of the inside extension type and at the top is enclosed by a streamline casing, the top of which is flush with the top of the stack and in which is the smoke-lifter air passage which opens upward behind the stack and has its intake through a grille in the casing over the smokebox front.

The streamlining consists of a cowl which completely encloses the boiler and smokebox back to the cab, with a heavily reinforced sloping shroud around the front end below the smokebox which serves as a pilot and extends around the sides to enclose the steam chests and cylinders. This is relieved by two horizontal stripes of polished metal, which conform in appearance to the polished steel of the rods and motion work. Skirts extending about 2 feet below the running boards along the sides of the boiler conceal the piping, the reverse gear, an air reservoir on each side and (partially) the air compressor and the feed-water pump. At the rear end these blend into the sides of the cab. The front corners of the cab are rounded.

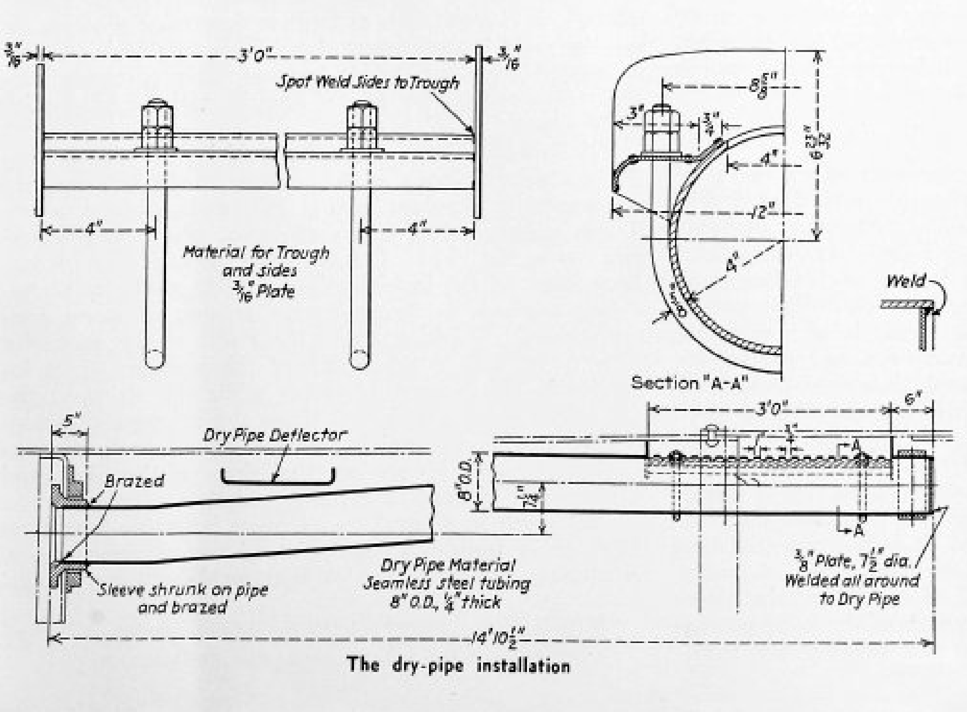
The general arrangement of parts usually mounted on the boiler, with the exception of the bell, has not been greatly disturbed by the application of the lagging. The feed-water heater, the smoke stack, sand boxes, top boiler check, safety valves, whistle and steam turret are in the customary locations. The bell, however, is located on the left back steam chest cover just under the running board, and one of the three air reservoirs has been placed on the deck casting under the front end of the smokebox. The headlight generator set has been placed on the back deck casting under the floor of the cab, and the exhaust piped up through the cab to the roof.

The boiler is lagged in the usual manner. The outer casing is built with a frame of angle construction covered with a planished steel jacket. This encloses everything mounted on the upper part of the boiler, with the exception of the smoke stack. The running board and running-board skirt are built as a part of the shroud, which is at no point rigidly attached to the boiler, but is held in lateral alinement by flexible connections to the top of the boiler. The running boards are supported from the main frames at the valve yokes and at the air-pump and feed-pump brackets. The rear end is supported from the side of the firebox by means of a sliding bracket connection which permits free movement of the boiler without strain on the running board.

The front of the engine is so designed that the coupler can be folded up when not in use and covered with a light removable panel. The hand-rail posts are of the Blunt type which simplify lining up the hand rail and provide for quick removal or replacement.

The tender is of the rectangular type, built up on a General Steel Castings water-bottom under frame. It is carried on two four-wheel trucks fitted with roller bearings. The top of the tender back of the coal space is curved in at the sides to conform with the contour of the new passenger coaches with which the locomotives will be operated.

In finish the locomotive presents a striking appearance. The cowling about the smokebox and around the front end, and the sides and front of the cab are finished in black. The remainder of the cowling over the boiler is in planished steel. On a black field along the skirting around the running board is a wide band of Tuscan red, the standard coach color of the Canadian Pacific, which is separated from the black border by a stripe of gold. Below each cab side window is a panel on which the Canadian Pacific shield is painted.



The dry-pipe installation

Designing for Welded Structures*

By Charles H. Jennings†

The application of welding to the fabrication of engineering structures and equipment presents a great many problems to the designer. Some of these problems are the result of the inherent properties of the deposited metal and the characteristic shape of certain welded joints while others are the result of the designer's efforts to create new and economical designs. Although many of the problems encountered are still unsolved and require a great deal of further research, the vast amount of data and experience that have been accumulated are sufficient to design welded structures and machines of all types rationally.

To design a welded structure properly, it is important that the designer be thoroughly familiar with the following items: (1) methods of calculating weld stresses, (2) allowable working stresses, (3) physical characteristics of parent and weld metals, (4) fabrication problems and (5) inspection and testing facilities. A welded design may be satisfactory from the standpoint of strength but entirely unsatisfactory from the standpoint of materials and fabrication.

A careful analysis should be made of each structure to insure that it can be economically fabricated. Welds must be designed and located so as to keep distortion of the finished product to a minimum. Rigid joints should be eliminated as much as possible to prevent the development of excessive residual stresses which might cause cracked welds during fabrication or ultimate failure in service.

The choice between butt and fillet welds is subject to much controversy, although when properly designed and fabricated, each has definite advantages and each is entirely satisfactory. The choice of materials and electrodes will vary greatly for different products and will depend largely upon the service conditions, the designer's knowledge of the weldability of materials, and the fabricating facilities available. In many cases two or more materials can be used for a given structure but the selection of the proper one will result in considerable saving in both fabrication and materials costs.

Typical Welded Joints

In the design of welded structures there are two general types of welds used, butt welds and fillet welds. These welds may be used in making many types of joints such as ordinary butt and fillet joints between parallel plates, T joints between plates joining each other at an angle, corner joints, joggled joints, etc. The proper selection between butt and fillet welds is of importance both from the standpoint of economics and the service life of the structure. Unfortunately, however, there is no set rule that can be applied in selecting the desired weld.

Fillet welds in general require less preparation of the parts preparatory to welding because the parts may be lapped or butted together without the necessity of spending a great deal of time in beveling or preparing the plate edges. If the plates are lapped, it is not essential that their dimensions be held to close tolerances. A variation of ⅛ to ¼ in the amount of overlap of the plates will have no effect upon the strength of the joint providing the minimum requirements for overlap are maintained. Also if this variation is not the result of abrupt changes it will be impossible to detect in the appearance of the completed structure.

In joints where the plates are butted at right angles to each other it is only necessary that the edge of the butting plate be cut at right angles with the plate surface. This requires only a single cutting operation with the shear, cutting torch, or planer. The greatest problem encountered is to insure that the prepared edge is straight so that it will fit uniformly to the abutting plate. A space or gap between two abutting plates will reduce the effective size of the fillet welds and require that the weld size be increased by the amount of the gap. The increase in the size of a fillet weld caused by a gap between two plates may materially effect the amount of deposited metal required to make a weld of the required size. When making a ½-inch weld between two plates, a $\frac{1}{16}$-inch free space represents an increase of 26.6 per cent in the amount of weld metal that must be deposited.

Butt welds in general require a better fit-up of the parts to be joined, and at least one of the butting edges is generally beveled (thin plates excepted). Beveling of the plate edges is an added operation which must be considered in the cost of the structure.

The presence of a gap larger than necessary between the parts to be welded will also materially increase the amount of metal that must be deposited. Butt welds have an advantage over fillet welds in this respect, however, because they are easier to inspect. After a fillet weld is made it is impossible to determine the presence of a gap between the parts by visual inspection, consequently, it is sometimes difficult to determine whether or not the weld is the correct size. This trouble is not encountered with butt welds because their particular design requires that the gap, if any, be entirely filled with weld metal.

The inherent shape of a fillet weld is such that it produces abrupt changes in the contour of the sections and consequently develops points of stress concentration. These stress concentrations are most severe at the heel and toe of the weld. Considerable theoretical work has been done on the investigation of fillet welds by photoelastic methods to determine the amount of stress concentrations. Solakian found the stress at the root of a fillet to be 6 to 8 times that of the average stress intensity in the connecting plates while the stress at the toe of the weld was 3 to 5 times the average stress intensity in the connecting plates. These stress concentrations varied with the external shape of the fillets and the amount of penetration and undercut present.

Butt welds in general have a more favorable form than fillet welds from the standpoint of stress concentration producing irregularities. A butt weld between parallel

* Abstract of paper presented before the American Society of Mechanical Engineers, Cleveland, last Fall.

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plates will produce no stress concentration providing it is a sound homogeneous weld and all the reinforcement has been removed. In actual practice, however, this condition is seldom obtained because nearly all butt welds have some reinforcement and a few internal flaws such as minute gas holes. Coker found by photoelastic tests that the reinforcement of butt welds would produce stress concentrations of 2.0. Small drilled holes representing flaws were also found to produce stress concentrations of 2.0.

In cases where T joints are made between plates by using butt welds there is the possibility of obtaining high stress concentration factors at the junction of the plates. For fillet sizes of 0.05 inch the theoretical stress concentration factor will approach 2.5.

Fabricating with Butt or Fillet Welds

From the standpoint of fabrication problems two important points must be considered when selecting between butt and fillet welds.

Butt welds in general produce greater residual stresses. This fact has been proven experimentally and in production.

The reason for higher stresses being developed by butt welds is primarily the result of their characteristic shape. When a section of deposited metal solidifies and cools it tends to shrink uniformly in all directions.

The second point in connection with the influence of fabrication problems on the choice between fillet and butt welds is the method of making the welds. In order to increase the speed of welding it is desirable to deposit the weld metal in the down-hand position with large diameter electrodes. Butt welds are ideal in this connection and are generally preferred. Fillet welds are of such a nature that in the normal horizontal position one fusion zone is in the vertical plane. This necessitates the use of small diameter electrodes, if welds of the highest quality are desired, unless the parts can be positioned so as to simulate a butt weld and permit down-hand welding.

In cases where fillet welds of intermediate quality are satisfactory special electrodes have been developed which make it possible to use ¼-inch diameters. Cases of this type make fillet welds as economical as butt welds.

Another factor in connection with the selection between butt and fillet welds is that butt welds allow the use of higher design stresses. This point will be discussed in greater detail later.

Reviewing the above it is evident that both butt and fillet welds have definite advantages and the proper selection between them depends upon many factors. For a designer to create the most satisfactory and economical structure it is essential that all of these variables be carefully considered.

The calculation of stresses in welds is of prime importance in connection with the design of every welded structure. Regardless of this fact there is a surprising lack of agreement among authorities, particularly with reference to fillet welds, as to the proper methods of analysis. This lack of agreement may be attributed primarily to the characteristic shape of fillet welds and the many attempts to account theoretically for the non-symmetrical stress distribution and the secondary bending moments encountered.

The object of this paper is not to give a highly theoretical analysis of the stresses in butt and fillet welds, but to discuss the commonly used methods and illustrate their application in the design of all types of structures and joints. (The following section of the paper was devoted to an explanation of the methods used in calculating stresses in corrections of welded structures.)

The design of a welded structure does not consist of simply designing the many joints to withstand the necessary loads. There are many economic and fabrication problems that must be considered in order to make the most satisfactory structure. In some cases these problems may be of sufficient importance to make the fabrication of the structure entirely impractical.

The ideal welded structure is composed of the fewest parts possible joined with the minimum amount of weld metal that is adequate for fabrication and service requirements. Whenever possible flanges and adjacent members should be bent from the same plate to eliminate corner welds. Structural steel plates and shapes cost about 2 cents a pound while deposited weld metal costs about $.50 to $1.00 a pound. Consequently, the advantage of reducing the amount of welding is readily recognized.

When butt welds are used, the plate edges need not be beveled for thicknesses of ¼ inch or less. The edges of heavier plates however should be beveled to form some type of V joint. The best design of the joint; that is, whether it is a single or double bevel, single or double V, single or double U, or single or double J will depend upon a number of factors.

Oxy-acetylene and oxy-hydrogen cutting is, in general, the cheapest method of preparing bevels for butt joints. It is adaptable to complicated shapes and suitable only for cutting plane kerf surfaces. Machining is particularly adapted for U type joints.

Double U and V type joints are recommended for plates ¾ inch thick and over if it is possible to weld from both sides of the plate. This type of joint produces less distortion of the welded parts and reduces the amount of weld metal necessary to weld a plate of a given thickness.

The U type joint with its rounded bottom makes it possible to make the first passes with an electrode of any desired diameter. The V joint is generally narrow at the bottom, consequently, the first passes must be made with small diameter electrodes. Regardless of this fact, however, experience indicates that on plate thicknesses up to 1 inch there is little or no difference between the welding speeds obtained on the two types of joints.

The width of the bottom of a U joint greatly influences the welding cost. On plates up to 1 inch in thickness it is advantageous to design the joint so that the first passes can be made with large diameter electrodes. On plates over 1 inch in thickness it is advantageous to design the joint for small diameter electrodes on the first passes.

When using fillet welds in any design it is important to remember that to double the size of a weld it is necessary to deposit four times as much weld metal. This fact often has an important influence in determining whether to use continuous or intermittent welding.

If a weld is designed on the basis of stress only it is often possible that very small welds will be satisfactory. Experience has shown, however, that there is a minimum size fillet weld that should be applied to a given plate thickness, if a sound strong weld is to be obtained. Recommended minimum size fillet welds for different plate thicknesses, are given as follows:

Minimum Size Fillet Welds for Different Thicknesses of Plate

Plate Thickness Inches	Minimum Weld Size Inch
⅛ to 3/16	⅛
¼ to 5/16	3/16
⅜ to ⅝	¼
¾ to 1	⅜
1⅛ to 1⅜	½
Above 1½	¾

When a continuous weld of the minimum size exceeds the required strength, and the weld is not required to be leak-proof, intermittent welds may often be used. The minimum length of an intermittent weld should be at least four times the size of the fillet and never shorter than 1 inch. A certain amount of time is required for a welder to start and stop a weld; consequently it is recommended that welds longer than 1 inch be used whenever possible in order to reduce the cost of fabrication.

Two types of intermittent welding are used, staggered and chain welding. The choice between the two types is open to controversy. The staggered welding, however, has the advantage of producing a joint stiffness approximately equivalent to that of chain welding by using only half as much welding.

Recommended spacings for intermittent welds limit the maximum center to center spacing between increments to 16 times the thickness of the thinner member for compression and 32 times the thickness of the thinner member for other loadings. In no case, however, should the spacing be greater than 12 inches between adjacent welds. (This spacing is somewhat greater than that permitted by the U. S. Navy on ship construction but it is entirely satisfactory for machinery and structures).

In cases where two parts are lapped together and it is possible to use either parallel or transverse fillet welds it is recommended that transverse welds be used because the load is generally more evenly distributed between the welds.

Bearing pads and other parts that require subsequent machining should have the welds designed strong enough to withstand the machining forces which may be larger than the service loads. Pads that have a width of over 12 times their thickness should be plug welded at the center to prevent the center from bulging. The diameter of plug welds should be made from 2 to 4 times the thickness of the plate.

The general design of all structures should be such as to eliminate rigid and fixed joints as much as possible. Such joints tend to develop high internal stresses which will produce difficulty in fabrication and may impair the service life of the structure.

Equipment that requires close machining tolerances and that will be subjected to dynamic service loads should be stress relieved after welding whenever possible. This stress relieving process should consist of heating slowly to 1100-1200 degrees F., soaking for one hour per inch of thickness and cooling slowly to at least 400 degrees F. before removing from the furnace.

Dome Failure on Locomotive Boiler

A report of the chief inspector, John M. Hall, Bureau of Locomotive Inspection, to the Interstate Commerce Commission, Washington, concerning a recent locomotive boiler failure is given below:

On January 11, 1937, about 8:15 p.m. the auxiliary dome blew off the boiler of New York, New Haven & Hartford Railroad locomotive 438 while the locomotive was in the Southampton Street Engine House at South Boston, Mass., for monthly inspection and repairs. Two employes who had been assigned to make repairs to steam leaks in the vicinity of the dome were injured as a result of the failure.

Description of Accident

The employes involved were preparing to make an examination to ascertain the source of the leaks; boilermaker J. P. Jaussaume was on the hand rail and helper C. D. Wiley was on the running board when the auxiliary dome blew off. Both were severly scalded by the escaping steam and they were taken to Carney Hospital in South Boston. The dome lodged in the roof of the engine house and was removed the following morning. The steam pressure at the time of the accident was estimated as being somewhere between 140 and 160 pounds; the working pressure of the boiler was 190 pounds per square inch.

Description of Auxiliary Dome

The auxiliary dome was located on the roof sheet forward of the cab; it was oval or oblong in shape, mounted with the long dimension lengthwise of the boiler. The dome was constructed of cast steel, 22 inches long and 16 inches wide, with a flange 2 inches thick, the total height of the casting being approximately 5 inches. It was secured to the ⅝-inch thick roof sheet and a liner ½-inch thick by sixteen iron rivets $1\frac{3}{16}$ inch in driven diameter. The pitch of the rivets was 3 inches on the sides and 4½ inches at the ends. There was a ⅛-inch copper gasket between the flange of the dome and the roof sheet. Two 3¼-inch holes were provided in the roof sheet and liner for the entrance of steam into the dome.

The boiler was built in 1905; the original back end was replaced in September, 1925, by a new back end, including the auxiliary dome.

Examination disclosed that the heads of all the rivets had broken off inside of the boiler and the appearance was such as to indicate that they had been overheated at time of application. Eight of the rivet heads were not found at the time of the investigation. Seven of the rivets appeared to have been broken for some time. All the rivets were tight in the dome casting.

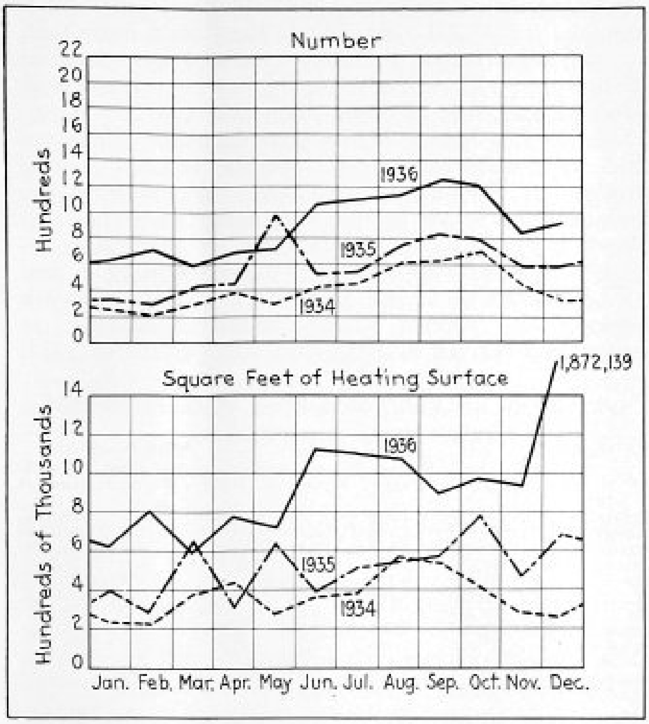
Condition Prior to Accident

The last annual inspection and hydrostatic test was made at Dover Street Shop, South Boston, in June, 1936, at which time the safety valve bushings in the auxiliary dome were renewed.

The locomotive had been in service at outside points most of the time since it received hydrostatic test and had been sent to South Boston for monthly inspection. Work reports were on file at Southampton Street dated June 13, July 12, August 13, September 14, October 8, 9, and 31, November 1, 2, 4, 5, 6, 8, 11, 12, and 14, December 8 and January 11.

October 8 the inspector reported, "Leak on boiler around auxiliary dome." This report was signed off, indicating repairs had been made. October 31 the inspector reported, "Leak under lagging in front of generator." This report had the notation "serviceable" and was approved by the boiler foreman. November 14 the engineer reported, "Leak in boiler sheet under lagging front of cab." This report was signed off indicating repairs had been made. December 8 the inspector reported, "Leak at auxiliary dome on boiler." This was signed off indicating repairs had been made. January 11, 1937, the inspector reported, "Leak under jacket on boiler in front of generator." It was on account of this report that the two men injured were assigned to make repairs.

Evidently the defective condition had been progressing since the last hydrostatic test and the calking which had been done from time to time to overcome leaking had probably aggravated the condition.



(Above) Trends of new boiler orders. (Below) Heating surface of boilers produced

Power Boiler and Heavy Plate Fabrication in 1936

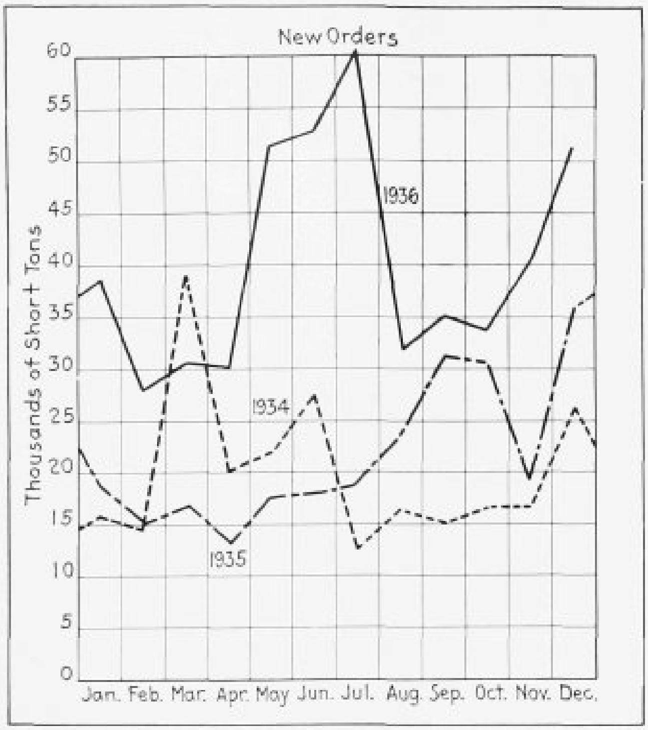
According to reports of the Bureau of the Census, United States Department of Commerce, for the year 1936, the recovery in the steel boiler manufacturing industry which really began to be felt in 1935, continued to make substantial progress throughout last year. While still slightly below production in 1930, new orders placed

New Orders For Steel Boilers — 1930 to 1936

(Number of boilers and square feet of heating surface)

	December		Total (Year)						
	1936	1935	1936	1935	1934	1933	1932	1931	1930
GRAND TOTAL:									
Number	915	595	10,806	7,040	5,009	4,118	3,652	7,673	12,758
Square feet	1,872,139	684,735	11,511,557	6,245,158	4,368,563	4,818,362	3,501,107	6,827,364	12,996,001
STATIONARY (Power boilers over 15 pounds pressure):									
Total:									
Number	461	206	3,657	2,130	1,634	1,628	1,263	2,307	4,420
Square feet	1,694,620	397,476	8,104,516	3,951,092	2,836,515	3,212,747	2,413,436	4,026,868	8,316,450
Watertube—									
Number	197	57	1,179	653	478	551	382	672	1,070
Square feet	1,487,696	265,701	6,086,787	2,914,401	1,951,020	2,361,557	1,797,591	2,838,608	5,562,877
Horizontal return tubular—									
Number	50	35	556	368	374	393	259	487	879
Square feet	55,960	54,064	740,924	464,565	485,530	510,356	326,770	612,802	1,179,486
Refractory-lined firebox return tubular—									
Number	26	19	261	140	*	*	*	*	*
Square feet	26,231	19,607	239,206	128,884	*	*	*	*	*
Locomotive (not railway)—									
Number	14	14	113	69	39	59	53	103	167
Square feet	12,370	11,308	87,441	46,014	28,920	35,371	45,153	87,030	145,251
Scotch type—									
Number	18	12	196	101	*	*	*	*	*
Square feet	14,919	5,692	137,802	43,324	*	*	*	*	*
Self-contained portable—									
Number	19	11	291	153	255	200	166	302	438
Square feet	13,828	7,018	220,162	106,313	180,504	152,481	120,803	233,888	310,027
Vertical fire tube—									
Number	81	37	656	498	393	360	373	626	1,140
Square feet	18,991	10,516	156,551	121,945	105,088	88,625	102,016	173,106	340,470
Oil country—									
Number	56	21	378	119	63	41	7	52	586
Square feet	64,625	23,570	408,382	113,225	58,547	37,862	5,612	48,430	661,207
Miscellaneous—									
Number	....	....	27	29	32	24	23	65	140
Square feet	....	....	27,261	12,421	26,906	26,495	15,491	33,004	117,132
STEEL HEATING (as differentiated from power boilers):									
Number	434	369	6,943	4,753	3,207	2,292	2,317	5,201	8,081
Square feet	157,883	183,076	2,828,845	1,870,681	1,169,277	851,071	964,131	2,300,394	3,546,144
MARINE: †									
Total:									
Number	20	20	206	157	168	198	72	165	257
Square feet	19,636	104,183	578,196	423,385	362,771	754,544	123,540	500,102	1,133,407
Watertube—									
Number	6	17	152	103	72	132	20	88	172
Square feet	16,152	103,290	560,008	396,834	313,381	713,141	84,099	455,987	1,072,103
Pipe—									
Number	....	....	1	5	7	2	6	7	3
Square feet	....	....	815	5,483	7,292	2,360	11,076	8,159	3,217
Scotch—									
Number	14	3	53	49	81	63	44	60	75
Square feet	3,484	893	17,373	21,068	33,906	37,943	22,891	26,286	54,159
Miscellaneous—									
Number	....	....	....	....	8	1	2	10	7
Square feet	....	....	....	....	8,192	1,100	5,474	9,670	3,928

* Data not available.
† No boilers of the 2 and 3 flue type were reported during the period 1930 to 1936.



Orders for fabricated steel plate products

in 1936 exceed by a wide margin those of the intervening years.

The fabricated steel plate industry also staged a sharp comeback in 1936; namely, nearly doubling the production of the previous two years, and exceeding 1933 by nearly 300,000 tons.

During the year 1936, a total of 10,806 new steel boilers were ordered having a heating surface of 11,511,557 square feet, as compared with 7040 boilers of 6,245,158 square feet of heating surface in 1935. In boiler production this represents a gain for last year over 1935 of 53.5 percent and in heating surface the gain amounts to 84.5 percent. Compared with the low point of the depression, 1932, the boiler manufacturing industry during 1936 gained 195 percent in the number of boilers ordered, with the total heating surface representing an increase of nearly 230 percent. At present the industry stands within 15.3 percent of the 1930 level of production in number, and within 11.5 percent of the total heating surface ordered. An accompanying table and chart show the record in boiler production for the years 1930-1936, inclusive.

Plate Fabrication Forges Ahead

A year ago the annual report for the heavy plate fabricating industry did not show the same degree of recovery as in that of boiler manufacturing. For 1936, however, a remarkably improved showing was made. New orders for the year totaled 484,036 tons, as compared with 258,315 tons in 1935; 241,992 tons in 1934, and 199,031 tons in 1933. The accompanying chart indicates the trend very clearly. The gain thus represented amounts to 85.5 percent over 1935; 100.5 percent over 1934; and 143.1 percent over 1933. The gain in production over the low point of 1932 is 200 percent. In that year but 161,801 tons of fabricated steel products were ordered.

Of the classified production the greatest volume for the year 1936 was in the fabrication of oil storage tanks; namely, 100,102 tons, which includes only tanks over 10,000 barrels in size. Refinery material and equipment accounted for 37,231 tons; gas holders 6628 tons; tank cars and blast furnaces 32,972 tons, and miscellaneous 307,103 tons. In each of these branches, production in 1936 exceeded that of every year since 1931.

Still another branch of the plate fabricating industry which represents considerable tonnage is that of steel barrels. In 1936 a substantial gain was made in the production of heavy barrels and drums over the two preceding years; the total production in 1936 being 8,608,491 units, as compared with 6,876,650 in 1935, and 6,677,322 units in 1934. During the year this branch averaged 45.8 percent of its productive capacity, as against 38.3 percent in 1935, and 36.0 percent in 1934.

New Orders for Fabricated Steel Plate—1934-1936

NEW ORDERS (SHORT TONS)						
Year and Month	TOTAL	Oil Storage Tanks*	Refinery Material and Equipment	Gas Holders	Tank Cars and Blast Furnaces	Miscellaneous
1936						
January	38,709	3,354	2,591	3,404	1,124	28,236
February	27,863	5,940	2,971	44	184	18,724
March	30,437	3,620	1,897	54	597	24,269
April	30,018	5,678	2,697	177	452	21,014
May	51,443	9,311	2,190	96	2,259	37,587
June	52,937	21,861	4,607	433	3,080	22,956
July	60,324	9,968	4,666	536	15,442	29,712
August	31,999	8,604	3,882	552	299	18,662
September	35,033	9,446	3,727	1,016	923	19,921
October	33,791	6,632	2,688	102	830	23,539
November	40,465	6,368	2,675	128	1,868	29,426
December	51,017	9,320	2,640	86	5,914	33,057
Total (Year)	484,036	100,102	37,231	6,628	32,972	307,103
1935						
January	18,778	1,389	1,202	167	710	15,310
February	15,064	2,531	1,156	503	318	10,556
March	16,832	2,377	965	456	87	12,947
April	13,244	2,152	877	399	271	9,545
May	17,630	3,690	821	347	102	12,670
June	17,914	1,872	1,994	1,030	293	12,725
July	18,890	4,193	1,615	573	35	12,474
August	23,628	3,505	2,599	531	769	16,224
September	31,105	3,531	3,061	74	245	24,194
October	30,530	5,850	3,081	334	292	20,973
November	19,116	2,617	2,620	8	176	13,695
December	35,584	9,341	5,327	173	724	20,019
Total (Year)	258,315	43,048	25,318	4,595	4,022	181,332
1934						
January	15,897	3,754	480	880	271	10,512
February	14,641	2,476	1,337	216	160	10,452
March	38,924	2,202	2,495	65	356	33,806
April	20,085	2,998	2,338	1,174	128	13,447
May	21,891	8,746	1,767	445	131	10,802
June	27,395	11,019	1,359	382	993	13,642
July	12,523	2,028	946	737	911	7,901
August	16,293	3,334	1,452	548	104	10,855
September	15,108	3,445	2,305	62	1,078	8,218
October	16,581	927	2,280	158	659	12,557
November	16,629	3,252	2,673	263	189	10,252
December	26,025	5,185	2,710	1,609	1,203	15,318
Total (Year)	241,992	49,366	22,142	6,559	6,183	157,762

* Reported as Oil storage tanks (10,000 barrels and over).

Glycerine and the Boiler Scale Problem

The problem of boiler-scale formation at one time or another confronts practically every industrial plant. Clearing it out means time and trouble. To prevent or retard the formation, and thus eliminate this item of overhead, glycerine has been found useful.

The power of glycerine as an almost universal solvent is largely the explanation of its efficiency in this usage. The boiler-scale formation is caused primarily by the presence of lime salts in the water in the boiler. The addition of glycerine acts to increase the solubility of the lime salts, forming soluble compounds.

The lime concentrations in the course of time will become too large to be assimilated in this way by the formation of soluble compounds, but as this happens, a viscous, gelatine-like substance is precipitated which has the advantage of not adhering to the surface of the plates. Moreover, it is not carried into the cylinders of an engine by the action of the steam.

No complicated apparatus is involved in this use of glycerine to prevent scale formation, nor is it necessary to work out any complicated formula. Figuring proportionately to the amount of coal used in firing the boiler, practical experience has shown that satisfactory results are obtained simply by adding five pounds of glycerine to the water for each ton of coal.

In this connection the report of the recent series of authentic tests of the effect of scale in cutting efficiency is of interest. In 120 tests, 11 percent greater output was obtained from steam engines during a single month after the boilers were freed from scale than was obtained during the three months period before they were cleaned. When boilers are operating at heavy loads, especially, scale formation is often directly responsible for the overheating and burning out of the boiler tubes.

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

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information on the application of the code is requested to communicate with the secretary of the committee, 29 West 39th St., New York.

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

Following are records of the interpretations of this Committee formulated at the meeting of November 20, 1936, and approved by the Council.

Case No. 828 (Reopened)

(Special Ruling)

Inquiry: Is it permissible, under the Unfired Pressure Vessel Code, to use nickel-clad material for fusion-welded vessels?

Reply: It is the opinion of the committee that unfired pressure vessels may be constructed of nickel-clad plates, provided that all code requirements covering the material of the base plates, welding, and tests for the class of service for which the vessels are intended, are complied with; the allowable pressure for the vessels is computed from the thickness of the base plates without any allowance for the nickel cladding; and such welds are completed before radiographing where this is required.

It is important that the completed weld or welds have a corrosion-resistant property substantially equal to that of the nickel cladding. Until such time as suitable rules to test corrosion-resistant properties of welds are formulated, the manufacturer should satisfy the purchaser that the weld is suitable for the intended vessel use.

Case No. 833

(Annulled)

Case No. 834

(Special Ruling)

Note: The Boiler Code Committee is actively working on a case to provide for rules for the welding of unstabilized materials of similar grades.

Inquiry: Will it be permissible to apply the Code symbol stamp to unfired pressure vessels fabricated by fusion welding of chrome-nickel steel conforming to A.S.T.M. Specifications A 167-35T, grade 4, with the following limitations:

Carbon, max. percent	0.07
Manganese, percent	0.40-1.50
Chromium, percent	at least 17
Nickel, percent	at least 9.5
Tensile strength, min. pounds per square inch	75,000
Yield point, min. pounds per square inch	35,000
Elongation in 2 inches, minimum, percent	30

It is pointed out that this class of material has previously been recognized in Case No. 792 and in the recently issued Specifications S-33 for alloy-steel castings, S-34 for seamless alloy-steel pipe, and S-35 for alloy-steel pipe flanges.

Reply: It is the opinion of the committee that stabilized austenitic chrome-nickel steel conforming to A.S.T.M. Specifications A 167-35T, grade 4, with the chemical limits modified as above, may be used for the construction of welded unfired pressure vessels, this steel to be stabilized with either columbium or titanium. The minimum columbium content shall be 10 times the actual carbon content with a maximum of 1 percent; the minimum titanium content shall be 6 times the actual carbon content with a maximum of 0.60 percent.

The rules in Par. U-68 shall apply, except modified as follows: The stress-relieving and stabilizing heat-treatment of the vessel of columbium-bearing steel shall be performed at a temperature not less than 1550 degrees F. and held at that temperature for a period of time proportioned on the basis of at least 1 hour per inch of thickness but in no case less than 2 hours, and of the vessel of titanium-bearing steel shall be performed at a temperature not less than 1550 degrees F. and not to exceed 1650 degrees F. and held at that temperature for a period of time proportioned on the basis of at least 1 hour per inch of thickness but in no case less than 4 hours. The complete vessel shall be heat-treated as a unit, no local stress relieving being permitted and it shall be allowed to cool slowly in a still atmosphere.

The welded test plates shall be made from the same lot of material as the vessel itself, they shall be heat-treated with the vessels, and, if possible, placed inside the vessel.

The free-bend test specimen, which need not be more than 6 inches in length, shall be subjected to a "susceptibility to embrittlement" test * as follows: The specimen shall be reheated to and held at 1200 degrees F. for 1 hour, the top and bottom surfaces of the specimen shall be ground and polished and the specimen immersed in a boiling copper-sulphate sulphuric-acid solution for a minimum period of 48 hours. This solution shall consist of 47 cubic centimeters concentrated sulphuric acid and 13 grams of crystalline copper sulphate ($CuSO_4.5H_2O$) per liter of solution. After immersion the samples shall be bent as specified in Par. U-68. The elongation on the outside fibers shall not be less than 20 percent, at which there shall be no evidence of fissuring.

Representative drillings of the weld metal shall be obtained from one of the welded test plates and the chemical analysis of the weld metal shall be within the following limits: The chromium and nickel content of the weld metal shall be within the same range as the parent metal;

* This test proves the stability of the weld metal and the parent metal adjacent to the weld.

the columbium content of the weld metal, when columbium is used as the stabilizing element in the weld metal, shall be at least 9 times the carbon content of the weld metal and shall not exceed 1 percent; the titanium content of the weld metal, when titanium is used as the stabilizing element of the weld metal, shall be at least 5 times the carbon content of the weld metal and shall not exceed 0.60 percent. In case the chemical analysis of the first drillings of the weld metal fails to meet the foregoing specifications, two additional sets of drillings may be taken from the same welded test plate and the test shall be considered satisfactory if both these retest analyses meet the specifications.

The allowable stress in the design formula shall not exceed 15,000 pounds per square inch, for operating temperatures up to 900 degrees F., with a joint efficiency of 90 percent.

CASE NO. 836

(In the hands of the Committee)

CASE NO. 837

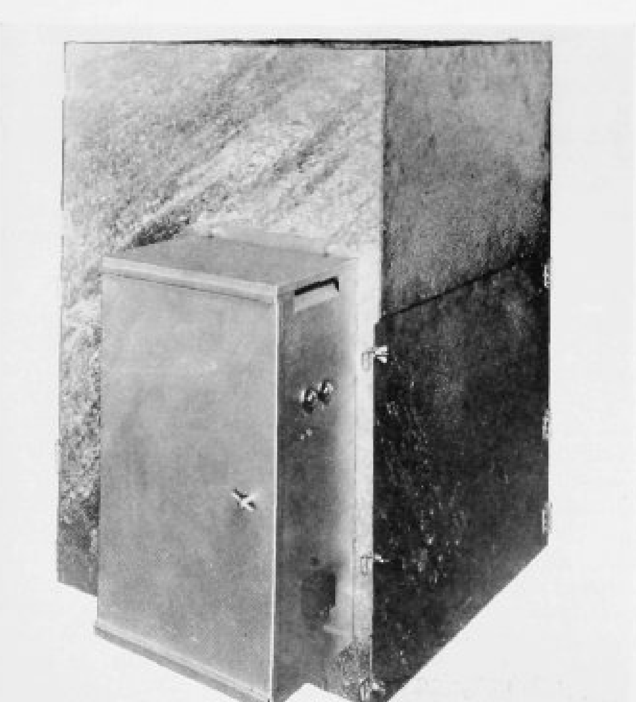
(In the hands of the Committee)

New Electrostatic Precipitator Introduced

A new electrostatic precipitator for general industrial air cleaning use with an operating efficiency as high as 99 percent by weight has been announced by the Pangborn Corporation, Hagerstown, Md. The unit is particularly suitable for salvaging valuable dust, mass air cleaning, or removing objectionable particles from gas or vapor and similar applications.

This precipitator with electrical parts by Westinghouse is claimed to have the following advantages:

1. Small size of unit reduces space requirements and cost and permits a complete factory assembled unit.



Electrostatic precipitator for air cleaning

2. Small vacuum tube power pack attached directly to precipitator cabinet eliminating the usual separate room for high voltage generating equipment.
3. Discharged air does not contain appreciable amounts of ozone nor oxides of nitrogen and may be breathed without irritation of the membranes.
4. May be designed for efficiencies as high as 99 percent (by weight) and to remove particles as small as one-fifth micron.
5. Operates at lower voltages permitting use of electronic tubes of standard industrial classification and with lower power consumption.
6. Low and constant air flow resistance through the unit resulting in reduced power and uniform air volume.

The illustration shows a unit recently built for a large pottery plant for the removal of excess glaze dust from the air. In general, the complete unit consists of three parts: collector cells, ionizing assembly, and power pack.

Number of Boilers Required on Passenger Vessels

In answer to a question frequently asked; namely, are there any special reasons why some of the large passenger vessels have a comparatively large number of boilers, and what are the particular reasons for employing a larger or smaller number of boilers, the following explanation is given:

The simplest and cheapest installation would be to have one main boiler, but in this case any damage or even slight derangement to this boiler would prevent steaming. Vessels are, therefore, generally supplied with at least two boilers. This allows one to be overhauled or cleaned while the other can supply steam. On vessels that do not steam continuously at full power a number of boilers permits boilers being put in operation to suit the power desired. Under such conditions idle boilers can be cleaned and overhauled at sea. Four boilers would enable a vessel to leave off one or two boilers when steaming below full power and would provide a boiler of reasonable size for port use.

The tendency is now toward the use of larger boilers and fewer of them. Since watertube boilers having 12,000 square feet of heating surface and which are capable of furnishing steam for 15,000 horsepower can be supplied to vessels, it is apparent that more than six boilers would hardly be required for even a high-powered vessel.

Until recently there has been some conservative hesitancy against using very large boilers, but since it has been found that the larger boilers can be provided, and that they give greater operating efficiency and provide less opportunity for heat losses and less expense for maintenance of refractory, the use of fewer and larger boilers may be expected. With fewer boilers the piping is simplified and the cost of boiler valves, fittings and accessories is less. A smaller number of boilers also requires less operating personnel.

There is, therefore, every reason to limit the number of boilers to such an extent that a reasonable sized unit is provided for port use, and that sufficient flexibility is provided for various rates of steaming, and that the derangement of one unit will not cause too much of a loss in power. As it is quite possible to secure as much as 20,000 horsepower from one boiler unit, a vessel of 200,000 horsepower would not require more than ten.

With fewer boilers the space required also will be less except that more height may be needed. This, of course, is usually available on a large passenger vessel.

Practical Plate Development—XXI

Development of Intersecting Cones

By George M. Davies

The intersecting cones to be developed are shown in Fig. 177, the elevation, and in Fig. 178, the end view. The two cones intersect each other at an oblique angle. For convenience, the thickness of the plate has been omitted and the outline shown has been taken on the neutral axis of the plates. The joints are assumed to be welded, with no allowances being provided on the pattern for fitting or welding.

To develop the conical sections it is first necessary to obtain the miter line at the intersection of the conical sections.

Extend the center line *O-K*, Fig. 177, and at any point as *L* draw the half profile of the base of the large cone as shown in Fig. 179. Divide half of this profile into any number of equal parts, the greater the number of equal parts taken the more accurate the final development; six parts being taken in this case. Number the divisions from 1 to 7 as shown. Then parallel to the center line *O-K* draw lines through the points 1 to 7 and extend them into the elevation, cutting the base line *A-B*. Number these points from 1′ to 7′ as shown. Connect the points 1′ to 7′ with the center *O* as shown.

Then in the end view extend the center line *O′-B′* and at any point as *L′* draw the half profile of the base to the large cone as shown in Fig. 180. Divide half the profile into the same number of equal parts as was taken in the half profile, Fig. 179. Number the points from 1 to 7, each number to correspond to the same number as taken in profile, Fig. 179. Parallel to the center line *O-B′* draw lines through the points 1 to 7, Fig. 180, and extend them into the end view cutting the line *K′-B′*. Number the intersections from 1′ to 7′, as shown. Connect the points 1′ to 7′ with the center *O′* as shown.

Next on the center line *N-P* of the small cone at any point as *S* draw the half profile as shown in Fig. 182. Divide this into any number of equal parts, the greater the number of equal parts taken the more accurate the final development, eight parts being taken in this case. Number the divisions from *a* to *k* as shown. Parallel to the center line *N-P* draw lines through the points *a* to *k*, extending same cutting the line *G-F*. Number the intersections from *a′* to *k′* as shown.

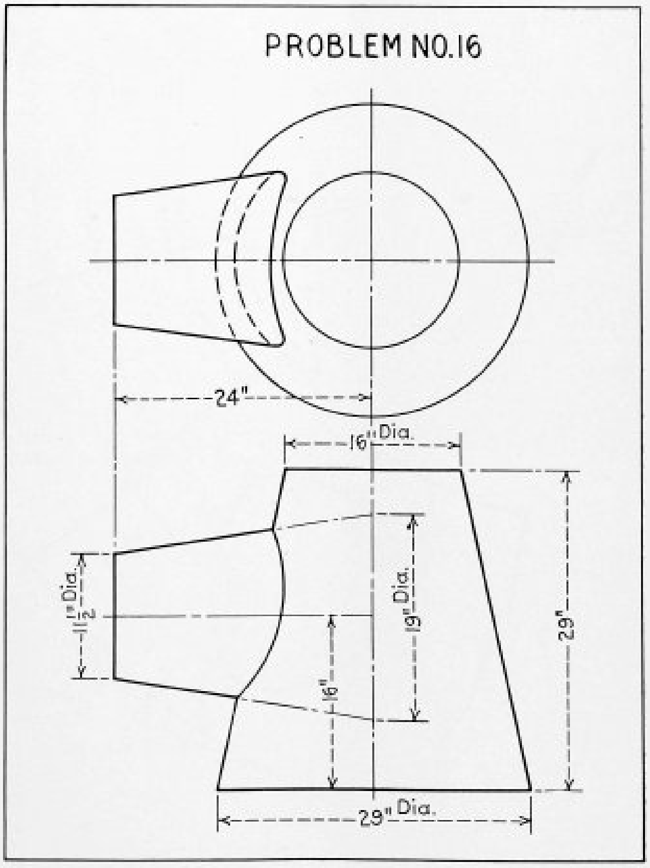
Next on the center line *O′-L′* at any point as *T* draw the profile, Fig. 181, this profile being a duplicate of profile, Fig. 182, just drawn. Divide the half profile of Fig. 181 into the same number of equal parts as was taken in profile, Fig. 182, and number the divisions from *a* to *k*, corresponding to the same numbers in profile, Fig. 182.

Parallel to the line *A-B*, draw a line through the point *a′*, Fig. 177, and extend same into the end view cutting the center line *O′-B′*, locating the point *a″*. Then parallel to the line *A-B* draw a line through the point *b′*, Fig. 177, and extend same into the end view. Parallel to the center line *O′-B′* draw a line through the point *b*, Fig. 181, extending same into the end view cutting the line just drawn locating the point *b″* of the end view; in like manner locate the points *c″*, *d″*, *e″*, *f″*, *g″*, *h″* and *k″*. Connect these points with a line as shown.

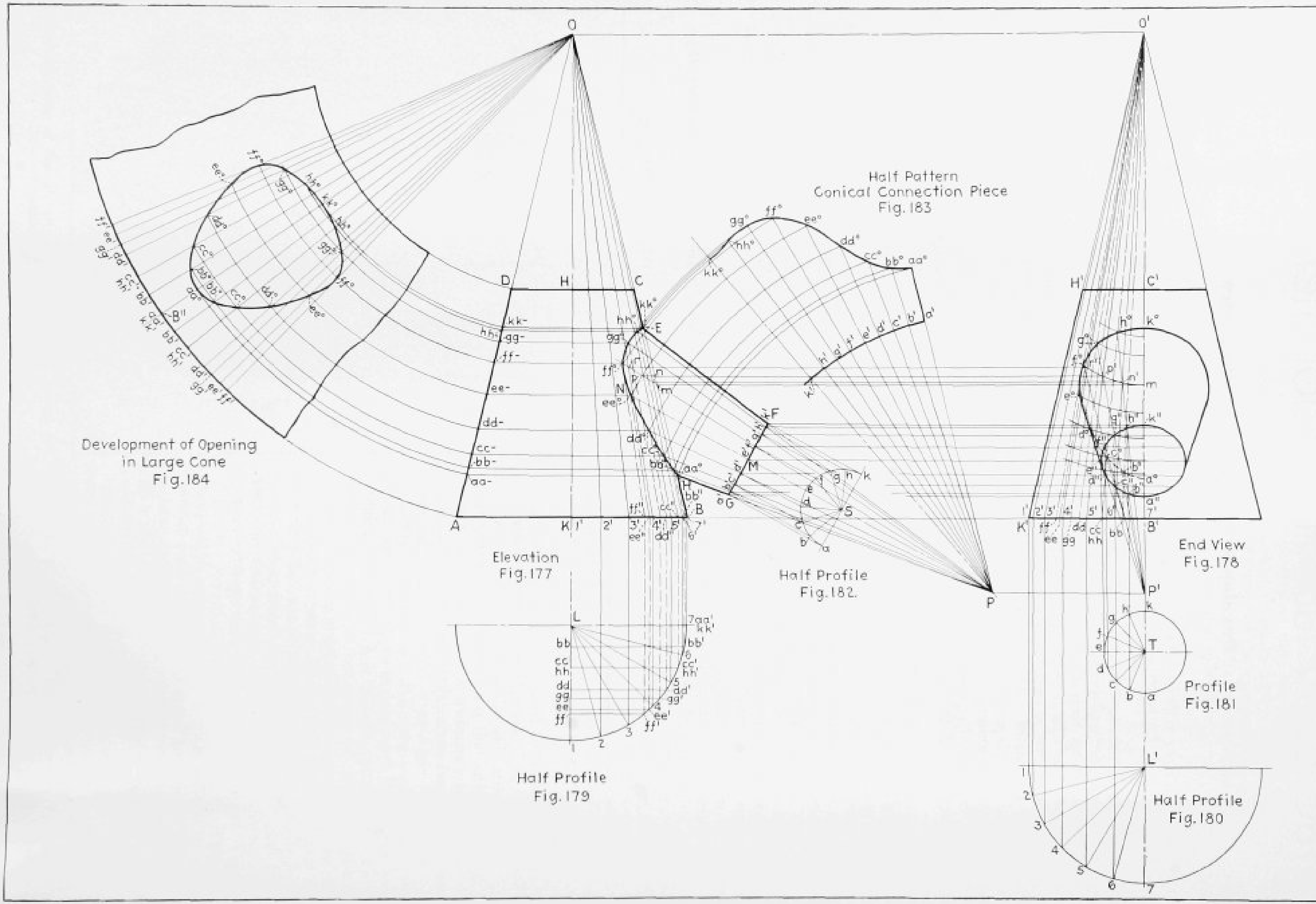
Next draw lines through the points *a′* to *k′* and the center *P*, Fig. 177, extending same into the side elevation cutting the surface lines drawn from the center *O* to the points 1′ to 7′. Each of the lines radiating from the center *P* through to points *a′* to *k′* must be taken as a plane which cuts the surface lines O-1′ to O-7′ of the large cone. The next step is to obtain the contour of the plane of each of the lines radiating from the center *P*. For example, take the line *P-f′*. This line cuts the surface line O-7′ at *m*, and the surface line O-6′ at *n*, the surface line O-5′ at *p*, and O-4′ at *r*.

Draw lines parallel to *A-B* through the points *m*, *n*, *p* and *r*, extending same into the end view and, where the line drawn through the point *m* cuts the line O′-7′ of the end view locates the point *m′*, Fig. 178. Where the line drawn through the point *n* cuts the line O′-6′, Fig. 178, locates the point *n′*, Fig. 178. In like manner locate the

Problem No. 16 for Readers to Lay Out



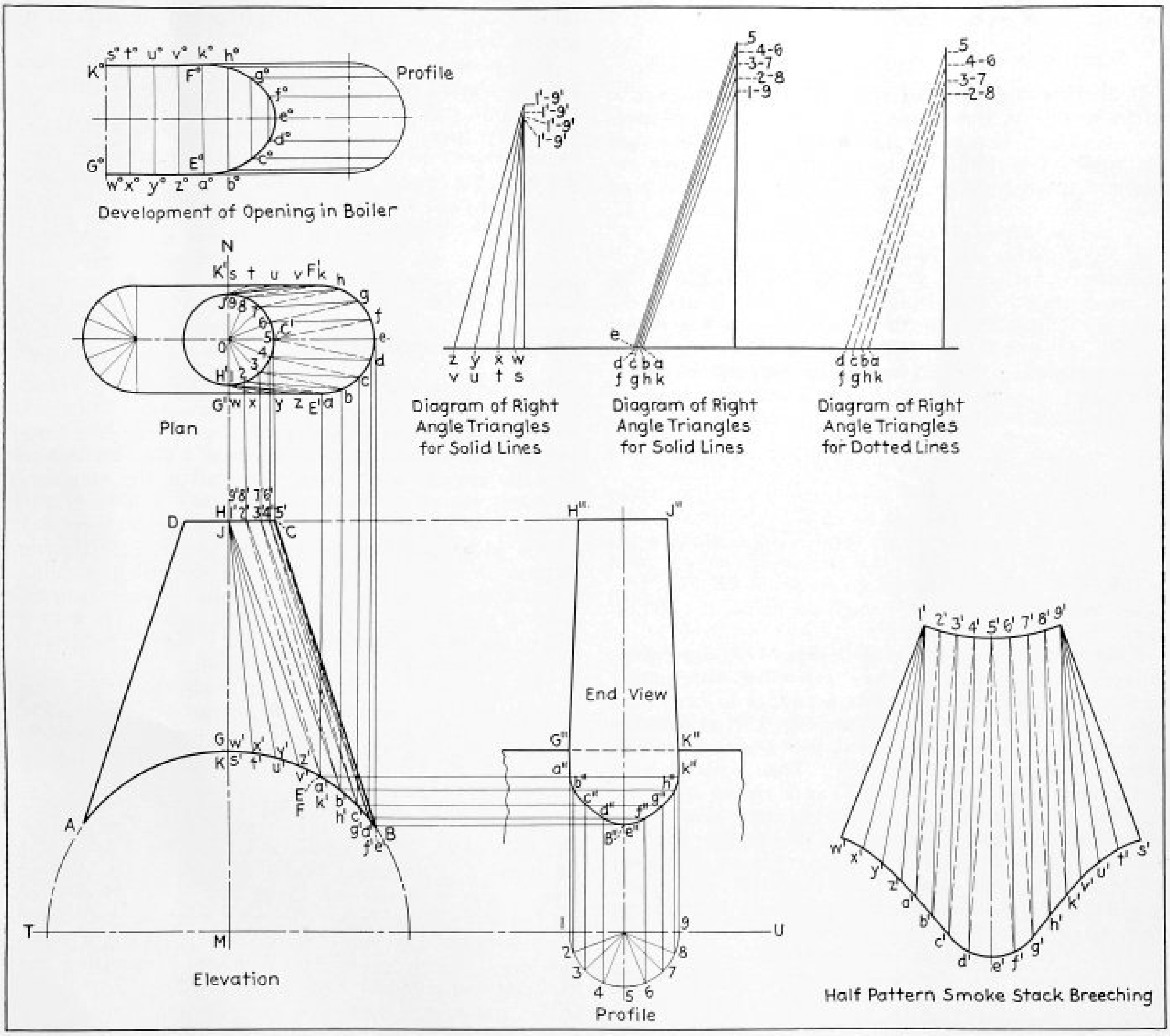
The correct solution of Problem No. 16 will be published in the April issue



Development of patterns for intersecting cones

Problem No. 15---Correct Layout

Smokestack Breeching



Problem No. 15 appeared on page 339 of the December, 1936, issue. The correct solution is published herewith in order to give our readers who have developed the problem an opportunity to check their work

points p' and r', Fig. 178. Connect the points m', n', p', r' with a line which represents the plane of the line P-f', Fig. 177, as it cuts the surface lines of the large cone.

In the same manner draw the planes of the lines P-b', P-c', P-d', P-e', P-g' and P-h' where same intersect the surface lines of the large cone in Fig. 177 as shown in Fig. 178.

Next draw a radial line from the point P', Fig. 178, through the point b''; extend same, cutting the line representing the plane of the line P-b', Fig. 177, locating the point b°, Fig. 178. Then draw a radial line from the point P', Fig. 178, through the point c''; extend same cutting the line representing the plane of the line P-c', Fig. 177, locating the point c°, Fig. 178. In the same manner locate the points d°, e°, f°, g°, h° and k°. Connect these points with a line, which line will be the miter line between the two cones as it appears in the end view.

Draw radial lines from the point o', Fig. 178, through the points b°, c°, d°, e°, f°, g° and h° and extend same to the base K'-B', locating the points bb, cc, dd, ee, ff, gg, hh.

Next in the profile, Fig. 177, on the center line O-L step off the distance L-bb equal to B'-bb of Fig. 178, L-cc equal to B'-cc, L-dd equal to B'-dd, L-ee equal to B'-ee, L-ff equal to B'-ff, L-gg equal to B'-gg, L-hh equal to B'-hh. Then draw lines parallel to L-7 through the points bb, cc to hh, Fig. 179, cutting the profile at the points bb', cc' to hh' as shown. Next parallel to the center line O-L draw lines through the points bb' to hh', extending same into the elevation cutting the base line A-B, locating the points bb'' to hh''.

Then from the center O draw radial lines through the points bb'' to hh''. Next parallel to the base line A-B' draw a line through the point $b°$, Fig. 178, extend same into the elevation, cutting the radial line O-bb'', locating the point $bb°$, Fig. 177. In the same manner locate the points $cc°$ to $hh°$. Connect the points $aa°$, $bb°$, $cc°$, $dd°$, $ee°$, $ff°$, $gg°$, $hh°$ and $kk°$ with a line, which line will be the miter lines between the two cones.

Pattern of the Conical Connection Piece

With P as a center and with P-F as a radius, scribe an arc as in Fig. 183. On this arc step off the distances a'-b', b'-c' to h'-k' equal to the distance a-b, b-c to h-k of the profile, Fig. 182. Next draw radial lines from the center P through the points a' to k', Fig. 183 and extend same. Then with P as a center and with P-$aa°$, Fig. 177, as a radius scribe an arc cutting the radial line P-a', Fig. 183, locating the point $aa°$, Fig. 183. Then with P as a center and with P-$bb°$, Fig. 177, as a radius scribe an arc cutting the radial line P-b', Fig. 183, locating the point $bb°$, Fig. 183; in like manner locate the points $cc°$, $dd°$, $ee°$ to $kk°$, Fig. 183. Connect these points with a line completing the half pattern of the conical connection piece. A duplicate of this pattern added on along the line k'-$kk°$ will give a complete pattern.

Opening in the Large Conical Section

With O as a center and with O-A as a radius scribe an arc; draw any radial line as O-B''. On the arc first drawn step off each side of the line O-B'' a distance equal to aa'-bb', aa'-cc', aa'-dd', aa'-ee', aa'-ff' aa'-gg', and aa'-hh', Fig. 179, locating the points aa' to kk', Fig. 184. Draw radial lines from O through the points aa', bb', cc' to kk', Fig. 184 as shown.

Next parallel to the line A-B, Fig. 177, draw lines through the points $aa°$, $bb°$ to $kk°$ extending same cutting the line O-A, locating the points aa, bb, cc to kk. Then with O as a center and with O-aa, Fig. 177, as a radius scribe an arc cutting the radial line O-aa', Fig. 184, locating the point $aa°$, Fig. 184. Then with O as a center and with O-bb, Fig. 177, as a radius scribe an arc cutting the radial lines O-bb', Fig. 184, locating the points $bb°$, Fig. 184. Continue in this manner locating the points $cc°$, $dd°$ to $kk°$, Fig. 184. Connect the points $aa°$ to $kk°$ each side of the center line O-B'' with a line completing the development of the opening in the large cone.

(*To be continued*)

Marine Inspection Bureau Requires Code Boilers

In circular letter No. 136, addressed to supervising, traveling, local and assistant inspectors, J. B. Weaver, director of the Bureau of Marine Inspection and Navigation, refers to blue prints covering design of boilers inspected for Government agencies as follows:

Your attention is called to the Bureau's circular letter of August 7, 1934, in regard to the approval of boilers purchased by various government agencies and inspected upon request by this bureau, and in this connection you are advised that this office is in receipt of information to the effect that government agencies are still purchasing boilers which do not conform to any recognized construction rules and that in many cases no blue prints or data are furnished the local inspectors upon which to base an approval of the design.

You are, therefore, instructed, when request is made by government officials for inspection of new boilers, to require that blue prints and other data be submitted to enable you to determine whether or not the boilers are constructed in accordance with recognized safety rules. The Boiler Code requirements of the American Society of Mechanical Engineers may be accepted for stationary, locomotive, or heating boilers installed in land plants. The requirements of the Bureau's Code should, on the other hand, govern the construction and installation of marine boilers on vessels.

Where request is made for the inspection of boilers not constructed in accordance with the above-mentioned codes, you will make the inspection and report on the conditions found. A definite statement should be made in your report that inasmuch as this particular boiler does not meet the requirements of the A. S. M. E. Code, nor of the Bureau's Code, as the case may be, you can not approve the design.

Ohio State University Welding Conference

The Department of Industrial Engineering, Ohio State University, Columbus, Ohio, announces March 3, 4 and 5 as the dates for the Sixth Annual Welding Conference and Exposition at Columbus. This conference annually attracts many men interested in the manufacture and use of welding equipment.

This year's conference will include a special three-day course in arc-welding design and practice, presenting material of interest to all who are interested in welding—architects, engineers, designers, production managers, welding supervisors, foremen and operators. The course will be under the direction of E. W. P. Smith, nationally known welding authority of Cleveland.

The purpose of the course is to study the arc-welding process and its applications to design and fabricating problems. The process will be considered from the arc to the finished product. The following subjects will be covered:

The Shielded Arc, Its Value and Use in Design; Welding Ferrous and Non Ferrous Metals; Use of Special Electrodes; Weld Inspection, Checking Fusion and Penetration; Calculating Stress Distribution in Welded Joints; Use of Polarized Light and Weld Models of Rubber and Celluloid; Arc-Welded Design as Applied to Structures and Dwellings; Redesign of Cast and Riveted Machine Structures for Arc Welding; Organizing the Welding Department; Estimating Welding Costs.

The course will consist of morning and evening sessions devoted to lectures and welding demonstrations.

Complete information regarding the Welding Conference and the special course in arc-welding design and practice can be obtained by writing to O. D. Rickly, general chairman, Sixth Annual Welding Conference and Exposition, Department of Industrial Engineering, Ohio State University, Columbus, O.

New York Safety Council to Meet in April

The Eighth Annual Convention of the Greater New York Safety Council will be held at the Astor Hotel, New York City, on April 13, 14 and 15. A program of approximately 40 sessions covering every phase of accident prevention work has been developed for the benefit of 7000 who will attend this annual meeting.

Sessions will cover safety in industrial occupation, in the home, highway, marine, air transportation, fire, dust control, first aid, eyesight and many other subjects of health and the elimination of hazards.

British Research on Cracking of Boiler Plates

By G. P. Blackall

Prolonged stress and tensile tests upon specimens of boiler plates were carried out at the British National Physical Laboratory, Teddington, last year, in a steel cylinder specially designed for the purpose. However, no widespread inter-crystalline cracking of the kind found in failures in service was produced in the specimens tested. Further work is therefore being carried out under intensified conditions of test.

The full-scale investigations into the behavior of steel boiler plate and riveted joints under corrosion and fatigue conditions, comparable to those which might occur in a boiler, have been continued upon the specially designed machine for the application of alternating bending stresses at slow speeds.

When these researches are concluded it is anticipated that data of great technical interest will be forthcoming for plate fabricators and boilermakers.

Requirements for Filler Rod for Marine Fusion Welding

Circular letter No. 140 has recently been issued to boiler manufacturers, shipbuilders, and contractors, U. S. supervising, traveling, local and assistant inspectors by J. B. Weaver, director of the Bureau of Marine Inspection and Navigation, on the subject of physical tests of filler metal for use in fusion welding. The information contained in the instructions is given below as follows:

The results of qualification tests of welding operators made by this bureau have clearly indicated the necessity for setting up rules for the approval of filler metal used in marine fusion welding; therefore, the Bureau has established an approved list of welding rods which may be used for this purpose. The approval of the welding rods in the list as published in Bureau Circular Letter No. 129, dated September 15, 1936, is based on the performance of certain filler metals used in the qualification tests of welding operators. This list may be supplemented from time to time by filler metal made by other manufacturers than those on the present approved list, which material shall be tested in accordance with the following requirements, and shall be made to the form and dimensions shown with instructions on the attached sketch.

Filler metal used in connection with electric arc welding will be referred to as electrodes. Filler metal used in connection with the gas process of welding will be referred to as welding rods.

Electrodes and welding rods shall be made in accordance with the following standard diameters: $\frac{1}{16}$, $\frac{3}{32}$, $\frac{1}{8}$, $\frac{5}{32}$, $\frac{3}{16}$, $\frac{1}{4}$, $\frac{5}{16}$ inch.

The test specimens shall be forwarded to Division 6, Section 5, National Bureau of Standards, Washington, D. C., for test.

The fee for making such tests shall be paid by the manufacturer requesting approval.

The test specimens shall be made of deposited metal.

The test specimens shall be prepared in the presence of a duly authorized inspector of this bureau and stamped by him for identification.

All test specimens shall be prepared either in the vertical or overhead position, regardless of the process used.

PHYSICAL CHARACTERISTICS

Electrodes and welding rods shall be of uniform quality, free from harmful segregation, pipe, seams, oxides, or other irregularities.

Cross-sectional dimensions shall not vary more than three percent plus or minus from that specified.

Cut lengths shall be commercially straight, and shall not vary more than $\frac{1}{8}$ inch plus or minus from that specified.

The surface of the metal shall be smooth and free from harmful scale, oil, or grease, and may be plain or copper finished, as specified.

The test specimens of the deposited metal shall show the following physical properties in the unstress relieved condition:

Tensile strength, 60,000 pounds per square inch.

Elongation, free bend method, in a length of 2 inches, 30 percent across the fibers of the weld.

Elongation, computed from tension test specimens, 22 percent in 2 inches.

Specific gravity not less than 7.80.

The test specimens of the deposited metal shall show the following physical properties in the stress relieved condition.

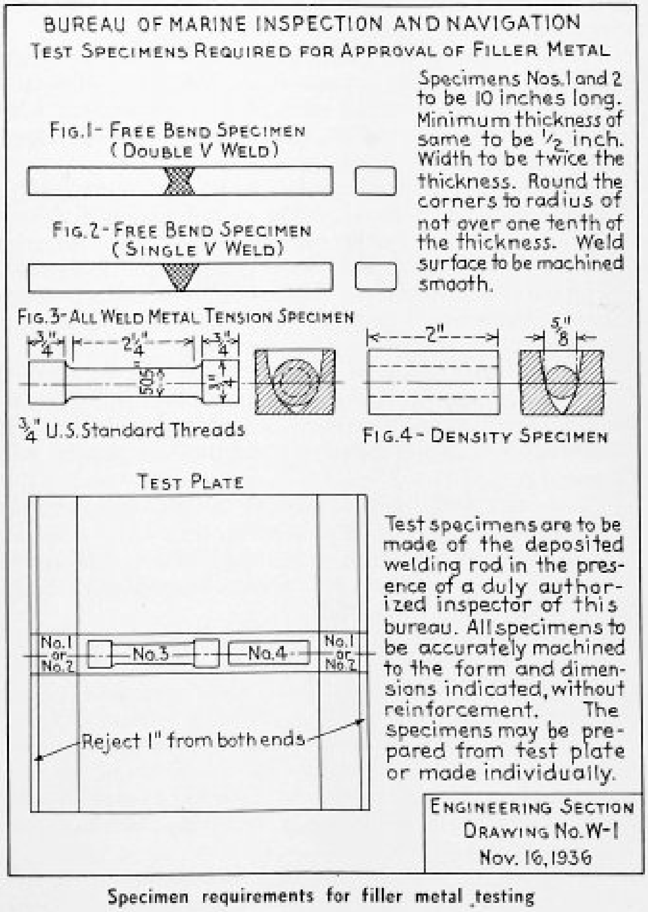
Tensile strength, equal to the minimum range of the plate which is to be welded.

Elongation, free bend method, 30 percent across the fibers of the weld.

Elongation, computed from tension test specimens, 25 percent in 2 inches.

Specific gravity not less than 7.80.

Stress relieving shall be within a range of 1100 de-



Specimen requirements for filler metal testing

grees to 1200 degrees F. for one-half hour for each ½ inch of thickness, based on one hour per 1 inch of thickness.

METALLIC ELECTRIC ARC ELECTRODES

Electrodes shall be of the shielded type and the coating or covering shall be tested and examined to ascertain that it is not readily damaged by ordinary handling. It shall be of commercially uniform thickness and present a workmanlike appearance. The ends shall be free of coating for a distance not exceeding one nominal diameter of the rod. The arc end of the rod shall be sufficiently uncovered as to cause no difficulty in striking an arc.

WELDING RODS

Welding rod specimens intended for use in fusion welding by the gas process shall be prepared in the same manner as those for welding electrodes, and shall conform to all the requirements for physical tests specified for welding electrodes.

Lincoln Foundation Announces Arc-Welding Competition

One of the richest awards ever established for competition in the field of mechanical science has just been announced by The James F. Lincoln Arc Welding Foundation.

To stimulate intensive study of arc welding, $200,000 will be distributed by the Foundation among winners of 446 separate prizes for papers dealing with this subject as a primary process of manufacture, fabrication or construction in eleven major divisions of industry.

The principal prize winner will receive not less than $13,700. Other prizes range from $7500 to $100—the latter sum to be awarded each of 178 contestants who receive no other prize, but whose papers are adjudged worthy of honorable mention.

In order to assure equal competitive opportunity, similar prizes are offered in the eleven major divisions of industry covered by the contest. These divisions are: Automotive, Aircraft, Railroad, Watercraft, Structural, Furniture and Fixtures, Commercial Welding, Containers, Welderies, Functional Machinery and Industrial Machinery.

Wide diversification of awards is effected by further dividing each major industry into various sub-classifications; with entrants required to select in advance the particular sub-classification to which their papers will relate.

When accepted by the Jury of Awards as properly classified, each paper will be in competition, in its particular sub-classification, for five initial prizes established for that group. These are worth, respectively, $700, $500, $300, $200 and $150.

From among these sub-classification winners, four papers will be selected in each major industry to receive additional prizes of $3000, $2000, $1000 and $800. Thus these 44 semi-finalists will be awarded a total of $74,800.

In addition, the semi-final winners in the various divisions will be considered as possible recipients of the four main prizes. These range from $10,000 to $3500, with the winner of the grand prize receiving not less than $13,700 for his paper.

To participate in this contest, it is necessary that submitted papers describe either the redesign of an existing machine, structure, building, etc., so that arc welding may be applied to its manufacture; or that they present a design (either in whole or in part) of a machine, structure, building, etc., not previously made—the description to show how a useful result, which was impractical with other methods of construction or could better be done by arc welding, is obtained.

In certain classifications, however, slightly different eligibility requirements obtain. In the divisions of Commercial Welding and Welderies, for example, owners and operators of functioning establishments may enter the competition with papers which describe details for successfully conducting such a business.

Contestants, it was announced, must have papers in duplicate on file with the secretary of the Foundation, at Cleveland, not later than June 1, 1938. Prospective entrants should communicate promptly with Foundation Secretary A. F. Davis, P. O. Box 5728, Cleveland, for complete details of the rules and conditions covering awards.

This competition, with its long list of valuable prizes, marks the first announced activity of the Foundation since its establishment, at the close of 1936. Already, however, the Foundation has received wide acclaim among educators and publishers in the engineering world.

Dr. Dreese emphasized the fact that the competition may be entered by any person, or group of two or more persons; the sole limitation being that any contestant may enter only one paper, on only one subject, in only one of the sub-classifications listed.

Further, each contestant must actually have participated in work upon which the subject matter of his paper is based; and the contestant's exact relation to that work, and to the producing or developing organization, must be clearly stated.

Employers are particularly invited to urge their qualified workers or associates to communicate with the Foundation promptly, and prepare to submit papers for some of the substantial awards offered.

Manufacturing Activity in December as Measured by Man-Hours Worked

Manufacturing activity in December, as measured by the total number of man-hours worked, increased 3.9 percent over November, according to the National Industrial Conference Board's regular monthly survey of wages, hours, and employment in 25 manufacturing industries.

This gain was the result of an increase of 2.5 percent in the number of workers employed and an advance of 1.2 percent in the average hours worked per wage earner.

Hourly earnings averaged 63.5 cents in December as compared with 62.4 cents in November, an increase of 1.8 percent. This rise in average hourly earnings in the face of a substantial increase in employment indicates that wage rates have been raised even to a larger degree than indicated by average hourly earnings. Average weekly earnings advanced from $25.83 in November to $26.62 in December, or 3.1 percent. Although part of the rise in weekly earnings was offset by an increase in living costs, real weekly earnings were still 2.6 percent higher than in November.

At the close of 1936, distinct gains were noted by the Conference Board as compared with conditions existing at the close of 1935. In December, 1936, there were

13.2 percent more workers employed than in December, 1935, and their combined payroll was 28.8 percent higher than a year ago. Average hourly earnings advanced during the year interval from 60.4 cents to 63.5 cents, or 5.1 percent. Nominal weekly earnings rose from $23.38 to $26.62, or 13.9 percent.

A comparison of conditions in December, 1936, with those prevailing in 1929, shows that although manufacturing activity, as measured by total man hours, was still 15.7 percent below the average 1929 level, the number of workers employed was only 2.7 percent less than in 1929. The average work week was 41.8 hours in December, 1936, as compared with 48.3 hours in 1929. Hourly earnings averaged 63.5 cents in December, 1936, as compared with 59.0 cents in 1929, or 7.6 percent higher. Real weekly earnings in December, 1936, were 8.3 percent higher than in 1929.

Lincoln Gold Medal Accepted by Welding Society

The President of the American Welding Society is pleased to announce the acceptance by the Board of Directors of the society of a gold medal to be known as the "Lincoln Gold Medal," to be presented to the author of the best paper on any phase of welding published in the *Journal* of The American Welding Society during the year October 1936 to October 1937.

A committee of three will be appointed to make the award, and the gold medal will be presented during the annual convention in October 1937.

The society appreciates the generosity of J. F. Lincoln, president of The Lincoln Electric Company, in offering this excellent award as a stimulus to the preparation of worth-while contributions to the art of welding.

No paper will be considered for this award unless it is received by the editor of the *Journal* before September 15, 1937.

The conditions of the award are:

First—Medal to be given through the American Welding Society.

Second—To be given to the writer of the paper which contributes most to the development and advancement of welding during 1937.

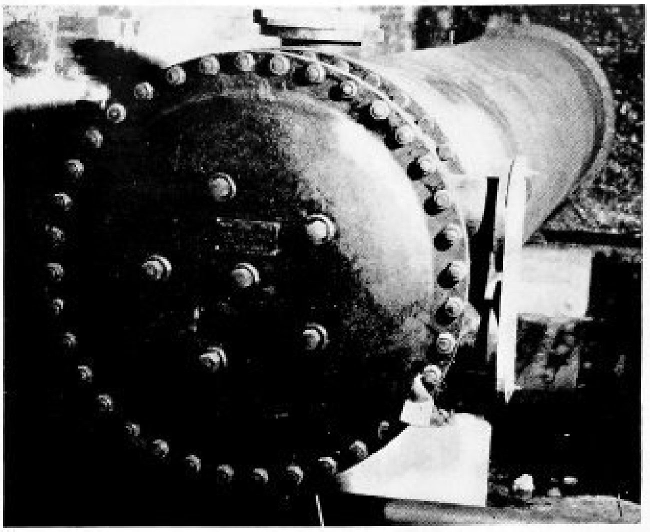
Third—This paper may be given before any Section of the American Welding Society or at the general Fall Meeting of the American Welding Society.

Fourth—No restrictions will be placed as to the subject matter; i. e., paper may be on electric arc, gas, resistance or any other form of welding coming under the scope of the American Welding Society.

Fifth—Decision as to the best paper to be made by a committee selected by the president, such committee to be known as "The Lincoln Gold Medal Award Committee." The award to be made at the Annual Meeting which will probably be held in October of 1937.

Sixth—The committee in considering the award will consider the papers to be given at the 1937 Fall Meeting.

Wrought Iron Used in Heat Exchanger



Wrought iron heat exchanger in chemical plant

The illustration shows one of two identical heat exchangers, installed January, 1936, at the plant of Penobscot Chemical Fibre Company, Great Works, Me. Both units were built by Whitlock Coil Pipe Company, Hartford, Conn., and tubed with Byers 1½-inch outside diameter gage wrought iron tubes 16 feet 9⅛ inches long. Also, the tube sheets were fabricated from Byers 1⅜-inch and 1⅝-inch wrought iron plates. The cooling medium in both exchangers is cold filtered water. In one of the units the hot liquid is the effluent of a washer handling a mixture of pulp and hypochlorite of calcium residue. The principal chemical constituent of this effluent is calcium chloride. The other exchanger has, for the hot fluid, a dilute solution of the black liquor resulting from digesting wood in a solution of caustic soda.

New District Managers Appointed by Crane Company

In pursuance of a plan started sometime ago to provide closer relations with the trade and between branches, general office, and factories, Crane Company, Chicago, announces the establishment of two new sales districts—the East Central and the South Eastern—in charge of C. S. Pitkin and J. G. Johns, respectively. Mr. Pitkin has been manager of the Pittsburgh branch since it was established in 1922, and Mr. Johns, at Birmingham, since 1920. Other changes in local branch management are as follows:

H. M. Moss, sales manager at Pittsburgh, succeeds Mr. Pitkin as branch manager.

F. D. Morrison, assistant manager at Birmingham, becomes manager, succeeding Mr. Johns.

F. W. Zander, manager at Buffalo, retires from active management on account of ill health but has consented to remain as special representative.

G. E. Anderson, manager of Lima branch, has been transferred to Buffalo as Mr. Zander's successor.

E. R. Henning succeeds Mr. Anderson as manager at Lima.

The retirement of H. L. Wood, Sioux City, Iowa, also on account of ill health, moves T. R. Brady, manager of the Rockford, Ill., branch to Sioux City as manager, and R. E. Doherty, sales manager at the Portland, Ore., branch, is made manager at Rockford.

E. T. Rowe, formerly manager of Syracuse branch, has been appointed manager of the Boston branch, succeeding T. H. Dawson, Jr., who has decided to leave the service of the company. A H. Buck, assistant manager at Pittsburgh branch, succeeds Mr. Rowe as manager of the Syracuse branch.

Boiler Maker and Plate Fabricator

Reg. U. S. Pat. Off.

VOLUME XXXVII NUMBER 2

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EDITORIAL STAFF: H. H. Brown, Editor. L. S. Blodgett, Managing Editor. H. W. MacDonald, Associate Editor.

BUSINESS MANAGER: Warner Lumbard.

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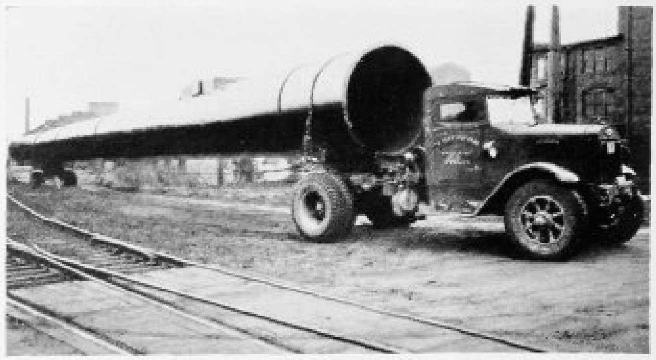
Communication

Pre-Fabricated Smokestack

TO THE EDITOR:

On page 332 of the December, 1936, issue of BOILER MAKER AND PLATE FABRICATOR there appeared an article pertaining to a 57-inch diameter by 104-foot smokestack. The article stated: "This is thought to be the tallest pre-fabricated steel stack ever erected."

I am enclosing an illustration of a steel stack which was built about two years ago by the Muskegon Boiler Works, Muskegon, Mich.



150-foot smoke stack being shipped to location

The stack is all-welded, 150 feet high, 72 inches in diameter, and made of 1/4 and 3/16-inch plate. This stack was built for the Naph-Sol Refining Company, Muskegon, Mich.

It was hauled by truck, completely built up, from the Muskegon Boiler Works to the refinery (a distance of about five miles) by the Erickson Trucking Service, Muskegon, Mich., who also erected it.

The picture was taken just after the stack had been hauled out of the boiler shop at the left side of the picture and the tractor is about to negotiate the first of two 90-degree turns which were encountered along the route.

Muskegon, Mich. SIDNEY CHEASLEY

Trade Publications

PLATING EQUIPMENT.—The Udylite Company, Detroit, Mich., manufacturer of a complete line of equipment and supplies for all plating processes, has prepared a bulletin giving a description of the more common equipment and supply items of plating installations.

NICKEL ALLOYS.—Inco No. 3, the Winter edition, 1936, published by the International Nickel Company, Inc., New York, includes articles on the use of nickel-alloys in linings for refrigerated holds of fishing vessels, thermometers, springs, heavy machine repairing, valve construction and hospital equipment.

ARC WELDING.—A new catalogue on the recently developed 40-volt simplified electric arc welding has been prepared by the Hobart Brothers Company, Troy, O. It contains many illustrations of the various jobs this new equipment can handle, as well as complete descriptions of the line of models, specifications, etc.

LESSONS IN ARC WELDING.—The Lincoln Electric Company, Cleveland, O., has recently published a volume of "Lessons in Arc Welding" which provides arc welding operators and other interested individuals with a thorough knowledge and practical application of arc welding. This volume is an enlarged re-issue and contains 44 lessons. It begins with general fundamental suggestions, takes the student by easy stages through all the important phases of practical arc welding, and affords him thorough instruction on the subject. Other lessons cover: the arc welding machine, its operation and control; the shielded arc and its uses; striking the arc and running horizontal beads; weaving the electrodes; effect of arc length, current and speeds on bead; padding and building up plates; building up shafts, butt welds, lap welds, etc.; welds in the various positions and the large number of other problems which confront the welder.

Questions and Answers Pertaining to Boilers

This department is maintained for the purpose of helping those who desire assistance on boiler and plate fabricating problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless special permission is given to do so.

By George M. Davies

Allowable Pressure for Air Reservoir

Q.—The air reservoir shown in Fig. 1 is made of steel tubing. What pressure will it carry? W. D.

A.—For the air reservoir submitted with the question illustrated in Fig. 1, the maximum allowable working pressure on the shell is computed from the formula:

$$\text{Maximum allowable working pressure} = \frac{S \times t \times E}{R}$$

Where:

S = maximum allowable unit working stress in pounds per square inch.

Assuming the tensile strength of the steel tubing to be 55,000 pounds per square inch, with a factor of safety of 5.

$$S = \frac{55,000}{5} \text{ or } 11,000 \text{ pounds per square inch}$$

t = minimum thickness of shell = $\frac{5}{16}$ inch

E = efficiency of longitudinal joints; for seamless steels E = 100 percent

R = inside radius of shell = 8 inches

Maximum allowable working pressure =

$$\frac{11,000 \times 0.3125 \times 1.00}{8} = 429 \text{ pounds.}$$

The maximum allowable working pressure on the head is computed from the formula:

$$P = \frac{2 \times TS \times t}{8.33 \times L}$$

Where:

t = thickness of plate = $\frac{7}{16}$ inch

P = maximum allowable working pressure, pounds per square inch

TS = tensile strength, pounds per square inch Assume 55,000

L = radius to which the head is dished measured on the concave side of the head, inches = 16 inches

$$P = \frac{2 \times 55,000 \times 0.4375}{8.33 \times 16}$$

$$P = \frac{48,125}{133.28}$$

$$P = 361 \text{ pounds.}$$

The lesser of the two pressures obtained being 361 pounds. This will be the maximum allowable working pressure in the reservoir with a factor of safety of 5.

The sketch did not include the circumferential seam of the heads and it is assumed that this seam has at least a factor of safety of 50 percent.

Applying Flexible Staybolt Sleeves

Q.—How are flexible staybolt sleeves of the welded type applied to a wrapper sheet where the staybolts are not radial with the wrapper sheet? F. N. J.

A.—Fig. 1 illustrates the application of a welded type staybolt sleeve where the staybolt is at an angle of 20 degrees.

The staybolt hole is drilled and reamed so that the sleeve penetrates the sheet ⅛ inch at the center. The sleeve is held tight against the sheet with an applicator, and tack welded in place, the applicator is then removed

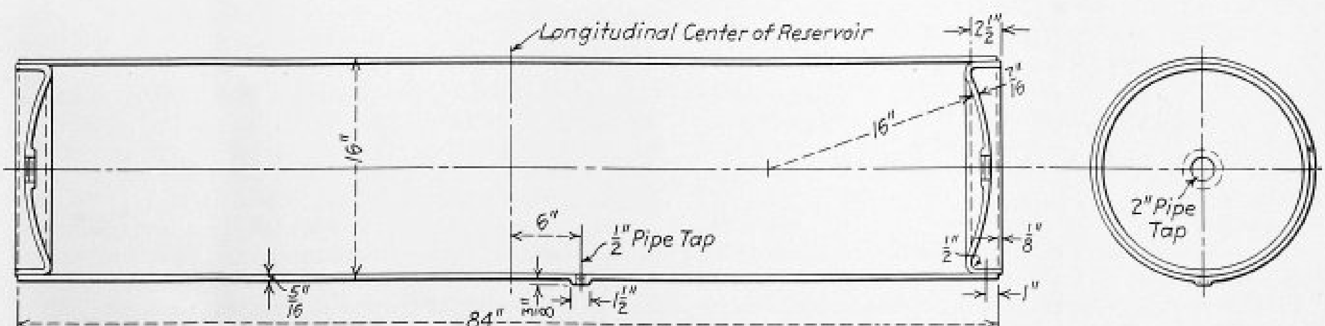


Fig. 1

and the sleeve welded all around as indicated in the illustration Fig. 1.

The applicator is made of a round bar of suitable

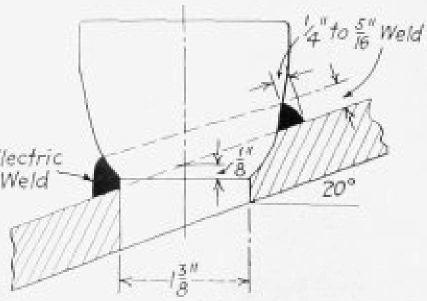


Fig. 1

length, threaded at one end to suit the tap of the staybolt hole in the crown sheet. A handle is secured to the opposite end for engaging the applicator in the crown

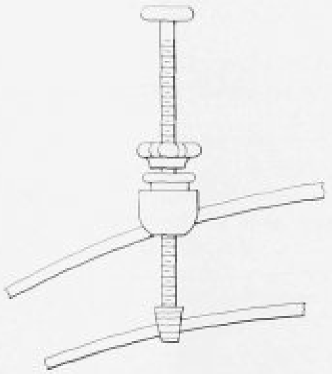


Fig. 2

sheet, a washer whose outside diameter is threaded to engage the staybolt cap threads of the sleeve is free to move along the applicator. The body of the applicator is threaded and a hand screw applied on same, as illustrated in Fig. 2.

Strength of Welded Bracket

Q.—I would be very pleased if you would answer the following problem in your column: The bracket shown in Fig. 1 was attached to the rear of a truck as a drawbar connection. Would you state the amount of shielded arc welding necessary, also the formulae, etc., to find same? The writer would appreciate your advice on handbooks which would contain the mechanics and strength of materials of arc welding. C. C.

A.—In Fig. 1, assuming 44,000 pounds per square inch as the ultimate strength of steel in shear, the 1-inch diameter pin in double shear would have an ultimate strength of:

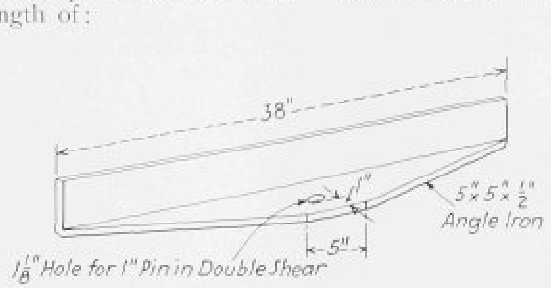


Fig. 1

Cross-sectional area of 1-inch diameter pin = 0.7854 square inches.

0.7854 × 2 × 44,000 = 69,115 pounds ultimate permissible load.

This would be the ultimate load that the pin could carry using a factor of safety of 12 for shock, the permissible load or unit stress would be

69,115 ÷ 12 = 5760 pounds, total permissible load.

The sketch in Fig. 1 shows the 1⅛-inch hole 1 inch back from the edge of the angle. This distance should

Fig. 2

be increased to 1¾ inches so that the shear of the pin will be the weakest part of the construction. As the sketch now stands the metal in front of the pin would shear out before the pin would shear off. If it is not possible to move the pin hole back it will then be necessary to find the ultimate strength of the plate in front of the pin and use that for the comparison against the strength of the weld.

In accordance with the American Welding Society Specifications, welds made by the shielded-arc process have a tensile strength of 60,000 to 80,000 pounds.

Taking the strength of the weld in shear as 80 percent of the strength in tension, we have:

80 × 60,000 = 48,000 pounds ultimate strength of weld in shear.

Using the same factor of safety as before, we have:

48,000 ÷ 12 = 4000 pounds, allowable load in pounds per square inch of weld.

Using a fillet weld as shown in Fig. 2.

Assuming ¼-inch fillet weld, each lineal inch of weld would have 1 × 0.25 or 0.25 square inch of weld in shear, and each inch of weld would carry a load of

4000 × 0.25, or 1000 pounds permissible load per lineal inch of weld.

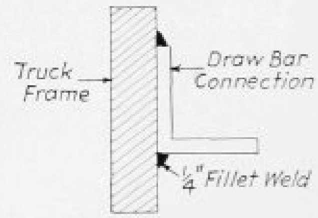


Fig. 3

Assuming the connection piece is welded to the truck frame as indicated in Fig. 3.

There will be thirteen 2-inch by ¼-inch fillet welds.

13 × 2 = 26 lineal inches of weld in shear.

26 × 1000 = 26,000 pounds permissible load carried by weld in shear.

Handbooks which contain the mechanics and strength of materials of arc welding are as follows: "The Welding Encyclopedia," published by The Welding Engineer Publishing Company, 608 Dearborn Street, Chicago, Ill., and "Procedure Handbook of Arc Welding," Design and Practice, published by The Lincoln Electric Company, Cleveland, O.

Industrial Safety.—The National Safety Council, Chicago, has prepared a booklet on the subject of industrial safety. It gives an interesting and enlightening picture of accident prevention work from the viewpoint of the presidents of 23 large industrial organizations, all of which are active members of the National Safety Council.

Associations

Bureau of Locomotive Inspection of the Interstate Commerce Commission

Chief Inspector—John M. Hall, Washington, D. C.
Assistant Chief Inspector—J. A. Shirley, Washington.
Assistant Chief Inspector—J. B. Brown, Washington.

Bureau of Navigation and Steamboat Inspection of the Department of Commerce

Director—Joseph B. Weaver, Washington, D. C.

American Uniform Boiler Law Society

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Boiler Code Committee of the American Society of Mechanical Engineers

Chairman—D. S. Jacobus, New York.
Acting Secretary—M. Jurist, 29 W. 39th Street, New York.

National Board of Boiler and Pressure Vessel Inspectors

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Vice-Chairman—F. A. Page, San Francisco, Cal.
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Vice-President: William N. Moore, general boiler foreman, Pere Marquette Railway.
Secretary-Treasurer: Albert F. Stiglmeier, general foreman boiler maker, New York Central System, West Albany Shop. Address, 29 Parkwood Street, Albany, N. Y.
Chairman Executive Board: William N. Moore.
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Secretary-Treasurer: A. C. Baker, 709 Rockefeller Building, Cleveland, O.
Executive Committee (Three years); A. W. Strong, Jr., The Strong-Scott Manufacturing Company, Minneapolis, Minn. R. J. Bros, William Bros Boiler & Manufacturing Company, Minneapolis, Minn. E. R. Stone, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. (Two years): E. E. Knoblock, Union Iron Works, Erie, Pa. A. G. Weigel, Combustion Engineering Corporation, New York. J. F. Dillon, Jr., Struthers-Wells-Titusville Corporation, Warren, Pa. (One year): F. H. Daniels, Riley Stoker Corporation, Worcester, Mass. M. E. Finck, Murray Iron Works, Burlington, Ia. A. G. Pratt, Babcock & Wilcox Company, New York. (Ex-Officio): Starr H. Barnum, The Bigelow Company, New Haven, Conn. Walter F. Keenan, Jr., Foster Wheeler Corporation, New York.

Office of Industrial Recovery Committee,
15 Park Row, New York

Manager—James D. Andrew.
Secretary—H. E. Aldrich.

Steel Plate Fabricators Association

President — Merle J. Trees, 37 West Van Buren Street, Chicago, Ill.

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

States

Arkansas	Missouri	Rhode Island
California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maine	Oklahoma	District of Columbia
Maryland	Oregon	Panama Canal Zone
Michigan	Pennsylvania	Territory of Hawaii
Minnesota		

Cities

Chicago, Ill.	Los Angeles, Cal.	Memphis, Tenn.
Detroit, Mich.	St. Joseph, Mo.	Nashville, Tenn.
Erie, Pa.	St. Louis, Mo.	Omaha, Neb.
Evanston, Ill.	Scranton, Pa.	Parkersburg, W. Va.
Houston, Tex.	Seattle, Wash.	Philadelphia, Pa.
Kansas City, Mo.	Tulsa, Okla.	Tampa, Fla.

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

States

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

Cities

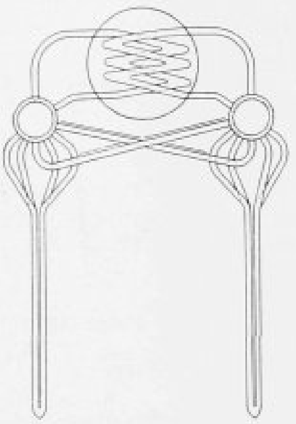
Chicago, Ill.	Memphis, Tenn.	St. Louis, Mo.
Detroit, Mich.	Nashville, Tenn.	Scranton, Pa.
Erie, Pa.	Omaha, Neb.	Seattle, Wash.
Kansas City, Mo.	Parkersburg, W. Va.	Tampa, Fla.
	Philadelphia, Pa.	

Selected Patents

Compiled by Dwight B. Galt, Patent lawyer, Earle Building, Washington, D. C. Readers desiring copies of patents or any information regarding patents or trade marks should correspond directly with Mr. Galt.

1,889,754. FIRE BOX FOR LOCOMOTIVES OR OTHER STEAM VEHICLES. AUGUSTE MAGIS AND ANDRÉ HUET, OF PARIS, FRANCE, ASSIGNORS TO THE SUPER-HEATER COMPANY, OF NEW YORK, N. Y.

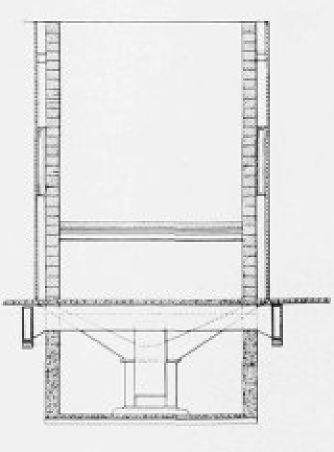
Claim.—In apparatus of the class described, the combination of a main steam generating drum, a steam collecting header, a U-shaped tubular



steam generating element with one of its legs adjacent to a furnace and the other shielded from the furnace by the first, both legs opening into said header, a tubular condenser element in the drum both ends of which open into the header. Five claims.

1,890,364. AIR-COOLED FURNACE WALL. JOSEPH S. BENNETT, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR TO AMERICAN ENGINEERING COMPANY, OF PHILADELPHIA, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

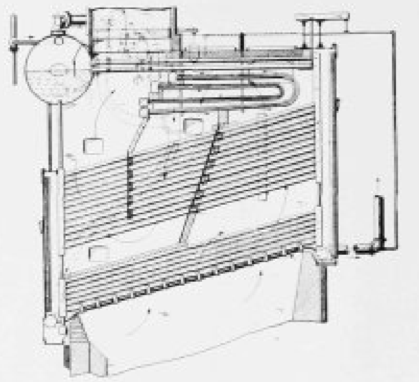
Claim.—A furnace comprising a stoker, a side wall extending upwardly from said stoker, a boiler system having one part thereof positioned in the



upper portion of the furnace, a wall spaced from the exposed side of said side wall to form an air passage, one portion of said side wall being heated to a greater extent than the other portions thereof, means whereby air may be drawn through said air passage over said exposed side of the furnace wall, and means positioned in said passage whereby the velocity of the air passing over said first-mentioned portion of said side wall may be increased. Seven claims.

1,890,784. SUPERHEATER STEAM BOILER. DAVID S. JACOBUS, OF JERSEY CITY, NEW JERSEY, ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

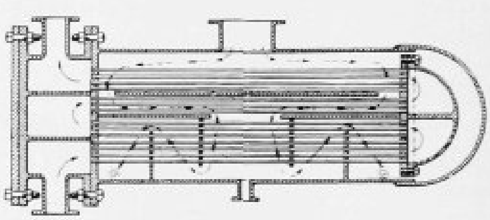
Claim.—In a steam boiler, a bank of superheater tubes with at least a portion of each tube exposed to radiant heat from the furnace, and a row of boiler tubes parallel and adjacent the portions of the superheater tubes



exposed to the radiant heat, and means to support each superheater tube from one of said boiler tubes and hold said superheated tube and said boiler tube in close thermal contact. Sixteen claims.

1,917,595. HEATER. JOHN R. McDERMET, OF JEANNETTE, PENNSYLVANIA, ASSIGNOR TO ELLIOTT COMPANY, OF JEANNETTE, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

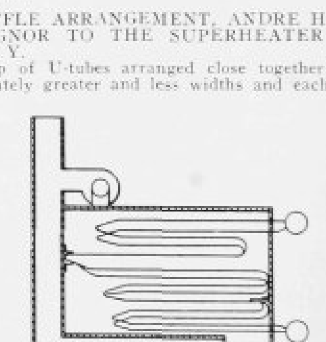
Claim.—In a heat exchanger, a shell, tubes therein, baffling means dividing the interior of the shell into two substantially equal divisions,



longitudinally extending baffling means cooperating with one division, and transversely extending baffling means cooperating with the other division. Ten claims.

1,889,861. BAFFLE ARRANGEMENT. ANDRE HUET, OF PARIS, FRANCE, ASSIGNOR TO THE SUPERHEATER COMPANY, OF NEW YORK, N. Y.

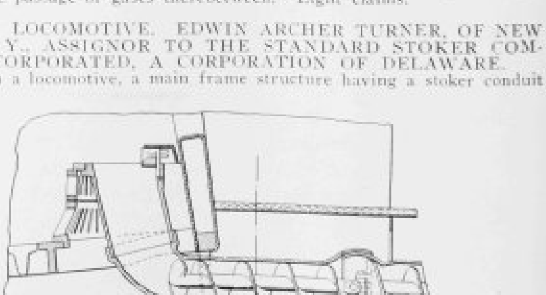
Claim.—A group of U-tubes arranged close together in parallel planes and having alternately greater and less widths and each having one of its



legs in a given plane at a considerable angle to said parallel planes and each having its other leg on the same side of said given plane, said legs in the given plane arranged to form a baffle and the other legs arranged to permit the passage of gases therebetween. Eight claims.

1,892,372. LOCOMOTIVE. EDWIN ARCHER TURNER, OF NEW YORK, N. Y., ASSIGNOR TO THE STANDARD STOKER COMPANY, INCORPORATED, A CORPORATION OF DELAWARE.

Claim.—In a locomotive, a main frame structure having a stoker conduit



section formed integrally with a part thereof, and longitudinally and transversely extending walls tying said conduit section to the aforesaid part of the frame. Five claims.

Boiler Maker and Plate Fabricator

Magnaflux Testing of Welded Seams

A real contribution toward the advancement of the fusion welding processes has been the development of the Magnaflux method for the non-destructive testing of welds. As a supplement to X-ray testing it is admirable, since it can be utilized on many occasions and in many places when the former is not convenient or practical. The explanation of the fundamentals of the process, as given in an article in this issue, will be helpful to many of our readers who have not already become familar with the method and its uses. In another article next month, further details of Magnaflux testing, applied to boiler drum and unfired pressure vessel seams, both welded and riveted, will be given.

Master Boiler Makers to Meet September 29 and 30

An announcement has been made by the secretary of the Master Boiler Makers' Association that a two-day business meeting of that body will be held at the Hotel Sherman, Chicago, on Tuesday, September 29, and Wednesday, September 30.

Committees have been appointed to prepare reports on topics approved at the last annual meeting, including continuation of studies on pitting and corrosion and on fusion welding as applied to locomotive boiler and tender work. Among other matters to be reported upon are proper thickness of front tube sheets; improvements in safe ending and application of flues and tubes; preventing cracking of firebox sheets and staybolt holes; and what is being done to prevent back tube sheets cracking at flange knuckles.

It is not too early for members of the association to begin giving some thought to the possibility of attending the meeting this year. Unquestionably the value of this business gathering is recognized by mechanical officials generally, as evidenced by the attendance and support at the 1936 meeting. With ever-increasing demands on the boiler department as traffic continues to improve, the educational possibilities of this two-day business meeting of the association, at which the most pressing boiler maintenance problems are threshed out, should be self-evident.

More than 100 members were in attendance at the 1936 meeting. Out of the total active membership of several times that number, with a small amount of intensive work on the part of the association and members, it should be possible to bring the coming meeting back to the level of activity of former years.

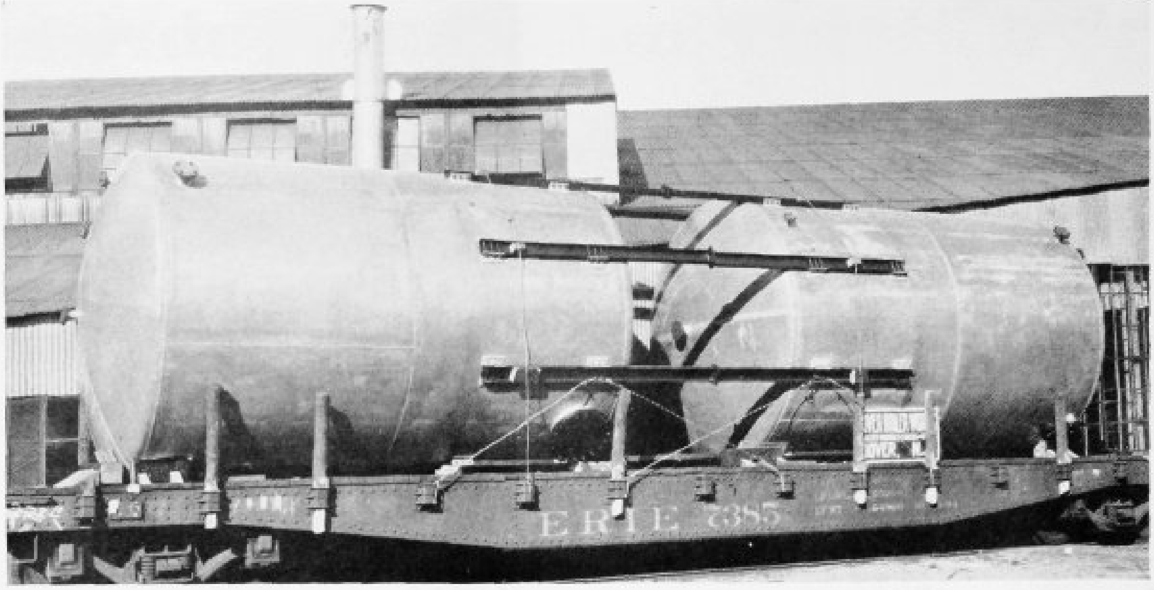
Apparently it has not yet been determined definitely whether or not an equipment exhibit will be presented by supply companies in connection with association meetings held at about that time. Information in this connection will be available shortly. It is hoped that, after the great lapse of time since members of the association have had an opportunity to view new developments in tools and equipment, this year the exhibit feature will be renewed.

Locomotive Orders Continue Active

The first ten weeks of 1937 saw a continuance of activity in the placing of orders for steam locomotives. As reported in the February issue of the Boiler Maker and Plate Fabricator, 58 steam locomotives were ordered in the period from January 1 to February 6. Since that time, 32 steam locomotives have been ordered from the manufacturers or are to be constructed in the shops of the railroads. The Chicago & North Western placed orders on February 27 for eight 4-6-4 type locomotives with the American Locomotive Company; the Northern Pacific ordered 17, including 11 of the 4-8-4 type from the Baldwin Locomotive Works of which eight are for the Northern Pacific and three for the Spokane, Portland and Seattle, and six of the 4-6-6-4 type from the American Locomotive Company, also for the Spokane road; and the St. Louis Southwestern announced plans to build five 4-8-4 type locomotives in its own shops at Pine Bluff, Ark. In addition, the Chicago, West Pullman and Southern ordered two steam locomotives from Baldwin and both Baldwin and American have received an order for an 0-8-0 type and 0-6-0 type switching locomotive, respectively, from an industrial concern. This brings the total number of orders for steam locomotives thus far this year to 92. Furthermore, the National Railways of Mexico is reported to be in the market for 18 units, 10 of the 4-6-2 type and eight of the 2-6-6-2 type.

When this additional volume of business on hand is added to the rather sensational amount of new work contracted for in the latter months of 1936, it is not surprising that the report of Bureau of the Census, Department of Commerce on unfilled orders for locomotives shows remarkable results when compared with similar reports for 1936 and 1935. On January 1, 1935, orders for approximately 35 locomotives remained unfilled. One year later at the same time, orders for 120 units had not been completed. On the first day of the present year, unfilled orders for approximately 375 were outstanding with a definite upward trend. A percentage comparison of this year with the two previous periods shows slightly over 1000 percent increase from 1935 and 300 percent from 1936. These Government results are based on orders reported from manufacturers only and do not include locomotives being built in railway shops.

Consequently, the increase in demand for materials and supplies to equip these new motive power units should soon show a parallel upward spurt while the demand for skilled boiler makers and mechanics will probably be found impossible to supply for some time to come.



Two of a series of twenty 10-foot 6-inch diameter aluminum tanks of special construction built by Dover

DOVER BOILER WORKS

A Modern Fabricating Shop

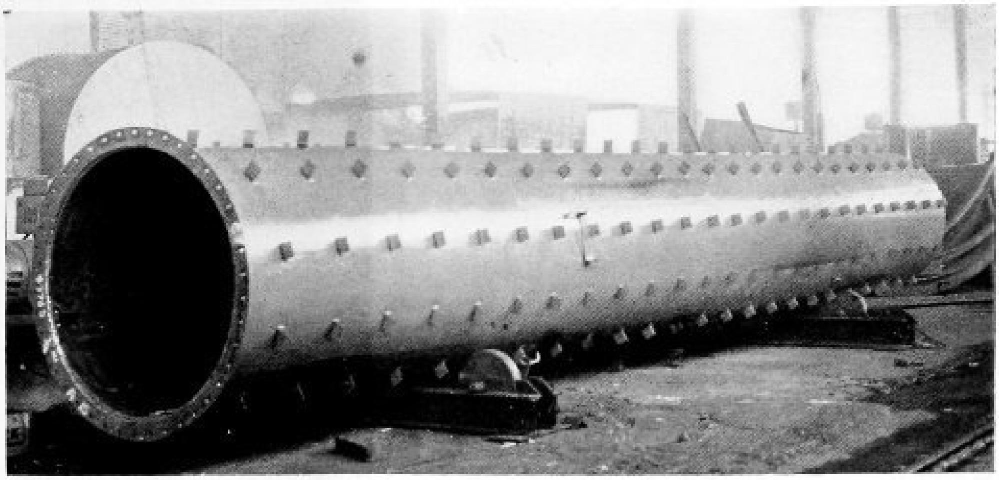
For sixty-three years, the city of Dover, N. J., has been the location of a boiler and plate fabrication shop which has managed to weather all the economic vicissitudes which have occurred during that period and has still retained its original ownership, now in the second and third generation. This organization is the Dover Boiler Works, Inc., founded in 1874 by Foster F. Birch, father of the present head and grandfather of the present purchasing agent who bears his name. The original shop started as an odd job and repair establishment, employing only a handful of employes. The building, in which the early activities of the Dover Boiler Works, Inc., took place still stands in Dover, but is no longer in use by the company.

Increases in the amount of business handled soon demanded larger quarters and the company moved to its present site in Dover where a new plant was erected and gradually added to through the years. The business at the same time expanded into new fields of construction. The founder was awarded the patent rights on the Birch heater which is a household heating and industrial cleaning and dyeing plant boiler. The building of these devices occupied the activities of the company for many years along with general production work on tanks, stacks, and various types of pressure vessels. In addition to this type of work, large size piping for culverts under highway and railroad embankments was produced. The brickwork construction in and around boiler settings was also handled by this boiler shop.

A destructive fire on February 22, 1935, abruptly brought an end to the old order. The extent of fire damage to the plant was so great that the management considered it necessary to rebuild the entire establishment with the exception of a few non-connecting structures. Consequently, work was begun on a new and modern structure of concrete block and corrugated iron with a steel truss roof, designed to be entirely fireproof. The new plant was completed in the summer of 1935. The plans called for a central structure nearly 500 feet in length and 78 feet in width to house the main productive activities of the company. Attached to this main building were additions to accommodate the blacksmith or flanging shop, the machine shop, tool and store room and a location for a large bull riveter and a flanging press. A patent shop and garage which are not directly connected to the main plant structure complete the production centers of the boiler works.

The location and layout of the various departments and machines was made with the purpose of reducing to a minimum the movement and handling of raw materials and materials in process of manufacture. In order to accomplish this economy of manufacturing, the principal of moving and handling materials the shortest possible distance in the straightest line was observed. Raw material supply is made by either motor truck or railway car directly into the plant. A spur track of the Delaware, Lackawanna and Western Railroad enters the main structure and ample sized doors accommodate the movement of motor trucks.

The raw material, plates, angles, dished heads, castings, etc., are stored on the floor of the main building immediately adjacent to the layout department at the south end. Consequently, material can be readily transferred from storage with the minimum of handling to this latter department to be marked and made ready for actual production work. Two overhead traveling cranes



Section of 39 inch diameter all welded smokestack. Lugs are welded to shell for securing asbestos insulation

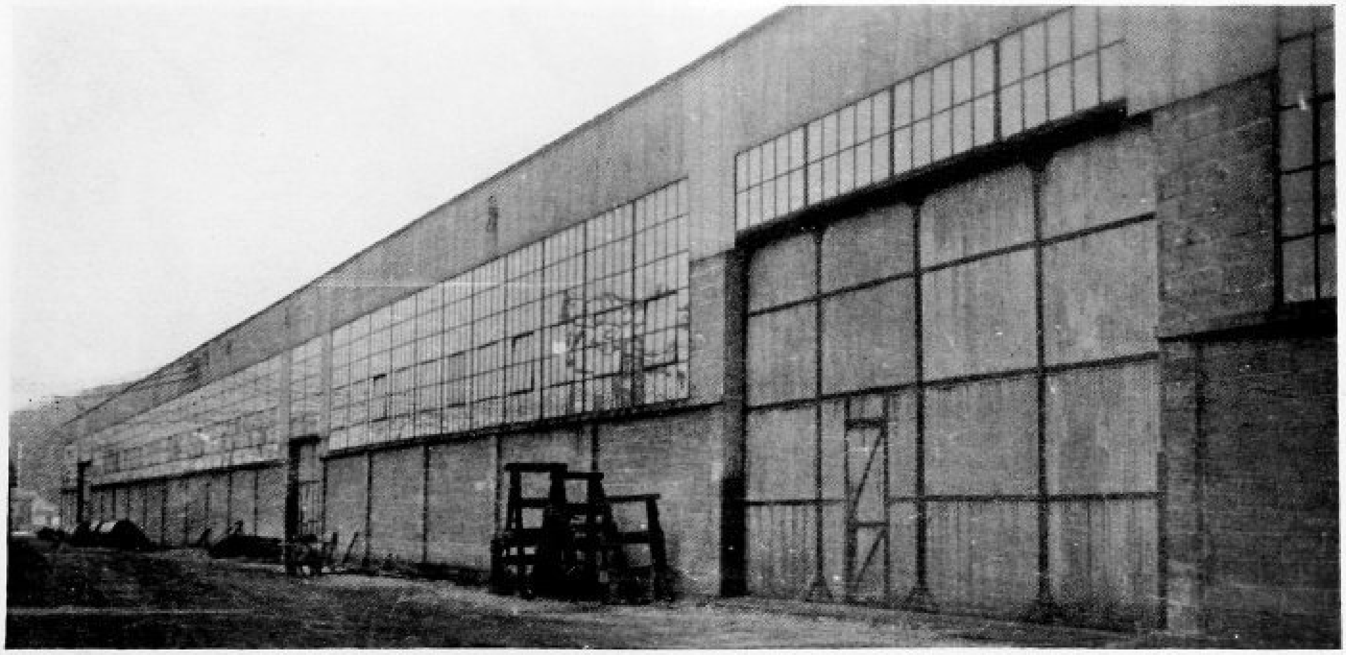
running the full length of the main building facilitate the handling of this material. After the layout department has completed its work, the material is ready for a practically straight-line movement from one end of the main building to the other, through a variety of fabricating and processing equipment.

The first machines are located beside the layout department as shown in the diagrammatic sketch and consist of a miller, three vertical punches of varying size and capacity for the initial rolling and punching of flat plates. Swinging cranes assist the handling of plates while being punched. They are followed by a trimmer for beveling plate edges for welding and a set of shears. Toward the center line of the shop at this point are placed two small horizontal punches. The next processing machines are a pair of rolls which are claimed to be the largest in any plate fabricating shop in the East. They are 30 feet long between housings; the top roll is 30 inches in diameter and the equipment is capable of rolling a plate 2 inches thick. The power plant for these rolls is located at one end of the installation and behind the horizontal punches previously mentioned. A large table is installed in front of the rolls for handling large plates and this table may also be utilized as a location for welding flat plates together prior to rolling. A smaller roll is installed nearby to handle plates of more moderate dimensions.

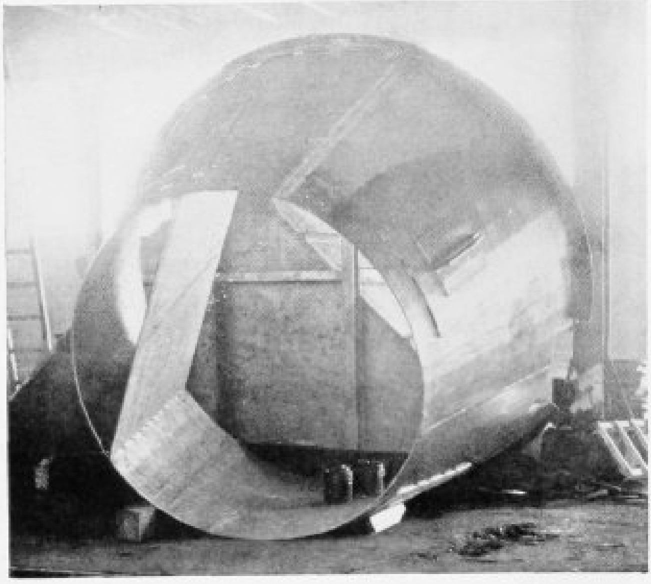
For the manufacture of stiffening rings, braces, etc., formed from angle iron, a high-powered angle shear is provided close by the large rolls. It is augmented by an angle roller capable of bending cold, angle iron up to 4 inches in width.

The list of machinery in this section of the shop is completed by a bending brake used in processing plate for use in rectangular tanks, pressure vessels, etc. Additional boiler shop equipment includes a large bull riveter, with a capacity of 100 tons and a heavy flanging press located in an alcove off the main shop and adjoining the flanging department. In addition, another small set of rolls has been placed close by these heavy machines.

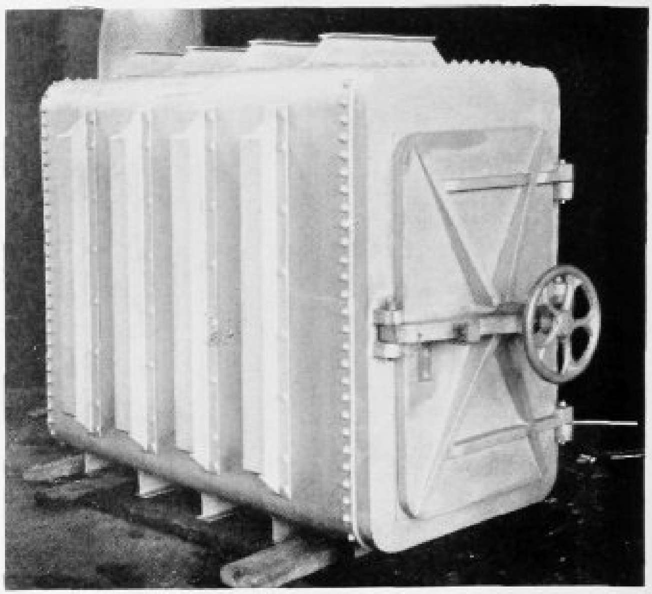
The absence of machinery at the north end of the shop provides sufficient space for the actual work of fabricat-



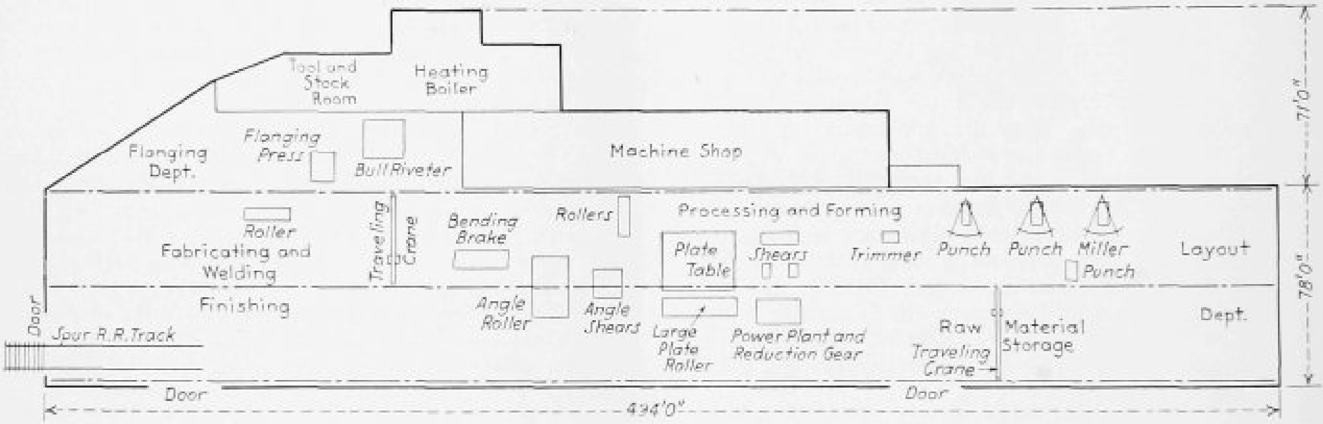
View of exterior of new main building



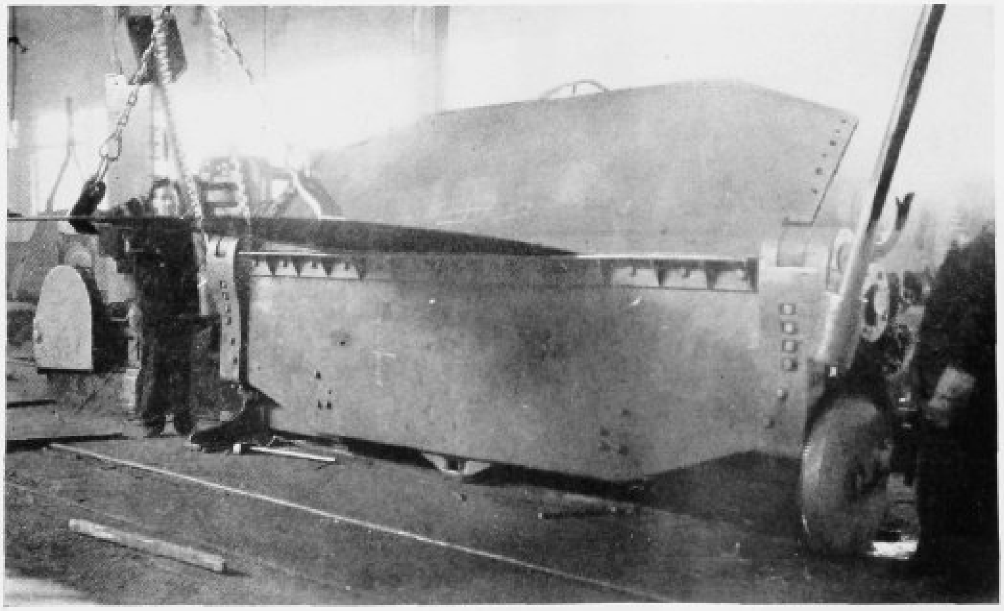
Welded section of hopper under construction



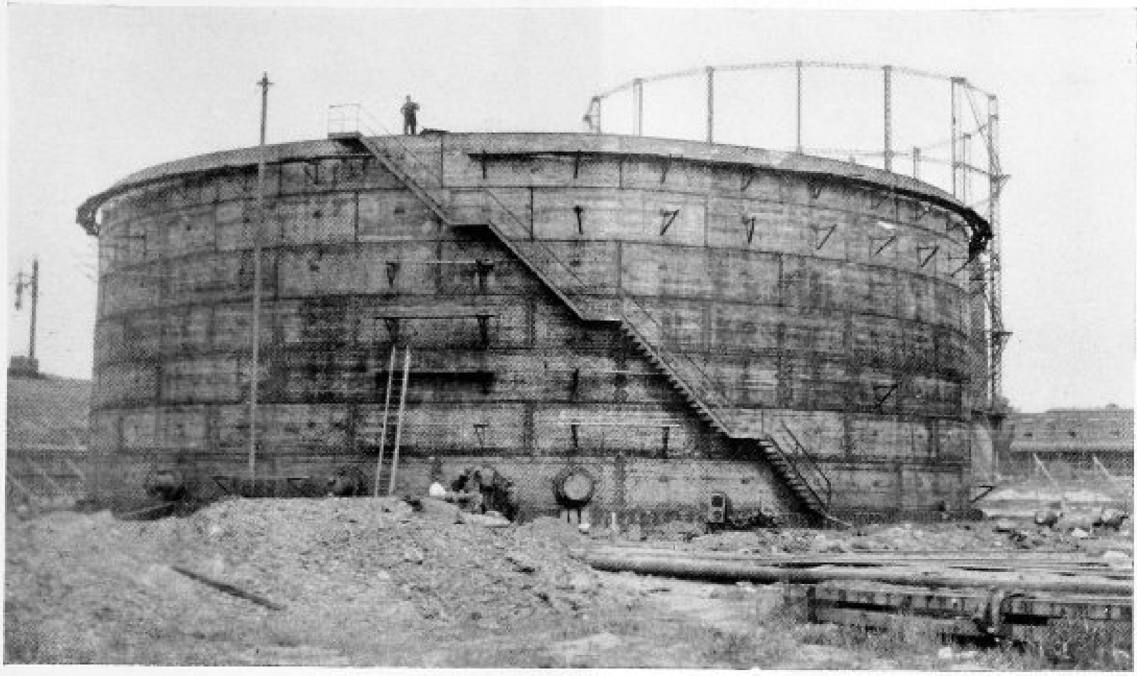
Pressure vessel for aging silk



Floor plan of machinery at Dover Boiler Works



Steel plate ready for cold working in bending brake



Gas holder fabricated at Dover

ing. This work can and generally does commence close by the bending brake, in the rear half of the main structure. Nineteen portable electric-arc welders are available for this work and the rolled and formed plates are assembled and welded in any convenient location in this working area.

Flanging, forging and work of similar character, requiring heating and heavy processing are performed directly beside the welding and fabricating area in the triangular shaped section of the shop. Mountings such as nipples, flanges, nozzles, and the like, are welded or bolted to the various vessels also in this area. The work of machining and finishing these attachments is performed in a well-equipped machine shop, housed under the same roof as the main fabricating shop but separated from it by a masonry wall. This machine shop is fitted with a battery of six engine lathes, one vertical lathe, two planers, two power pipe threaders, a power hack saw and a circular saw; one milling machine and one shaper; and a group of six drill presses of varying sizes for different types of work.

The final finishing, cleaning and painting of completed work takes place as a rule in the front half of the main building at the north end. Easy access to railway cars or motor trucks is available here and the completed product can be shipped from the plant without disturbing other activities.

The variety of products now being produced at the Dover Boiler Works, Inc., is large. Tanks, stacks, pressure vessels of all descriptions are turned out. The tallest smokestack in the country was built at Dover for the Woolworth Building, New York, while the tallest on the Pacific Coast in the Smith Building in Seattle, Wash., was also fabricated at Dover. Many of the sprinkler system tanks installed and being installed in buildings in and around the New York area are products of this shop. In the construction of vessels of special design, credit is claimed for fabricating the largest stainless steel plate, 96 inches wide by 272 inches long by ½ inch thick, into a tank for a refinery still.

In addition, a series of twenty welded aluminum tanks were built recently that are the largest yet fabricated. Considerable work on nickel-clad steel and in building large kettles for breweries has also been performed.

The Dover Boiler Works, Inc., usually employes a total force of 150, 125 persons being at work in the shops alone. During the worst period of the depression, sufficient work for 50 men was found to keep the plant reasonably active.

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

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information on the application of the code is requested to communicate with the secretary of the committee, 29 West 39th St., New York.

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

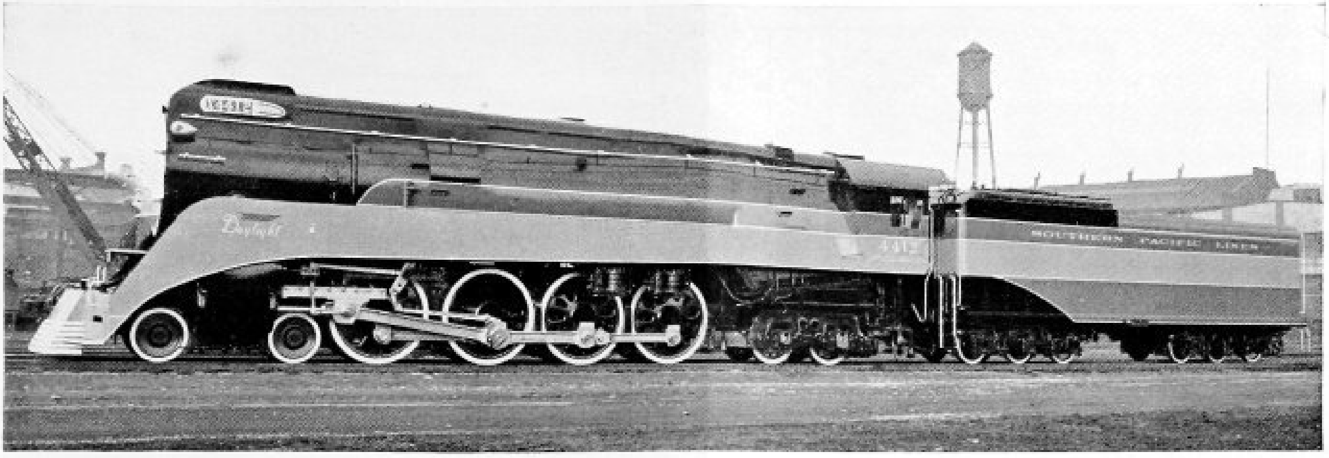
Case No. 838

(Interpretation of Par. P-17)

Inquiry: Is it the intent of the requirement in Par. P-17 which states that the minimum thickness of plates in stayed surface construction shall be 5/16 inch, that the outside shell of a vertical fire-tube boiler shall be 5/16 inch?

Reply: It is the opinion of the Committee that it is the intent of Par. P-17 that only the sheets which require support by staying shall be subject to the minimum thickness limitation of 5/16 inch.

The streamlining and decoration of the front end of the Southern Pacific locomotives is simple and effective. The smokebox front is aluminum and the pilot orange with aluminum bands



Southern Pacific 4-8-4 type passenger locomotive streamlined and finished to conform to the train

Southern Pacific Locomotives

The Lima Locomotive Works, Inc., has delivered six streamline passenger locomotives of the 4-8-4 type to the Southern Pacific for use on the new Daylight train service between Los Angeles and San Francisco to be inaugurated during the coming spring. The locomotives develop 74,710 pounds tractive force, including the trailer booster. The weight on drivers is 266,500 pounds, the cylinders are 27 inches by 30 inches, the driving wheels 73½ inches in diameter, and the boiler pressure 250 pounds per square inch.

These locomotives have been streamlined by enclosing the sand box, dome and other equipment mounted on the top of the boiler within a smooth casing, and by applying deep aprons below the outside edges of the running boards, which join the metal-covered pilot in long sweeping curves. The headlight is enclosed within a casing which is faired into the smokebox door and through the sides of which are openings for the illuminated engine numbers.

A striking color effect has also been achieved by the extensive use of red and orange on the sides of the locomotive and tender. The smokebox front is painted aluminum and the train-number indicators are aluminum with black stripes. The streamline hood of the pilot is in orange with aluminum bands. The name of the train is lettered in aluminum on the orange of the apron below the running board on each side. The emblem associated with the lettering is in red, outlined in black. The marker lamps are in aluminum. The cylinders are finished in black, and the guides, the main and side rods and the motion work are steel with a highly polished finish. The tires and wheel rims on all wheels are painted in aluminum, with steps and grab handles cadmium plated. The red on the sides of the boiler above the running board and on the sides of the tender, separated by the band of orange, will match the same color on the sides of the coaches and the yellow panel will line up with the window panel of the coaches.

The boiler has an outside diameter of 86 inches at the first ring. It is designed to carry 250 pounds pressure and is built of carbon steel of basic flange quality. The firebox is equipped for oil burning and the combustion space includes a chamber extending 60 inches into the boiler barrel. Welding is employed at the ends of the longitudinal seams in the barrel courses, and the firebox sheets are seal welded to the mud ring 12 inches each way from the corners. Calking edges of the back firebox are lightly welded to the crown sheet after calking. The staybolts are of Ulster iron with an installation of Flannery telltale type flexible bolts at the usual corner breaking zones and completely around the combustion chamber.

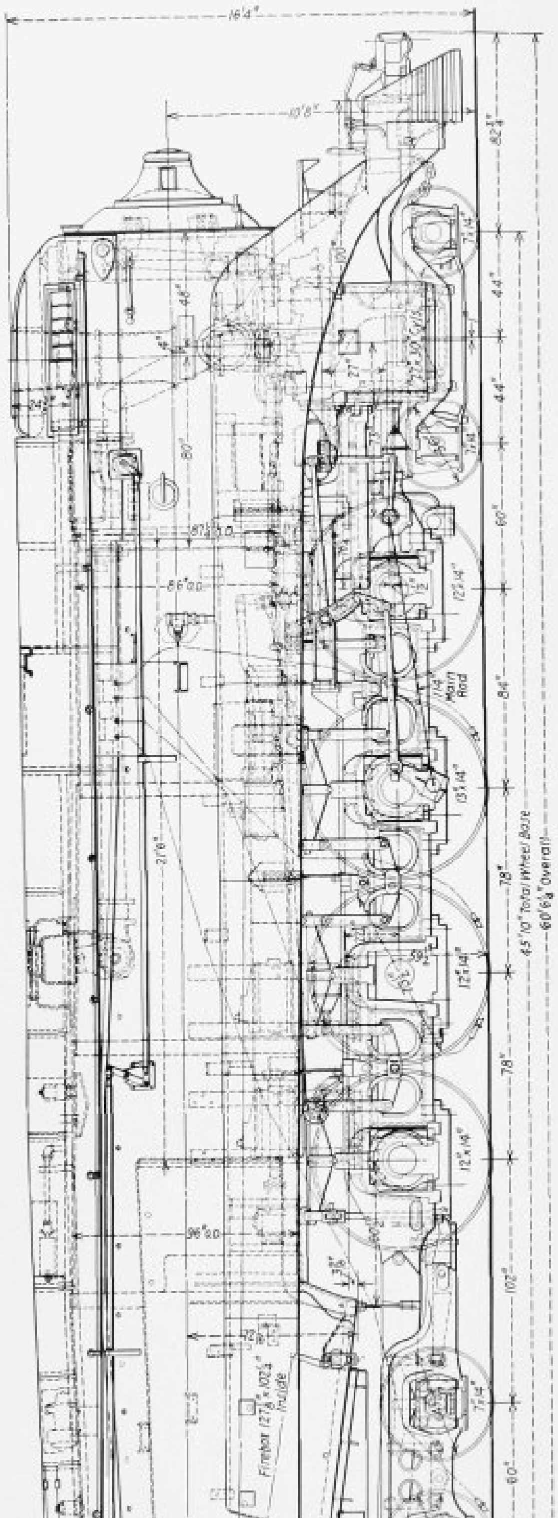
The firebox is equipped with an installation of fusible plugs of the type developed on the Southern Pacific. There are three plugs along the top center line, one between the first and second rows of the crown stays, one between the seventh and eighth, and one between the fifteenth and sixteenth rows. Two laterally spaced plugs are located between the eleventh and twelfth rows.

The boiler is equipped with a type E superheater with a tangential steam dryer in the dome. An American multiple front-end throttle is built in the superheater header. The feed-water heater is the Worthington type 5SA. The boiler is also equipped with the Signal Foam-Meter.

The foundation for these locomotives is a steel bed casting with which the cylinders are cast integral. The firebox is supported, both front and back, by expansion sheets. These, are attached to bolting flanges which extend practically across the entire length of the front and back mud-ring members and are supported from ample bolting flanges on the bed casting both inside and outside of the side-frame parts of the casting.

The engine and trailer trucks are also General Steel Castings design, the former with inside bearings and the latter of the four-wheel Delta type. The trucks are all fitted with oil-packed journal boxes. The driving wheels are cast steel of the Boxpok type. All driving axles, as well as the engine-truck and trailer axles, are of medium carbon steel normalized and drawn.

The cylinders are fitted with two-stage bushings which,



Elevation of the Southern Pacific locomotive

General Dimensions, Weights and Proportions of the Southern Pacific 4-8-4 Type Locomotives

Railroad	Southern Pacific
Builder	Lima Locomotive Works
Type of locomotive	4-8-4
Road class	G-52
Road numbers	7646—7651
Date built	1936
Service	Passenger
Dimensions:	
Height to top of stack, ft. and in.	16— 4
Height to center of boiler, ft. and in.	10— 8
Width overall, in.	10—11
Cylinder centers, in.	93
Weights in working order, lb.:	
On drivers	266,500
On front truck	77,400
On trailing truck	104,500
Total engine	448,400
Tender	372,880
Wheel bases, ft. and in.:	
Driving	20— 0
Rigid	13— 0
Engine, total	45—10
Engine and tender, total	94—½
Wheels, diameter outside tires, in.:	
Driving	73½
Front truck	36
Trailing truck	45½
Engine:	
Cylinders, number, diameter and stroke, in.	2—27×30
Valve gear, type	Walschaert
Valves, piston type, size, in.	12
Maximum travel, in.	7¾
Steam lap, in.	1¾
Exhaust clearance, in.	3/16
Lead, in.	¼
Boiler:	
Type	Conical
Steam pressure, lb. per sq. in.	250
Diameter, first ring, outside, in.	86
Diameter, largest, outside, in.	96
Firebox length, in.	127⅝
Firebox width, in.	102¼
Combustion chamber length, in.	60
Tubes, number and diameter, in.	49—2¼
Flues, number and diameter, in.	198—3½
Length over tube sheets, ft. and in.	21—6
Fuel	Oil
Grate area, sq. ft.	90.4
Heating surfaces, sq. ft.:	
Firebox, total	350
Tubes and flues	4,502
Evaporative, total	4,852
Superheating	2,086
Comb. evap. and superheat	6,938
Feed-water heater, type	Worthington
Tender:	
Type	Rectangular
Water capacity, gal.	22,000
Fuel capacity, gal.	6,275
Trucks	6-wheel
Journals, dia. and length, in.	7×14
General data, estimated:	
Rated tractive force, engine, 83 percent boiler pressure, lb.	62,200
Rated tractive force, booster	12,510
Total rated tractive force	74,710
Weight proportions:	
Weight on drivers ÷ weight engine, percent	59.2
Weight on drivers ÷ tractive force	4.28
Weight of engine ÷ comb. heating surface	64.63
Boiler proportions:	
Firebox heat. surface, percent evap. heat. surface	7.21
Tube-flue heat. surface, percent comb. heat. surface	64.9
Superheat. surface, percent evap. heat. surface	30.07
Firebox heat. surface ÷ grate area	3.87
Tube-flue heat. surface ÷ grate area	49.8
Superheat. surface ÷ grate area	23.08
Comb. heat. surface ÷ grate area	76.75
Tractive force, engine ÷ grate area	688.05
Tractive force, engine ÷ comb. heat. surface	8.97
Tractive force, engine × dia. drivers ÷ comb. heat. surface	658.94

like the valve bushings, are of Hunt-Spiller gun iron. The valve bull rings are also of this material and are fitted with Hunt-Spiller duplex sectional packing rings. The pistons are of cast steel, without separate bull rings, and are fitted with the Locomotive Finished Material Company's bronze packing rings. Paxton-Mitchell packing is applied to the valve stems and piston rods.

All rods and motion work are finished with a high polish, free from surface marks, in accordance with the practice of the builder. The back end of the main rod and the intermediate side-rod connections are fitted with floating bushings, having fixed bushings of Hunt-Spiller gun iron. The bearings on the front and back crank pins are fixed bushings. The locomotives are fitted with the Walschaert valve gear having a maximum travel of 7¼ inches. They are equipped with the Alco reverse gear and the Valve Pilot for cut-off control. In order to prevent hooking up to a cut-off of less than 25 percent the quadrant from this point to the center is blanked. The valve motion parts are of medium steel like the running gear and crank pins, with the exception of the eccentric rod and radius bar which are of mild steel.

The tender is of the rectangular type and is designed in cross-section to conform with the exterior of the coaches of the train. It is built up on a cast-steel water-bottom underframe. The tank has a capacity of 22,000 gallons of water and carries 6275 gallons of fuel oil.

The schedule for the Daylight trains will be considerably accelerated over the present running time. The trains will operate over the Southern Pacific Coast Line via San Luis Obispo, a line which has a maximum grade of 2.2 percent, with grades of 1 percent over a large part of the run. The trains now being built will be of light-weight construction, with six of the coach body units articulated into three pairs and the remaining six cars each an independent vehicle. Exclusive of the locomotives, the train will weight 1,187,500 pounds and will be 870 feet long. It was the need to haul these trains at high speeds under the difficulties imposed by the line that led to the development of a locomotive possessing both high tractive force and the ability to make high speeds on level track.

The general dimensions and weights are given in the table.

Heating and Ventilating Exposition Planned

The Fifth International Heating and Ventilating Exposition will be held at Grand Central Palace, in New York City, January 24 to 28, 1938. Since its inception in 1930, the Heating and Ventilating Exposition has been held every two years. The first showing was in Philadelphia, the second in Cleveland, the third in New York City, and the fourth, which took place in 1936, was held in Chicago. Each successive exposition has met with an increasingly active response, both on the part of exhibitors and audience. The presentation of the exposition in leading cities in different parts of the country, coupled with the growing interest in air conditioning, has made it a most significant industrial exposition which has drawn attendance from all over the world.

Significant in connection with the Fifth Exposition scheduled for early in 1938, and for which plans go forward during the entire twelve months preceding, is the trend to new building activity which is a natural part of national recovery. Healthful living and efficient working conditions necessitate new expenditures for modern heating and ventilating equipment. In every section of the United States, it is becoming recognized that the atmospheric conditions in the home, office, and factory are properly a subject for year-round attention. For instance, it is as natural to cool buildings in summer as it is to heat them in winter, and most of the important new building construction is being planned with a view to the installation of suitable equipment to maintain optimum temperature and humidity conditions throughout the year, regardless of the weather.

The annual meeting of the American Society of Heating and Ventilating Engineers, under whose auspices the exposition is held, will take place during the same week in New York. Three floors of Grand Central Palace have been reserved for the exposition, and invitations to participate have been extended to a number of organizations in the fields concerned with the heating, ventilating, and air conditioning industry. All former exhibitors have received advance notification of the event. The conduct of the exposition and all details of exhibit arrangement and leasing will be in charge of the International Exposition Company, Grand Central Palace, New York. It will be under the personal direction of Charles F. Roth, manager, who was similarly responsible for the earlier exposition.

Active Interpretations of the A.S.M.E. Boiler Code

Since the first edition of the Boiler Code in 1914, the Boiler Code Committee has issued over 800 cases or interpretations of the rules in the various sections of the code and the different editions of each, which affect the application of these rules to boiler and pressure-vessel construction.

From time to time revisions have been made in the code rules to incorporate the intent of some of the cases which have thus rendered these cases unnecessary and, as a result, some of them have been annulled. The large number of apparently active cases has led to some confusion in the use of the code and the Boiler Code Committee has recently undertaken a thorough study of all these cases with a view to retaining only those which are considered to be active.

The result of these studies is represented in the following list of cases which are the only ones active on June 26, 1936. The present active cases include those which have been issued after that date.

The Boiler Code Committee will continue the work of making such revisions as are necessary to permit the annulment of more of these active cases in order to reduce the number to a minimum.

2	408	600	709	759	804
49	454	606	712	764	808
104	463	608	715	768	811
110	474	638	716	771	813*a*
154	505	655	719	778	817
163	515	659*b*	724	780	819
169	532	670	732	781	820
185	542	683	734	782	823
209	547	684	737	785	824
234	549	691	738	786	825
257	560	693	745	787	826
275	561	700	751	792	827
397	575	701	752	793	828
403	584	706	753	795	829
406	588	708	754	796	830

Rubber Hose.—Designed to provide a wealth of easily accessible information on rubber hose for industrial use, United States Rubber Products, Inc., has just issued its new "U.S. Hose Catalogue" for 1937. United States Rubber Products, Inc., which has contributed so much to the general development of hose construction and improvement, offers in this catalogue, its complete line, embracing every type of hose for which a need may arise. In addition to its complete line, it also offers the services of its rubber chemists and engineers in solving difficult hose problems for individual manufacturers.

Acceptable methods developed for

Fusion Welded Power Piping*

By William D. Halsey†

In recent years there has been an increasing use of fusion welding in the fabrication of power plant piping, particularly for piping subject to the higher pressures and temperatures. For numerous reasons it will be apparent that such lines must be absolutely free from leakage and, because of troubles that have been experienced in the past in trying to keep mechanical joints tight, fusion welded high pressure lines have become a practical necessity in most cases.

A high pressure pipe line should be designed by consulting engineers or by others who have experience in such design. The proper thickness of pipe, the quality of pipe material, and the general layout with suitable provisions for expansion and contraction are the designer's responsibility.

It is the responsibility of the contractor who installs the line to meet the requirements of the designer and also to see that the required quality of welding is obtained.

As an organization making inspection of fusion welded pipe lines, Hartford Steam Boiler is interested primarily in safety, and it will be apparent that the physical properties of the fusion welded joints are a large factor in the safety of a fusion welded pipe line.

Considerable thought has been given to the quality of welding which should be required in high pressure pipe line work. Many purchasers, having in mind the classification for fusion welded pressure vessels adopted by the A. S. M. E. Code, have specified "Class 1" for the quality of the welding. The intent of the code in referring to classes was primarily for a distinction in the degree of severity of service for a vessel rather than for the quality of the welding, although there was some difference in the requirements for weld quality. Because of the improper interpretation placed upon the designations "Class 1," "Class 2," and "Class 3," the Unfired Pressure Vessel Code has discontinued these designations and now refers to paragraph designations such as "U-68," "U-69," and "U-70." There is little difference in the tensile strength, ductility, and soundness requirements of welds for U-68, (formerly Class 1) and U-69 (formerly Class 2) pressure vessels. The outstanding difference between the two lies in the manner of accomplishing the end desired. For U-68 vessels a test weld must be made for every vessel, the major seams must be radiographically examined, such as by X-ray, and all vessels must be stress-relieved by heating. For U-69 vessels the intent is that a procedure for welding must be adopted by the manufacturer, which procedure must be investigated by making sample welds and testing such welds for tensile strength, ductility, and soundness. Every welding operator must then be examined for his ability to make, by the procedure that has been adopted, welds which will have the required tensile strength, ductility, and soundness. It is assumed that if the adopted procedure of welding is followed and only qualified welding operators are used, the results obtained in actual construction will conform to the results obtained under test.

In a fusion welded pipe line, to meet completely the requirements of the A. S. M. E. Code for Class 1, or what is now known as U-68, it would be necessary that every welded joint be examined by X-ray. Obviously such a procedure would be impractical and in most cases, impossible, because, to obtain the best results in X-ray examination, the film must be placed close to the weld being examined and *on the side opposite the X-ray tube.*

To meet the stress-relieving requirements every section of pipe containing a weld would have to be placed in a stress-relieving furnace after the welded joint between the sections had been completed, and for every group of welded joints it would be necessary that a test

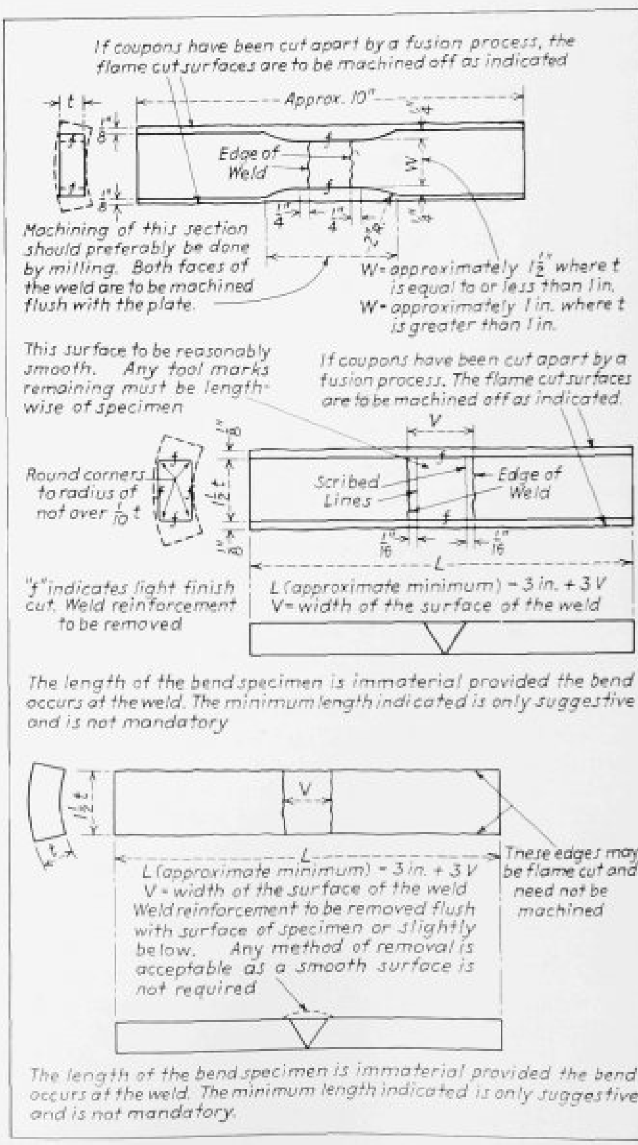


Fig. 1 (top). Fig. 2 (center). Fig. 3 (bottom)

* From a paper presented before the convention of the International Acetylene Association, St. Louis, Mo., November 15 to 20, 1936.

† Assistant chief engineer, Boiler Division, Hartford Steam Boiler Inspection and Insurance Company.

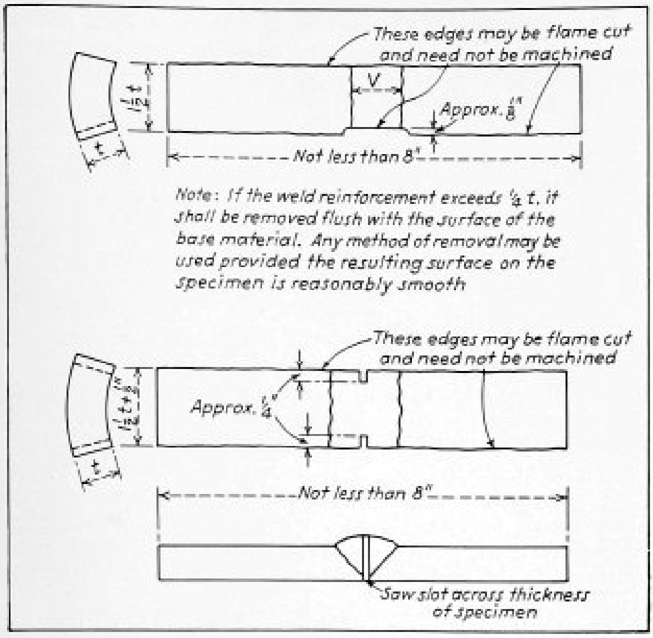


Fig. 4 (top). Fig. 5 (bottom)

weld be made for determination of tensile strength, ductility, and specific gravity—a procedure which is manifestly impracticable.

When consideration is given to all the requirements of the A. S. M. E. Code as it applies to fusion welded boiler drums and U-68 vessels, it will be apparent that they cannot be met from a practicable standpoint, nor are they applicable to fusion welded pipe line construction. The proper procedure for fusion welded pipe lines is to call for a specified technique of welding, an investigation of that technique to determine that it will produce certain desired results, qualification of the welding operators under such procedure of welding, and an insistence that that procedure be followed in actual construction. It is upon this principle that the requirements for welding in the American Standards Association Code for Pressure Piping are based, although certain recent developments have brought about some changes with respect to the method of qualifying welding operators, which might well be incorporated in the A. S. A. Code.

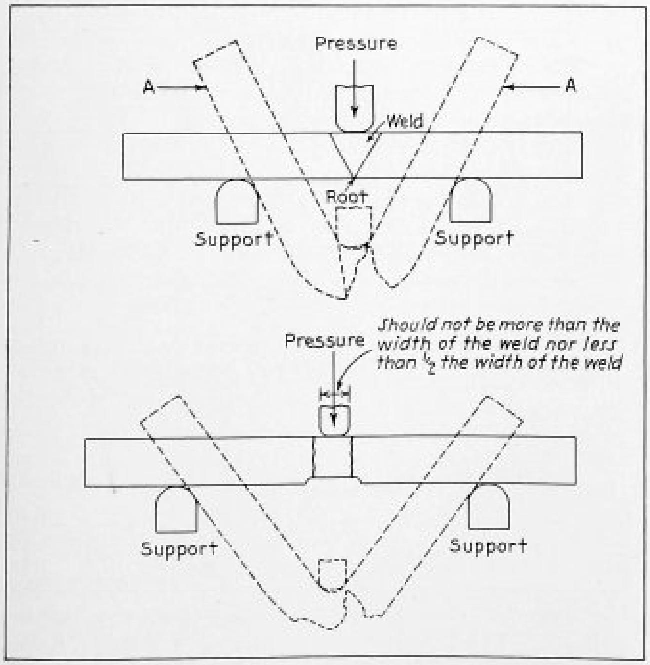


Fig. 6 (top). Fig. 7 (bottom)

Within the near future Hartford Steam Boiler will adopt a new inspection procedure for pipe lines it is called upon to inspect. The first requirement will be, as heretofore, that the fabricator or piping contractor adopt a specific procedure for welding and that he demonstrate to the company's representative that such procedure will produce welds having satisfactory tensile strength, ductility and soundness. The method to be followed to determine these factors is outlined in the "Tentative Rules for the Qualification of Welding Processes and Testing of Welding Operators," as published by the American Welding Society.

The second requirement will be for the fabricator or contractor to demonstrate that all welding operators employed on the work can make sound welds when they follow the outlined procedure that has been investigated and found satisfactory. The procedure for the qualification of a welding operator is outlined also in the "Tentative Rules" referred to above.

The third requirement will be that a representative of

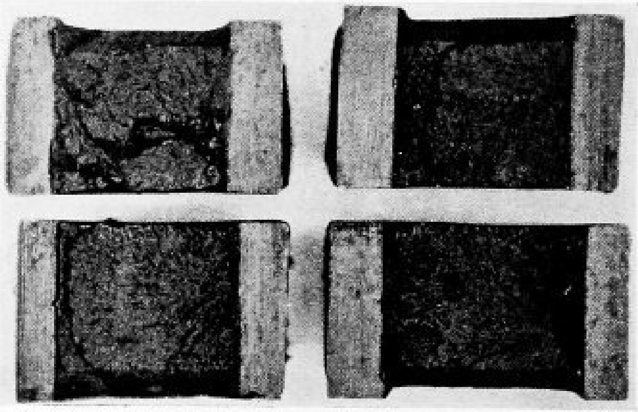


Fig. 8

the Company make a sufficient number of visits of inspection during the fabrication of the pipe line for the purpose of checking upon the procedure for welding. Particular attention will be paid to the materials that are used, as such materials determine to a large degree the quality of weld metal that will be obtained.

It will be required that all welding operators be assigned an identifying number or symbol, which number or symbol must be stamped adjacent to every weld which the operator makes. Upon the completion of the work, the inspector will remove from the pipe line a complete welded joint or a specimen from the joint for each welding operator, and these welds or specimens will be examined for soundness.

As long as such examinations show that the individual operator is doing acceptable work by the prescribed procedure, no re-qualification tests will be required. In other words, the individual operator must pass an initial examination to demonstrate his ability, and will be held fairly close to that quality of workmanship through the medium of a check on his work on the job. In unusual cases some other method of inspection may be agreed upon by the owner or purchaser and the inspecting company.

The final step in the inspection will be, of course, the hydrostatic test.

Some points of the above procedure in the inspection

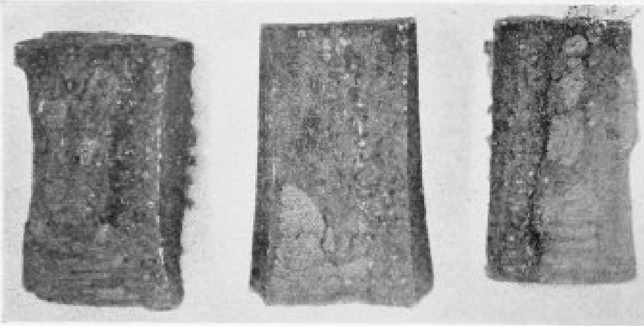


Fig. 9

of fusion welding on pipe lines are worthy of further discussion.

It is of particular interest to note that the American Welding Society's "Tentative Rules" recognize the principle that tensile strength and ductility in weld metal are determined by the procedure or technique of welding. This procedure or technique involves all the variables encountered. Consideration is given, not alone to the question of whether the gas or metallic arc process is used, but also to the specific kind of welding wire, to the shape of the welding groove, to the quality of flame, to the number of beads deposited, and several other items. When it has been determined that a given procedure will produce certain tensile strength and ductility of weld metal, it is then useless to test every operator's work for tensile strength and ductility because those qualities are predictable under the given procedure. For the qualification of a welding operator under any given process it is necessary to know, not whether he can produce welds of a certain tensile strength and ductility, but rather, whether he can make a *sound* weld by that process. By a sound weld is meant one that is properly fused and without excessive slag inclusions or porosity.

The "Tentative Rules for the Qualification of Welding Processes and Testing of Welding Operators" give suggested forms for the writing of specifications for different methods of welding, but no specific instructions for welding are given. It is the duty of the person or persons having responsible charge of the welding to write the specifications setting forth in detail the method to be followed. No limitations are placed on the methods to be used and there is entire freedom for the development of new ideas.

For the qualification of a process, it is necessary that welded pipe joints be made in those positions which are to be encountered in actual construction, and the welding of these joints must be done in accordance with the specifications. From each of these test joints there are removed two reduced section tensile specimens, two free bend specimens for ductility, two root break specimens, two side break specimens, and two nick break specimens. The specimens for the reduced section tensile tests are prepared for testing as shown in Fig. 1. The specimens for the free bend are shown in Fig. 2, those for the root break specimens in Fig. 3, those for the side break specimens in Fig. 4 and those for the nick break specimens in Fig. 5.

The methods for testing the tensile, free bend, and nick break specimens have been in general use for several years and need no comment here. The methods of testing the root break and side break specimens are shown in Figs. 6 and 7 respectively.

In the case of pipe lines which are welded with backing strips or chill rings on the inside of the pipe, the specimens shown in Fig. 3 are polished on the sides and etched in a boiling solution of 50 percent hydrochloric acid and water. This method of testing is used instead of the root break to determine what penetration into the chill ring has been obtained.

The side break test is somewhat new. It had been felt that the nick break specimen might not reveal defects that might exist on the side walls of the welding groove. To investigate this matter a defective weld was made in which there was a slag streak of somewhat minor proportions on the side wall. The weld was X-rayed and it was found that the defect continued throughout the length of the weld. Four nick break specimens and three side break specimens were removed. Two of the nick break specimens were broken in the customary manner with a quick, sharp blow, and the other two nick break specimens were broken by a slow bending. All of the nick break specimens broke directly through from notch to notch as shown in Fig. 8. The side break specimens broke through the side wall defect as shown in Fig. 9.

In the qualification test for welding operators only the face break, root break, side break, and nick break specimens are used. The face break test is made in the same manner as the free bend test except that no measurement is made of ductility.

It is not to be expected that perfect welds will be demanded. There must be some tolerance and, therefore, there must be some method of evaluating lack of soundness. Thus, consideration must be given to what constitutes a defect.

The company has adopted the following standards for welded joints in pipe lines:

Tensile Test—The reduced section tensile test specimen shall show an ultimate tensile strength not less than 90 percent of the tensile strength of the pipe material.

Free Bend Test—The ductility by the free bend method shall be not less than 20 percent.

Soundness—The permissible total depth of all zones

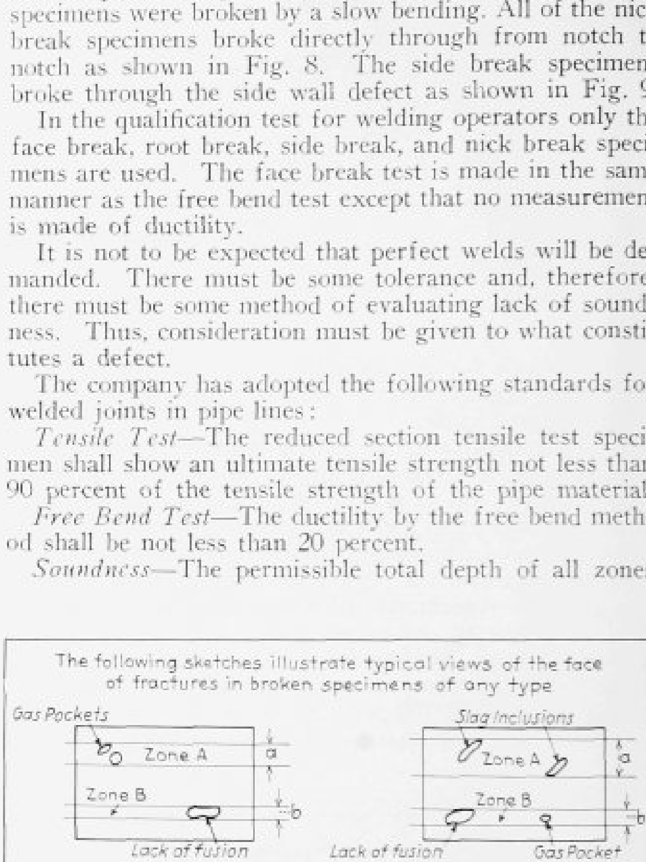


Fig. 10

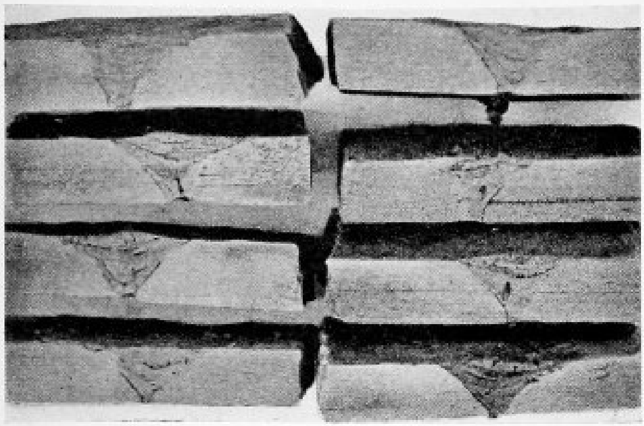


Fig. 11

of defects on any plane parallel to the throat of the weld shall not exceed 10 percent of the specified weld throat dimension in the case of fillet welds, or of the thinner of the two parts jointed in the case of butt welds.

Defects are defined as gas pockets, slag inclusions, and lack of fusion exceeding $\frac{1}{16}$ inch in greatest dimension. Typical cases of zones of defects are shown in Fig. 10. For single welded butt joints without backing rings, all defects in a zone of 10 percent of the pipe wall thickness at the root of the weld may be disregarded.

The length of any permissible defect, measured on a line perpendicular to the throat of the weld, shall not exceed $\frac{1}{2}$ inch.

When joints or specimens of joints are removed from the completed line for examination, no single zone of defect in excess of 10 percent or a total of all zones in excess of 20 percent of the pipe wall thickness will be permitted. The 10 percent zone at the root of the weld in single welded joints without backing-up strips will be disregarded and the $\frac{1}{2}$-inch limitation on the length of a defect will not apply to lack of fusion between layers of welding.

If the defects found exceed 50 percent of the wall thickness the work of that welding operator will not be accepted. If the defects exceed the 20 percent limit given above but not the 50 percent limit, two additional joints or specimens for each welding operator will be removed. Should these additional joints meet the 20 percent requirement the work of that welding operator will be accepted. However, if either one of the additional joints or specimens shows defects exceeding the 20 percent limit, the work of that operator will not be accepted.

When a complete joint is removed from the pipe line, examination will be made by a root bend test of specimens taken at the top, bottom and two sides of the joint and all specimens must meet the requirements. If they do not, the remainder of the joint may be subjected to the root bend test and judgment of the joint made upon the average condition of all specimens.

It must be understood, however, that even though the specimens may technically meet the requirements, the inspector shall have the right to call for additional specimens, if, in his judgment, further investigation is necessary to determine satisfactorily that the welding is safe.

The matter of position in which the welding is done is of paramount importance and a procedure of welding should be investigated, not in one position but in all positions which may be encountered in actual construction, and each and every welding operator should be examined for his ability in all positions. Furthermore, it must be borne in mind that the average welding qualification test is made under the most advantageous conditions and surroundings. Frequently the welding operator must encounter much more difficult conditions on the actual job. When the oxy-acetylene process is used, the average welder is apt to secure better results by the use of multiple layer welding.*

Those who have responsible charge of welding should give serious thought to these matters and determine to their own positive satisfaction, and not by the word of any other person, that a certain technique of welding is proper and that it is followed in the execution of work for which they are responsible.

As regards the requirement that a welded joint or sample from a welded joint be cut from the work of every welding operator, there are some very pertinent facts to be considered. A welding operator may demonstrate his ability to make a sound weld by a given process and under the most adverse conditions. Human beings, however, are at times peculiar in that, while they may have the ability to do a certain job, they do not always extend themselves to accomplish the results of which they are capable. In several instances welded pipe lines have been constructed by operators who had demonstrated their ability to make sound welds, yet joints cut from the line have revealed unsound welds. Fig. 11 shows an example of this. A constant prodding thought in the mind of a welding operator, to encourage him to do his best work at all times, will have a most beneficial effect and will be the most effective instrument that can be used to secure properly welded joints. Certainly no competent and conscientious welding operator could possibly object to such a procedure. Both employer and employe, knowing that a sample will be taken, are stimulated to continuously endeavor to avoid the penalties attached to unacceptable work.

There is a bright future for fusion welded pipe lines. That future will be safeguarded if every possible effort is made by all concerned to make doubly sure that all welding be consistently of high quality.

Popularizing Welding by Way of the Radio

Welding is the art of sewing iron and steel together, Bennett Chapple, vice-president of The American Rolling Mill Company, Middletown, O., and "Ironmaster" of the Armco Band radio program over the N.B.C. Blue network, told his audience during a recent broadcast.

He emphasized the importance of tailoring new iron and steel garments for the world, describing the automatic welding machines that make possible the hundreds of better products that serve both home and industry.

The text of his chat: "Tonight is Sewing Circle night for the Ironmaster, so draw your chairs up close; for I'm going to tell you something about welding—the art of sewing iron and steel together through the use of terrific heat.

"You perhaps have seen a strange hooded figure crouching over a street car track with a brilliant light sputtering all about. He's sewing a patch on a steel rail—that's all. Instead of a needle and thread, the welding operator has a piece of welding wire which is melted by the tremendous heat, and the molten metal is used to make the patch. Or perhaps we visit a great car building plant and see a huge flash-welding machine in operation. It takes the whole side of a car, with its many pieces held firmly in place, and in the flash of an eye welds them together as one. Or perhaps we see an automatic welding machine creeping over the joint of two

* This subject was discussed in two papers given before the American Welding Society at Cleveland in October, 1936.

heavy iron plates like a giant glow worm, fusing them together and leaving its deposit to cool in the sputtering glare.

"Welding has come into the world of industry very rapidly during the past few years, especially since the World War. To be able to create a one-piece tank or furnace of iron or steel through the use of welding, is a worthwhile contribution, and the finished product is strong and leakproof. This is more important than we realize at first, for the world is leaning more heavily upon the use of water, oil and gas. You may not fully realize how important welding is to the home today. Take your oil burner tank, your water heater, or any underground tank—welding has played an important part in the development of these products.

"Welding, too, has had an important part to play in modernization. Designers set the streamline fashions in new style metal creations and take them to the shop where busy welders work at the task of tailoring new attractive iron and steel garments for the world."

Huge Manifold Fabricated by Arc Welding

Not a seven-nosed mammoth unearthed from subterranean haunts, but the arc-welded inlet manifold to the Gene pumping station on the $236,000,000 Colorado River Metropolitan Water District Aqueduct, scheduled for completion in 1938. This giant arc-welded steel pipe (note size of men on top of structure) was fabricated by the Consolidated Steel Corporation, Los Angeles. A great deal of field work was necessary and Fleetweld electrode, as well as numerous machines, manufactured by The Lincoln Electric Company, Cleveland, were used.

The capacity of the aqueduct—a billion gallons of water per day—will not be used immediately. Consequently only three of the outlets—those at the far end of the illustration at the right will feed the pumps when the aqueduct is completed. Later, when future needs demand, pumps will be added to the other four outlets which for the time being will be closed by bull plugs.

This colossal welding job in the field is but one of many which prove the adaptability of the processes under almost every conceivable condition.

Boiler Code Committee Celebrates Jacobus' 75th Birthday

On Friday evening, January 29, at the Engineers' Club, New York, about forty members of the Boiler Code Committee of The American Society of Mechanical Engineers and their guests celebrated the seventy-fifth birthday of Dr. D. S. Jacobus, who is chairman of the committee, and a past-president and an honorary member of the Society.

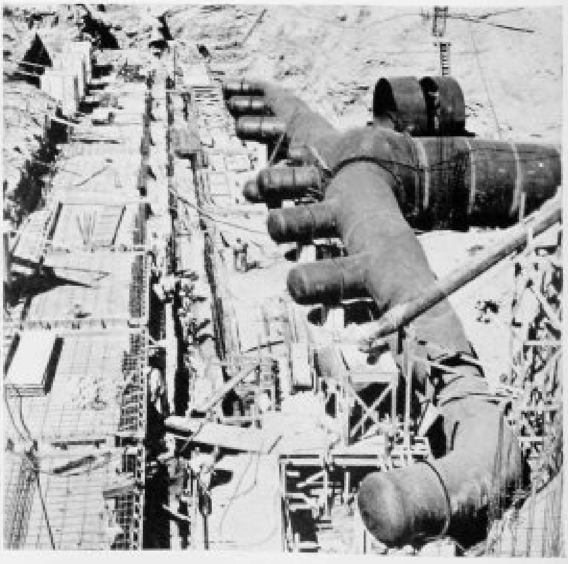
The birthday dinner followed one of the regular meetings of the committee and inasmuch as Doctor Jacobus had no suspicion of what had been planned, great adroitness and a certain amount of evasion had to be practiced in order to insure his presence.

Henry B. Oatley acted as master of ceremonies for the informal committee that arranged the dinner, and amid laughter and applause read an account of the Boiler Code "football team" on which each member played some characteristic part. As a sports writer, Mr. Oatley is a keen critic of prowess in team play, and he did not hesitate to comment on the weak as well as the strong points of the individual players. He also read from numerous letters and telegrams of congratulation that had been sent by friends of Doctor Jacobus who could not attend.

Following Mr. Oatley's exposé of the personnel of the Boiler Code Committee, H. H. Vaughan, who had come all the way from Montreal to honor his former associate on the committee, undertook the task of toastmaster and called upon a dozen or more persons to pay tribute to Doctor Jacobus and recall happy days and historic incidents. Dr. W. H. Durand, past-president and honorary member A.S.M.E., spoke for the society, and C. B. LePage, assistant secretary, for Secretary Davies and the headquarters staff.

H. Leroy Whitney, after a witty preamble, presented Doctor Jacobus, as an expression of the esteem of the committee and on behalf of its members, a gavel handsomely ferruled in silver on which an appropriate inscription had been engraved.

In acknowledging the gavel and the felicitations and congratulations of his colleagues, Doctor Jacobus spoke of his deep emotion at being thus honored and recalled some of the interesting experiences that had enlivened his association with boiler-code work.

Giant welded inlet manifold for Colorado River Aqueduct

Magnafluxing Pressure Vessel Welds*

By J. W. Yant†

Application of the magnaflux test to pressure-vessel welds is a rather recent development, oil companies having specified it on certain classes of this work only within the last 18 months. This method of testing was first applied by our company to the alloy welds of vessels lined with ferritic stainless steel in which the liner was fastened to the carbon-steel backing plate by resistance or arc welding, or a combination of both. Subsequently, magnafluxing was used as a final test after the hydrostatic test for all welds of vessels not X-rayed and for all welds of vessels X-rayed before stress relieving. Where vessels have been X-rayed after stress relieving, the test has been applied only to welds, such as nozzle, manhole, and supporting-lug welds, that could not be X-rayed.

Complete or Local Magnetization Must Precede Testing

A pressure vessel to be magnaflux tested must first be magnetized. Therefore, this test is not applicable to welds of the nonmagnetic austenitic-type steels such as the 18 percent Cr, 8 percent Ni grade. Vessels may be either completely or locally magnetized, depending somewhat on preference or on the quantity of testing to be done. Where vessels are large and have many feet of welded seam to be tested, or where a vessel is alloy lined for corrosion resistance and the entire inner surface is to be tested, magnetizing the whole vessel at once is probably most convenient for the inspector. Where only a small length of welded joint is to be tested, local magnetization by either of two methods may be quicker. However, some manufacturers prefer to use local magnetization even though large areas are to be tested. Where large areas are tested by either complete or local magnetization, they should be mapped so that no portion will escape inspection.

A vessel to be magnetized entirely is wrapped with cable, and to perform a thorough job of testing it must be tested separately with a girth wrapping and with a longitudinal wrapping. Welder's cable is satisfactory. The first step is winding from 6 to 14 turns of cable around the girth of a vessel at the center and connecting the cable ends to the terminals of a welding generator. The quantity of current to be used can be gaged roughly by determining whether the ends of the vessel are magnetized enough to attract small pieces of steel. On a vessel of $1\frac{9}{16}$ inch wall thickness, 8 feet in diameter, and 40 feet long, wrapped with eight turns of cable, a current of 300 amperes has produced satisfactory magnetization.

When the vessel is magnetized, the test is performed by sprinkling magnaflux powder, which is finely divided iron, mixed with some other ingredients, lightly over the weld and striking the plate alongside the weld with a hammer to cause the powder to arrange itself and line up over any defects that are present. Where a crack exists in a magnetized vessel, the powder will attempt to bridge the gap between the two edges. Should the vessel be rather strongly magnetized, the powder may line up on the high spots of the ripples of a cover bead or at sharp changes of contour but a light jet of air will remove such lines. If a crack is present, even a strong jet of air will not remove the powder line.

If the surface of a weld to be tested slopes too much, the magnaflux powder will slide off and will not give a good indication. When testing circumferential seams, the vessel must be rolled as the testing progresses and only that portion of the seam, from which powder will not slide off too readily, tested.

When a vessel is magnetized by energized cables wrapped around the circumference, the path of the magnetic flux is parallel with the longitudinal axis, and weld defects, such as cracks perpendicular to the flux path, will cause the greatest magnetic disturbance and will show powder lines more readily than defects parallel with the flux path. Weld cracks running parallel with the flux path, that is, perpendicular to the cables, may not show at all. Thus, to insure that dangerous weld imperfections are not missed, cable must be wrapped around the vessel a second time—this time in a longitudinal direction.

In longitudinal cable winding, nozzles in each head are an advantage since the cable is then led in the nozzle at one end, out the nozzle at the other end, and carried back along the outside of the shell and again inserted through the entrance nozzle until six or eight turns are made. The cable ends are attached to the terminals of a welding generator. Wrapping cables longitudinally is a more efficient way of magnetizing, since the magnetic flux has a complete metallic path around the circumference as compared with the air path from end to end of a girth-wrapped vessel.

If a vessel does not have a nozzle in the upper head, the cable can be brought out through a side nozzle or manhole near the top. The vessel will not be magnetized beyond the cables and a portable means of magnetization such as electromagnets must be used to test the remainder. If an upper-head nozzle is too small to accommodate enough turns of cable, a set of bus bars can sometimes be made up, each one being insulated from the other, and the assembly inserted through the nozzle. The individual turns of the cable can each be attached both inside and out to a separate bus bar, and the circuit completed in that manner.

Portable Electromagnets Provide Local Magnetization

When a vessel is small or when the quantity of welding to be tested does not justify magnetizing the whole assembly, a pair of portable electromagnets or one with a U-shaped core can be used to magnetize small areas at a time. About a foot of seam should be tested at a time, once with the magnets straddling the seam and once with the magnets about 1 foot apart on the seam. This procedure should locate either longitudinal or transverse cracks in a weld. The electromagnets will be found rather burdensome to handle due to their weight if much welding is to be tested.

* Presented at the Welding Practice Symposium which was sponsored jointly by The American Society of Mechanical Engineers and American Welding Society, October 22-23, 1936, Cleveland.

† Standard Oil Company of Indiana, Whiting, Ind.

Another means of local magnetization is to pass a heavy current through the area to be tested. This can be accomplished by an apparatus having two metal fingers set in an insulating handle, and having no contact with each other. The contact points are pressed on the surface of the vessel, the area between them is magnetized by the flow of current and the test is made while the current is on.

The defect most readily indicated by the magnaflux test is a crack that extends to the surface of the weld, even the shallowest crack or checks showing a powder line. In numerous welds of an air-hardening steel, the radiographs of a given length of welded seam showed no defects, but a powder line appeared on the magnaflux test. The cause of the powder line was determined by chipping and, in each instance, was found to be a surface crack about $\frac{1}{64}$ inch deep. Since the total thickness of the weld was about $1\frac{3}{4}$ inches, the cracks were too shallow to show on the radiographs and, without the aid of the magnaflux test, were invisible although some could be seen with a magnifying glass.

More serious defects have been found in welds around nozzles and manholes. In one case, the outside fillet weld around a 20-inch manhole of the integral reinforcing-pad, extended-neck type was being tested. Before the magnaflux test, an air pressure of 100 pounds per square inch had been introduced between the vessel plate and the nozzle pad, and painting the weld with a soap solution revealed no leaks. In magnafluxing, the powder tended to concentrate in the crevasses that were located between the circumferential beads of weld used to build up the outside fillet around the manhole pad, but it could be blown away easily, indicating that a sharp change in section, and not a crack, was causing the powder lines. At one location in the fillet, a powder line 1 inch long that crossed one bead of weld could not be removed with an air jet. Exploration of the cause of this powder line showed that the outside fillet weld was cracked for three quarters of the distance around the manhole although the crack had come to the surface only at the location of the powder line.

Weld cracks extending perpendicular to the wrapping cables may not be found by magnaflux testing. In a vessel that had not been X-rayed, the cables were first wrapped circumferentially, and several transverse cracks were found in two girth seams. When the same seams were later tested with the cables wrapped longitudinally, many more transverse cracks were found.

An unexpected location of cracks in a pressure vessel was found while the head seams of a drum with a wall $\frac{9}{16}$ inch thick were being tested. The powder falling on the tangential section of the head formed a multitude of lines parallel to the axis of the vessel around nearly two thirds the circumference of each head. When the powder was blown away, very fine lines could be seen on the surface of the oxide scale. The scale was ground away and the metal itself was found to be checked. About $\frac{1}{16}$ inch of metal had to be removed to eliminate these checks or cracks which had probably been produced in the head-forming operation. Had the magnaflux powder not fallen on these heads more or less by chance, this vessel would have left the shop containing many cracks which were probably of little consequence at the time but might have developed into something more dangerous in service.

While some users of this test have reported finding subsurface defects repeatedly in other classes of work, its efficacy for detecting subsurface defects in pressure-vessel welds is open to question. With the exception of subsurface porosity which will be discussed later, the writer has never found any subsurface defects by this test, either during routine inspections or laboratory investigations. Most of the welds covered by the routine inspections had been X-rayed and repaired before the magnaflux test and, therefore, were not expected to reveal any defects of importance other than cracks that might have developed subsequent to the X-raying. Other pressure-vessel welds were not X-rayed at any time, however, and, in all probability, contained some subsurface defects when magnafluxed. The specimens investigated in the laboratory were welds that were known to contain slag inclusions and unfused lip edges which, however, could not be located by magnafluxing.

Better testing conditions would prevail if the cover beads on welded seams were removed and nozzle and manhole fillets were chipped smooth. If this procedure did nothing else, it would remove the cause of false indications such as powder lining-up in grooves between beads on nozzle fillets or powder lines forming on the ripples and ridges of a seam cover bead. Furthermore, detection of subsurface defects might be made more certain.

Strangely enough, one clear-cut detection of subsurface defects was the location of porosity, a type of weld imperfection which, due to the relatively small size of the individual centers of magnetic disturbance, would seem to offer the least opportunity for location by magnaflux. In this case, the welds of nine 20-inch, integral reinforcing-pad, extended-neck manholes, each located in an elliptical head, were magnafluxed before the heads were attached to the cylindrical sections of the vessels. The inside weld between the vessel and the extended neck had been built up two heads higher than the inside surface of the head and had been chipped and ground flush. No porosity was visible on the surface. In testing these welds, the powder clung to the surface in many small spots on three of the manhole welds after the bulk of the powder had been blown away with a mild air jet. A number of these individual locations were marked, the magnaflux test repeated, and the powder adhered to the same spots. Chipping these welds opened up areas of considerable porosity extending to within $\frac{1}{16}$ inch of the surface.

In conclusion, while many defects have been located by magnafluxing, these with the exception of the three cases previously mentioned, have all been cracks that extended to the weld surface. On several occasions known defects in welds were not found by magnaflux testing, although it is exceedingly well adapted to some weld investigations. In testing the welding contained in a magnetic stainless-steel vessel-liner, no other type of test will indicate the cracks as completely. However, a valuable supplement to the magnaflux test on lined vessels is a hydrostatic test using a light oil. If a liner is not bottle tight, oil will collect between the liner and the carbon-steel plate. When the vessel is opened and drained, the oil will seep out of any cracks in the liner for as long as a week. Although the oil test will not disclose all the cracks in a liner, it may disclose some defects that were overlooked in the process of making the magnaflux test.

As a final test of vessel welds, such as those around nozzles and manholes, whose position makes them impossible to X-ray; as a final test of longitudinal and girth seams subsequent to radiographing and stress relieving; or as a final test of Class-2 vessels, magnaflux is of definite use in determining whether these welds are cracks. Thus, this test as applied to pressure-vessel welds is a useful auxiliary to the X-ray test and, should a technique be developed which would locate subsurface defects more readily and definitely, could become of even greater utility.

Practical Plate Development—XXII

Irregular Transition Piece

By George M. Davies

The irregular transition piece to be developed is shown in Fig. 185, the elevation, Fig. 186, the end view, and Fig. 187, the plan. The transition piece is square at one end, round at the other end, the round end setting at an oblique angle to the square end. For convenience, the thickness of the plate has been omitted and the outline shown has been taken on the neutral axis of the plate.

The first step in developing the transition piece is to complete the end view by projecting the circular end from the elevation. At any point on the line *G′-H* as *O′* draw the profile of the circular end as shown in Fig. 187. Divide this profile into any number of equal parts, the greater the number of equal parts taken, the more accurate the final development. Sixteen parts were taken in this case. Number the points from 1 to 16 as shown. Then parallel to *G′-H* draw lines through the points 1 to 16 of the profile, Fig. 188, extending them into the elevation, Fig. 185, cutting the line *E′-F′*. Number the intersections from 1′ to 16′ as shown.

Then parallel to the center line *M-N*, draw lines through the points 1′ to 16′ extending same into the end view, Fig. 186, both sides of the center line *E-F*. Next, on the center line *O-P* of the end and plan, Figs. 186 and 187, at any point as *O″* draw the half profile of the circular end as Fig. 189. Divide the half profile into eight equal parts and number the divisions from 1 to 16 to correspond with the same points in the profile, Fig. 188, as shown.

Parallel to the center line *O-P*, draw a line through the point 1 of the half profile, Fig. 189, and extend same down into the end view cutting the line drawn parallel to the line *M-N* through the point 1′, Fig. 185, locating the point 1″ in the end view, Fig. 186; then parallel to the center line, *O-P*, draw a line through the point 2 of the half profile, Fig. 189, and extend same down into the end view, cutting the line drawn parallel to the line *M-N* through the point 2′, Fig. 185, locating the point 2″ in the end view, Fig. 186.

Continue in this manner until the points 3″, 4″, 5″, 6″, 7″, 8″, 9″, 10″, 11″, 12″, 13″, 14″, 15″ and 16″ of the end view, Fig. 186, are located. Connect these points with a line which will be the projection of the circular end into the end view, Fig. 186.

In the end view, Fig. 186, connect the points 1″ to 5″ with the point *B*, 5″ to 9″ with the point *A*, 9″ to 13″ with the point *E* and 13″ to 1″ with the point *D*, and in the elevation, Fig. 185, connect the points 1′ to 5′ with the point *B′*, 5′ to 9′ with the point *A′*, 9′ to 13′ with the point *E′* and 13′ to 1′ with the point *D′* as shown. These lines represent the surface lines of the transition piece and, in order to complete the development, it is necessary to obtain the true length of these surface lines. This is done by constructing a series of right angle triangles as shown in Figs. 190 and 191.

To construct the right angle triangles draw any line as *x-y*, Figs. 190 and 191, and at any points as *r* and *s* erect perpendiculars to *x-y*.

From *B*, Fig. 190, step off along the base line *x-y* the distance *B*-1″ equal to the distance *B*-1″, Fig. 186, locating the point 1″, Fig. 190, and from *B*, Fig. 190, step off on the perpendicular the distance *B*-1′ equal the perpendicular distance between the line *A′-B′* and the point 1′, Fig. 185, locating the point 1′, Fig. 190. Connect the points 1′-1″, Fig. 190, with a line, which line will be the true length of the surface line *B*-1″, Fig. 186 or *B′*-1′, Fig. 185.

Then from *B*, Fig. 190, step off along the base line *x-y* the distance *B*-2″ equal to the distance *B*-2″, Fig. 186, locating the point 2″, Fig. 190; and from *B*, Fig. 190, step off on the perpendicular the distance *B*-2′ equal to the perpendicular distance between the line *A′-B′* and the point 2′, Fig. 185, locating the point 2′, Fig. 190. Connect the points 2′-2″, Fig. 190, with a line, which line will be the true length of the surface line *B*-2″, Fig. 186, or *B′*-2′, Fig. 185. Continue in this manner until all the true lengths of all the surface lines in Figs. 190 and 191 are obtained. The bases of the right angle triangles are taken in all cases, in their true lengths from the end view, Fig. 186, and the altitudes taken equal to the perpendicular distance from the line *A′-B′* and *D′-E′* to the points 3′ to 16′ in Fig. 185.

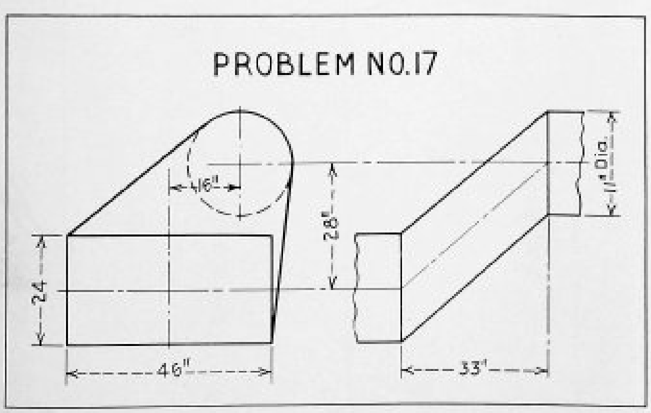
The true length of the surface line 1″-C, Fig. 186, is obtained in the same manner and is shown in Fig. 190.

To Develop the Pattern

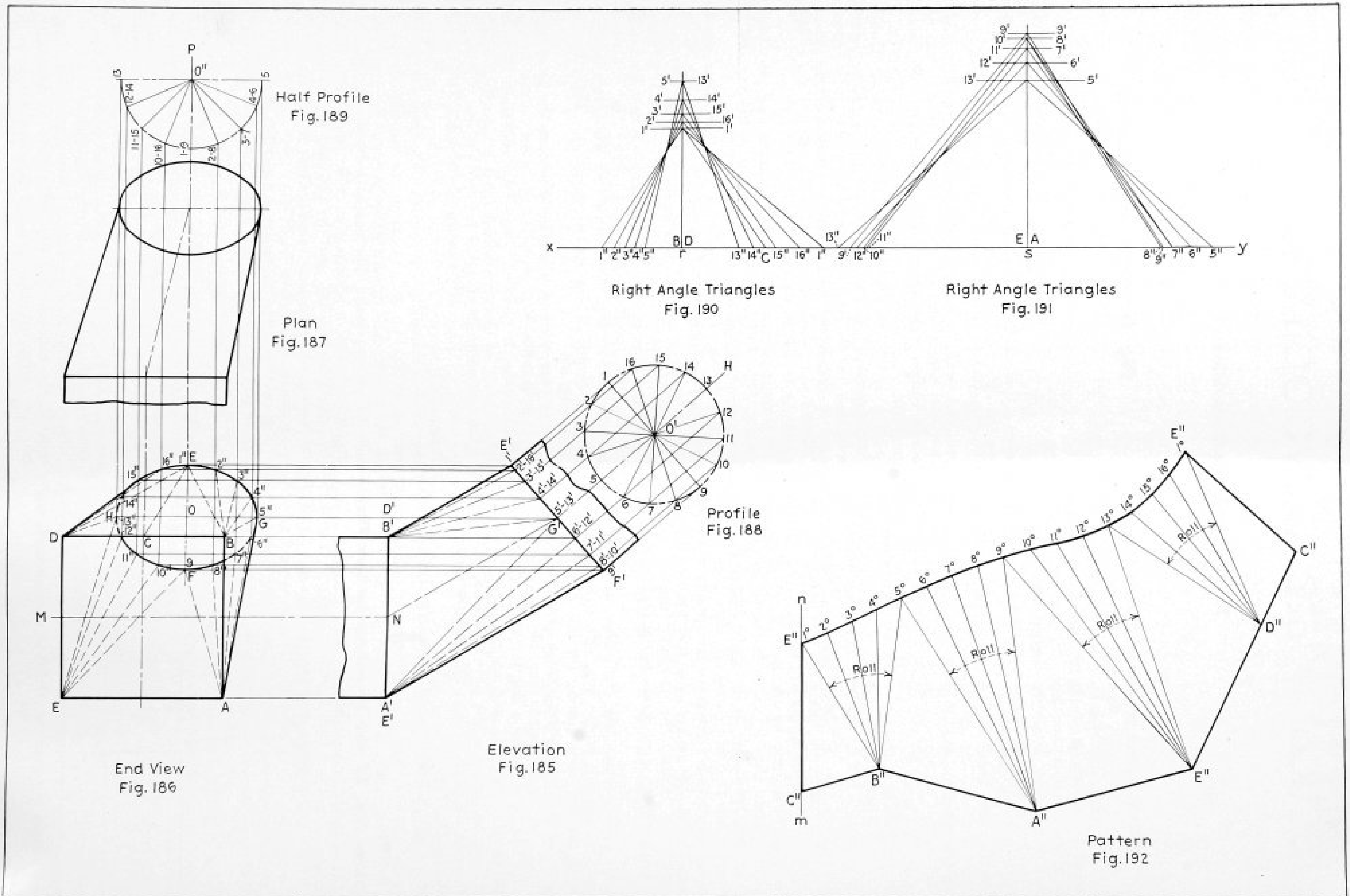
Draw any line as *m-n*, Fig. 192, and on *m-n* step off the distance 1°-*C″* equal to the length of the surface line 1′-*C*, Fig. 190. Then with *C″*, Fig. 192, as a center, and with the trams set equal to *C-B*, Fig. 186, scribe an arc. Then with 1°, Fig. 190, as a center and with the trams set equal to 1′-1″, Fig. 190, scribe an arc, cutting the arc just drawn locating the point *B″*, Fig. 192.

Then with 1° as a center and with the dividers set equal to the distance 1-2, Fig. 188, scribe an arc. With *B″*, Fig. 192, as a center and with the trams set equal to

Problem No. 17 for Readers to Lay Out



The correct solution of Problem No. 17 will be published in the May issue



Half Profile Fig. 189

Plan Fig. 187

Right Angle Triangles Fig. 190

Right Angle Triangles Fig. 191

Profile Fig. 188

End View Fig. 186

Elevation Fig. 185

Pattern Fig. 192

Development of patterns for an irregular transition piece

2′-2″, Fig. 190, scribe an arc cutting the arc just drawn, locating the point 2°, Fig. 192. Continue in this manner, taking the distances 2°-3°, 3°-4°, 4°-5° equal to the distances 2-3, 3-4, 4-5, Fig. 188, and the distances *B*″-3°, *B*″-4°, *B*″-5° equal to the distances 3′-3″, 4′-4″, and 5′-5″, Fig. 190, until the line *B*″-5°, Fig. 192, is drawn.

With *B*″, Fig. 192, as a center and with the trams set equal to *B-A*, Fig. 186, scribe an arc. Then with 5°, Fig. 192, as a center, and with the trams set equal to 5′-5″, Fig. 191, as a radius, scribe an arc, cutting the arc just drawn, locating the point *A*″, Fig. 192.

Continue as before making 5°-6°, 6°-7°, 7°-8°, 8°-9°, Fig. 192, equal to 5-6, 6-7, 7-8, 8-9, Fig. 188, and *A*″-6°, *A*″-7°, *A*″-8°, *A*″-9°, Fig. 192, equal to 6′-6″, 7′-7″, 8′-8″, and 9′-9″, Fig. 191, until the line *A*″-9° is drawn.

Repeat the process, making *A*″-*E*″, *E*″-*D*″ and *D*″-*C*″ equal to *A-E*, *E-D* and *D-C*, Fig. 186. The small spaces 9°-10° to 16°-1° are taken equal to 9-10 to 16-1, Fig. 188. The distances *E*″-9° to *E*″-13° are taken from Fig. 191 and the distances *D*″-13° to *D*″-1° are taken from Fig. 190. The distance *C*″-1° also is taken from Fig. 190.

Connect all the points with lines as shown in Fig. 192, completing the full pattern of the irregular transition piece.

(To be continued)

Hartford Steam Boiler and Welding Progress*

Fusion welding today occupies a merited place of importance in the fabrication of all kinds of pressure vessels. In their construction, the fundamentals of good welding technique are rigorously followed by many shops, but, unfortunately, this condition of adherence to good technique is not universal.

The somewhat sporadic growth of welding has led to serious misunderstanding with regard to it, and to its abuse by those who are uninformed respecting the factors that control the production of acceptable welds. At the other extreme, because of their experience with or knowledge of welding failures, another group holds to the view that welding is inadequate, and forthwith condemns everything of welded construction. The number of the latter group is decreasing, but men of this viewpoint are still to be found in industrial circles, and their contentions are valuable. They help to keep the over-enthusiastic advocates of welding nearer to the middle way.

Among the adherents of the "middle way"—adherents of sound welding consistently achieved—are the insurance company engineers. Even two decades ago they were in agreement with forward thinking manufacturers and plant engineers that welding had distinct advantages. Properly controlled, said they, welding may some day be a reliable aid to pressure vessel fabrication. Their predictions are being fulfilled.

It was not until a decade after the war that pressure vessels of welded construction were generally insured, and then only after careful consideration of the shop standards that had to do with their construction, coupled with knowledge of the use to which each vessel was to be put. A more general acceptance of fusion welded vessels for insurance came still later, after standards for the construction of fusion welded pressure vessels had been outlined by the insurance companies, the American Welding Society, the A. S. M. E. Boiler and Unfired Pressure Vessel Codes and the manufacturers themselves through their individual efforts.

The Hartford Steam Boiler Inspection and Insurance Company, as its contribution to the work of obtaining welded vessels of proper construction, has insisted and continues to insist that finished welds be of proper soundness, strength and ductility. Concurrently with the adoption by the company of standards of acceptance for fusion welded pressure vessels, engineers on the A. S. M. E. Committees revised the Boiler and Pressure Vessel Codes so that they permitted construction by welding in addition to other methods of fabrication.

The company since has adopted the A. S. M. E. Code for Boilers and Unfired Pressure Vessels as its recommended standard of construction. Any vessel built to the requirements of that code and shop-inspected by the company is acceptable for insurance, provided, of course, that the conditions of service also meet the company's requirements for insurance. However, the fact that a manufacturer has demonstrated that his process is proper and that his welders are competent to weld ordinary low carbon steels does not necessarily mean that this same manufacturer is experienced in the construction of welded vessels of the new corrosion-resistant and other alloy steels or for the welding of any of the many non-ferrous alloys which are coming into use because of their superiority for certain specific applications in fields where they will be advantageous.

The need for greater care in the welding of pressure vessels has been reflected by the engineering press during 1936. More detailed specifications are given in articles than ever in the history of welding, and the writers further make it evident that they consider it not only good engineering to say that some factors are not known, but find it absolutely necessary to do so if the papers that they present to men who know welding are to be given credence. The atmosphere of "cock-sureness" has nearly disappeared, and there are being published many carefully written papers on the subject of welding which are backed by tireless research. These contributions to the subject are helping to give sturdy impetus to the advancement of safe welding. Attesting this advancement is the fact that welding is being used for pressures in excess of 1000 pounds for boiler drums and piping, that it is proving acceptable in the fabrication of unfired pressure vessels subject to high pressures and temperatures and serious corrosive influences, and that piping fabricated by the welded method is both safe and economical of construction. Of course, in all such applications of welding it is essential that the work be done by proper methods and by welders whose ability has been proved not alone by their years of experience but by proper tests and periodic checks on their work.

Welders of pressure vessels and piping (as well as of machinery) in 1937 will range all the way from the owner of $50 worth of equipment and a pair of goggles to the plant which has spent thousands of dollars on the development of its technique of welding and of its methods of testing the finished work. If his experience is inadequate, the owner of the $50 worth of equipment and the goggles, or for that matter of much finer equipment, may not know that he doesn't know how to weld—and neither will the persons who hire him for welding realize that he doesn't know—until a weld fails and discloses a lack of fusion, the presence of slag or porosity or some other bad defect.

Having in mind all this, reliable manufacturers and many individual operators have come to the conclusion that the sooner users of welded vessels know that weld-

*From an editorial appearing in *The Locomotive*.

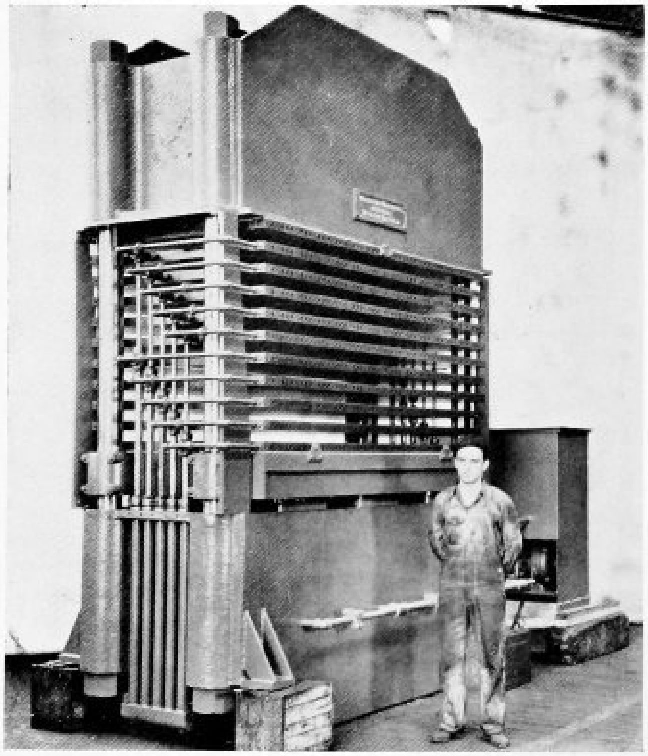
ing can be either skillfully or poorly done, according to the technique of the welder, the more quickly will the standard of all welding be improved. If all who weld and all who use welding will inform themselves of its correct employment and will insist on compliance with established standards of quality and safety, the advancement of welding in 1937 should be the most satisfactory thus far made in the history of that process as applied to construction.

Hartford Steam Boiler today is backing good welding technique with insurance accident limits in large amounts on policies covering losses from accidents to welded boiler drums. The company also is insuring welded piping and welded unfired pressure vessels of many kinds. It expects to insure many more such vessels, but it will continue in the future, as it has in the past, to insist, if insurance is to be written on them, that welded vessels be designed and fabricated in accordance with established safe practices.

Hot Plate Press of Welded Construction

The accompanying illustration shows a new 500-ton hot plate press built for a manufacturer of plywood by Williams, White and Company, Moline. The plies, spread with glue, are placed in the openings between the hot plates at center. Tremendous pressure is applied and live steam, introduced into the hot plates, bakes the glue.

This interesting machine is 15 feet high, 10 feet wide and 4 feet deep, front to back. It weighs 80,000 pounds. Steel plate used in construction is 1 inch thick and is electrically welded to simple steel castings forming the ends of the press. The large steel plates at the top of its press are of sufficient size to prevent deflection. The welding was done by the shielded-arc process with Lincoln equipment. Test of the weld under full pressure showed only 0.010 inch deflection at the center. The hot plates, drilled for the passage of steam, are 100 inches long, 50 inches wide and 2 inches thick.



Welded hot plate press

Novelties in Steam Boilers*

Novel designs of modern steam generators, introduced to readers through such papers as those on the Velox boiler and the Steamotive, must have emphasized the fact that those whose acquaintance with steam power was formed in the days when fire-tube and water-tube boilers offered a convenient classification of a relatively few types need to be brought up to date. With emphasis on German constructions that are more radical than those seen in this country, Friedrich Münzinger discussed "Modern Forms of Watertube Boilers for Land and Marine Use" at a meeting on November 20 of The Institution of Mechanical Engineers (England).

The main causes of change in the construction of watertube boilers since 1920, he said, are the introduction of pulverized-fuel firing, the astonishing increases in steam pressures and temperatures, the heating of feed-water by bled steam, and the extensive use of chemically treated feed water.

The amenities of international relations are graciously covered in the statement that practically all industrial nations have contributed to the advance of boiler construction. The United States, said Dr. Münzinger, is above all to be thanked for the construction of practical pulverized-coal-firing systems and for important research into heat transfer. Great Britain is the birthplace of the first boiler with completely water-cooled walls (the Wood boiler) and of the first forced-flow boiler (the Benson boiler); Germany has carried out extensive research into the relationship between heat transfer and loss of draft and has developed forced-flow boilers; and Switzerland has produced the first boiler with a supercharged furnace (the Velox boiler). Then turning to the attitude with which engineers must view all developments in their profession, he observed shrewdly that close specialization and scientific methods of working are of great importance if the utmost in power and efficiency is to be won, but no less valuable are common sense, cool-headedness, and the ability to recognize essentials. These qualities are the finest guard, he asserted, against the degeneration of theory into fruitless, scientifically crabbed speculations, and against overemphasis of theoretical quibbles made at the expense of practical engineering.

A number of schematic cross sections of stationary boilers of present design were next offered with observations on stable conditions of water circulation in natural-circulation boilers and the effect of chemically treated feed water. Directing his attention to forced-flow boilers (Loeffler, La Mont, Velox) in which steam or water pass continuously through the heating surface, Dr. Münzinger differentiated them from once-through boilers (Benson and Sulzer) in which exactly as much water is forced through the heating surface as is converted into steam. With the aid of diagrams in some cases he discussed forced-flow boilers in relation to their behavior when fed with impure feed water, the power required by feed and circulating pumps, behavior under changes of load, and cost, and concluded by saying that, in general,

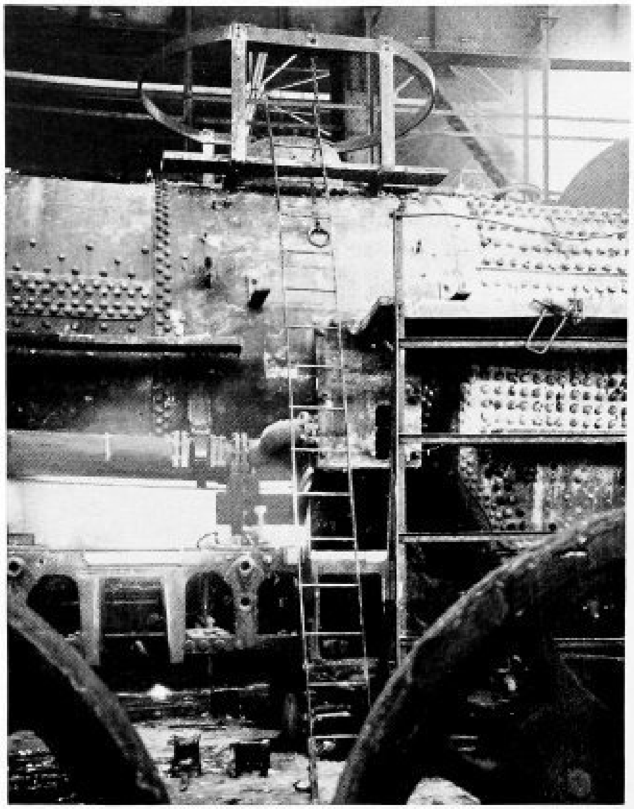
* Review by courtesy of *Mechanical Engineering*.

forced-flow boilers are primarily to be considered for special purposes, and that the question of first costs renders it rather unlikely that they will displace the natural-circulation boiler to any great extent within the near future, since the latter type adequately fulfills the exacting requirements of today and has been brought by decades of experience to a high degree of perfection.

A following section discussed special boilers for fluid and gaseous fuels and the advantages of heavily loaded furnaces. The final section was devoted to watertube marine boilers, with cross sections of the Yarrow (*Queen Mary*), Johnson, Loeffler, and Sulzer (single-tube) boilers and a table of principal proportions of 15 installations of typical merchant ships.

Looking to the future, Doctor Münzinger said that if it is possible to make large boilers as reliable as those of usual capacities, the safety and ease of maneuvering of multi-screw ships can be much enhanced by dividing the whole machine plant into several fully automatic units, each consisting of a turbine with either one or two automatically regulated boilers and installed in a separate watertight compartment.

Safety Platform for Dome Work



Safety dome platform and ladder used at the Joliet, Ill., locomotive shops of the E. J. & E.

The illustration shows a substantially constructed safety dome platform which may be readily applied over the dome of a locomotive undergoing repairs and provide ample protection for workmen who are engaged in making throttle repairs or doing any other work around the steam dome. The upper rail of this protective platform is approximately 7 feet in diameter and made of 1-inch by 4-inch steel bar stock, being supported on four uprights made of the same material and continuous with the two bottom supports which rest on and are fitted to the curve of the boiler. A plank placed across these bottom supports on either side of the dome affords a secure footing.

The safety dome platform is sufficiently heavy so that there is little tendency for it to slide or slip even when the weight of one or two workmen is concentrated on one side. To serve as an added precaution, however, the actual bearing of the bottom supports against the boiler consists of four 2-inch by 4-inch by 6-inch wood blocks bolted to the supports.

The steel ladder, shown in the illustration, also is more satisfactory than most wooden ladders, being relatively lighter and stronger. This ladder is made of ⅜-inch by 2-inch steel side bars into which ¾-inch round bar steps are inserted and welded, with wood foot pieces bolted to the side bars at the bottom to serve as a bearing against the shop floor and prevent the possibility of slipping.

One side of the adjustable safety scaffold, used in connection with boiler work, is also shown in the illustration. This scaffold is 7 feet long by 44 inches wide on the base and 9½-feet high to the wood platform. It is made of 2½-inch vertical side angles with horizontal cross angles 1½ inches by 2 inches, spaced 24 inches apart. The light guard rail made of a ¾-inch steel rod, is 22 inches above the 2-inch by 30-inch wood platform which is supported on two steel brackets adjustable for height by means of bolts applied through the vertical side angles.

This adjustable safety scaffold, like the safety dome platform, may be readily moved about the shop by the shop crane and, once suitably placed, contributes both to safety and increased production on the relatively hazardous work on large locomotive boilers. Both devices are successfully used at the Joliet, Ill., locomotive shops of the Elgin, Joliet & Eastern.

Manufacturers Approve Horizontal Boiler Standards

The proposed Simplified Practice Recommendation for Steel Horizontal Firebox Heating Boilers has been accorded the required degree of acceptance by the industry and is to become effective at once, according to an announcement by the Division of Simplified Practice, National Bureau of Standards. The recommendation will be identified as Simplified Practice Recommendation R157-37.

The recommendation was approved at a general conference held in Cleveland, on June 5, 1934, and subsequently modified to meet the needs of various interested groups. As finally accepted for promulgation, the recommendation lists 19 sizes of boilers ranging from 1800 to 35,000 square feet of steam radiation and from 2880 to 56,000 square feet of water radiation for hand firing. Nineteen ratings are also given for these boilers mechanically fired, ranging from 2190 to 42,500 square feet of steam radiation and from 3500 to 68,000 square feet of water radiation. The recommendation also includes British thermal units per hour, heating surface, grate area, furnace volume, size of outlets, and number and size of safety valves for each size of boiler.

Until printed copies are available, complimentary mimeographed copies of this Simplified Practice Recommendation may be obtained from the Division of Simplified Practice, National Bureau of Standards, Washington, D. C.

Lincoln Arc Welding Prize Contest

The object and purpose of The James F. Lincoln Arc Welding Foundation is to encourage and stimulate scientific interest in, and scientific study, research and education in respect of, the development of the arc-welding industry through advance in the knowledge of design and practical application of the arc-welding process, and to provide for the payment of awards, by prizes (as announced in the February issue), to those persons who by reason of the excellence of their papers upon said subject may be selected in the manner herein provided as most worthy to receive such awards.

In order to stimulate greatest study of arc welding, this contest embraces practically every field of industry where arc welding can be applied as a primary process of manufacture, fabrication or construction. Any of literally thousands of subjects can be selected for papers.

The Prize Contest may be entered by any person, or group of two or more persons. Any contestant, or group, may enter only one paper on only one subject in only one of the official classifications. Payment will be made to person or persons signing the paper. Neither the founder, its employes, its officers, its advertising agency nor its distributing agents shall be permitted to contest for any award or benefit of the contest, and no award shall be given to any such party or person.

To be eligible, each contestant must have actually participated in work upon which the subject matter of his paper is based. The work described in the paper should be the product of the company or firm with which the contestant is or has been connected. The contestant's connection with the company or concern may be either in the capacity of employe or consultant. Consulting engineers may have the work on their product done by a job welding shop.

Other persons, or groups of persons, not so affiliated, may submit a paper on the design of any machine, structure, building, manufactured or fabricated product.

The contestant's exact relation to the work and to the producing or developing organization must be clearly stated to assure eligibility.

Subject Matter of Papers

Participation in this contest necessitates submission of a paper which shall describe one of the following:

A. *Redesign of Existing Machine, Structure, Building, etc.* A machine structure, building, manufactured or fabricated product of ferrous or non-ferrous metals within the limits hereinafter prescribed, previously made in some other way, which has been redesigned in whole or in part, so that arc welding may be applied to its manufacture.

B. *New Design of Machine, Structure, Building, etc., Not Previously Made.* A machine, structure, building, manufactured or fabricated product of ferrous or non-ferrous metals within the limits hereinafter prescribed, not previously made but which has been designed in whole or in part for the use of arc welding, the description to show how a useful result, which was impractical with other methods of construction, or could be better done by arc welding, is obtained. To qualify, the machine, structure, building, manufactured or fabricated product so designed need not have been manufactured or built at the time of the writing of the paper.

C. *Organizing, Developing and Conducting a Welding Service.* The welding service to be described in the papers may be conducted by commercial welders or job shops, garages or service stations, commercial welderies or plant welderies.

In order to be eligible as to subject matter, the machine, structure, building, manufactured or fabricated product, with respect to which the paper is submitted, must have been actually designed. However, machines, structures, buildings, manufactured or fabricated products will be excluded from this contest which have been designed for welding and sold in the open market, or generally used, prior to January 1, 1937. Nevertheless, any preliminary studies, investigations or laboratory work conducted at any time will be admitted as part of any paper, provided the finished product referred to was not sold in the open market, nor generally used, prior to January 1, 1937.

Treatment of Subject Matter

The description of the machine, structure, building, manufactured or fabricated product featured in the paper must be expressed in practical language and be of sufficient clarity to be readily understood by those skilled in the art. Any photographs, drawings, charts, etc., which will add clarity to the description, should be included.

Comparisons as to proportionate savings, gross savings, performance, service life or social advantage provided by the design described in the paper should be made with the previous design and method of construction. In case of a design of a new machine, building, structure, etc., these same items should be considered by the contestant and compared with other methods of construction. Any savings claimed must be clearly substantiated. Any reasonable method by which the contestant believes these savings can be proved will be acceptable. It is suggested that the contestants follow the method outlined in the Procedure Handbook of Arc Welding Design and Practice for calculating welding costs. The Procedure Handbook is published by The Lincoln Electric Company.

In making comparisons and estimates of cost, particular attention should be paid to direct labor and material cost.

Close of the Contest

Only papers contained in envelopes postmarked not later than June 1, 1938, and received in Cleveland not later than July 1, 1938, will be accepted. Personal delivery of papers will not be accepted. Upon receipt of the manuscript in Cleveland, the contestant will be notified by mail.

For complete details write to Secretary, The James F. Lincoln Arc Welding Foundation, P. O. Box 5728, Cleveland, O.

Foster Wheeler Appoints Regional Director

Announcement is made by Foster Wheeler Corporation of the appointment of Howard B. Hall as regional director in charge of its Cleveland, Cincinnati and Pittsburgh territories. Mr. Hall assumed his duties as of March 1, and he will make his headquarters in the Cleveland office of the corporation at 526 Superior Avenue.

The experience of Mr. Hall covers a wide range of industrial activity, and for the last eight years he has been director of the Industrial Division of Murray and Flood, consulting engineers. Prior to that time, Mr. Hall served many years as corporation sales executive.

Air Reduction Sales Manager Dies

Edward M. Sexton, railroad sales manager of Air Reduction Sales Company, died on February 15, in New York, after an illness of several weeks. He was 56 years old. Mr. Sexton was born on Staten Island, N. Y., and was educated in the public schools there. Previous to his

Edward M. Sexton

connection with Air Reduction, he was in the sales department of Holt & Company, flour merchants, and the Western Electric Company, which he represented in Chicago and Denver, Colo. He began his career with Air Reduction as a salesman in the New York metropolitan district in 1916. Later he was appointed manager of the Chicago district, and from this position he was transferred back to New York as manager of the metropolitan district. When in 1922 the Davis-Bournonville Company's personnel was merged with that of Air Reduction, he was selected to manage the railroad sales department, with headquarters at New York.

Washington Editor of Railway Age Dies

Harold F. Lane, Washington editor of *Railway Age* since 1916, died of a heart ailment on February 27 at his home in that city. He was 54 years of age. Mr. Lane, who for the past 21 years had been a familiar

Harold F. Lane

figure wherever railway news was breaking on the Washington front, had served also as correspondent for other Simmons-Boardman publications. He had been on the staffs of *Railway Age* Chicago predecessors as early as 1905 but spent a four-year interval, 1908-1911, in daily journalism before returning to Simmons-Boardman for his subsequent quarter century of continuous association. The latter began with four years' service as associate editor in Chicago before his transfer to Washington.

Harold Francis Lane was born November 2, 1882, at Ashburnham, Mass., and attended the public schools there and at St. Paul, Minn., and Chicago. After being graduated from Calumet High School, Chicago, in 1901, he entered Dartmouth College where he was awarded an A.B. degree in 1905. In the same year Mr. Lane entered the editorial department of the Railway Age (predecessor to the present *Railway Age*) then published by the Wilson Company, Chicago. In 1906 he was transferred to the Electric Railway Review, also published by the Wilson Company. After two years in the latter position Mr. Lane became railroad editor of the Chicago Tribune, a position he held for four years.

Meanwhile the original Railway Age had been consolidated with the Railroad Gazette into the Railway Age Gazette, under Simmons-Boardman ownership, and Mr. Lane in January, 1912, became associate editor of the Railway Age Gazette at Chicago. In September, 1916, he was transferred to Washington where he remained until his death. While in the Chicago office Mr. Lane edited the 1913 edition of the Biographical Directory of Railway Officials (now Who's Who in Railroading). He was a member of the National Press Club, the White House Correspondents' Association, both of Washington, and the Dartmouth College Club of New York.

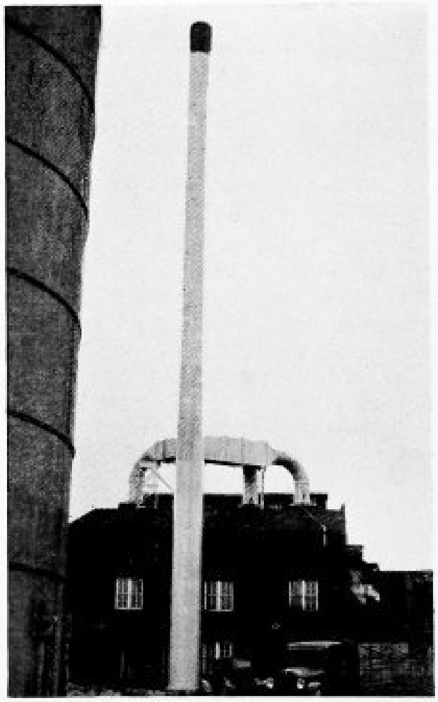
Communications

Another Tall Steel Stack

To the Editor:

On page 332 of your December, 1936, issue of Boiler Maker and Plate Fabricator, we find an article which refers to a smokestack, one hundred and four feet in height, as the largest pre-fabricated stack ever erected.

May we respectfully call your attention to the stack which the Klein Steel Company, Belleville, O., fabri-



Stack at Celina, O., 150 feet high

Boiler Maker and Plate Fabricator

Reg. U. S. Pat. Off.

VOLUME XXXVII NUMBER 3

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Request for change of address should reach us on or before the 15th of the month preceding the issue with which it is to go into effect. It is difficult and often impossible, to supply back numbers to replace those undelivered through failure to send advance notice. In sending us change of address, please be sure to send us your old address as well as the new one. Address H. E. McCandless, circulation manager, 30 Church Street, New York, N. Y.

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EDITORIAL STAFF: H. H. Brown, Editor. L. S. Blodgett, Managing Editor. H. W. MacDonald, Associate Editor.

BUSINESS MANAGER: Warner Lombard.

Contents

cated and erected for the village of Celina, O., Municipal Light Plant in January, 1935.

The stack was 150 feet in height, 72 inches in diameter, and weighed approximately 22 tons. We trucked this one to the site in three 50-foot sections and riveted them together on the ground. The stack was then erected in a single unit, using a 115-foot steel gin pole which weighed 6½ tons, and a steam hoist.

William C. Kammerer, Cleveland, consulting engineer, designed the stack.

Belleville, O. E. A. KLEIN.

Factor of Safety of Air Receiver

TO THE EDITOR:

We wish to call your attention to the example of an air receiver shown on page 53 of the February issue of BOILER MAKER AND PLATE FABRICATOR, as possibly implying that this construction is in accordance with accepted engineering practice and has a factor of safety of 5 at the pressure indicated in the text.

The formula used in calculating the working pressure on the heads is that given in the A.S.M.E. Unfired Pressure Vessel Code for dished heads concave to pressure, where the knuckle and flange are not reversed as shown in Fig. 1 of the example. The implication is that the type of head shown is governed by the A.S.M.E. formula, but this is not the case, as evidenced by Case No. 691 adopted by the Boiler Code Committee on June 27, 1931. Case No. 691 states that a head designed as shown in Fig. 1 does not meet the requirements of the code.

The A.S.M.E. formula provides a safety factor of 5 only when the head meets the requirements of the code, and this includes the requirement that the corner radius shall be at least three thicknesses and at least 6 percent of the shell diameter. Neither of these conditions is met by the design in question.

In our estimation the design illustrated in your magazine is sub-standard from the A.S.M.E. Code standpoint. Under the A.S.M.E. Code, the adequacy of the construction would have to be proved by means of a special hydrostatic test, from the results of which the allowable working pressure would be determined.

Hartford, Conn. JOHN MCLAREN,
Supervising Engineer, The Travelers.

Trade Publications

NICKEL STEEL PRODUCTS.—The International Nickel Company, Inc., New York, in the December number of Nickel Steel Topics has given descriptions of a variety of applications of nickel steel ranging from heavy refinery castings to small bicycle parts.

SHIELD ARC WELDING.—The Lincoln Electric Company, Cleveland, O., has recently issued a pamphlet describing in full the engine-driven model type S-6005 200-ampere shield-arc SAE welder. Full details of the structure and the equipment of the machine are given as well as operating performance data.

CIRCUIT BREAKERS.—The General Electric Company, Schenectady, N. Y., has prepared a pamphlet on the type AF-1 circuit breaker for office buildings and industrials. These circuit breakers are available in a variety of sizes and types for both A.C. and D.C. current of high and low voltage. The pamphlet gives full dimensions and operating data on these devices.

REPUBLIC STEEL REPORT.—The annual report of the Republic Steel Corporation, Cleveland, O., for the year 1936 has been recently issued in booklet form. The financial condition of the company at the end of the year is presented as well as a description of new features which have been introduced into the activities of the company in the past year.

WELDING INSTRUCTIONS.—A comprehensive book entitled "How to Weld 29 Metals" covering the procedure, conditions and materials for welding modern alloys has recently been published by the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa. Specific data for welding all types of joints with varying thicknesses of metals such as electrode diameter, welding current, speeds, deposition, etc., are included. The cost of the book is fifty cents.

Questions and Answers Pertaining to Boilers

This department is maintained for the purpose of helping those who desire assistance on boiler and plate fabricating problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless special permission is given to do so.

By George M. Davies

Non-Pressure Heating Tank

Q.—I would appreciate having a sketch of a non-pressure heating tank for use with 100-pound air pressure. F. N. H.

A.—The question does not include sufficient information, the thickness of the tank and the detail construction being dependent upon the size of tank required.

The A.S.M.E. Rules for the Construction of Unfired Pressure Vessels, Section VIII of the A.S.M.E. Boiler Construction Code gives the rules, formulas, and detail construction for all unfired pressure vessels.

A copy of these rules can be obtained from the American Society of Mechanical Engineers, 29 West 39th Street, New York.

Safety Valve Calculations

Q.—I would like to ask a question or two about a safety valve. We'll say we have a shell boiler whose grate area is 48 square feet and each square foot burns 12 pounds of coal per hour. The coal contains 13,000 British thermal units per pound absolute pressure of boiler, 115 pounds.

According to the A.S.M.E. code we have

$$48 \times 12 \times 13{,}000 = 7{,}488{,}000 \text{ British thermal units per hour.}$$

A 1-inch safety valve having a bevel seat of 45 degrees, having a lift of 0.11 inch, will handle

$$161{,}000 \times 115 \times 0.11 = 2{,}036{,}650 \text{ British thermal units per hour.}$$

For this boiler we would need a valve having a diameter of

$$\frac{7{,}488{,}000}{2{,}036{,}650} = 3.68 \text{ inches.}$$

According to the rules of the Government

$$\frac{\text{Square foot of grate area}}{\text{3 for spring loaded safety valve}} = \text{area of valve in square inches.}$$

$$\frac{48}{3} = 16 \text{ square inches.}$$

Diameter of valve = 4.5 inches.

Which is correct?

I would appreciate hearing from you on this:

This boiler can generate 5100 pounds of steam per hour and a 1-inch safety valve will relieve 0.11-inch lift, 1390 pounds per hour.

$$5100 \div 1390 = 3.66\text{-inch safety valve.}$$

As this boiler generates more than 2000 pounds per hour, according to the A.S.M.E. code two or more valves must be used. If two valves are used must each valve have the above diameter, or can each valve have a diameter of 1.83 inches? L. O.

A.—I am not familiar with the second formula quoted in the question. The formula generally quoted as the United States Board Rule is

$$A = 0.2074 \times \frac{W}{P}$$

Where:

A = area of safety valve, in square inches, per square foot of grate surface

W = pounds of water evaporated per square foot of grate surface per hour

P = absolute pressure per square inch = working pressure + 15.

When this calculation results in an odd size of safety valve, use next largest standard size.

Rules for the calculation of safety valve sizes vary in the different boiler codes and government rules, and for all practical purposes one is as correct as the other, all of the formulas being empirical.

The safety valves on any boiler should conform to the rules or code under which the boiler is to operate.

In addition to the formulas, practically all codes and rules provide that the safety-valve capacity shall be such that the safety valve or valves will discharge all the steam that can be generated by the boiler without allowing the pressure to use more than five or six percent above the maximum allowable working pressure, also that the safety valves be tested.

In answer to the second question, the A.S.M.E. Code provides:

P-270—The safety-valve capacity for each boiler shall be such that the safety valve or valves will discharge all the steam that can be generated by the boiler without allowing the pressure to use more than six percent above the maximum allowable working pressure, etc.

P-276—When two or more safety valves are used on a boiler, they may be mounted either separately or as twin valves, made by placing individual valves on Y-bases, or duplex, triplex or multiplex valves having two or more valves in the same body casing. The valves shall be made of equal sizes, if possible, and in any event, if not of the same size, the smaller of the two valves shall have a relieving capacity of at least 50 percent of that of the larger valve.

From the above it will be noted that when two valves are used their combined discharge capacity shall discharge all the steam that can be generated by the boiler and if possible they shall be of equal sizes.

The reason for using more than one safety valve is that experience has taught that with higher working pressures now used the sudden blowing of a large safety valve produces a severe strain upon the boiler, also especially in locomotive boilers, and under many conditions of overload working, the sudden opening of large valve units will draw water out of the boiler with the steam, the water thus raised chokes the safety valve and prevents the normal discharge of steam.

Phosphorus and Sulphur in Steel

Q.—The A.S.M.E. Code shows the amount of phosphorus in boiler sheets to be not over 0.04 and for sulphur not over 0.05. Will you please advise what effect a higher percent of phosphorus would have on the sheets and what effect on the sheets a higher percent of sulphur would have? I have been a subscriber to your magazine for many years and would appreciate an answer to this question. R. H. L.

A.—Phosphorus enhances the strength of steel. It also adds to the hardness of the plate and thus makes it better able to resist abrasion. However, these qualities are best secured through the medium of carbon, because phosphorus tends to make the material brittle. Steel containing much phosphorus is particularly weak against shocks and vibratory strains. On this account it may be considered the most harmful impurity which occurs in steel boiler plate.

Sulphur increases the brittleness of steel while hot, causing red-shortness, or a tendency of the steel to crumble while being rolled; also interfering seriously with theshaping and forging of the material during the fabricating processes.

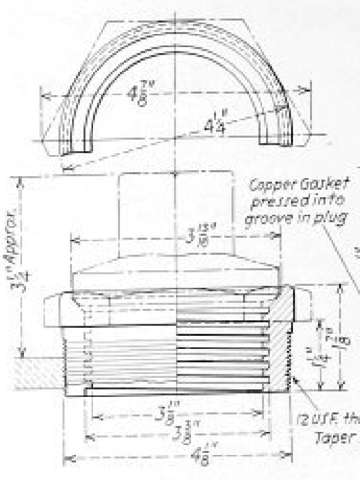

Fig. 1

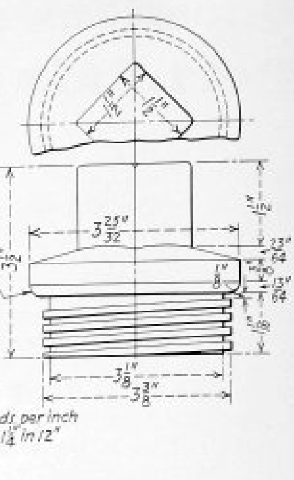

Fig. 2

Superheater Operation

Q.—The chief engineer of a local plant inquires as to the correct method for starting up a boiler fitted with an attached superheater. He wants to know if it is the usual power plant practice to vent the superheater so that the air can escape when steam is raised, thereby preventing the warping or burning of the superheater elements. Also, should the superheater safety valve be set lower than the boiler safety valves, so that the superheater can be flushed by the blowing of the superheater safety valve when the demands for steam suddenly cease? We will appreciate any information you are able to give us with reference to the two items mentioned and also any additional information with reference to care and management of superheaters. M. A. E.

A.—The following instructions for the operation of superheaters answer both questions:

In Starting Up

1. Water is drained from both headers by opening all superheater drain valves. Then close drain on saturated-steam header. But leave drain on superheated-steam header open to insure ample flow of steam through the superheater until the boiler is cut in on the line, when that drain must be closed.

2. Steam is flowing through the superheater units at all times for ample protection.

During Operation

1. Superheater safety valve is set to blow at three to five pounds below lowest boiler safety valve setting pressure. This insures a flow of steam through the superheater units during operation.

2. Pressure setting of superheater safety valve is checked periodically.

In Shutting Down

1. When boiler is taken off the line, drain valve on superheater-steam header is opened and allowed to blow until boiler is cooled down.

2. When boiler is down for any reason, all superheater drain valves are open.

Superheater drains should have a free flow to a sump or the atmosphere through piping of the same size as the drain valves.

Washout Plugs

Q.—What are the advantages of the square-thread washout plug over plugs screwed into the boiler with V or U.S.F. threads? J. B. J.

A.—Washout plugs having V or U.S.F. threads are screwed directly into the boiler, the constant removing and reapplying of the plugs at washout periods makes it practically impossible to eliminate thread troubles and as the threads in the boiler sheet show signs of wear, it becomes difficult to stop leaks or to insert plugs without cross-threading. If the plug is cross-threaded, it is then not only impossible to keep the plug tight, but it is a constant source of danger. As soon as the plug or boiler sheet thread is damaged, it is necessary to retap the hole in the sheet and a new plug is required.

Also in washing out the boiler, if the proper care is not taken to protect the threads, the entering and working around of the hose nozzle often causes damaged threads.

The square thread plugs commonly known as the Huron plugs eliminate this trouble. Fig. 1 illustrates an assembly of the plug and Fig. 2 illustrates the plug.

The plug actually consists of a plug and bushing as illustrated in Fig. 1; the bushing is screwed permanently into the boiler sheet which eliminates the necessity of constant breaking of the threads in the boiler sheet. The inside of the bushing and the plug itself is threaded with a heavy square thread which eliminates cross-threading.

The plug maintains a tight joint without excessive stress on the thread by the use of a copper gasket, as shown in Fig. 2, the copper gasket being a permanent part of the plug. Using a copper gasket to obtain a tight joint eliminates excessive tightening and for this reason the plug may be removed quickly and with minimum of effort, thereby reducing the time of removing and applying plugs at washout periods.

Also due to the size and shape of the threads they are less liable to become injured during the washout operations.

Locomotive Orders in February

The activity which characterized January markets for railway equipment continued throughout February when domestic orders were reported for 33 locomotives. Meanwhile also there was spectacular buying in Canada where orders were reported for 50 locomotives.

February's orders for 33 locomotives brought this year's two-months' total to 79 as compared with the 64 reported during the same period of 1936. In addition six locomotives have been ordered since the close of February and inquiries are outstanding for 24 others. The 50 locomotives ordered in Canada represent more business than has been reported there for the entire 12 months of any year since 1930 when 95 locomotives were ordered.

A complete review of the locomotive situation is commented upon editorially elsewhere in this issue.

Associations

Bureau of Locomotive Inspection of the Interstate Commerce Commission

Chief Inspector—John M. Hall, Washington, D. C.
Assistant Chief Inspector—J. A. Shirley, Washington.
Assistant Chief Inspector—J. B. Brown, Washington.

Bureau of Navigation and Steamboat Inspection of the Department of Commerce

Director—Joseph B. Weaver, Washington, D. C.

American Uniform Boiler Law Society

Chairman of the Administrative Council—Charles E. Gorton, 95 Liberty Street, New York.

Boiler Code Committee of the American Society of Mechanical Engineers

Chairman—D. S. Jacobus, New York.
Acting Secretary—M. Jurist, 29 W. 39th Street, New York.

National Board of Boiler and Pressure Vessel Inspectors

Chairman—William H. Furman, Albany, N. Y.
Secretary-Treasurer—C. O. Myers, Commercial National Bank Building, Columbus, Ohio.
Vice-Chairman—F. A. Page, San Francisco, Cal.
Statistician—L. C. Peal, Nashville, Tenn.

International Brotherhood of Boiler Makers, Welders, Iron Ship Builders and Helpers of America

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Assistant International President—J. N. Davis, Suite 522, Brotherhood Block, Kansas City, Kansas.
International Secretary-Treasurer—Wm. E. Walter, Suite 506, Brotherhood Block, Kansas City, Kansas.
Editor-Manager of Journal—L. A. Freeman, Suite 524, Brotherhood Block, Kansas City, Kansas.
International Vice-Presidents—Joseph Reed, 3753 S. E. Madison Street, Portland, Ore.; W. A. Calvin, Room 402, A. F. of L. Building, Washington, D. C.; Harry Nicholas, 6215 S. Benton Blvd., Kansas City, Mo.; Chas. J. McGowan, 220 South State Street, Room 2116, Chicago, Ill.; J. H. Gutridge, 2178 South 79th Street, W. Allis, Wis.; W. G. Pendergast, 1814 Eighth Avenue, Brooklyn, N. Y.; W. J. Coyle, 424 Third Avenue, Verdun, Montreal, Quebec, Can.; A. M. Milligan, 262 Trent Avenue, East Kildonan, Man., Can.; J. F. Schmitt, 28 S. Roys Street, Columbus, Ohio; William Williams, 1615 S. E. 27th Avenue, Portland, Ore.

Master Boiler Makers' Association

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Vice-President: William N. Moore, general boiler foreman, Pere Marquette Railway.
Secretary-Treasurer: Albert F. Stiglmeier, general foreman boiler maker, New York Central System, West Albany Shop. Address, 29 Parkwood Street, Albany, N. Y.
Chairman Executive Board: William N. Moore.
Executive Board—Three Years: William N. Moore, general boiler foreman, Pere Marquette Railroad; Carl A. Harper, general boiler inspector, Cleveland, Cincinnati, Chicago & St. Louis Railroad; E. C. Umlauf, supervisor of boilers, Erie Railroad.
Executive Board—Two Years: M. V. Milton, chief boiler inspector, Canadian National Railway; Charles J. Kline, locomotive inspector, Interstate Commerce Commission; Sigurd Christopherson, supervisor of boiler inspection and maintenance, New York, New Haven & Hartford Railroad.
Executive Board—One Year: George L. Young, boiler foreman, Reading Company; C. W. Buffington, general master boiler maker, Chesapeake & Ohio Railroad; A. W. Novak, general boiler inspector, Chicago, Milwaukee, St. Paul & Pacific Railroad.

American Boiler Manufacturers' Association

President: Starr H. Barnum, The Bigelow Company, New Haven, Conn.
Vice-President: W. F. Keenan, Jr., Foster Wheeler Corporation, New York.
Secretary-Treasurer: A. C. Baker, 709 Rockefeller Building, Cleveland, O.
Executive Committee (Three years); A. W. Strong, Jr., The Strong-Scott Manufacturing Company, Minneapolis, Minn. R. J. Bros, William Bros Boiler & Manufacturing Company, Minneapolis, Minn. E. R. Stone, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. (Two years): E. E. Knoblock, Union Iron Works, Erie, Pa. A. G. Weigel, Combustion Engineering Corporation, New York. J. F. Dillon, Jr., Struthers-Wells-Titusville Corporation, Warren, Pa. (One year): F. H. Daniels, Riley Stoker Corporation, Worcester, Mass. M. E. Finck, Murray Iron Works, Burlington, Ia. A. G. Pratt, Babcock & Wilcox Company, New York. (Ex-Officio): Starr H. Barnum, The Bigelow Company, New Haven, Conn. Walter F. Keenan, Jr., Foster Wheeler Corporation, New York.

OFFICE OF INDUSTRIAL RECOVERY COMMITTEE,
15 PARK ROW, NEW YORK
Manager—James D. Andrew.
Secretary—H. E. Aldrich.

Steel Plate Fabricators Association

President — Merle J. Trees, 37 West Van Buren Street, Chicago, Ill.

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

States

Arkansas	Missouri	Rhode Island
California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maine	Oklahoma	District of Columbia
Maryland	Oregon	Panama Canal Zone
Michigan	Pennsylvania	Territory of Hawaii
Minnesota		

Cities

Chicago, Ill.	Los Angeles, Cal.	Memphis, Tenn.
Detroit, Mich.	St. Joseph, Mo.	Nashville, Tenn.
Erie, Pa.	St. Louis, Mo.	Omaha, Neb.
Evanston, Ill.	Scranton, Pa.	Parkersburg, W. Va.
Houston, Tex.	Seattle, Wash.	Philadelphia, Pa.
Kansas City, Mo.	Tulsa, Okla.	Tampa, Fla.

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

States

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

Cities

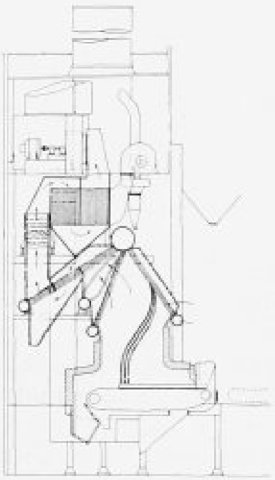
Chicago, Ill.	Memphis, Tenn.	St. Louis, Mo.
Detroit, Mich.	Nashville, Tenn.	Scranton, Pa.
Erie, Pa.	Omaha, Neb.	Seattle, Wash.
Kansas City, Mo.	Parkersburg, W. Va.	Tampa, Fla.
	Philadelphia, Pa.	

Selected Patents

Compiled by Dwight B. Galt, Patent lawyer, Earle Building, Washington, D. C. Readers desiring copies of patents or any information regarding patents or trade marks should correspond directly with Mr. Galt.

1,891,862. WATER TUBE BOILER. HAROLD EDGAR YARROW, OF GLASGOW, SCOTLAND.

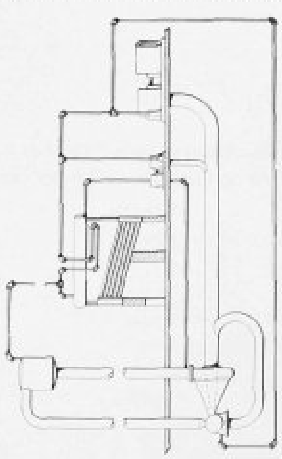
Claim.—A water tube boiler of the Yarrow type having two water drums on one side of the furnace and two banks of water tubes, namely an outer and an inner bank, connecting the respective water drums with the



saturated steam drum of the boiler, the said outer bank being of considerably greater length than the said inner bank of tubes, baffles for the outer bank, said baffles being constructed and arranged to compel the gases to traverse said outer bank of tubes in several passes, and a soot hopper arranged beneath said outer bank over a considerable portion of its length. Five claims.

1,893,715. STEAM RECUPERATOR. JOHN M. ROBB, OF PEORIA, ILLINOIS.

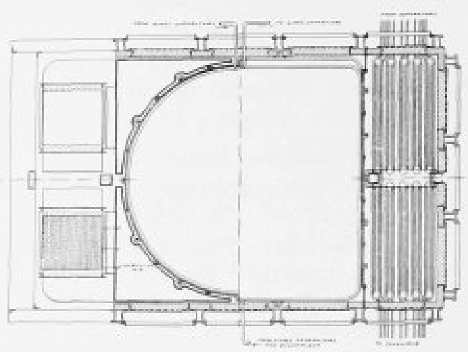
Claim.—In a steam recuperator the combination of a pair of columns, a separator to which both columns are connected, a boiler, means for utilizing the pressure developed by the boiler, a steam line from the boiler to



the separator, a Venturi tube between the columns, a circulating pump in the recuperator, and an exhaust steam conduit from the means for utilizing pressure developed by the boiler and terminating in a discharge nozzle associated with the Venturi tube. Three claims.

1,895,790. TUBULAR STEAM BOILER. MARTIN EULE, OF BERLIN-SPANDAU, GERMANY, ASSIGNOR TO SIEMENS-SCHUCKERT-WERKE AKTIENGESELLSCHAFT, OF BERLIN-SIEMENSSTADT, GERMANY, A CORPORATION OF GERMANY.

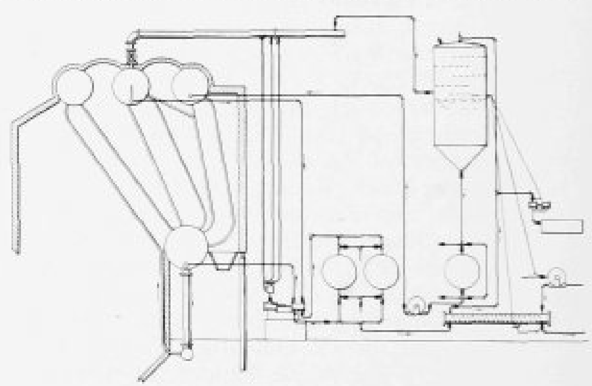
Claim.—A vertical boiler having a polygonal outside contour and having a vertical combustion chamber, and means for supplying fuel from one of its ends, the portion of said chamber near the fuel supply having cylindrical form, and the remainder of the chamber having polygonal



form, and steam generating tubes arranged in coils along the walls of both chamber portions to follow respectively the round and polygonal contour of said chambers, said combustion chamber being dome-shaped at its fuel supply end, said dome consisting in part of a pipe coil following the dome contour and uniformly surrounding the flame emanating from the fuel supply and forming part of the generating coil system, whereby the coil dome is heated by radiation from said flame. Nine claims.

1,895,635. BOILER WATER TREATMENT. WILLIAM McDONALD, OF RIVER FOREST, ILLINOIS.

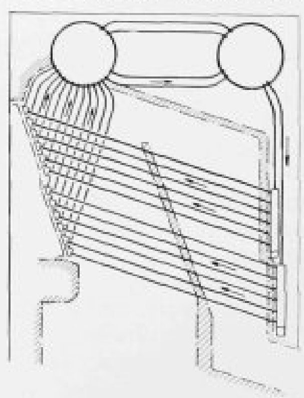
Claim.—The method of conditioning boiler water consisting of supplying chemically treated water to said boiler continuously withdrawing a measured quantity of water from a boiler, filtering the same to remove the salts in suspension, continuously discharging a sufficient quantity of the withdrawn boiler water after filtration so that there is removed from the system substantially as much soluble salts as are introduced by the



fresh water and chemical treatment, and continuously returning the remaining withdrawn water to the boiler, thereby maintaining the soluble salt content of the boiler water at the desired amount. Thirty-one claims.

1,894,988. WATER TUBE BOILER. HERMAN GARBE, OF GLOGAU, GERMANY.

Claim.—In a water-tube boiler, the combination with an upper drum, of inclined water-tubes disposed in vertical rows, risers connecting the forward ends of said inclined water-tubes to said upper drum, said risers being located between the vertical rows of said inclined tubes, a plurality



of separate headers receiving the rear ends of said inclined water-tubes, a head interposed between the forward end of each water-tube and the lower end of the corresponding riser, and descending tubes connected to said headers and being disposed outside of the rows of said inclined tubes. Two claims.

Boiler Maker and Plate Fabricator

Increased Activity in Locomotive Boiler Field

Hardly a month goes by but that some new and interesting addition is made to the motive power of the country. Modern power built to replace obsolete equipment represents a tremendous advance in locomotive design and construction both from the standpoint of the materials used and the results being obtained in service.

The volume of new locomotive construction in the last months of 1936 and this year as well as the tremendous rebuilding programs going forward quietly throughout the country definitely indicate the reliance placed on this mode of power generation by the railroads.

All this activity has meant improvement in the morale of the shop staffs. More boiler makers are at work today than at any time since 1930 and with definite assurance that this is only the beginning of a long period of gainful employment.

Accompanying the increase in production demand there has been a trend towards improvement of physical equipment and tools in the shops entirely above and beyond purely replacement requirements. Where increasing quantities of heavy plate and other materials entering into boiler work must be fabricated, tools and shop facilities must be kept up to date if schedules are to be maintained. There is a real opportunity today for every manufacturer of boiler shop tools and equipment as well as materials entering into the construction and maintenance of locomotive boilers to perform a constructive service to the railroads by co-operating and advising on plans for modernizing the shop facilities where important programs are being carried out.

Non-Destructive Testing of Welds

The recent rapid advance of fusion welding in practically every industry where metals have to be fabricated into structures of one sort or another has been made possible by a parallel development of methods of testing the integrity of the welds. Better welding equipment, materials and above all else better training and checking of operators have constituted the basis upon which the broader use of this modern tool could go forward. However, without equally acceptable methods for testing finished structures so fabricated but little progress would have been possible.

It is fortunate, indeed, that the X-ray and radiographic systems of testing were available for the non-destructive examination of welds. Supplementing these, the latest acceptable method, that of magnafluxing welds, offers a wide range of possibilities for the examination of welded structures in the field and in locations not accessible to other types of equipment. The technique employed by this method of examination has progressed to a point where, in the hands of skilled inspectors, it may be relied upon fully. Details of its application to the inspection of welds in boiler drums and unfired pressure vessels are published in this issue.

Our readers should become familiar with this process. Those shops which have not been equipped with X-ray or radiographic apparatus will find a wide application for the present development since any shop equipped with an arc-welding machine may adapt it to magnaflux inspection.

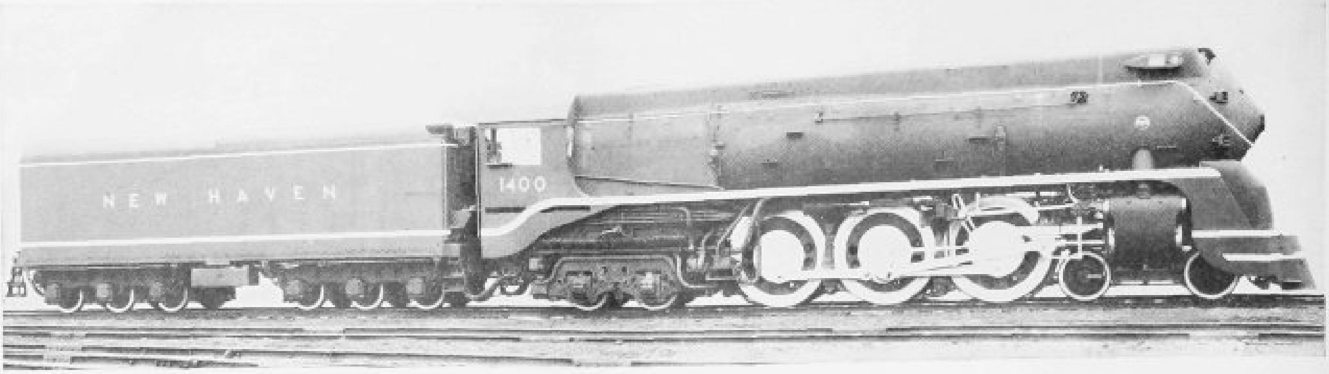
Lincoln Contest to Advance Welding in Boiler Making and Plate Fabricating

Attention of the boiler making and plate fabricating industry is directed to the prize contest on arc-welding processes now being conducted by the James F. Lincoln Arc Welding Foundation. It will be recalled that several years ago leading prize winning papers in a similar contest were contributed by members of this industry.

While the present contest is far broader in scope and in the number of prizes to be distributed in many industries where welding is utilized as a major process, the design and construction of boilers, pressure vessels, and other industrial equipment will be covered under four main classifications. Major prizes will be awarded for the best papers on arc welding boilers and containers, welderies, functional machinery, and industrial machinery. These four main classifications are in turn subdivided into classified subjects on which papers may be submitted by a contestant. Prizes are also awarded for the winners in these subdivision contests. In addition to the prizes already mentioned for the group and subdivision contests, papers entered will also be eligible for the four main prizes of the contest.

The fundamental purpose of the Foundation in sponsoring this project is to stimulate wide interest in the welding art. Throughout industry better design and procedure in fabricating structures and vessels for almost every conceivable purpose will result in increased efficiency and economy. In the field of boiler making and plate fabricating, while welding is now enjoying a widespread employment and application, possibilities are practically unlimited for further improvement in arc welding processes and practices. From the designer to those performing the actual construction and fabrication of pressure vessels, the present contest offers a tremendous incentive to develop inherent potentialities still further in the welding art.

Complete details of the rules and conditions of the contest may be obtained directly from the James F. Lincoln Arc Welding Foundation, Cleveland.



New high-speed Shore Line type passenger locomotive for the New York, New Haven and Hartford

Streamline design a feature of

New Haven Passenger Locomotives

Deliveries of 10 streamline 4-6-4 type passenger locomotives are now being made to the New York, New Haven & Hartford by the Baldwin Locomotive Works. The first of these locomotives was formally accepted by the railroad in ceremonies held at South Station, Boston, Mass., on the afternoon of March 3 following a trip from New Haven to Boston hauling a special train for the guests of the railroad.

The new locomotives, which are known on the New Haven as the Shore Line type, are designed for high-speed service and provide a capacity for handling trains of 15 cars on fast schedules. The boilers have a combined heating surface of 4857 square feet with a grate area of 77.1 square feet. They carry a working pressure of 285 pounds per square inch and, with cylinders 22 inches by 30 inches and driving wheels 80 inches in diameter, develop a rated tractive force of approximately 44,000 pounds.

The locomotives present a clean-cut appearance. All projections above the top of the boiler are housed within a shrouding which is flush with the top of the cab at the rear and with the top of the stack at the front. The boiler front is enclosed within a conical shrouding, in the apex of which is the headlight. The space between the smokebox and the front bumper is completely enclosed, as is also the pilot. The locomotive and tender are finished in black with striping of aluminum paint or stainless-steel. The large disk centers of the Boxpok driving wheels and the rims and tires are also finished in aluminum. There is a 6-inch stainless-steel strip edging the running boards. The air-brake radiator pipes are located over the top of the engine bed so that the sides of the locomotive are free from unsightly lines.

The boiler is of the conical type and the horizontal mud ring is supported by four sliding furnace bearers. The working pressure is 285 pounds per square inch, but it is designed for a maximum working pressure of 300 pounds per square inch. The barrel sheets, the wrapper sheet, the back head and throat sheet are of nickel steel. The firebox sheets are of deoxidized steel produced by the silicon-aluminum process. The firebox is 132 inches long by 84⅛ inches wide at the grate and includes a 42-inch combustion chamber. The tubes are 18 feet long. The Type A superheater includes an American multiple throttle in the header.

The firebox sheets are completely welded. Seal welding is also employed at the mud-ring corners, at the lower ends of the vertical wrapper-sheet seams, at the ends of longitudinal barrel seams and behind pad locations. Alco flexible staybolts are applied in the breaking zones and there is a complete installation in the water space around the combustion chamber and on the throat sheet.

The firebox is fitted with Firebar grates and coal is fed by a Standard Type HT stoker, the engine of which is located in a compartment in the left front corner of the tender. The ash pans are of cast steel. Other boiler appliances include the Hancock turbo-injector, the Barco Type F4a low-water alarm and the Dri Steam steam separator.

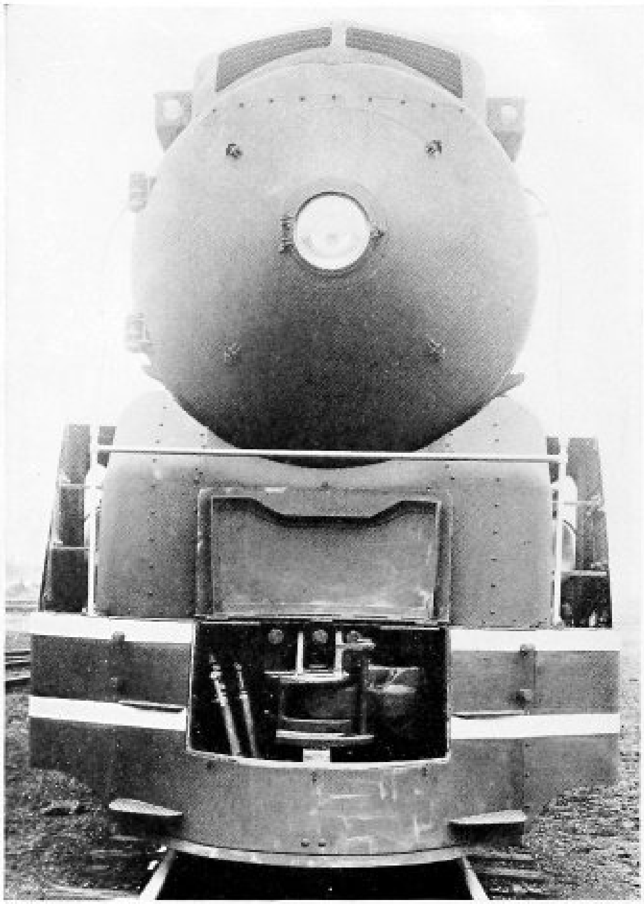
The locomotives are fitted with the Master Mechanics' front end. The smokebox is closed with the usual type of hinged front with a central door opening. At the base of the cone, the front-end shrouding is welded continuously to the smokebox front and will swing out with it. The apex portion of the cone is a separate piece which is hinged inside and held in place by four clamps. By releasing the clamps it can be swung to one side to give access to the front-end door.

The enclosed space under the front-end conceals the 8½-inch cross-compound compressor, the bell and the heater portion of the turbo-injector. The coupler is hinged vertically and when swung back to one side is concealed by a hinged drop door located in the pilot shrouding.

Back of the front end, the principal feature of the streamlining is the shrouding which encloses all of the customary projections above the top of the boiler. This is mounted above the usual boiler jacket, is 5 feet 8 inches in width, and up to the top clearance line in height.

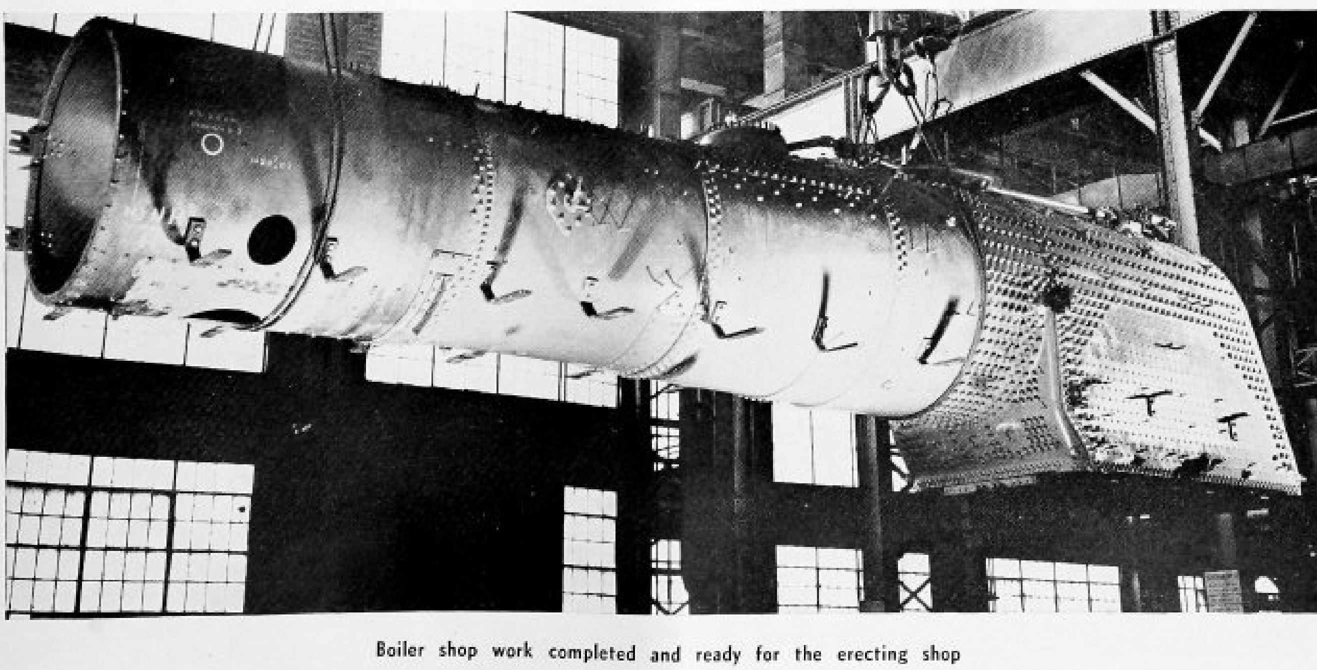
General Dimensions and Weights of the N.Y.N.H. & H. 4-6-4 Type Passenger Locomotives

Railroad	N.Y.N.H. & H.
Builder	Baldwin Locomotive Works
Type of locomotive	4-6-4 (Streamline)
Road class	I-5
Road numbers	1400-1409
Date built	1937
Service	Passenger
Rated tractive force, engine, lb.	44,000
Weights in working order, lb.:	
On drivers	193,000
On front truck	71,500
On trailing truck	100,800
Total engine	365,300
Tender	332,000
Wheel bases, ft. and in.:	
Driving	14-0
Engine total	40-1
Engine and tender total	84-10
Driving wheels, diameter outside tires, in.	80
Cylinders, number, diameter and stroke, in.	22x30
Valve gear, type	Walschaert
Valves, piston type, size, in.	11
Maximum travel, in.	7½
Boiler:	
Steam pressure, lb.	285
Diameter, first ring, inside, in.	82 7/16
Firebox length, in.	132
Firebox width, in.	84¼
Combustion chamber length, in.	42
Thermic syphons, number	3
Tubes, number and diameter, in.	199-2¼
Flues, number and diameter, in	48-5½
Length over tube sheets, ft. and in.	18-0
Fuel	Soft coal
Stoker	Standard Type HT
Grate area, sq. ft.	77.1
Heating surfaces, sq. ft.:	
Firebox and comb. chamber	341
Syphons	139
Firebox, total	480
Tubes and flues	3,335
Evaporative total	3,815
Superheating	1,042
Combined evap. and superheat	4,857
Feedwater heater	Hancock Turbo-Injector
Tender:	
Style	Water bottom
Water capacity, U. S. gal.	18,000
Fuel capacity, tons	16
Trucks	6-wheel

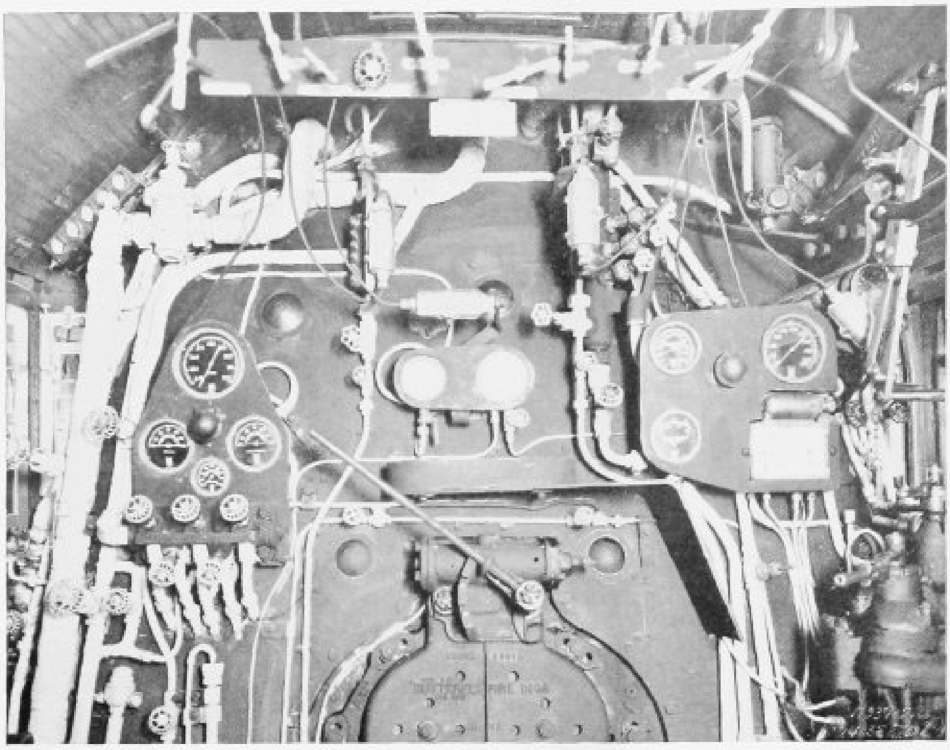


Front end showing streamline treatment

This shrouding is built-up on a series of transverse frames of light flat sections, stiffened at the corners with gussets which are welded in place. Light angles are applied longitudinally to the under side of the sheathing. From a point about 3 feet ahead of the cab to the rear of the smoke lifter a width of 3 feet on the top of the housing is covered with Diamondette foot plate. Wells are provided for the safety valves, and a suitable hatch fur-



Boiler shop work completed and ready for the erecting shop



Backhead of one of the New Haven locomotives, showing the complicated yet orderly arrangement of the piping

nishes access to the sand box. In addition to the sand box this shrouding conceals the dome, the low-water alarm and the single saturated-steam turret. The smoke lifter, which completely encloses the stack, has louver openings in front and a wide horizontal slot in the top of the casing at the rear of the stack.

The tender is built-up on a General Steel Castings water-bottom frame. This frame is arranged to furnish access to the rear of the stoker feed trough from underneath the tender.

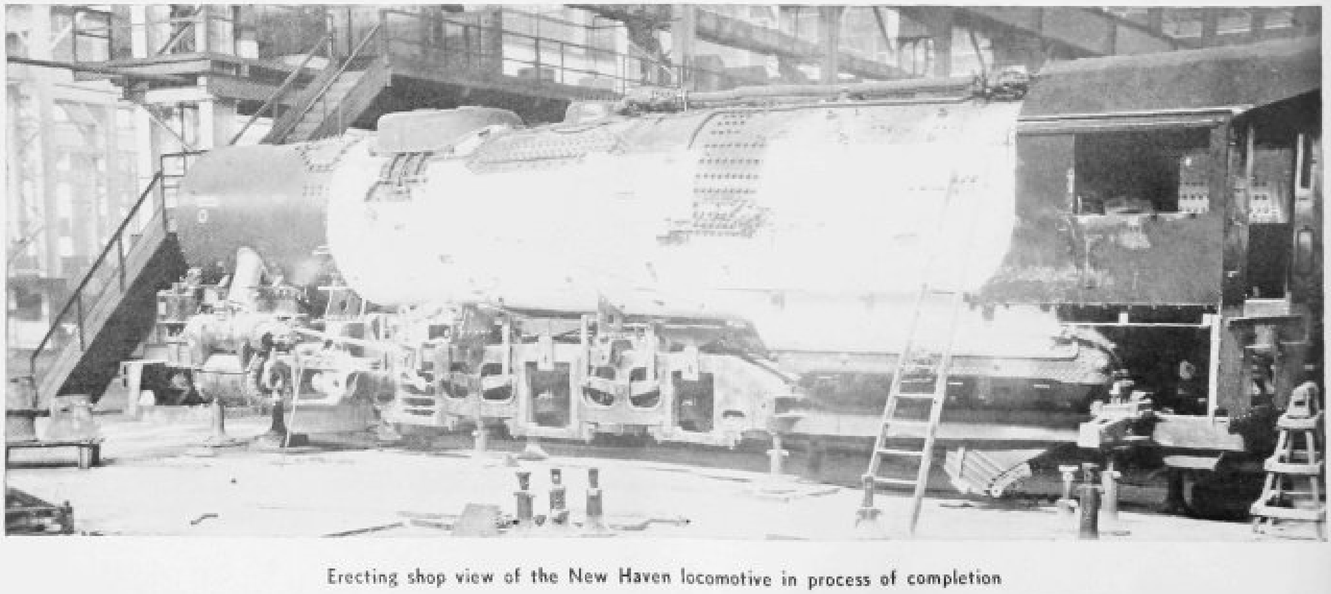
The tender tank is of riveted construction. The principal materials of construction are Cor-Ten steel plates and structural sections of copper-bearing steel. In the coal space, however, wrought-iron plates are used.

The principal dimensions and weights are shown in the table on page 87.

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

Primarily as a result of a demand for safety standards for steam boilers, the committee came into existence in 1911, when state inspection departments and safety laws, insurance companies, consulting engineers, users, and the manufacturers of boilers found it necessary to give individual consideration to practically every design and every boiler built, and to do so under conditions and re-

* From an editorial in *Mechanical Engineering*, commenting upon the birthday celebration recently held for Dr. D. S. Jacobus, chairman of the A.S.M.E. Boiler Code Committee.



Erecting shop view of the New Haven locomotive in process of completion quirements that differed in almost every location. Prior to this time in states where no safety laws were in force, an uninformed public was faced with a lack of assurance that boilers sold to them conformed to specifications that provided reasonable safety because no generally accepted standards had been set up. It is obviously unnecessary to enlarge upon the numerous implications of this state of affairs as they existed when The American Society of Mechanical Engineers undertook the work of codification in the boiler field.

By 1914 the first edition of the Boiler Code was issued and, thanks to the wisdom which prevailed in its drafting, it won almost immediately the hearty approval of those competent to judge its merits. Power and heating boilers were covered in this first draft which, with revisions in 1918, 1924, 1927, 1930, and 1933, has been expanded to include eight sections covering power boilers, material specifications, locomotive boilers, low-pressure heating boilers, miniature boilers, rules for inspection, unfired pressure vessels, and suggested rules for care of power boilers.

That the code has won its way in public approval to the extent of becoming national in scope is attested by the fact that it has been adopted by 21 states and 18 municipalities as local regulations. The committee's code symbol stamp, imprinted on boilers constructed under its code, is the "hallmark" by which conformance to the requirements of the code is shown.

It is obvious that back of the code is a body of men whose intelligence and integrity of purpose are guarantees of its worth and authority. It is easy to appear to be overstating the facts in speaking of the qualities and achievements of this group of men. Drawn from every field concerned with the common problem, these men meet monthly to interpret individual cases arising under the various codes and to consider what revisions and additions are indicated by changes in engineering practice. The codes are in this manner endowed with a vitality that insures not only the best interests of all concerned but also that adaptability without which they might become brakes on progress. In spite of the special personal interests that members of the committee must naturally have, it is the practical idealism implicit in the codes that provides the common ground upon which decisions, which must have unanimous approval, are made. That this makes for spirited debate goes without saying, but it also results in decisions that are received with deserved confidence in their justness and validity.

There is a significance in the success of the Boiler Code Committee that calls for comment and provokes the wish that more groups might be organized to perform similar services in our national life. Here, in a very narrow and highly technical field, is to be found an example of the spirit of the finest co-operation under democratic institutions. Fundamentally, and in spite of its acceptance by governmental agencies, the boiler code is an example of what competent and interested groups can do for their own and the public's welfare. No central governmental agency dictates to it. No powerful special interests warp its efforts to their own ends. In its special field it represents the flowering of the democratic spirit—a regulation by rule rather than an individual.

One other thought will bring all engineers into the sphere of influence exercised by the Boiler Code Committee. The competence and special knowledge of the persons who comprise the committee give authority to its judgments. But public confidence in the integrity of these judgments and the atmosphere in which they are formed are derived from the fact that the committee is a representative of The American Society of Mechanical Engineers. It partakes of, as it contributes to, the prestige of that larger body—a prestige made and shared by all who comprise its membership.

Is There a Shortage of Skilled Labor?

A scarcity of highly skilled craftsmen already exists in the metal-working industries and is becoming increasingly acute, according to a study made public recently by the National Industrial Conference Board. Reports from companies in other industries including textiles, paper, printing, and lumber, indicate that in some sections there is a definite scarcity of certain types of labor, but that labor shortage has not yet become as serious a problem as in the metal-working industries.

The Conference Board's survey of conditions in the metal-working industries covered 404 companies employing approximately 467,200 workers. Of these companies, 21.4 percent reported no skilled labor shortage; 26.5 percent indicated that a serious scarcity of such labor existed; and 52.2 percent reported that they had found it impossible to secure competent craftsmen to fill jobs that were open. This last group of 211 companies would employ a total of 7158 additional skilled craftsmen if they could be found.

The number of skilled craftsmen needed but unobtainable amounted to 1.53 percent of the total employment of all companies reporting to the Conference Board. This figure varied considerably among the states from which a sufficient number of reports was received to justify the computation of separate state figures. In Rhode Island, the number of workers required but not obtainable amounted to 12.14 percent of total employment by reporting companies; in Wisconsin to 3.15 percent; in Michigan to 2.46 percent; in Ohio to 2.18 percent; and in New York to 1.27 percent.

The Conference Board's analysis of the shortage of craftsmen by type of occupation in the metal-working industries indicates that more all-around machinists are required than any other type of worker. The companies reporting to the Conference Board needed 1889 such craftsmen. Other types of workers and the number required included: special machine tool operators, 1007; tool and die makers, 756; molders, 553; assemblers and erectors, 370; welders, 220; and core makers, 150.

There are a number of reasons, according to the Conference Board's study, why a scarcity of skilled labor exists while large numbers are still unemployed. The most important contributing cause was the suspension, during the depression, of most company training programs. Since it is conservatively estimated that 5 percent of the skilled labor of the country withdraws from service each year because of death or obsolescence, practically 25 percent of the skilled labor reserve was permanently lost during the depression, while very few replacements were being trained.

In addition, many skilled workers, either voluntarily or as a result of loss of jobs during the depression, abandoned their trades and secured other work. Many other skilled workers were promoted from the ranks of production workers, and world economic conditions, combined with immigration restrictions, shut off the former inflow of skilled artisans from Europe. Of serious social significance was the loss of skill by formerly competent craftsmen through prolonged inactivity and association with various "made work" relief projects that destroyed efficiency and work discipline acquired in industrial employment.

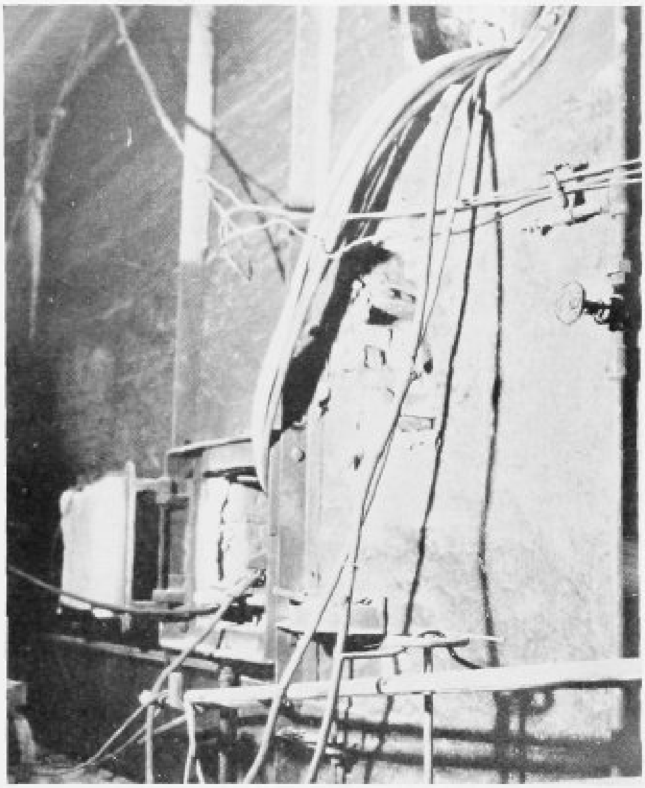


Fig. 1.—Magnetizing a watertube boiler for inspection

MAGNAFLUX*

Method of Inspecting Boiler Drums and Unfired Pressure Vessels with Magnaflux

By R. F. Cavanagh†

The nondestructive magnetic-dust method of discovering invisible cracks and defects has been successfully applied to steam boilers and unfired pressure vessels. This dust is manufactured by the Magnaflux Corporation and is generally known as magnaflux powder. It is basically metallic iron that has been finely ground to pass a 100-mesh sieve. The individual particles are spindle-shaped rather than globular to obtain the better polarization which facilitates their grouping or arranging at a crack or defect. This grouping is facilitated by specially coating the particles to prevent rusting and to add lubricating and insulating properties that retard packing and sticking. When dry, the powder particles are effectively insulated from each other electrically. An infinity megger reading should be obtained even with the electrode terminals buried only a fraction of an inch apart in a can of powder.

In applying the powder, the best results are obtained by using a common bulb spray, such as is used for spraying powder on plants, with a perforated aluminum nozzle that is set at an angle. When using the powder in a confined space, an approved type respirator is recommended to prevent possible irritation of the mucous membranes or the eyes.

The bulb should not be filled to more than half of its capacity. For vertical and particularly for the underside of horizontal surfaces, practice will enable the operator to lay the powder in place, by a combination of throwing and light rapid squeezing of the bulb. Best results are obtained when the small puff of powder just reaches the surface under investigation. If the air blast is too hard, the powder is likely to be blown from any defect that may be present. For horizontal surfaces, sufficient powder is dispersed by giving the bulb a slight shake.

By carefully observing the factors involved, a fairly accurate estimate of the depth of a crack can be made. The variation in the quantity of powder adhering to the crack corresponds with the variation in its depth.

To permit proper inspection, all interior and exterior seams must be exposed and made accessible for examination either directly or with a mirror. The seams should be wire-brushed and any thick scale or sediment removed. A perfectly clean bright surface is not necessary, as the powder will reveal cracks through a light scale or rust coating, but all loose rust or scale should be removed.

Where riveted seams are used, some rivets should be removed to permit detailed examination of the rivet itself and the sides of the hole, especially the shell plate between the inner and outer butt straps. Ordinarily four or five rivets are removed from each longitudinal seam and two or three from each girth seam. Those rivets are selected for removal which show indications of past leakage or repeated calking. Removing at least one rivet near the bottom of each girth and head seam is also advisable.

Unlike the magnifying and photographic methods that require careful polishing and etching in and around the rivet hole to make cracks visible, the magnaflux method requires no preparation of the hole. If a crack is there, the powder will make it visible to the unaided eye several feet away.

Boiler shells or drums are magnetized by winding several turns of flexible cable through or around

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* Presented at a joint meeting of the New York Section of the American Welding Society and the Metropolitan Section of The American Society of Mechanical Engineers, January 13, 1937, New York, N. Y.

† Engineering Department, Fidelity & Casualty Company of New York.

Fig. 2.—Typical examples of caustic-embrittlement cracks in girth seam of horizontal tubular boiler

them. The cable is energized by an ordinary portable electric welding set. The current value is dependent on the size of the shell or drum and the number of turns of cable, the average being about 2000 ampere turns. For multiple-drum watertube boilers, a convenient method is to wind two drums at one time by passing the cable across through circulating tubes and out the manhole opening of the second drum (Fig. 1).

Where each end of a boiler drum or shell has a manhole opening, the cable is wound longitudinally through the manhole openings and around the outside of the drum, and, in some cases, winding the cable circumferentially around the shell or drum is more convenient. In general, a magnetic field should be set up within the shell or drum at right angles to the direction in which cracks or defects are expected to be found. However, most cracks running in the general direction of the lines of flux present sufficient transverse components to prevent their escaping detection. Where incipient cracks of microscopic dimensions are being searched for, magnetization in both directions is necessary.

Winding shells or drums longitudinally is usually more convenient, and, in addition, the flux direction will be the most favorable for investigating the greatest area. As this flux direction will be less favorable for detection of circumferential cracks, investigation in that direction can be conveniently made by portable electromagnets.

Portable electromagnets are also used where magnetization in the desired direction is not practical by the cable-winding method. For the head seams, one magnet is placed on the head and the other on the shell in a radial line with the first and approximately 1 foot away. A similar set-up is effective for other girth seams. The magnet poles on either side of the seam should, of course, be checked. Portions of the drum of a watertube boiler farthest from the coil, particularly drums with blank heads where the cable has been passed through tube holes instead may not have sufficient flux density. In such cases, portable electromagnets can generally be used to cover these local areas.

The best method for determining whether the flux density is sufficient is to observe how the powder collects at the edge of the rivet head against the shell or strap, as this, so far as the powder is concerned, is a crack. With some practice, the manner in which a light dusting of powder clings to any surface or edge will indicate whether the magnetization in the right direction is sufficient.

Fig. 3.—Crack in $^{15}/_{16}$-inch shell plate

Fig. 4.—Example of welding employed to stop leakage through crack in boiler girth seam, discovered by visual method, which proved to be inaccurate in showing full extent of crack

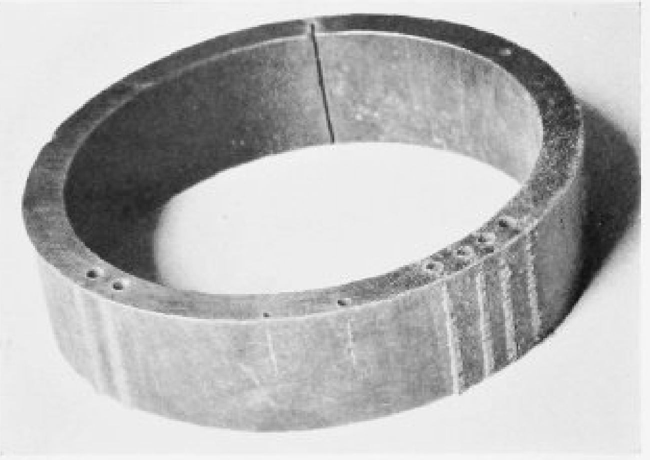

Fig. 5.—Specimen having hidden defects, discovered by Magnaflux process of inspecting welds

Generally the tendency will be to over-magnetize rather than under-magnetize the drum. Often, the residual magnetism after shutting off the current is sufficient to show up cracks. If the flux is too great or flux lines come into the air at right angles, the powder will fly directly to the surface and collect in "streamers" or hairs that stand out from the surface. Cracks will then not show up properly. In such cases, the residual-flux way gives best results, particularly for those portions of the head inside the loop.

Cracks are sometimes caused by the local concentration of stresses that are set up by breathing action or thermal expansion and contraction. This type of crack follows the general behavior of fatigue cracks, often preferring a surface notch, such as is provided by the rough surface or porosity of a poorly laid bead of weld, for its starting point.

All cracks radiating from a rivet hole are not necessarily embrittlement cracks, and recognized authorities

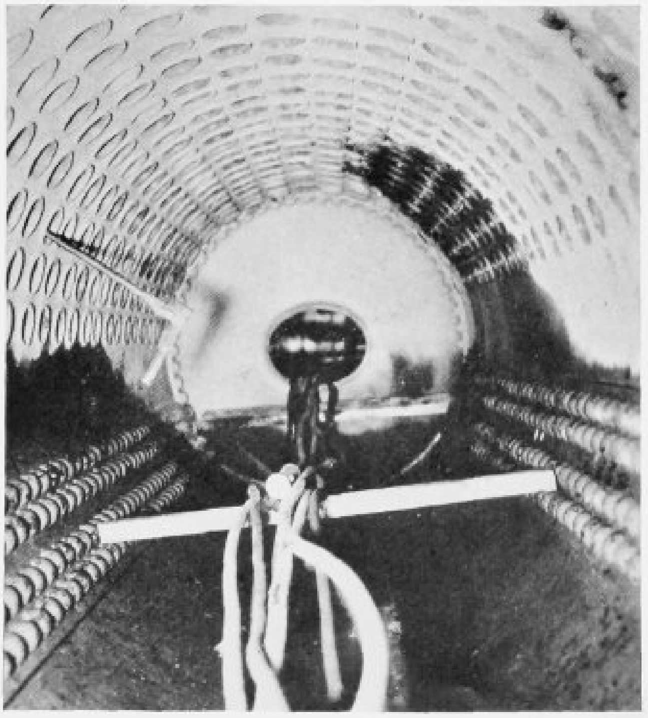

Fig. 6.—Preparing boiler drum for Magnaflux test

are not in agreement as to what is or is not embrittlement. The most reliable information indicates that cracks may start at local areas that are stressed beyond the yield point in the presence of a concentration of caustic, silica, and heat. By some mysterious process, nascent hydrogen, which is liberated by oxidation under these conditions, has the power to penetrate the intercrystalline cementite and cause cracks.

Many cracks found at rivet holes by magnaflux were definitely not embrittlement cracks but were caused by mechanical processes, such as excessive drifting and riveting pressures in manufacturing, excessive calking, or by fatigue from breathing. Microscopic examination of the crack with suitable etching reagents may disclose its origin, but here again some confusion exists, as examples of embrittlement cracks are found transversing the crystals instead of being intercrystalline, and portions of stress-fatigue cracks may follow crystal boundaries instead of being transcrystalline.

Generally, irregular, branching and discontinuous cracks that radiate in all directions, pass each other, and form islands, are indicative of embrittlement, especially where caustic concentration is found between plates. Stress cracks, on the other hand, have a general tendency to progress in a more direct line and usually are not as numerous, sometimes occurring as a single crack between rivet holes.

Fig. 2 is an example of embrittlement cracks that occurred in the girth seam of a horizontal tubular boiler which was found to be a typical case of caustic embrittlement. This boiler had been in service less than four years, was built according to the requirements of the A.S.M.E. Boiler Code, and received the required inspection during construction. It was of butt and double strap, quadruple-riveted seam construction. The condition was obviously caused by improper feed-water treatment.

Fig. 3 shows part of a 5 by 20-inch plate that was cut from a 15/16-inch shell plate of a hammer-welded digester, which was 8 feet in diameter and 25 feet long and operated under a pressure of 110 pounds per square inch. One crack more than 14 inches long and reaching the maximum depth of ¾-inch was revealed by magnaflux on the interior surface. This crack was not visible under a four-power magnifying glass. Several smaller cracks were also found. Imperfect seams in this digester were easily demonstrated by magnetizing with portable electromagnets. Here, the thin edge of the scarfed joint had either chilled or else scale prevented making a perfect bond.

The extent of the imperfect seams and the cracks were investigated further by trepanning to obtain a small coupon. This investigation confirmed the previous estimate of the depth of the cracks, and also revealed that they were caused by caustic embrittlement.

Magnaflux inspection was immediately made of the other two digesters in this particular plant, after the conditions previously mentioned were disclosed, and they were found in practically the same condition. All three were condemned for further use as pressure vessels and were immediately replaced by new ones.

Other Types of Defect Revealed

Fig. 4 shows a piece of plate taken from the girth seam of a horizontal firetube boiler. In this case, the operator of the boiler laid a bead of weld along the seam, thus forming a fillet on the inside to stop leakage. The large cracks at the weld had developed through to the outer surface, and a bead of weld 6 inches long had been applied to seal it. A magnaflux test revealed that the crack continued intermittently for 20 inches. At some points, the larger crack penetrated to within 1/32-inch of the outer surface of the plate. While this method of repair could not be approved, the test did prove conclusively that the crack was considerably longer than could be detected with the eye.

Cracked ligaments are frequently found in the top tube sheet of the waste-heat type of vertical firetube boiler that is used in connection with the manufacture of water gas. The flame or hot gases are applied in periodic cycles recurring every few minutes. This sets up a cyclic expansion and contraction or breathing which is very conducive to the start and propagation of cracks. Usually such cracks have been repaired by welding. New cracks often develop subsequently alongside the weld, due to improper annealing and continued breathing. On one occasion of this type, nearly fifty cracked tube-sheet ligaments were found, which, had they progressed farther, would have freed a section of the sheet with its tubes.

Nozzles and fittings on digesters and other pressure vessels of the welded type cannot generally be X-rayed satisfactorily. The magnaflux process is, therefore, particularly useful for this application as the powder will collect over flaws or voids in the weld even when these defects are considerably below the surface.

One of the outstanding advantages of this over other methods adaptable to field investigations is its ability to reveal flaws and other defects beneath the surface of the material faithfully. The ring in Fig. 5 was prepared by drilling holes of several different diameters in the ring and at different distances from the outer edge of the ring. Applying the powder very clearly outlines these holes on the surface of the ring.

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

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information on the application of the code is requested to communicate with the secretary of the committee, 29 West 39th St., New York.

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

Case No. 837 *(Special Ruling)*

Inquiry: May unfired pressure vessels to be stamped as Code vessels be built in whole or in part of cast iron (other than nozzles and frames for openings now definitely provided for)?

Reply: It is the opinion of the Committee that under a correlation of the several sections of the Code, unfired pressure vessels of any size may be built wholly or in part of cast iron, subject to the following restrictions:

(1) Vapor (steam) pressure shall not exceed 15 pounds per square inch.

(2) Liquid (water) pressure shall not exceed 160 pounds per square inch, nor the temperature 250 degrees F.

(3) Cast-iron pressure parts conforming to the requirements of the several A.S.A. standards for cast-iron fittings may be used as a whole or in part for temperatures not exceeding 450 degrees F. and pressures not exceeding the A.S.A. ratings given in the several tables.

(4) All such cast-iron vessels or cast-iron parts shall be inspected and given a hydrostatic test in the presence of an authorized inspector, the test to be at least equal to 2½ times the maximum allowable working pressure but in no case less than 60 pounds.

(5) Following the hydrostatic test, the vessel may be stamped as required by Par. U-66 and data sheets made out as required by Par. U-65.

Case No. 839 (In the hands of the Committee)

Semi-Annual A. S. M. E. Meeting to Be Held at Detroit

Plans for the 1937 Semi-Annual Meeting of The American Society of Mechanical Engineers, to be held at Detroit, Mich., May 17 to 21, with headquarters at the Hotel Statler, were advanced to a point where the unusual and regular features of the program began to crystallize when Sabin Crocker, secretary of the Detroit Committee, met with the Committee on Meetings and Program on Friday, February 5, and discussed the general outline and details of specific events.

On Wednesday of the same week at a meeting of the Committee on Professional Divisions the technical program, which is to include at least 15 simultaneous sessions at which papers contributed by the divisions will be presented, was reviewed. At both of these meetings a wealth of technical material was found to be available and the distinctive character of the general plan being worked out by the Detroit Committee was accorded hearty endorsement.

Mr. Crocker reported that the Detroit Papers Committee, which is headed by Harry T. Woolson, executive engineer of the Chrysler Corporation, has set up a series of six general sessions which will be held on the mornings and evenings of three days, Tuesday, Wednesday, and Thursday, of the meeting and culminate in the dinner scheduled for Thursday evening. On the afternoons of these same days the simultaneous sessions and tours of the professional divisions are to be held. Thus there will be no conflict between the general sessions, at which eminent authorities from the engineering and industrial fields of the Detroit area will develop a broad survey of the modern techniques employed by the mass-production industries typified by the automobile builders, and the special technological problems in which lie the varied interests of the professional divisions.

Monday is to be given over to a meeting of the A.S.M.E. Council and major inspection tours of the Detroit area. A business meeting of the Society, at which the principal business will be the announcement of the results of the members' ballot on proposed changes to the Constitution of the Society, will be held on Monday evening.

As plans are developed to date, all day Friday will be available for additional inspection tours. All persons attending the meeting will be able to participate in these tours without the conflicting interests of technical sessions that might otherwise interfere with full enjoyment and profit insured by this unusual opportunity to see what industrial Detroit has to offer.

Chemical Intercrystalline Fracture of Riveted Joints in Boilers*

By S. F. Dorey

During the past twenty years much attention has been given by land engineers, metallurgists, and physicists to the question of what is known as the chemical or caustic embrittlement of steel.

Many cases of cracked plating in boilers and some explosions have been attributed to chemical embrittlement, but the cases described in the already large literature which exists on the subject have been confined to land boilers or to apparatus used in the manufacture of caustic soda.

The matter has not received the attention it deserves from those engaged in the management of marine boilers, doubtless for the reason that marine boilers have hitherto been considered to be immune from the trouble. As, however, a few cases have occurred in the past three years where the shells of marine cylindrical boilers fitted in vessels classed with Lloyd's Register of Shipping were found to be so seriously cracked that the boilers were unfit for further service and were condemned, it is well that marine engineers should be warned that their attention should be directed to the matter.

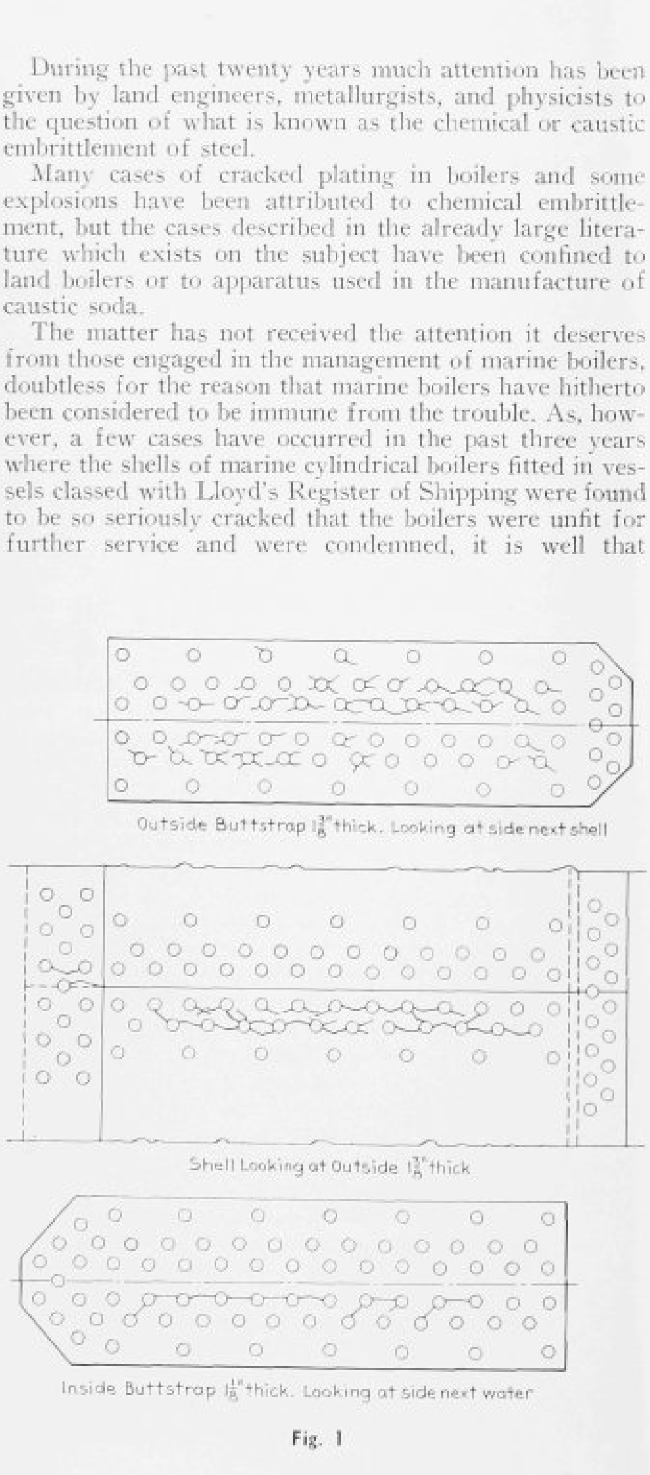

Fig. 1

The term "caustic embrittlement" is really a misnomer. The steel does not become brittle in the way that glass or cast iron is brittle. It remains ductile, but is fissured through the grain boundaries. Neither is it certain that the phenomenon is due to the action of pure caustic. Recent investigations indicate it is probably due to the presence of sodium silicate in the soda and in other chemicals commonly used in boilers.

Attention was first of all drawn to the matter through the failure of vessels used in the manufacture of caustic soda, and these failures were attributed to embrittlement due to caustic, and the term "caustic embrittlement" was then applied to the condition. This term has passed into the literature on the subject, but it may be more accurately referred to as intercrystalline fracturing due to chemical action.

Quite naturally, when the theory of caustic embrittlement of steel was first propounded, it was received with a good deal of scepticism and much adverse and frequently biased criticism was directed against it; but a careful and unbiased examination of the evidence leaves no room for doubt that steel can be rendered defective by this form of chemical attack.

The features of the attack in boilers are characteristic and well defined, and for all practical purposes are independent of the quality of steel employed in their construction.

They are:

(1) The cracking is confined to the plating in way of riveted seams. The plating away from the seams is unaffected. Joints above and below the water-level are equally liable to this form of cracking.

(2) The cracking begins at rivet holes and on the surfaces in contact—not at the outside surfaces.

(3) The cracking of the plating is usually accompanied by the breaking off or cracking of rivet points, and this is usually the first observable symptom.

(4) The path of the cracks is along the grain boundaries and is not transcrystalline as is the case with fatigue failure.

(5) The boiler water is strongly alkaline and low in sulphates.

In three cases of marine boilers to which reference has been made, all these characteristic features were present with the exception that the water analysis in one case did not reveal the amount of sulphate, the quantity of water available, unfortunately, not being sufficient for a complete analysis.

* Abstract of paper presented at the Spring Meetings of the Seventy-eighth Session of the Institution of Naval Architects, March 18, London.

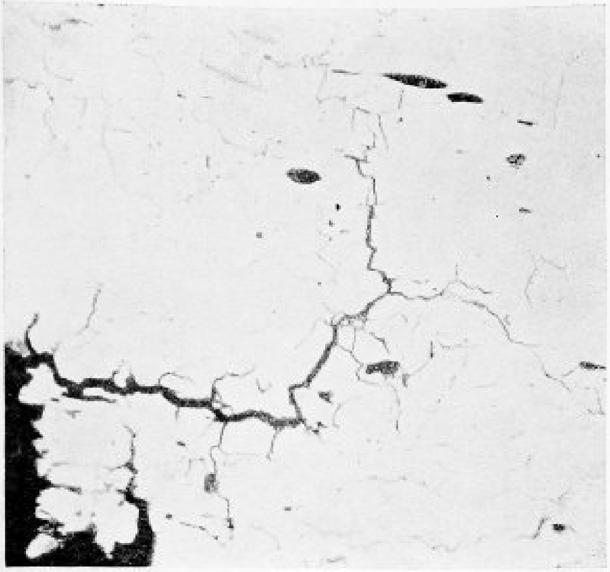

Fig. 2

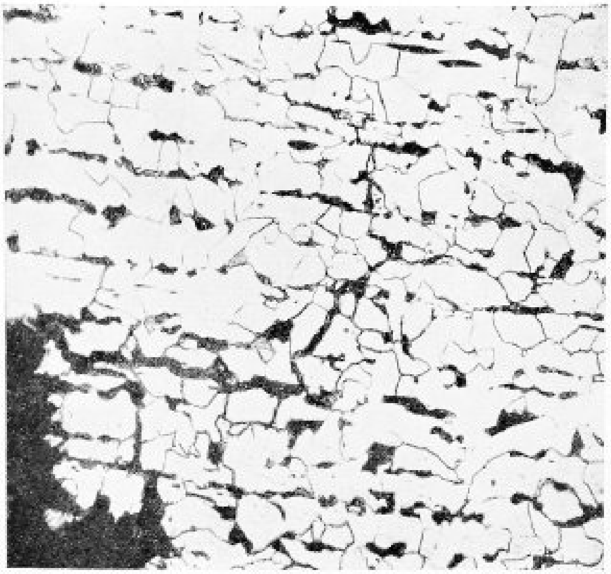

Fig. 3

In each case attention was at first drawn to the fact that a number of rivet points had fallen off in the longitudinal shell joints and, on investigation, it was found that there was evidence of cracking in the outer butt straps.

The outer strap was then removed and the strap and shell plating in way were found to be extensively cracked on the faying surfaces, the origin of the cracks being at rivet holes. Samples of the defective material were then subjected to full investigation, which revealed that initially the steel was perfectly satisfactory and that the cracks were intercrystalline.

Some typical examples from boiler joints which have failed due to intercrystalline cracking are illustrated.

The first example refers to a marine cylindrical boiler condemned after 4 years' service, working pressure 180 pounds per square inch. While under steam, water and steam were observed coming from under lagging on side of boiler and on removal of lagging a crack was observed in the strap of the longitudinal joint. The boiler was emptied and on examining the inside strap it was found also cracked about 3 feet long in way of rivets. Fig. 1 shows clearly how the cracking extends in both shell plate and butt straps. Fig. 2 shows cracks in the plate before the sample had been etched, while Fig. 3 shows the same cracks after etching. It is clearly seen that these cracks are essentially intercrystalline in character and that rupture occurs only occasionally through the material of the crystals themselves.

Figs. 4 and 5 show cracks at a rivet hole in a butt strap and in a rivet of a watertube boiler in service about 3½ years, working pressure 260 pounds per square inch. Micrographs of cracks in a rivet head and butt strap are illustrated in Figs. 6 and 7.

A further case refers to another marine cylindrical boiler which failed after 6 years' service, working pressure 260 pounds per square inch. Fig. 8 shows a portion of the butt strap in which cracks are seen radiating from the circumference of the rivet hole, while Fig. 9 illustrates portions of rivets which had fractured at the junction of shank and head. The fractured surfaces of the rivets were coated with a white deposit which was distinctly alkaline. Chemical analyses were made of the boiler materials and gave compositions quite normal and indicative of good metallurgical practice. Mechanical tests also showed that the physical properties were satisfactory.

Possibly one of the simplest methods for revealing

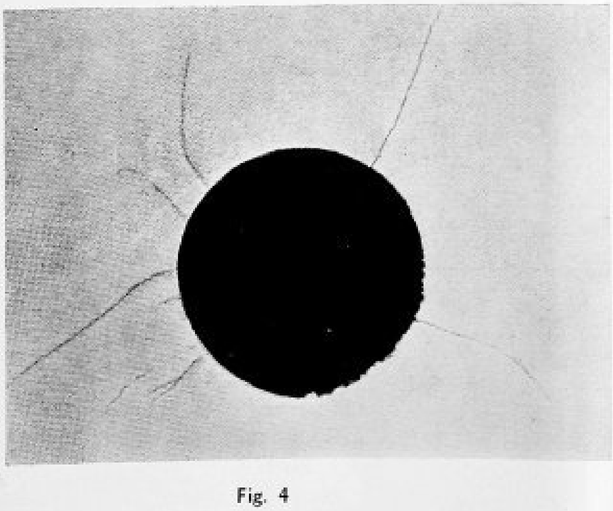

Fig. 4

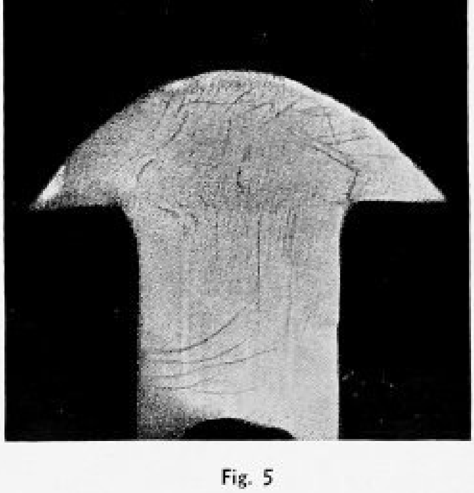

Fig. 5

Fig. 6

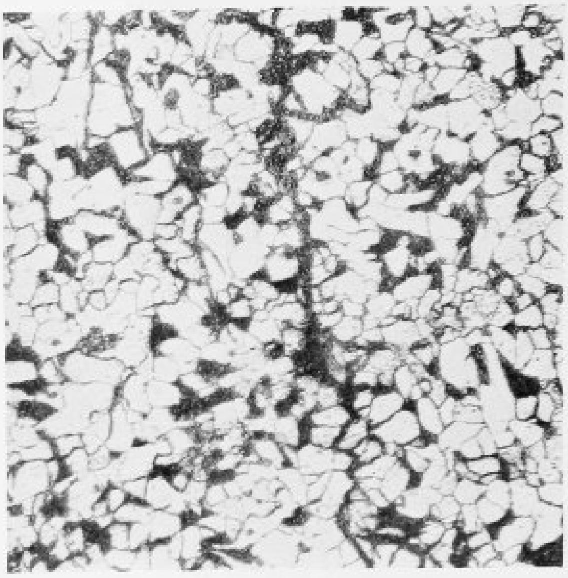

Fig. 7

cracks is to magnetize the suspected area and spray with a solution of paraffin oil and fine iron filings. Any crack, not visible to the naked eye on the surface, will then be observed by the filings piling up along the line of the crack.

It has been urged by some with an incomplete knowledge of the matter that cracking of the plating such as has been described is due solely to an entirely different cause; viz., excessive riveting pressure, but there is clear evidence which effectually disposes of such an argument.

(1) Cracking by excessive rivet pressure would reveal transcrystalline failure and grain distortion.

(2) It has been shown in the United States, where most of the early work on the subject was carried out, that failures revealing the characteristic features of caustic embrittlement were largely confined to certain areas where the feet water used contained sodium carbonate. Replacement boilers failed in the same way, while boilers made at the same time by the same makers and sent to other districts having a different water supply were quite free from trouble.

Experiments carried out indicate, however, that it is possible to develop intercrystalline cracks in boiler plate material and rivets which have been overheated and subsequently stressed above the yield point.

In some cases it has been claimed that cracking has been due to pulsating stresses causing fatigue at the locally stiffened boiler shell joints. Experimenters have shown, however, that it is not possible artificially to produce intercrystalline fractures such as occur at boiler joints by applying alternating stresses, yet this type of fracture could easily be obtained by immersing boiler steel statically stressed up to or slightly beyond its yield point in a suitable alkaline solution at the right temperature. The same material immersed in the same alkaline solution but subjected to alternating stresses, generally below the yield limit of the material, always failed by typical corrosion-fatigue fractures with transcrystalline propagation as is the case with fractures frequently observed at the root of the flanges of boiler end plates where connected to furnaces.

Parr and Straub and other well-known investigators have established that caustic embrittlement can only occur when the material is stressed to the yield point. Baumann holds that even with the lowest possible rivet pressure consistent with properly formed rivets, the material at the joint is actually stressed beyond the yield point, and Straub in the laboratory produced caustic embrittlement in riveted specimens which were not stressed in any other way.

It may be difficult for some to look with perfect equanimity upon the use of material stressed beyond the yield point, and it is of course true that if the whole joint was so stressed it would be bound to fail in the long run. The fact is, however, that this stress only obtains in the vicinity of the rivet holes. At the same time it must not be forgotten that in bending the shell plate circular the material is necessarily stressed beyond the yield point. In a marine boiler shell the stress due to steam pressure is about 6½ tons per square inch. There is a concentration of stress at the edges of the holes owing to discontinuity which may bring the stress up to about 13 tons, and there is also stress in the vicinity of the rivets due to the inevitable work hardening round the holes. It is apparent, therefore, that the total stress in the vicinity of the holes can easily approach the yield point of the steel, and it is at the holes that chemical intercrystalline cracking begins. Once begun, the cracking is, of course, progressive and extends in some of the reported cases from hole to hole.

Although it has been definitely stated that intercrystalline cracking of boiler plating at riveted joints is not due to excessive riveting pressure alone, evidence has been found in certain cases that cracks were first started by overstressed material, due to excessive riveting pressure, in either plates or rivets or both. This cracking, however, would be conducive to intercrystalline fissuring of the stressed material where exposed to the action of caustic. In one case lately, other cracks were found in rivets and plate adjacent to the first cracks which showed no caustic inclusion. On examining the rivet holes the surface at the edge of the rivet hole was found to be depressed about $^{3}/_{64}$ inch and cracks starting from the edge of the rivet hole were found, together with cracks in the necks of the rivets, indicative of very excessive rivet pressure. These cracks were of transcrystalline character.

Experiments carried out for Lloyd's Register of Shipping on the effect of work hardening in the vicinity of rivets showed differences in Brinell hardness numerals of 50 points between plate under rivet and plate away from rivet, while Izod impact tests gave for the plain plate material an average of 20 foot pounds, compared with an average of 6 foot pounds for plate in way of rivet holes. Experience indicated that the most suitable riveting pressure was about 60 tons per square inch of rivet shank area.

Recent tests carried out for the author by Messrs. John Brown & Company, Ltd., on a riveted double butt strap joint of $^{28}/_{32}$-ton boiler plate and with a riveting pressure of 81 tons per square inch of rivet section, showed that whereas the Brinell hardness number of the shell in way of the rivet holes was increased by 27 percent above its original value, the Brinell hardness of the butt straps in way of the rivet holes was increased by 36 percent. This indicates that the effect of work hardening is greater in the butt straps than in the shell plating, from which it may be inferred that embrittlement will take place more quickly in the straps, and this is borne out in practice.

Research into the action of caustic soda upon mild steel subjected to conditions of temperature and stress encountered in boilers up to working pressures of 700 pounds per square inch has revealed that no attack takes place with concentrations normally occurring. With a 10 percent solution of caustic, however, a considerable reduction in the tensile breaking strength of the steel has been observed, with evidence of intercrystalline breakdown.

It has not been definitely established what is the minimum alkaline concentration at which chemical intercrystalline cracking may take place. Straub suggests a concentration equal to not less than 100 grams per liter, a concentration considerably in excess of that at which a boiler could be normally worked. It is of interest to consider how the alkaline concentration takes place.

It is generally recognized that no matter how carefully a boiler may be made and calked, fluctuations in pressure and temperature cause slight opening of the seams through which water enters. In the seam the water is evaporated and is ejected as steam, and the solid constituents are left behind, and this cycle goes on until the concentration point is reached at which attack on the steel takes place. This concentration is not so quickly reached if there is a leak through the joint, as then the solid constituents of the water are deposited outside the joint in the way with which everyone is familiar. Trouble may, however, be considerably aggravated if the leak is stopped by external calking often excessively applied. This not only gives an opportunity for a rapid concentration of the caustic but overstresses the material, conditions jointly liable more quickly to initiate intercrystalline breakdown.

What appears to be an important advance in the available knowledge of the subject has resulted from experiments carried out in the United States by Schroeder and Berk on the action of solutions of sodium silicate and sodium hydroxide at 250 degrees C. on steel under stress. These investigators were unable to obtain caustic embrittlement failure when using chemically pure caustic soda, but failure was rapidly attained when commercial caustic soda was used. Upon analysis the commercial soda was found to contain sodium silicate, together with the carbonate and chloride of sodium, and further experiments showed that the carbonate and chloride had no effect, but that 0.64 percent of sodium silicate in the caustic soda was the reason for the rapid failure.

An analysis of a boiler fluid which it is understood is largely used in the mercantile marine shows that it contains a considerable quantity of sodium silicate, while analyses of certain other boiler fluids and compositions have indicated the presence of sodium silicate in excess of the 0.64 percent mentioned above.

The foregoing represents a very broad outline of the present position in the matter. No attempt has been made to summarize the large amount of work carried out in this country, America, and Germany. Soda (which when hydrolized by use in a boiler becomes caustic soda) and boiler fluids of various kinds have been used for a great many years in ships' boilers, yet it is

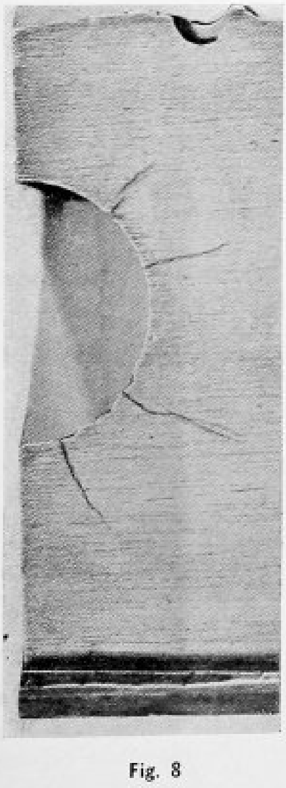

Fig. 8

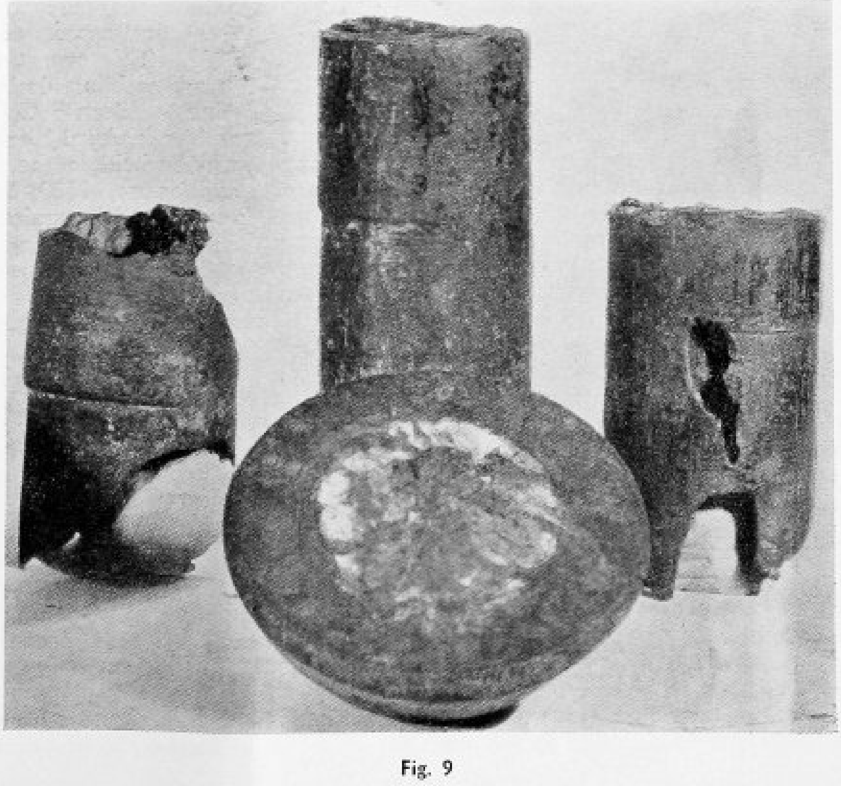

Fig. 9

only comparatively recently that definite knowledge is available that damage is being done, and it is probable that more cases of the kind will be revealed in the near future.

It is necessary, therefore, that those who have charge of marine boilers should take particular care that nothing containing silicate should be used in the treatment of boiler water and that the required alkalinity should be obtained from soda chemically free from sodium silicate.

Further, when broken rivet heads or points are found, the case should be very carefully examined, since these may be a symptom of a grave condition, particularly in the case of shell seams. Broken rivet points or heads are not necessarily a grave matter, but they may be indications of great importance and as such should not be lightly treated.

There are some features in the matter which have not yet been fully explained.

For example, why is it that one boiler in a vessel has been attacked and the shell plating rendered unfit for further service, and another boiler in the same ship working under the same conditions shows no sign of defect whatever? And how is it that the shell plating may be attacked while the combustion chamber and furnace joints, which are of course exposed to precisely the same conditions of water, remain intact and vice-versa?

This appears to point to the attack being of a highly selective order and that a particular metallurgical condition of the structure is necessary before the material is broken down. Schroeder and Berk's findings are that sodium silicate is the chemical agent in producing a very rapid breakdown, and it is for that reason that it is recommended that soda, boiler fluids, or other chemicals free from sodium silicate should be used when it is necessary to counteract an acid condition of the boiler water. These investigators found, however, that pure sodium hydroxide (caustic soda) had a marked effect in reducing the resistance of locally stressed specimens.

That sulphates in the water prevent intercrystalline cracking has been fully proved by Parr and Straub, and the American Society of Mechanical Engineers Boiler Code Committee in 1932 recommended the following minimum ratios of sodium sulphate to the total alkalinity of the boiler water:

For pressures up to 150 pounds	1 to 1
For pressures between 150 pounds and 250 pounds	2 to 1
For pressures over 250 pounds	3 to 1

But it is questionable whether for the higher pressures the ratio is not too high and would be productive of heavy calcium sulphate scale. Straub says they are too high, but adds that that view is the result of laboratory observation only and that investigation is proceeding.

Schroeder, Berk, and Partridge state, however, that their experiments indicated sodium sulphate only retarded the failure of specimens with stress concentrations when the load was applied at room temperature and point out that high concentrations of sodium sulphate in solution, and a solid layer of sodium sulphate may both play an important part in the influence of this salt. They further state that at the present time it appears desirable to maintain as high a concentration of sulphate in the water as compatible with satisfactory boiler operation, since this should create conditions least favorable to embrittlement. The protection offered by sodium sulphate may not be satisfactory where the steel is subjected to repeated stress.

An analysis of a sample of boiler water taken from a boiler which has recently been condemned on account of chemical intercrystalline cracking in way of the longitudinal joints was found to be as follows:

Total alkalinity	126.2 parts calcium carbonate/100,000
Alkalinity as carbonate	67.0 parts/100,000
Caustic alkalinity (caustic soda)	59.2 parts/100,000
Sodium sulphate	12.1 parts/100,000
Sodium chloride	39.2 parts/100,000
Calcium oxide	1.0 part/100,000
Sodium silicate	1.0 part/100,000
Phosphate also present, but less than 1 part/100,000	

It is evident that the water is of a suitable composition to initiate intercrystalline failure, the sulphate being low and caustic content high. Further, the ratio of sodium sulphate/total alkalinity is approximately 1/10, a condition indicative of potential danger. It is to be noted that the sodium silicate present is about 1.7 percent of the sodium hydroxide.

It is known that soda of unknown composition was commonly used for many years before caustic embrittlement was ever spoken of, and although it may be that some if not all of the many cases of cracking from hole to hole in firebox plating which have occurred in the past in classed vessels were due to chemical intercrystalline breakdown. During the last three years Lloyd's Register of Shipping has only had five definite cases of the trouble having assumed a dangerous aspect. One is therefore led to the conclusion that soda (really carbonate of soda) as manufactured nowadays may be different from the soda of many years ago and very likely sodium silicate among possibly other ingredients is the cause of the trouble. In the present state of knowledge one cannot be more definite than this. An analysis of carbonate of soda of thirty years ago might be a pointer.

Welding Course Offered in Pittsburgh

Engineers, designers, architects, production managers, welding supervisors, foremen and operators, and other individuals from industrial concerns of Pittsburgh and environs interested in welding, will have an opportunity of obtaining advanced instruction in the practical and theoretical aspects of arc-welding the week of April 19, 1937. This opportunity is offered by a special course in arc welding design and practice sponsored by The Lincoln Electric Company, Cleveland, O. The course will begin April 19 and last through April 23. Meetings will be held in the Clifford B. Connelly Trade School auditorium, 1500 Bedford Avenue, Pittsburgh. The course will be under the direction of E. W. P. Smith, nationally known welding authority of Cleveland.

The primary object of the 5-day course is to provide engineers and designers in the Pittsburgh area the opportunity of studying the design of products and structures for arc-welded construction. The course will include lectures and technical papers by prominent authorities on welded design and construction in their respective fields, and free consultation service on welding engineering problems.

The lectures, to be given by Mr. Smith, will cover the following subjects: The shielded arc; calculating stress distribution in welded joints; use of rubber models and polarized light in study of stress distribution; determining the most economical section in changing from cast to arc-welded construction; weld inspection; checking fusion and penetration. The course will also include practical studies of welding character.

Free consultation will be available by appointment each day except Monday at the Pittsburgh office of The Lincoln Electric Company, 926 Manchester Boulevard.

Practical Plate Development—XXIII

Irregular Transition Piece Joining a Cone

By George M. Davies

The irregular transition piece to be developed is shown in Fig. 193, the elevation, and in the plan view of the transition piece, Fig. 194. The transition piece is an irregular shape, being a circle on one end and an ellipse at the junction with the cone. The transition piece sets at an angle to the cone.

For convenience in showing the development, the allowance for the thickness of the plates has been omitted and the outline shown has been taken as the neutral axis of the plate.

The first step in the development of the transition piece is to consider the elliptical end of the transition piece as a pipe of this shape passing directly through the cone at the angle shown. In passing this elliptical section through in this manner, assume the elliptical end to be divided into sections as *b-b, c-c, d-d* to *h-h* as shown in the plan view, Fig. 194.

These sections may be considered as flat strips or planes. By passing these planes through the cone, the surface of the cone will be cut and sections of it, irregular in form, will be produced. These sections are shown foreshortened in the plan, Fig. 195.

To determine their shape and position in the plan, Fig. 195, divide one-half the base into any number of equal parts, the greater the number of equal parts taken the more accurate the final development, six being taken in this case. Label these parts *r, s, t, u, v, w, x* as shown. Connect these points with the center *O'*. Then parallel to the center line *O-O'*, draw lines through the points *r* to *x*, extending them into the elevation and cut the base line *A-B*. Number the intersections from *r'* to *x'* and connect the points *r'* to *x'* with the center *O* as shown.

Next, divide the plan view of the elliptical end of the transition piece, Fig. 194, into any number of equal parts, sixteen being taken in this case. Label them each side of the center line from *a* to *j* as shown. Connect the points *b-b, c-c, d-d,* to *k-k*. Then parallel to the center line *J'-K'*, draw and extend a line through the point (a) and into the elevation, cutting the lines *O-s', O-t'* to *O-w'* and locating the points 1, 2, 3 as shown. In like manner, draw a line parallel to *J'-K'* through the point *b*, extending it into the elevation to cut the lines *O-s', O-t'* to *O-w'* thereby locating the points 4, 5 and 6 as shown. Continue in this manner until all the points up to point 24 are located.

To obtain the contour of the plane *b-b* in the plan view, Fig. 195, draw a line parallel to the center line *O-O'*, through the point 1, Fig. 193, and extend this line down into the plan, Fig. 195, cutting the line *O'-u*, and locating the point 1', Fig. 195. In the same manner, draw a line through the point 2, Fig. 193, and extend it down into the plan, Fig. 195, to cut the line *O'-t* and *O'-v*, and locate the points 2', Fig. 195. Likewise locate the points 3', Fig. 195. Connect the points 1'-2'-3' on each side of the center line *O'-u* with a line. This line will represent a section of the cone cut by the line *b-b*.

Construct the sections of the cones for the planes, *c-c* to *k-k*, in the same manner, locating the points 4' to 24' as shown.

The next step is to obtain the miter line between the transition piece and the cone in both the elevation and plan views.

In order not to make the layout too complex, Figs. 196, 197 and 198 are a reproduction of Figs. 193, 194 and 195, as far as the development has progressed; that is, the lines in the plan view represent the sections of the planes taken in the plan view of the transition piece.

Draw the profile of the elliptical end of the transition piece as shown in Fig. 199, and divide this profile into the same number of equal parts as was taken in the plan view, Fig. 197, and label the points corresponding to the same figures in Fig. 197 from *a* to *j* on each side of the center line *M-N*.

Extend the center line *a-j* into the plan, Fig. 198, and the intersection where this line cuts the curved line representing the section of plane (a) locates the point *a'* and in like manner *j'*. Parallel to *M-N*, draw a line through the points *b* and *h* and extend it into the plan view, Fig. 198. The intersection where the line cuts

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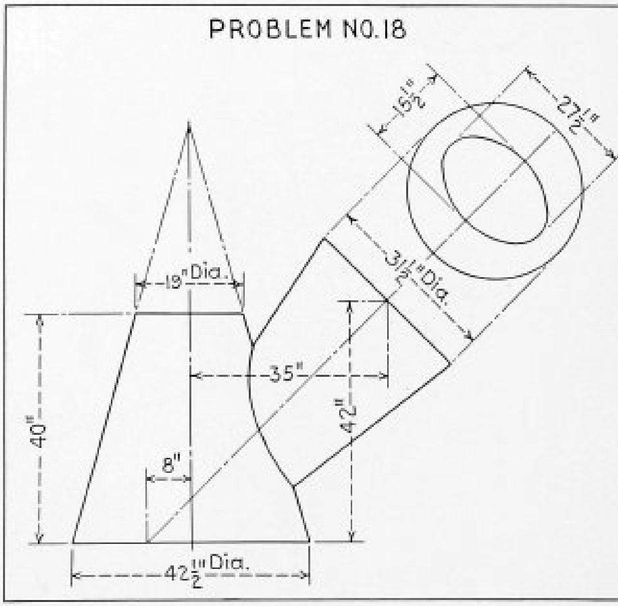
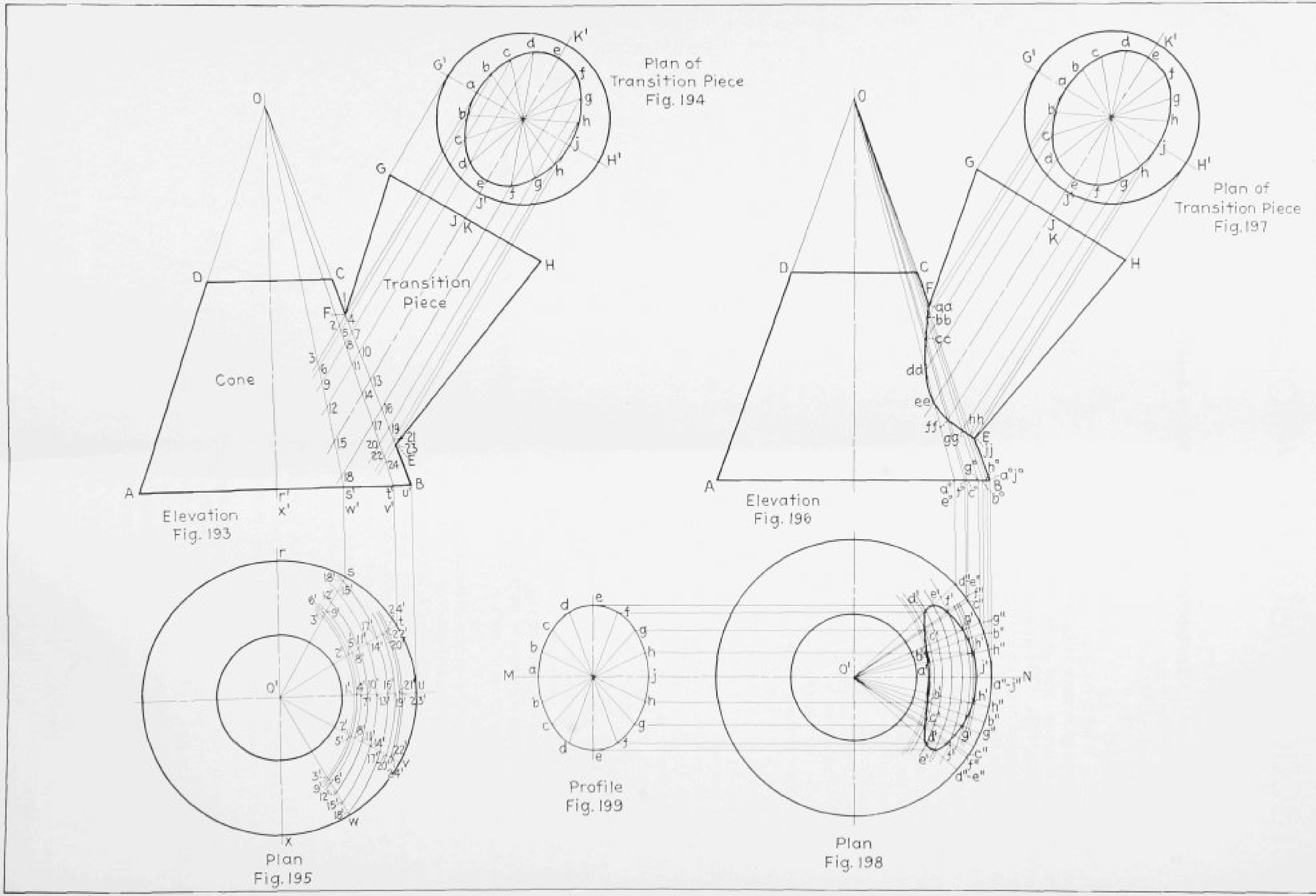
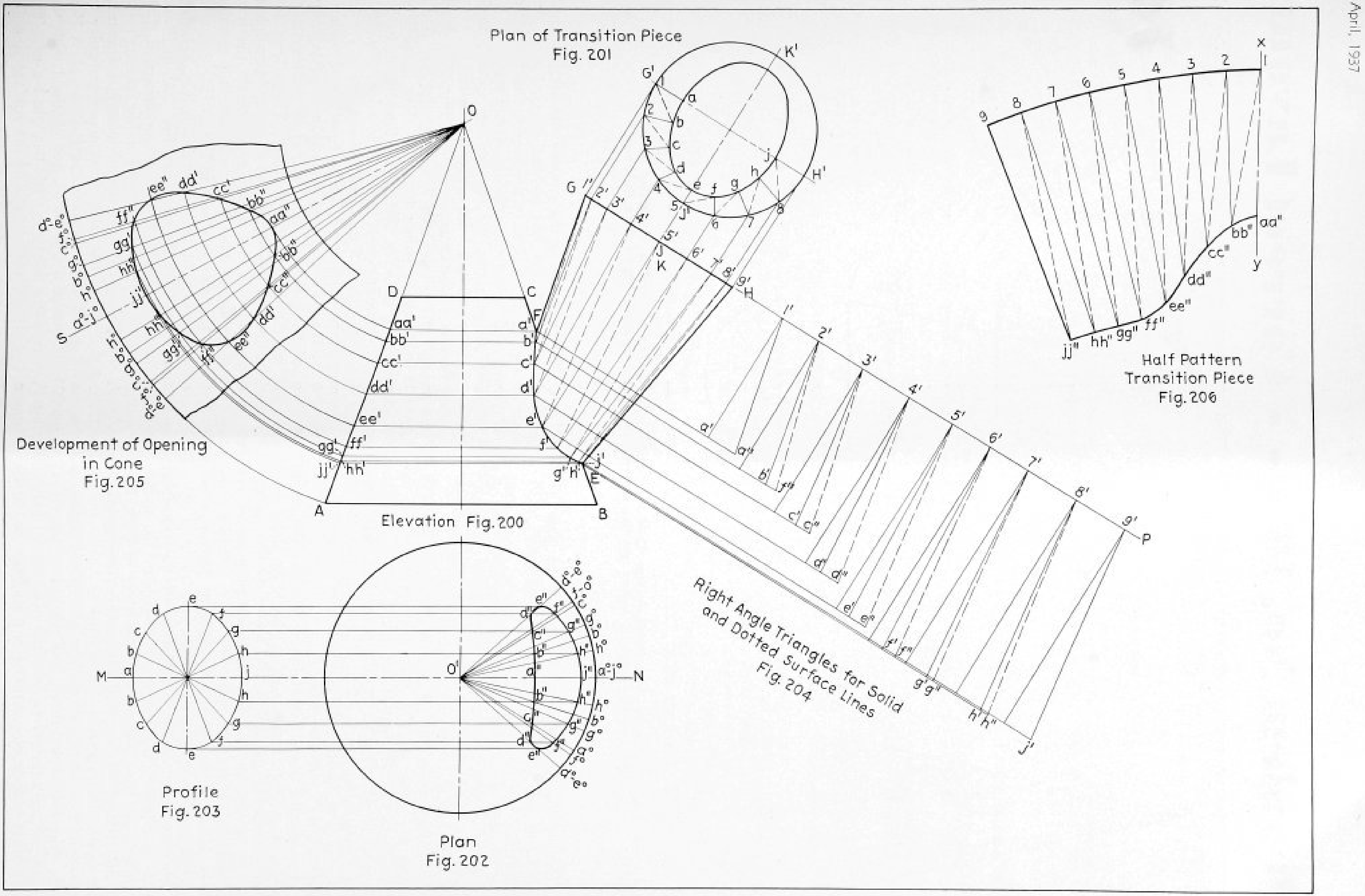
Problem No. 18 for Readers to Lay Out



The correct solution of Problem No. 18 will be published in the June issue

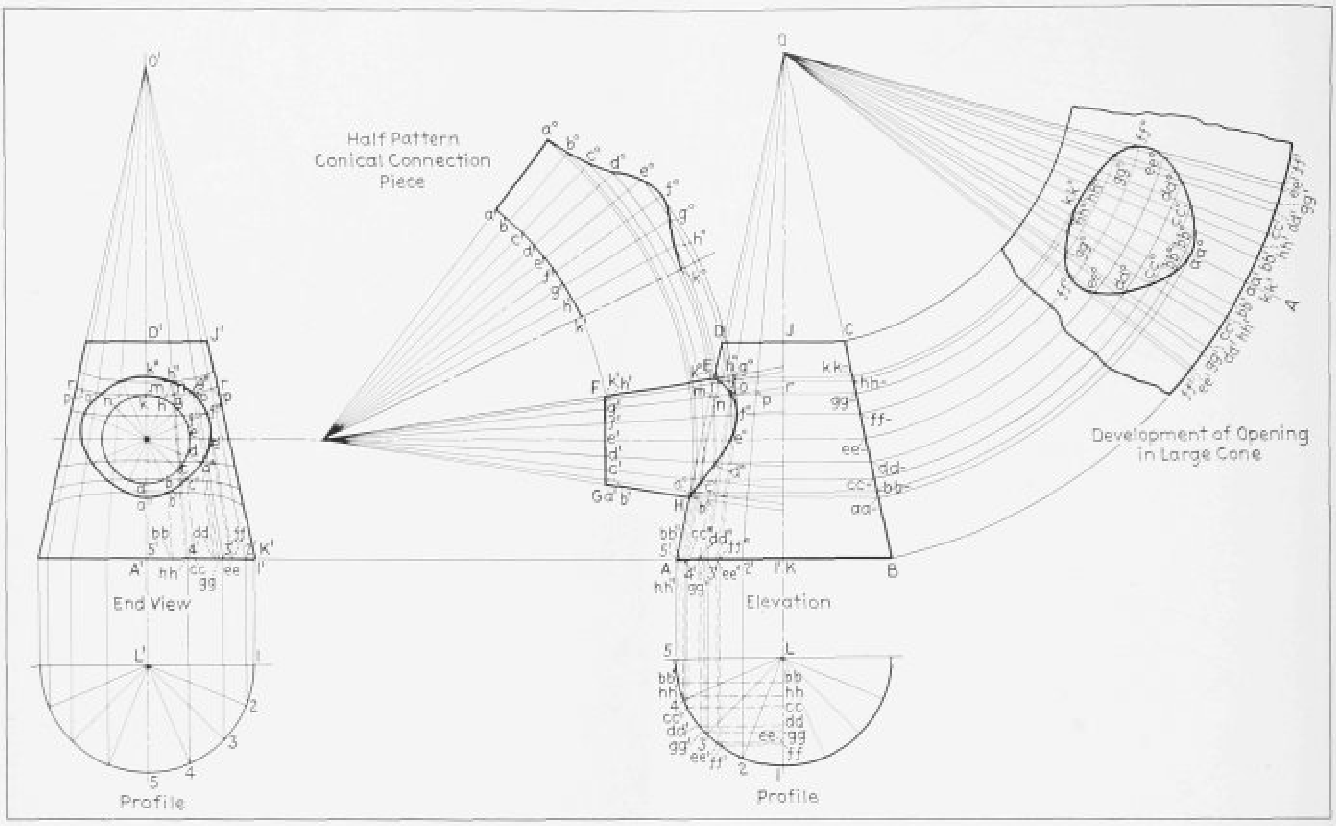


Development of irregular transition piece joining a cone



Further details of the transition piece and connecting cone layout

Problem No. 16 - - - Correct Layout



Problem No. 16 appeared on page 45 of the February issue. The correct solution is published herewith in order to give our readers who have developed the problem an opportunity to check their work.

the curved line representing the section of plane (b) locates the points b' on each side of M-N and in like manner h'.

Continue in this manner locating the points c', g', d', f' and e'. Connect these points with a line which will be the miter line of the intersection between the transition piece and the cone in the plan view.

Then draw radial lines from the center O', Fig. 198, cutting the points a' to j, extending these so that the circumference of the base at the points a'' to j'' is intersected as shown. Parallel to the center line O-O' draw lines through the points a'' to j'', cutting the base line A-B, Fig. 196, locating the points a° to j°. Connect the points a° to j° with the center O.

Next parallel to the center line J'-K', Fig. 198, draw lines through the points a to j, extending these lines down into the elevation, Fig. 196, where the line through the point a cuts the line O-a° to locate the point aa. In like manner, locate the points bb to jj. Connect the points aa to jj with a line completing the miter line between the transition piece and the cone.

The next step is the development of the transition piece. As before, in order not to complicate the layout, Figs. 200, 201 and 202 are a reproduction of Figs. 196, 197 and 198, as far as the development has progressed; that is, the miter lines are complete.

From an examination of the plan view of the transition piece, Fig. 201, it is noticed that the center line G'-H' divides the transition piece into two symmetrical halves, and therefore a development of one half can be duplicated for the other half.

Divide the half plan of the circular top and elliptical connection, Fig. 201, into any number of equal parts, the same number of parts, eight in this case, being taken for the circular end as for the elliptical connection.

Number the points on the circular end from 1 to 9 and on the elliptical end from a to j as shown.

Then parallel to the center line J'-K', Fig. 201, draw lines through the points 1 to 9, cutting the line G-H, Fig. 200, locating the points $1'$ to $9'$. Also parallel to the center line J'-K', Fig. 201, draw lines through the points a to j extending them into the elevation, Fig. 200, to cut the miter line E-F and locate the points a'-j'.

Connect the points 1-a, 2-b, 3-c to 9-j of the plan view, Fig. 201, with solid and dotted surface lines. Also connect the points, $1'$-a', $2'$-b', $3'$-c' to $9'$-j of the elevation, Fig. 200, with solid and dotted lines. These lines are the surface lines of the object and in order to complete the development it is first necessary to obtain the true length of these lines. This is done by erecting a series of right angle triangles as shown in Fig. 204.

To construct the right angle triangles in Fig. 204, first extend the line G-H of the elevation, Fig. 200, to P and at any point on G-P as $1'$ erect a perpendicular to G-P. Parallel to G-P, draw and extend a line through the point a', Fig. 200, to cut the perpendicular just drawn at a', Fig. 204. At a', Fig. 204, erect a perpendicular to $1'$-a' and step off on it the distance a'-a'' equal to $1'$-a, Fig. 201. Connect the point a'' just obtained with the point $1'$, completing the right angle triangle 1-a'-a''. The distance $1'$-a'' is the true length of the surface line 1-a of the plan and $1'$-a' of the elevation.

The altitudes of the triangles are obtained by projecting this distance from the elevation. The bases of both the solid and dotted triangles are obtained from the plan view, thus completing the diagram of the triangles.

The next step is to obtain the development of the opening in the cone. Draw the profile, Fig. 203, and divide it into the same number of equal parts as was taken in the plan, Fig. 201. Label these points on each side of the center line M-N from a to j as shown. Draw lines through the points a to j, parallel to the center line M-N and cutting the miter line at the points a'' to j''.

With O' as a center, draw and extend lines through the points a'' to j'' to cut the circumference of the base of the cone at the points a° to j°, Fig. 202.

Then with O as a center and with O-A as a radius, scribe an arc. Draw any line as O-S, Fig. 205. On each side of the line O-S, step off the distance a°-b°, b°-c°, c°-c°, d°-d° equal to the same distance in the plan view, Fig. 202.

Connect the points a° to j° to the center O, Fig. 205, with a series of radial lines. Parallel to the base line A-B, draw lines through the points a' to j' and extend them cutting the line A-D, Fig. 200, to locate the points aa' to jj'. Then with O-aa', Fig. 200, as a radius, scribe an arc, cutting the line O-S, Fig. 205, and locating the point aa'', Fig. 205.

With O-bb', Fig. 200, as a radius, scribe an arc cutting the lines O-b°, Fig. 205, and locating the point bb'' on each side of the center line O-S. In like manner, develop the points cc'' to jj'', Fig. 205. Connect the points aa'' to jj'', Fig. 205, to complete the development of the opening in the cone.

Development of the Pattern

Draw any line as X-Y, Fig. 206, and at any point 1 on X-Y, step off the distance 1-aa'' equal to the distance $1'$-a'', Fig. 204. With aa'' as a center and with the dividers set equal to the distance aa''-bb'', Fig. 205, scribe an arc; then with 1 as a center and with the trams set equal to the distance $2'$-b', Fig. 204, scribe another arc, which will cut the arc just drawn to locate the point bb''. With 1 as a center and with dividers set equal to the distance 1-2, Fig. 201, scribe an arc. Then with bb'', Fig. 206, as a center and with the trams set equal to $2'$-$6'$, Fig. 204, scribe another arc, cutting the arc just drawn and locating the point 2, Fig. 206.

Continue in this manner, making the distances 2-3, 3-4 to 8-9, Fig. 206, equal to their corresponding distances in Fig. 201, and the distances bb''-cc'', cc''-dd'' to jj'' equal to their corresponding distances in Fig. 205, and the solid surface lines 3-cc'', 4-dd'', 5-ee'', 6-ff'', 7-gg'', 8-hh'', 9-jj'' equal to $3'$-c', $4'$-d', $5'$-e', $6'$-f', $7'$-g', $8'$-h', $9'$-j', Fig. 204, and the dotted surface lines 2-cc'', 3-dd'', 4-ee'', 5-ff'', 6-gg'', 7-hh'', 8-jj'' equal to $3'$-c'', $4'$-d'', $5'$-e'', $6'$-f'', $7'$-g'' and $8'$-h''. Connect all the points with a line completing the half pattern of the transition piece.

(To be concluded)

Reconstruction of Sixteen-Year Old Boilers

An interesting reconstruction has recently been carried out at a power plant in Great Britain, on two boilers which have been installed since about 1920, giving an indication of the advance which has taken place in combustion chamber design since the installation was originally constructed.

The boilers are of the Babcock and Wilcox 3-drum W.I.F. type, and were fitted with underfeed class "A" stokers of 177 square feet grate surface, designed to burn 18 pounds of coal per square foot per hour, and each boiler gave an evaporation of 28,000 pounds per hour at 170 pounds per square inch pressure.

The reconstruction was designed to increase the evaporation capacity to 60,000 pounds per hour for the normal load, and 75,000 pounds per hour maximum per boiler.

A new stoker of the underfeed "L" type having a grate area of 196 square feet, and a rate of combustion of 43 pounds per square foot per hour at maximum load, was installed under each boiler. In addition, side walls of 650 square feet effective heating surface were added. An air heater was also installed which can deliver air under forced draft at 123 degrees C.

In order to obtain the increased combustion chamber capacity, the boiler was lifted 5 feet and the stoker lowered into the basement about 2 feet. Only one boiler at a time was available for reconstruction. The reconstruction of the first boiler was started on January 20, 1936, and this boiler in its completely redesigned condition went into commission again on April 16, about one week before the contract date.

The load was increased gradually until full load was obtained easily without undue forcing. In fact, practically full load was attained without the use of preheated air.

With regard to the fuel, the stoker was designed to burn a variety of coal with an average calorific value of about 11,000 British thermal units, and in addition to being able to operate with coal only, the overhead bunkers have been divided so that separate chutes may deliver both coal and riddlings on the sandwich system.

In the process of lifting the boilers with a minimum amount of tackle, the drums were suspended from cross beams on the original setting and temporary supports passed under the drums while alterations were carried out. The original beams were removed, and the existing columns were extended by 5 feet, after which new beams were fitted. Rods were then passed through the new beams, and secured to the temporary supporting transverse beams, and square-threaded nuts utilized these suspension rods to take the weight of the boiler. Hydraulic jacks were then placed at three points on the temporary beams, and the whole boiler was lifted. As an extra precaution, the load was followed up with the square-threaded nuts, so that in the event of any failure of the jacks the boiler would be held by the suspension rods. The total time required to lift each boiler, which weighed 90 tons, a height of 5 feet was about twelve hours.

The reconstruction was carried out by International Combustion, Ltd., London and Derby. *The Engineer.*

New Heating and Ventilating Guide Available

A new and revised edition of the guide for 1937, has been issued by the American Society of Heating and Ventilating Engineers, New York. This is the fifteenth edition of the Guide which contains an outline of changes and developments that occurred in the course of the year. The technical section has been completely revised and in some cases rewritten. A few of the changes in technical data include: Recalculated tables for the properties of dry and saturated air, principles of air conditioning (completely rewritten), heat transmission coefficient tables amplified, humidification, dehumidification and water cooling, mechanical draft cooling, chimney and draft calculations, cooling methods, air cleaning devices, etc. The price of the Guide is $5.00.

Proposed Revisions and Addenda to the A.S.M.E. Boiler Construction Code

It is the policy of the Boiler Code Committee to receive and consider as promptly as possible any desired revision of the rules and its codes. Any suggestions for revisions or modifications that are approved by the committee will be recommended for addenda to the code, to be included later in the proper place in the code.

The following proposed revisions have been approved for publication as proposed addenda to the code. They are published below with the corresponding paragraph numbers to identify their locations in the various sections of the code, and are submitted for criticism and approval from any one interested therein. It is to be noted that a proposed revision of the code should not be considered final until formally adopted by the council of the society and issued as pink-colored addenda sheets. Added words are printed in SMALL CAPITALS; words to be deleted are enclosed in brackets [ ]. Communications should be addressed to the secretary of the Boiler Code Committee, 29 West 39th St., New York, N. Y., in order that they may be presented to the committee for consideration.

PAR. P-270. Revise to read:

P-270 The safety-valve capacity for each boiler shall be such that the safety valve or valves will discharge all the steam that can be generated by the boiler without allowing the pressure to rise more than 6 percent above THE HIGHEST PRESSURE AT WHICH ANY VALVE IS SET AND IN NO CASE TO MORE THAN 6 PERCENT ABOVE the maximum allowable working pressure.

[If the highest pressure at which any valve is set is less than the maximum allowable working pressure, the safety-valve capacity shall be such that the pressure cannot increase more than 6 percent above this highest set pressure.]

PAR. P-271. Revise to read:

P-271 One or more safety valves on the boiler proper shall be set at or below the maximum allowable working pressure. IF ADDITIONAL VALVES ARE USED THE HIGHEST PRESSURE SETTING SHALL NOT EXCEED THE MAXIMUM ALLOWABLE WORKING PRESSURE BY MORE THAN [The remaining valves may be set within a range of] 3 percent, [above the maximum allowable working pressure but]. The COMPLETE range of PRESSURE settings of all [of] the valves on a boiler shall not exceed 10 percent of the highest pressure to which any valve is set.

PAR. P-272. Revise to read:

P-272 All safety valves shall be so constructed [that no shocks detrimental to the valve or to the boiler are produced and so] that THE [no] failure of any part can NOT obstruct the free and full discharge of steam from the valve. Safety valves SHALL [may] be of the direct spring-loaded pop type, with seat [and bearing surface of the disk] inclined at any angle between 45 degrees and 90 degrees inclusive, to the center line of the spindle. The maximum rated capacity of a safety valve shall be determined BY ACTUAL STEAM FLOW, IN THE PRESENCE OF AUTHORIZED INSPECTORS at a pressure of 3 percent in excess of that at which the valve is set to blow, and with a blowdown IN ACCORDANCE WITH PAR. P-281 AND CREDITED WITH 90 PERCENT OF THE FLOW DEVELOPED [of not more than 4 percent of the set pressure, the blowdown to be in no case less than 2 lb].

Safety valves may be used which give any opening up to the full discharge capacity of the area of the opening of the inlet of the valve (See Par. P-273*c*), provided the movement of the valve is such as not to induce lifting of water in the boiler.

Dead-weight or weighted-lever safety valves shall not be used.

PAR. P-273. Revise to read:

P-273 Each safety valve [½ in. size and larger] shall be plainly marked by the manufacturer in such a way that the markings will not be obliterated in service. The marking may be stamped [or cast] on the casing or stamped or cast on a plate or plates securely fastened to the casing, and shall contain the following markings:

(*a*) The name or identifying trademark of the manufacturer.

(*b*) MANUFACTURER'S DESIGN OR TYPE NUMBER.

(*c*) [*b*] Size......in.......SEAT DIAMETER......IN.
The pipe size of the valve inlet. [(Where the valve inlet is not threaded, the initial diameter of the inlet shall not be less than the inside diameter of a standard pipe of the same nominal diameter as that of the valve.)]

(*d*) [*c*] Pres..................lb
The steam pressure at which it is to blow.

(*e*) [*d*] B.D...................lb
Blowdown. (Difference between the opening and closing pressure.)

(*f*) [*e*] Cap...................lb per hr
IN ACCORDANCE WITH PARS. P-272 AND P-281 [The weight of steam discharged in pounds per hour at a pressure of 3 percent higher than that for which the valve is set to blow,] (and with the valve adjusted for the blowdown given in the preceding item.)

(*g*) CAPACITY LIFT.............IN.
CAPACITY LIFT—DISTANCE THE VALVE SEAT RISES UNDER THE ACTION OF THE STEAM WHEN THE VALVE IS BLOWING UNDER A PRESSURE OF 3 PERCENT ABOVE THE SET PRESSURE.

(*h*) A. S. M. E. SYMBOL AS SHOWN IN FIG. P-29½ [Std.]

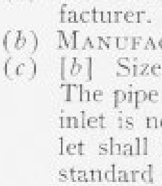


Fig. P-29½

PERMISSION TO USE THE SYMBOL DESIGNATED IN THE FOREGOING PARAGRAPH WILL BE GRANTED BY THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS TO ANY MANUFACTURER COMPLYING WITH THE PROVISIONS OF THE CODE WHO WILL AGREE UPON FORMS ISSUED BY THE SOCIETY, THAT ANY SAFETY VALVE TO WHICH THE SYMBOL IS APPLIED WILL BE CONSTRUCTED IN ACCORDANCE WITH THE CODE AND HAS THE

CAPACITY STAMPED UPON THE VALVE UNDER THE STATED CONDITIONS, AND THAT HE WILL NOT MISUSE OR ALLOW OTHERS TO USE THE STAMP BY WHICH THE SYMBOL IS APPLIED.

A STEEL STAMP FOR APPLYING THE SYMBOL MAY BE PURCHASED BY SUCH MANUFACTURERS FROM THE SOCIETY.

AFTER OBTAINING THE CODE STAMP THE MANUFACTURER OF SAFETY VALVES THAT ARE TO BE STAMPED WITH THE CODE SYMBOL SHALL FIRST SUBMIT AT LEAST THREE VALVES, OF EACH OF THREE REPRESENTATIVE SIZES AND OF EACH DESIGN AND FOR THREE DIFFERENT PRESSURES, FOR TESTING AT THE PLANT OF THE MANUFACTURER OR AT A PLACE WHERE ADEQUATE EQUIPMENT IS AVAILABLE TO CONDUCT PRESSURE AND RELIEVING-CAPACITY TESTS.*

TESTS SHALL BE MADE TO DETERMINE THE LIFT, POPPING AND BLOWDOWN PRESSURES AND CAPACITY FOR AT LEAST THREE POINTS IN THE EXPECTED RANGE OF PRESSURES AND CAPACITIES FOR WHICH THE VALVE IS TO BE USED IN ORDER TO ESTABLISH THE PERFORMANCE FOR EACH SIZE AND DESIGN.

THE TESTS SHALL BE MADE WITH STEAM AND IN A MANNER CLOSELY APPROXIMATING ACTUAL OPERATING CONDITIONS ON STEAM BOILERS, THE RELIEVING CAPACITY SHALL BE MEASURED BY CONDENSING THE STEAM OR WITH A CALIBRATED STEAM-FLOW METER.

THESE TESTS SHALL BE CONDUCTED IN THE PRESENCE OF, AND CERTIFIED BY, A STATE INSPECTOR, A MUNICIPAL INSPECTOR OR AN INSPECTOR REGULARLY EMPLOYED BY AN INSURANCE COMPANY AUTHORIZED TO INSURE BOILERS AGAINST EXPLOSION IN THE STATES AND MUNICIPALITIES THAT HAVE ADOPTED THIS CODE.

A DATA SHEET FOR EACH SAFETY VALVE TESTED SHALL BE FILLED OUT AND SIGNED BY THE MANUFACTURER AND THE INSPECTOR WITNESSING THE TEST. SUCH DATA SHEET WILL BE THE MANUFACTURER'S AUTHORITY TO BUILD AND STAMP VALVES OF CORRESPONDING DESIGN AND CONSTRUCTION. WHEN CHANGES ARE MADE IN THE DESIGN, SIMILAR TESTS MUST BE REPEATED.

THE RELIEVING CAPACITY THAT MAY BE STAMPED ON THE SAFETY VALVES SHALL NOT EXCEED 90 PERCENT OF THE VALUE DETERMINED BY THE WITNESSED TESTS.

PAR. P-276. Revise to read:

P-276 When two or more safety valves are used on a boiler, they may be mounted either separately or as twin valves made by placing individual valves on Y bases, or duplex [triplex or multiplex] valves having two [or more] valves in the same body casing. TWIN [the] valves MADE BY PLACING INDIVIDUAL VALVES ON Y BASES OR DUPLEX VALVES HAVING TWO VALVES IN THE SAME BODY shall be [made] of equal sizes [if possible, and in any event if not of the same size.]

WHEN NOT MORE THAN TWO VALVES OF DIFFERENT SIZES ARE MOUNTED SINGLY, THE RELIEVING CAPACITY OF the smaller [of the two] valve shall NOT BE LESS THAN [have a relieving capacity of at least] 50 percent of that of the larger valve.

PAR. P-277. Omit the words "when possible" at the end of this paragraph.

PAR. P-278. Revise last sentence of second section to read:

For iron- and steelbodied valves exceeding 2-in. size, the drain hole shall be tapped NOT LESS THAN 3/8 IN. PIPE SIZE.

PAR. P-281. Revise to read:

P-281 *a* Safety valves shall operate without chattering and shall be set and adjusted as follows: To close after blowing down not more than 4 percent of the set pressure but not less than 2 lb in any case. For springloaded pop safety valves [operating on] FOR pressures [up to and including] BETWEEN 100 AND 300 lb per sq in., BOTH INCLUSIVE, the blowdown shall not be less than 2 percent of the set pressure. To insure the guaranteed capacity and satisfactory operation, the blowdown as marked upon the valve (Par. P-273*e*) shall not be reduced.

(*b*) THE BLOWDOWN ADJUSTMENT SHALL BE MADE AND SEALED BY THE MANUFACTURER.

(*c*) THE POPPING POINT TOLERANCE PLUS OR MINUS SHALL NOT EXCEED THE FOLLOWING: 2 LB FOR PRESSURES UP TO AND INCLUDING 70 LB, 3 PERCENT FOR PRESSURES FROM 71 TO 300 LB, AND 10 LB FOR PRESSURES OVER 300 LB.

PAR. P-282. Revise to read:

P-282 To insure the valve being free, each safety valve [on boilers with maximum allowable working pressures up to and including 200 lb per sq in.] shall have a substantial lifting device by which the valve disk may be positively lifted from its seat [at least 1/16 in.] when there is AT LEAST 75 PERCENT OF FULL WORKING [no] pressure on the boiler. THE LIFTING DEVICE SHALL BE SUCH THAT IT CANNOT LOCK OR HOLD THE VALVE DISK IN LIFTED POSITION WHEN THE EXTERIOR LIFTING FORCE IS RELEASED. [For boilers with working pressures above 200 lb per sq in., the safety-valve lifting device need not provide for lifting the valve disk 1/16 in. except at such times as there is at least 75 percent of the full working pressure upon the boiler. Except at times of general inspection, the valve should not be lifted, unless there is sufficient steam pressure on the boiler to blow the dirt and scale clean from the seat.]

PAR. P-284. Revise the first sentence to read:

P-284 Springs used in safety valves shall not show a permanent set exceeding 1 PERCENT OF THEIR FREE LENGTH [1/16 in.] ten minutes after being released from a cold compression test closing the spring solid.

PAR. P-285. Revise to read:

P-285 *a* The spring in a safety valve IN SERVICE, FOR PRESSURES UP TO AND INCLUDING 250 LB shall not be used for any pressure more than 10 percent above or 10 percent below that for which it was designed. FOR HIGHER PRESSURES THE SPRING SHALL NOT BE USED FOR ANY PRESSURE MORE THAN 5 PERCENT ABOVE OR 5 PERCENT BELOW THAT FOR WHICH IT WAS DESIGNED.

b IF THE OPERATING CONDITIONS OF A VALVE ARE CHANGED SO AS TO REQUIRE A NEW SPRING UNDER (*a*) FOR A DIFFERENT PRESSURE, THE VALVE SHALL BE ADJUSTED BY THE MANUFACTURER OR HIS AUTHORIZED REPRESENTATIVE WHO SHALL FURNISH AND INSTALL A NEW NAME PLATE AS REQUIRED UNDER PAR. P-273.

PAR. P-286. Revise the second sentence to read:

The dimensions of flanges subjected to boiler pressure shall conform to the American Standards as given in Tables A-5 to A-8 in the Appendix, subject to the restrictions of Par. P-12*b* [except that the face of a safety valve flange and the face of a nozzle or fitting to which it is attached may be flat without the raised face for pressures not exceeding 250 lb per sq in. but for higher pressures shall] THE [have] facings SHALL BE similar to those shown in Fig. A-9 [and of dimensions given in Table A-5 in the Appendix].

PAR. P-287. Revise to read:

P-287 When the valve casing is marked as required by Par. P-273, it shall be the guarantee by the manufacturer that the valve ALSO conforms to the details of construction herein specified.

PAR. P-289. Revise the second sentence of this paragraph to read as follows:

* Facilities available at the present time may impose limitations on the testing of some valves at high pressures and of large capacity.

The valve shall have a flanged inlet connection, and shall have the seat and disk of SUITABLE HEAT EROSIVE-AND CORROSIVE-RESISTING [nickel composition or equivalent] material, and the spring fully exposed outside of the valve casing so that it shall be protected from contact with the escaping steam.

Australian Railroad Solves Boiler Water Problem

By G. P. Blackall

One of the outstanding achievements of the Trans-Australian Railroad has been its successful solution of the water problem, which was so grave during the line's early history that on several occasions a cessation of traffic appeared almost inevitable. Within recent years, however, a process of water treatment has been perfected which is unique in so far as railroads are concerned, although a stationary plant operating on similar principles has been in operation at the Leonora gold fields, Western Australia.

The chief troubles encountered on the railroad were scaling, corrosion, foaming and priming. In operating the train service, almost continuous leakage of boiler tubes resulted, with consequent long delays to trains, high fuel and maintenance expenses. The scaling, resulting from calcium and magnesium salts, formed an incrustation in the boiler, sometimes $\frac{1}{16}$-inch thick, causing loss of boiler efficiency, and overheating and burning of firebox plates. The magnesium chloride content of the boiler water amounted, in some cases, to 38 grains per gallon and, under the pressures and temperatures obtaining in the boilers, liberated hydrochloric acid and caused virulent corrosion of the boiler plates in the form of pitting, grooving and wasting. Another contributory factor causing corrosion was the electrolytic action set up between the copper and steel and between portions of steel plates having dissimilar characteristics.

Foaming and priming seriously handicapped the maintenance of scheduled running times. Fortunately, however, it was possible to reduce this to a minimum by the use of an anti-foam compound containing castor oil, which was introduced into the tender of the locomotive. The scaling and corrosion, however, was far more serious in its behavior and more difficult to treat. After a thorough investigation of the problem, the Australian Commonwealth Railways administration finally decided to test a new form of treatment which had proved successful at Leonora. Exhaustive tests were conducted to prove whether the treatment was satisfactory for locomotive boilers, after which a trial plant was erected at one of the most troublesome watering stations along the 1051-mile line. The results were so successful that G. A. Gahan, Commonwealth Railways commissioner, had two other stations similarly equipped.

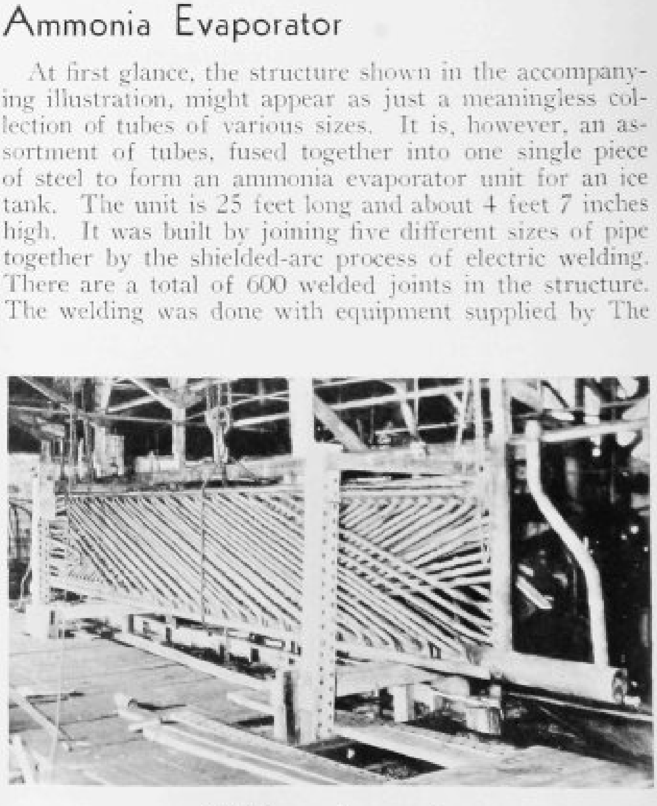
The treatment consists of the agitation of cold well and bore water with weighed amounts of caustic lime and barium carbonate in vats of 15,000 gallons capacity. The agitation usually occupies about six hours and, before it is stopped, tests are conducted on each vat, and additional lime added as necessary, after which the vats are allowed to stand overnight to allow the precipitates to settle. The result of the treatment is that calcium, magnesium bicarbonates, and calcium sulphate are precipitated and no other salts are left in solution replacing them; magnesium chloride is converted into magnesium hydrate and soluble calcium chloride. Thus both carbonates and sulphates are precipitated, but chlorides are left in solution either as sodium or calcium chloride, both of which have a very high solubility and are inert in boilers using treated water. The average cost of treatment per 1000 gallons amounts approximately to 25 cents, which is fully justified in view of the immense saving in boiler maintenance, avoidance of delays to trains through locomotive failures, saving in coal consumption, etc.

It is claimed that nowhere else in the world is boiler water hauled such long distances as on the Trans-Australian Railroad, which for the entire 1051 miles of its length does not cross a single permanent stream. Where the contour of the country is suitable, endeavors have been made to retain supplies of surface water by the construction of large reservoirs, some of these being of 8,000,000 gallons capacity. With the infrequent rains in the country traversed, long periods must elapse, however, during which the reservoirs are dry, necessitating reliance on supplies from the treatment plants, the water from which is transported by water trains in 8000-gallon tank wagons.

By this means supplies for boiler requirements are transported for distances up to 500 miles. Prior to the installation of the latest treatment plant water was conveyed from Kalgoorlie to Cook, a distance of 538 miles, the water having previously been piped 350 miles from Mundaring reservoir to Kalgoorlie. Since the treatment plants have been operating the delays to trains caused by boiler troubles have been reduced to an absolute minimum, the cost of boiler maintenance has been decreased, and the life of the boilers and copper fireboxes correspondingly improved.

Welding Fabricates Ammonia Evaporator

At first glance, the structure shown in the accompanying illustration, might appear as just a meaningless collection of tubes of various sizes. It is, however, an assortment of tubes, fused together into one single piece of steel to form an ammonia evaporator unit for an ice tank. The unit is 25 feet long and about 4 feet 7 inches high. It was built by joining five different sizes of pipe together by the shielded-arc process of electric welding. There are a total of 600 welded joints in the structure. The welding was done with equipment supplied by The



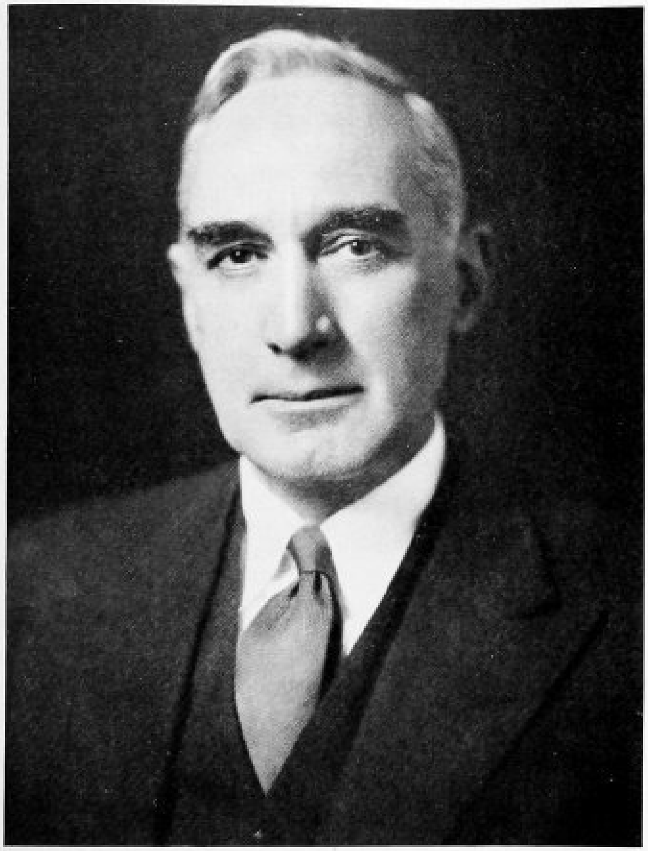
Welded ammonia evaporator

Lincoln Electric Company, Cleveland, O. The unit was fabricated by Rierson Brothers Welding Works, Greensboro, N. C.

Boiler Manufacturers Association Executive Dies

James D. Andrew, since 1933 manager of the American Boiler Manufacturers Association and Affiliated Industries, died at his home in Englewood, N. J., on March 22, at the age of 62 years.

During his career as an engineer and executive Mr.



James D. Andrew

Andrew was connected with the Metropolitan Street Railway Company of New York as mechanical engineer, during the period of its electrification. He was for four years chief engineer of the New York Edison Company, for six years superintendent of power with the Boston Elevated Railway system and for a period of years superintendent of engineering with the Edison Electric Illuminating Company of Boston. For a considerable period he was executive with miscellaneous industrial projects, principally with American International Corporation interests. This work included the post of manager of ship construction at the Hog Island Shipyard, president of the American Balsa and Balsa Refrigerator Company, New York, and president and general manager of the Standard Tank Car Company, Sharon, Pa. Later he became vice-president of Stevens & Wood in charge of design, construction and operation of power plants in Ohio and Pennsylvania. For three years he was general consulting engineer of Armour & Company, Chicago, and later chief engineer with the Niagara Hudson Power Corporation. As noted, since 1933 Mr. Andrew was manager of the American Boiler Manufacturers' Association and Affiliated Industries. He was a member of the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, Engineers Club, The Society of Naval Architects and Marine Engineers, American Trade Association Executives, Winslow Lewis Lodge F. & A. M. and Aleppo Shrine in Boston.

Flannery Bolt Company Representative Dies

Leo Finegan, eastern sales manager of the Flannery Bolt Company, Bridgeville, Pa., died on March 8. Mr. Finegan was a well known figure in railroad shops throughout the East, and numbered among his friends practically all those who were in charge of the construction and maintenance of locomotive boilers. He was a member of the Master Boiler Makers' Association.

Hannifin to Build Allen Riveters

Hannifin Manufacturing Company, Chicago, has purchased the machinery, equipment and name of John F. Allen Company, New York, makers of air operated riveting machines. Manufacture, sales and service of Allen riveting machines will be continued as the Allen Riveter Works, division of Hannifin Manufacturing Company, at St. Marys, O. The Hannifin Manufacturing Company has recently completed a new plant at St. Marys, equipped for the production of large machinery.

Republic Announces New Appointments

Announcement was made recently by N. J. Clarke, vice-president in charge of sales, Republic Steel Corporation, Cleveland, of the following appointments: R. C. Klemm has been appointed manager of sales, bolt and nut division, to succeed C. F. Newpher, who has joined the National Screw & Manufacturing Company. Mr. Klemm has been with Republic Steel and its predecessor companies for 25 years.

Harry W. Schrenk has been appointed as manager of sales, tool steel department, succeeding the late Frank J. Bauman. Mr. Schrenk has been associated with the tool steel department for a number of years.

Power Show Planned in Chicago

A new Power Show for the Mid-West—the Chicago Exposition of Power and Mechanical Engineering has been announced. The place is the new International Amphitheatre at Chicago, and the dates are October 4 to 9, 1937. The important consideration in connection with the announcement of this event is that it is to be under the same management which, over a long period of years, has conducted so successfully the National Expositions of Power and Mechanical Engineering at the Grand Central Palace in New York. The new exposition is not intended to supplant the National Power Show at New York, nor to interrupt its sequence. The next one, the Thirteenth National Exposition of Power and Mechanical Engineering, will be held at Grand Central Palace in New York, December 5 to 10, 1938, retaining the biennial interval now established.

Realizing the extent of the United States and the territorial interests involved, it is natural that the International Exposition Company should conduct expositions both in New York and Chicago. The interests to be served are so great and the potential audience so large that this exposition "localized" is entirely justified.

The Chicago Exposition of Power and Mechanical Engineering will be conducted with the viewpoint and manner of the national power shows. No periodic holding of this exposition in Chicago has yet been decided. The frequency of its repetition will be decided after the forthcoming Chicago exposition has been held.

Communication

Boiler Making in the Old Days and Now

TO THE EDITOR:

It has been about thirty years since I started to work in a boiler shop as a green apprentice boy. And how green I was. The life of an apprentice in those days was no snap. The boiler makers seemed to delight in thinking up tricks to play on the boys, and ways to make their lives miserable; such as having a boy soak rivets in water all night to soften them, or having him hunt a left-hand monkey wrench, or a square drill. But they also helped us to learn, and most of them were always glad to show a boy the "tricks of the trade," if he really wanted to learn.

The work was hard in those days. There were no cutting torches, welding torches, or electric welders. When we went to cut a patch out of a boiler, we did it with diamond point chisel and ripper. Of course we had air tools, but they were still new enough that all boiler makers had to be expert hand chippers and calkers, both right and left hand.

Hand chipping is becoming a lost art nowadays. It may be for the best, but one cannot help but sigh for a lost skill. We also had to be expert with the hack-saw, as that was our only way of cutting angles and all structural shapes. I have used a hack-saw continuously for ten days at a time.

I served my time in a mining district, in a fair sized shop, working about twenty men. We handled a great variety of work, in addition to building and repairing boilers. In those days a boiler maker had to be a good all around mechanic, and it seems to me that the general level of skill was much higher then than now. In fact, we do not seem to be developing any mechanics any more. Most men in modern shops seem to be satisfied to learn one or two operations, and go no farther. Most of them take no pride in skilled hand work, and without that no man has a right to call himself a mechanic. To refer to a man as a mechanic should be a mark of respect, as it once was, for it means a man who has applied himself earnestly to a trade, and mastered it to the best of his ability. Such men deserve respect.

Of course, under modern conditions, really skilled, all around men are not so badly needed, but there will never be a time when we can get along entirely without them.

I hardly ever call myself a boiler maker any more, as I have not done much boiler work in a good many years. Since the oil industry has grown to such large proportions, it has kept most plate shops busy. And by the way we say plate shop now instead of boiler shop.

Since the advent of electric welding, the trade has changed so much that, were some of the old-timers to come back, they would hardly recognize it. But it is a better trade than it used to be, in most ways, if a man is interested and wants to learn. Welding is so big a field that we can never learn too much about it.

In my opinion, most shops are making a mistake in not giving more effort to the training of their men to be better mechanics. There do not appear to be any layerouts coming up at all. I have been a shop foreman for a number of years, as well as a layerout, and have tried to get my men to learn laying out, but without much success. They just will not take the trouble and do the hard work necessary to learn it.

The methods of fitting up welded work are so different from riveted work, that there are few men who can do a good job of fitting up in reasonable time. Most of them can not work from a drawing at all, and unless constantly supervised, make mistakes one after another.

To be a good mechanic in a modern plate shop, a man should understand at least some of the principles of layout; he should be able to work from drawings, and should be at least a fairly good welder. Then if he has reasonable skill in handling tools, and will use his head just a little, he will be a valuable man.

Most employers and foremen do not seem willing or able to train such men. I have always considered that training to be a part of a foreman's job, and have always practiced it to the best of my ability. And I have trained some very good men.

You will often hear a foreman say that he cannot get his men to think, to pay attention to what they are doing. When he says that, he admits that he should not be a foreman. It takes some study, and quite a bit of practical psychology, but it can be done, and it pays big dividends in more and better work.

Another mistake is not studying men, and trying to fit the man to the job. Certain men seem to have a knack for certain operations, and to be weak on others. Put him on the thing he can do best, and maybe some day he can do other things well too.

However, the worst mistake of most foremen is in trying to do all the thinking, and not allowing their men to think for themselves. As long as you do that, most men will let you do all their thinking for them, and just work like machines. They can be made to think for themselves, if handled right. I have proved this over and over.

I suppose I am something of a crank on the subject of training men, but it is so important that I can not see why employers do not insist on it.

Old-time boiler makers were really fine mechanics, but they are about all gone. The trade has become more complicated and instead of developing better men to do the better grade of work now called for, most shops are trying to get along with a few college men at the top, and wooden men for the rest.

As for layerouts, there are none being made. More and more plants are trying to do the layout work in the drafting room. This works all right in some cases, but we will always need first class men in the shop, who can work from detailed drawings, or if necessary go out and take his own measurements, and make the work without any drawings other than his own sketches.

I have seen a draftsman spend a week making up drawings for a job, that a good layerout could have measured up, laid out and had ready to go in a day or so.

Another difference in modern shops from the old-time shops is in the personal relations between shop force and office. It used to be common for the "Old Man," to notice just what was going on in the shop, and if a man did a really good piece of work, to speak a few words of praise. And you can be sure, most men appreciate that. A little praise is sometimes worth more than money. But that too, seems a thing of the past. Instead nowadays the office watches with an eagle eye for the job that costs a little too much and they im-

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Reg. U. S. Pat. Off.

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BUSINESS MANAGER: Warner Lumbard.

Contents

mediately send the shop a sarcastic memorandum about it; whereas if a job is finished a little ahead of schedule, or by some redesign on the part of a shop man a little material or time is saved, that job is ignored by the management.

It is said that when a man begins to recall the good old times and bemoan the present conditions, he is getting old. Maybe I am although I have kept up with the modern methods and in years, I am still in early middle age.

I do, however, regret the passing of the fellowship of the old-time shop, when an employer liked and respected his men, because they were good skilled mechanics, and self respecting men. They in turn liked their boss because he was not too good to help out in a pinch. That is the main reason why men do not take interest and pride in their work any more. When you lose that human touch, you are trying to use the methods of the automobile factories, which want not men but automatons.

Our trade still requires too much skill to be handled by robots. We need skill, and are not developing it, and I am sorry to see that day.

Houston, Tex. W. R. STARKE.

Trade Publications

ELECTRODE HOLDERS.—The Lincoln Electric Company, Cleveland, O., has recently published a pamphlet describing in detail the type T electrode holder.

ELECTRIC WELDING.—The E. and M. Sales Company, Detroit, Mich., has prepared a pamphlet giving some of the details of the Weaver "Andarc" welder, a device which utilizes the best advantages of both alternating and direct currents.

KINNEAR DOORS.—The latest catalogue issued by the Kinnear Manufacturing Company, Columbus, O., builder of various types of rolling doors, for both domestic and industrial purposes, explains in detail the mechanical operation of these devices and gives a well illustrated discussion on their application.

INCO.—The Spring edition of "Inco" published by the International Nickel Company, Inc., New York, contains articles on the use of nickel alloys in the motor industry, various kinds of machinery, radium mining operations in northern Canada, oil-well drills, navigating equipment, etc.

ANNUAL REPORT.—The annual financial statement and balance sheet of the Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa., for the calendar year 1936, has been recently issued. In addition, information is also given on employes and payrolls, unfilled orders and inventories, and surveys of current trends.

PROCESS EQUIPMENT.—The Edge Moor Iron Works, Inc., New York and Edge Moor, Del., has published recently a new bulletin No. 103, illustrating the great variety of special fabricated processing equipment which has been made at the plant. The list includes acid plant equipment, agitators, ball or pebble mills, watertube boilers, condensers or heat exchangers, dryers, kettles, stills, towers, etc.

ALUMINUM RIVETING.—The Aluminum Company of America, Pittsburgh, Pa., has recently revised its booklet entitled "The Riveting of Aluminum and Its Alloys." Useful information on the design, dimensions and characteristics of various types of aluminum alloy rivets, plates and shapes is given, as well as a discussion of procedure to be used in riveting with various sizes and types of aluminum alloy rivets.

BENT-TUBE BOILERS.—The Combustion Engineering Company, Inc., New York, has just issued another of its series of equipment catalogues. This catalogue covers its extensive line of bent-tube boilers, many pages being devoted to cross-sections of typical installations of various types, in addition to descriptive matter, photographs of furnace and boiler details, and shop views showing the fabrication of high-pressure, fusion-welded drums.

Questions and Answers Pertaining to Boilers

This department is maintained for the purpose of helping those who desire assistance on boiler and plate fabricating problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless special permission is given to do so.

By George M. Davies

Railway Car Disinfestation

Q.—I have read with much interest the article "Arc-Welded Treating Tank" on page 343 of the December, 1935, issue of BOILER MAKER AND PLATE FABRICATOR, and in particular the statement "The gas, which is a mixture of ethylene oxide and carbon dioxide . . . kills all forms of infestation including the egg" attracted my attention. I should be very grateful if you could put me in touch with means of obtaining more information on this process. I am chiefly interested in disinfection of railway coaching stock, etc., though under atmospheric pressure and not in a vacuum. Disinfection by sulphur dioxide or formalin is not altogether satisfactory and does not destroy the eggs.—J. H. D.

A.—This question is somewhat outside the field of boiler making and plate fabrication. However, upon the receipt of your question, I wrote the Guardite Corporation, but to date they have not offered any solution to your problem.

You can obtain the information you desire by writing to Chemistry and Industry, Journal of the Society of Chemical Industry, Central House, Finsbury Square, London, England. The society conducted a series of experiments on this subject in the year 1935.

Intersecting Cone Development

Q.—In the February issue of BOILER MAKER AND PLATE FABRICATOR, on page 45, George M. Davies outlines the "Development of Intersecting Cones" as one of his very interesting series of practical plate developments.

In developing the pattern for the conical connection piece, Figs. 182 and 183, I think Mr. Davies has made a slight error.

Referring to Fig. 183, the points *bb°*, *cc°*, *dd°*, *ee°*, *ff°*, *gg°*, and *hh°* were located by using *P* as a center and drawing arcs, from *bb°*, *cc°*, etc., along the miter line in Fig. 177, until they intersect the radial lines in the development of the half pattern.

This should not have been done, in my opinion, because the lengths from point *P* to points *bb°*, *cc°*, etc., Figs. 177 and 182, are simply in the plane of the paper and are not true lengths on the surface of the cone.

Therefore, before the arcs can be drawn, the points *bb°*, *cc°*, etc., Fig. 177, must be projected to line *E-F*, Fig. 182, by straight lines drawn parallel with *G-F*, Fig. 182. After the intersections of these straight lines with line *E-F* have been determined, then by using *P* as a center, arcs can be drawn from these intersections to the radial lines in Fig. 183 in order to determine the shape of the half pattern.

This method was used by Mr. Davies in developing the hole in the large cone. In Fig. 177, instead of using point *O* as a center and drawing arcs from *bb°*, *cc°*, etc., to intersect radial lines in the development of the large cone, he first projected *bb°*, *cc°*, etc., by straight lines parallel with *A-B* and established *bb-*, *cc-*, etc., along line *A-D*.

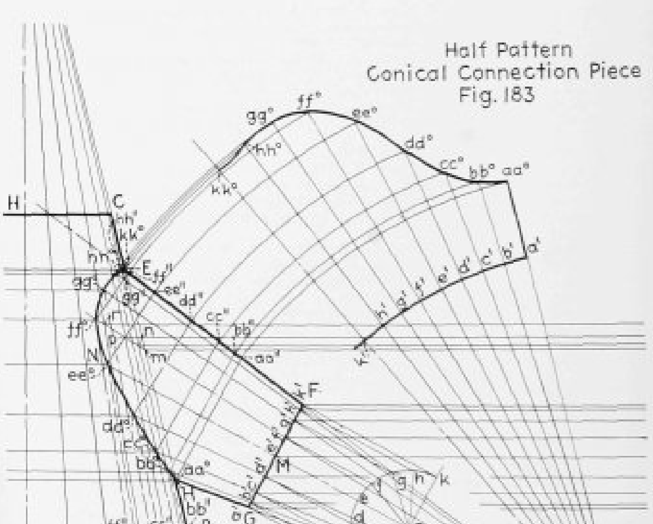
The lengths from point *O* to *bb-*, *cc-*, etc., are true lengths along the surface of the large cone and similar true lengths must be found on the surface of the small cone before arcs can be drawn into the development of the half pattern.—S. C.

A.—You are correct, there will be a slight discrepancy in the pattern due to the fact that the points *bb°* to *hh°* of the elevation, Fig. 177, were transferred to the pattern radially around the center *P* without first obtaining the true lengths of the surface lines *b'-bb°*, *c'-cc°*, *d'-dd°*, Fig. 177, as was done in developing the opening in the large cone.

The text for the development of "intersecting cones," "Practical Plate Development—XXI," page 48 of the February issue, should read as follows:

PATTERN OF THE CONICAL CONNECTION PIECE

Draw lines through the points *aa°*, *bb°*, *cc°* to *hh°* of the elevation, Fig. 177, perpendicular to the center line



Development of conical connection

N-S and extend them so as to cut the line *E-F* and locate the points *aa″*, *bb″*, *cc″* to *hh″*.

Then with *P* as a center and with *P-F* as a radius, scribe an arc as in Fig. 183. On this arc, step off the distances *a'-b'*, *b'-c'* to *h'-k'* equal to the distance *a-b*, *b-c* to *h-k* of the profile, Fig. 182. Then draw and extend the radial lines from the center *P* through the points *a'* to *k'*, Fig. 183.

With *P* as a center and with *P-aa″*, Fig. 177, as a radius, scribe an arc cutting the radial line *P-a'*, Fig. 183, locating the point *aa°*, Fig. 183. Then with *P* as a center and with $P\text{-}bb''$, Fig. 177, as a radius, scribe another arc cutting the radial line $P\text{-}b'$, Fig. 183, and locating the point $bb°$, Fig. 183. In like manner, locate the points $cc°$, $dd°$, $ee°$ to $kk°$, Fig. 183.

Connect these points with a line completing the half pattern of the conical connection piece. A duplicate of this pattern added on along the line $k'\text{-}kk°$ will give a complete pattern.

Electric Staybolt Tester

Q.—Can you send me a few details of an electric tester for staybolts, also any information (in detail on actual jobs, if possible) on smoke and dust prevention, sound absorption and control in boiler and other shops and on welding repairs of copper combustion chambers of boilers by the oxy-acetylene?—H. E. H.

A.—The electric staybolt tester is used on flexible staybolts having a tell-tale hole extending through the entire length of the body section and terminating within the head of the bolt. They are applied in exactly the same manner as the ordinary flexible bolt. If the method of riveting closes the end of the hole, it may easily and quickly be reopened as shown in Figs. 1 (*a*) and 1 (*b*).

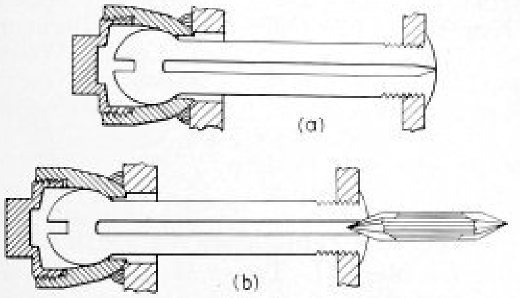


Fig. 1

Inspection of such bolts is accomplished by establishing electrical contact at the extreme inner end of the tell-tale hole by means of a tester consisting of a handle with batteries and electric bulb contained therein, and an

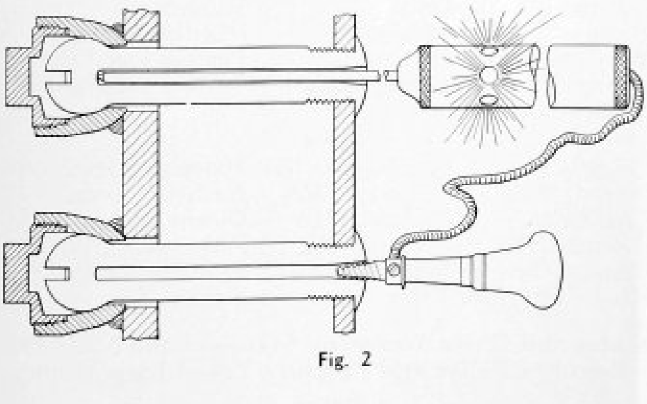


Fig. 2

indicating rod attached thereto as shown in Fig. 2; also a ground connection to the boiler which may be made to any nearby staybolt.

The indicating rod of the tester is inserted into the tell-tale hole of the bolt to be tested. As soon as the end of the indicating rod has reached the end of the tell-tale hole, the electric circuit is completed and is indicated by the flashing of the electric bulb in the tester handle. Thus, assurance is given that the tell-tale hole of the bolt tested is open its full length and properly functioning.

If the indicator rod of the tester is stopped before the light flashes, contact is not made with the end of the indicator rod and the end of the tell-tale hole. This will show that the hole is obstructed in some manner. In this event the hole must be cleaned out as shown in Fig. 3.

If the bolt is broken, it will appear in the hydrostatic test that is applied after the electrical contact has been made with all the bolts, and the tell-tale holes, being

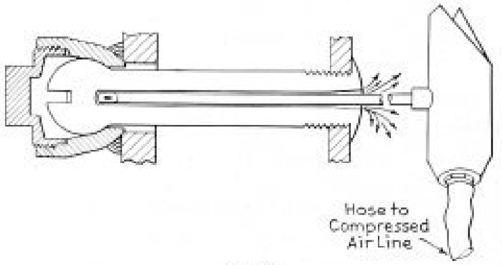


Fig. 3

clean, will immediately indicate a fracture by water leakage from any bolts which have failed.

The basis upon which this electrical contact has been developed is that staybolt breakage will be easily detected if the tell-tale holes are kept open and extend to every part of the bolt which can possibly break. A tell-tale hole, under this method, must extend from one end of the bolt into, but not through, the head at the other end, and, therefore, covers every breakable part of the bolt.

To insure clean tell-tale holes, a fireproof porous cement is used to seal the end of the tell-tale hole after the bolts are installed and riveted. If the tell-tale hole has been closed with the porous cement, no sediment, or any other obstruction can lodge in the tell-tale hole and prevent contact between the testing rod point and the end of the tell-tale hole. The porous cement is applied as shown in Fig. 4.

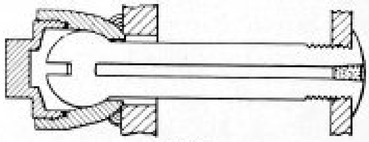


Fig. 4

The electric tester illustrated in Fig. 2 is made by the Flannery Bolt Company, Bridgeville, Pa., U. S. A.

I do not know of any books upon the subject of prevention of smoke and dust or on the control of and absorption of sound in boiler and other shops. Any information along this line would have to be obtained from the engineering departments of companies dealing in blowers, ventilating systems, and soundproof materials.

There are only a few copper fireboxes in use in the United States and for this reason there is but little information obtainable concerning the repair of copper combustion chambers of boilers by oxy-acetylene welding. Information on this subject may be available by writing the Oxweld Railroad Service Company, 30 East 42nd Street, New York, N. Y.

Locomotive Bureau Official—President Roosevelt has appointed Allyn C. Breed assistant chief inspector of the Bureau of Locomotive Inspection of the Interstate Commerce Commission and has sent his name to the Senate for confirmation. Mr. Breed, senior inspector in point of service, will succeed John A. Shirley who recently retired.

Associations

Bureau of Locomotive Inspection of the Interstate Commerce Commission

Chief Inspector—John M. Hall, Washington, D. C.
Assistant Chief Inspector—J. A. Shirley, Washington.
Assistant Chief Inspector—J. B. Brown, Washington.

Bureau of Navigation and Steamboat Inspection of the Department of Commerce

Director—Joseph B. Weaver, Washington, D. C.

American Uniform Boiler Law Society

Chairman of the Administrative Council—Charles E. Gorton, 95 Liberty Street, New York.

Boiler Code Committee of the American Society of Mechanical Engineers

Chairman—D. S. Jacobus, New York.
Acting Secretary—M. Jurist, 29 W. 39th Street, New York.

National Board of Boiler and Pressure Vessel Inspectors

Chairman—William H. Furman, Albany, N. Y.
Secretary-Treasurer—C. O. Myers, Commercial National Bank Building, Columbus, Ohio.
Vice-Chairman—F. A. Page, San Francisco, Cal.
Statistician—L. C. Peal, Nashville, Tenn.

International Brotherhood of Boiler Makers, Welders, Iron Ship Builders and Helpers of America

International President—J. A. Franklin, Suite 522, Brotherhood Block, Kansas City, Kansas.
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International Secretary-Treasurer—Wm. E. Walter, Suite 506, Brotherhood Block, Kansas City, Kansas.
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Vice-President: William N. Moore, general boiler foreman, Pere Marquette Railway.
Secretary-Treasurer: Albert F. Stiglmeier, general foreman boiler maker, New York Central System, West Albany Shop. Address, 29 Parkwood Street, Albany, N. Y.
Chairman Executive Board: William N. Moore.
Executive Board—Three Years: William N. Moore, general boiler foreman, Pere Marquette Railroad; Carl A. Harper, general boiler inspector, Cleveland, Cincinnati, Chicago & St. Louis Railroad; E. C. Umlauf, supervisor of boilers, Erie Railroad.
Executive Board—Two Years: M. V. Milton, chief boiler inspector, Canadian National Railway; Charles J. Kline, locomotive inspector, Interstate Commerce Commission; Sigurd Christopherson, supervisor of boiler inspection and maintenance, New York, New Haven & Hartford Railroad.
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Executive Committee (Three years): A. W. Strong, Jr., The Strong-Scott Manufacturing Company, Minneapolis, Minn. R. J. Bros, William Bros Boiler & Manufacturing Company, Minneapolis, Minn. E. R. Stone, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. (Two years): E. E. Knoblock, Union Iron Works, Erie, Pa. A. G. Weigel, Combustion Engineering Corporation, New York. J. F. Dillon, Jr., Struthers-Wells-Titusville Corporation, Warren, Pa. (One year): F. H. Daniels, Riley Stoker Corporation, Worcester, Mass. M. E. Finck, Murray Iron Works, Burlington, Ia. A. G. Pratt, Babcock & Wilcox Company, New York. (Ex-Officio): Starr H. Barnum, The Bigelow Company, New Haven, Conn. Walter F. Keenan, Jr., Foster Wheeler Corporation, New York.

OFFICE OF INDUSTRIAL RECOVERY COMMITTEE,
15 PARK ROW, NEW YORK

Manager—James D. Andrew.
Secretary—H. E. Aldrich.

Steel Plate Fabricators Association

President — Merle J. Trees, 37 West Van Buren Street, Chicago, Ill.

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

States

Arkansas	Missouri	Rhode Island
California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maine	Oklahoma	District of Columbia
Maryland	Oregon	Panama Canal Zone
Michigan	Pennsylvania	Territory of Hawaii
Minnesota		

Cities

Chicago, Ill.	Los Angeles, Cal.	Memphis, Tenn.
Detroit, Mich.	St. Joseph, Mo.	Nashville, Tenn.
Erie, Pa.	St. Louis, Mo.	Omaha, Neb.
Evanston, Ill.	Scranton, Pa.	Parkersburg, W. Va.
Houston, Tex.	Seattle, Wash.	Philadelphia, Pa.
Kansas City, Mo.	Tulsa, Okla.	Tampa, Fla.

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

States

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

Cities

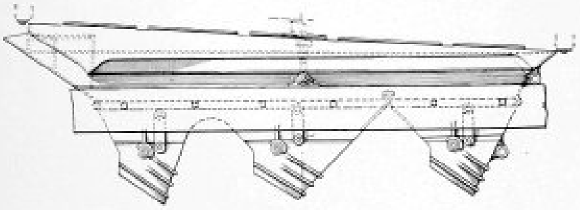
Chicago, Ill.	Memphis, Tenn.	St. Louis, Mo.
Detroit, Mich.	Nashville, Tenn.	Scranton, Pa.
Erie, Pa.	Omaha, Neb.	Seattle, Wash.
Kansas City, Mo.	Parkersburg, W. Va.	Tampa, Fla.
	Philadelphia, Pa.	

Selected Patents

Compiled by Dwight B. Galt, Patent lawyer, Earle Building, Washington, D. C. Readers desiring copies of patents or any information regarding patents or trade marks should correspond directly with Mr. Galt.

1,894,170. ASH PAN FOR LOCOMOTIVES. HARRY GLAENZER, OF PHILADELPHIA, PENNSYLVANIA.

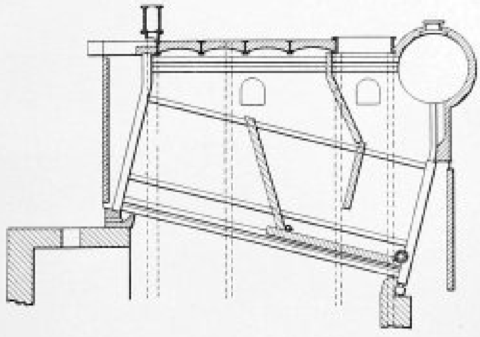
Claim.—The combination in a locomotive fire box, of an ash pan located under the fire box, said ash pan having a central hopper and side



inclined surfaces, and having side openings at the outer edges of said inclined surfaces whereby the ashes from the outer end sections of the side grates will be directed through the openings. Twelve claims.

1,894,297. BOILER CLEANER. NORMAN L. SNOW, OF NEW CANAAN, CONNECTICUT, AND WILLIS P. THOMAS, OF DETROIT, MICHIGAN, ASSIGNORS TO DIAMOND POWER SPECIALTY CORPORATION, OF DETROIT, MICHIGAN, A CORPORATION OF MICHIGAN.

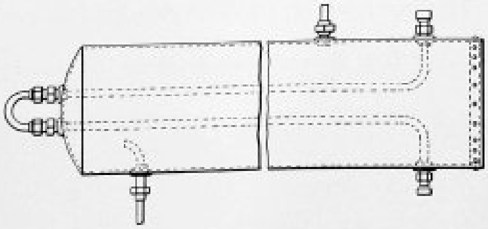
Claim.—In a boiler associated with a furnace, the combination with a plurality of boiler tubes and a baffle located in proximity to said tubes



for directing the furnace gases thereabout, of a hollow member mounted adjacent the baffle, a port in said member, means to diminish the pressure within said member, and means adapted to move toward the said port, deposits normally lying at a distance therefrom. Eleven claims.

1,920,598. HEATING COIL. WILLIAM H. SCHIRMER, HIBBING, MINN.

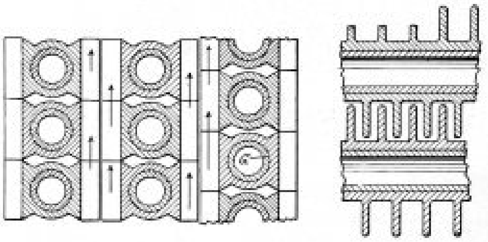
Claim.—A tank coil and sealing means therefor comprising a pipe having unthreaded end portions adapted to extend through and outwardly



of a tank wall, a flanged member adapted to be secured to a tank wall, a threaded sleeve loosely engaging about an end of the pipe and having external threads engaging said flanged member, a seat formed on the outer end of said sleeve, an annular threaded member having one portion thereof of greater diameter than another portion, said other portion loosely engaging about a second pipe, a material between said two portions constituting a second seat, and an annular member having oppositely tapered peripheral portions interposed between said two seats and the abutting ends of the pipes to spread said ends and hold said ends against the seats upon inward movement of said angular threaded member relative to the sleeve. One claim.

1,922,351. TUBE FOR BOILER ECONOMIZERS, HEAT EXCHANGERS, AND THE LIKE. ROGER STUART BROWN, CHICAGO, ILL.

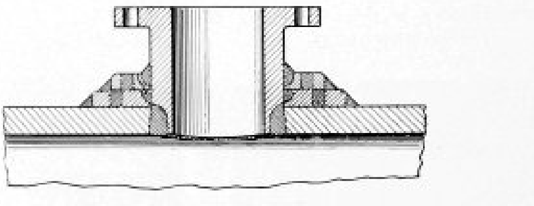
Claim.—A bank of tubes for heat exchangers and the like, each tube including an interior cylindrical tube, and a separately formed exterior



jacket tube positioned thereabout in heat conductive relationship therewith whose sides define passageways of approximately equal width at points along the line of gas travel between the banks of tubes, such measurement being normal to the surfaces. Eleven claims.

1,924,121. WELDED MANWAY FOR PRESSURE VESSELS. THOMAS McLEAN JASPER, MILWAUKEE, WIS., ASSIGNOR TO A. O. SMITH CORPORATION, MILWAUKEE, WIS., A CORPORATION OF NEW YORK.

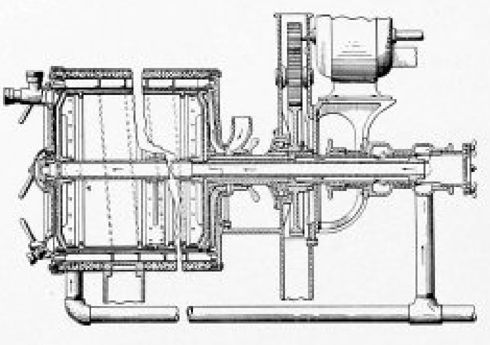
Claim.—In a pressure vessel having a manway neck, in combination, a manway disposed in the manway opening, the lower end of the manway being chamfered circumferentially to provide a welding groove between the wall defining the manway opening and the manway, a plurality of re-



enforcing plates having openings therethrough for receiving the manway, and holes for receiving plug welds, said reenforcing plates being superimposed on the vessel and one another, the superimposed plates being chamfered to form welding grooves with the manway, and weld metal deposited in the welding grooves and holes for securely attaching the manway to the vessel. Four claims.

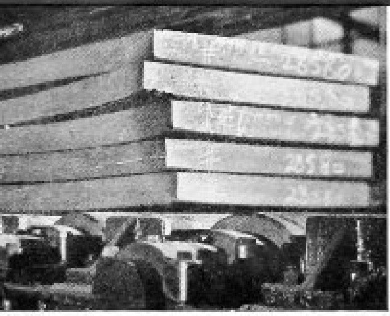
1,897,613. APPARATUS FOR TREATING LIQUIDS. AAGE JENSEN, OF LOS ANGELES, CALIFORNIA.

Claim.—In an apparatus for treating liquids, a stationary casing, a rotating drum spaced therefrom, the space between being adapted to receive liquid to be treated, passageways for a heat exchange medium

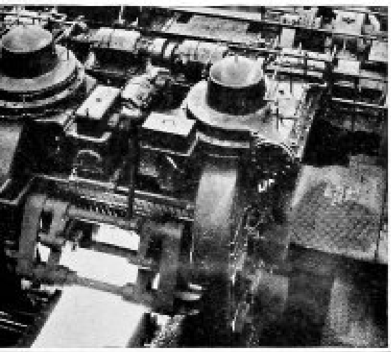


adjacent to the space through which the liquid undergoing treatment is passed, a cover plate through which the material undergoing treatment is discharged, and a joint between the cover plate and the surrounding casings, comprising a V-shaped ground seal. Nineteen claims.

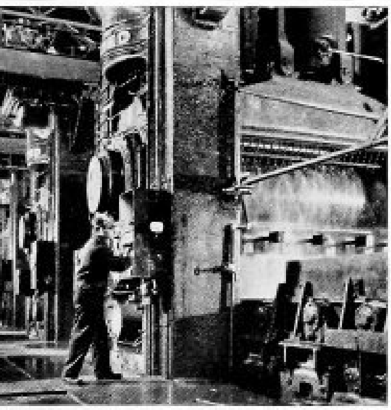
LAST WORD IN PLATE



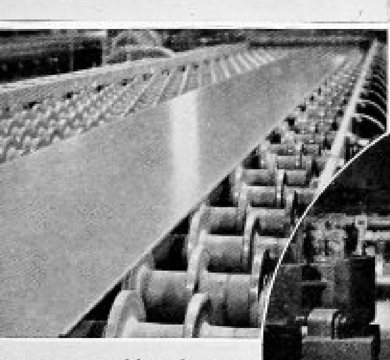
e magazine feeder saves space, time.



e most modern equipment gives the plates uniformity.

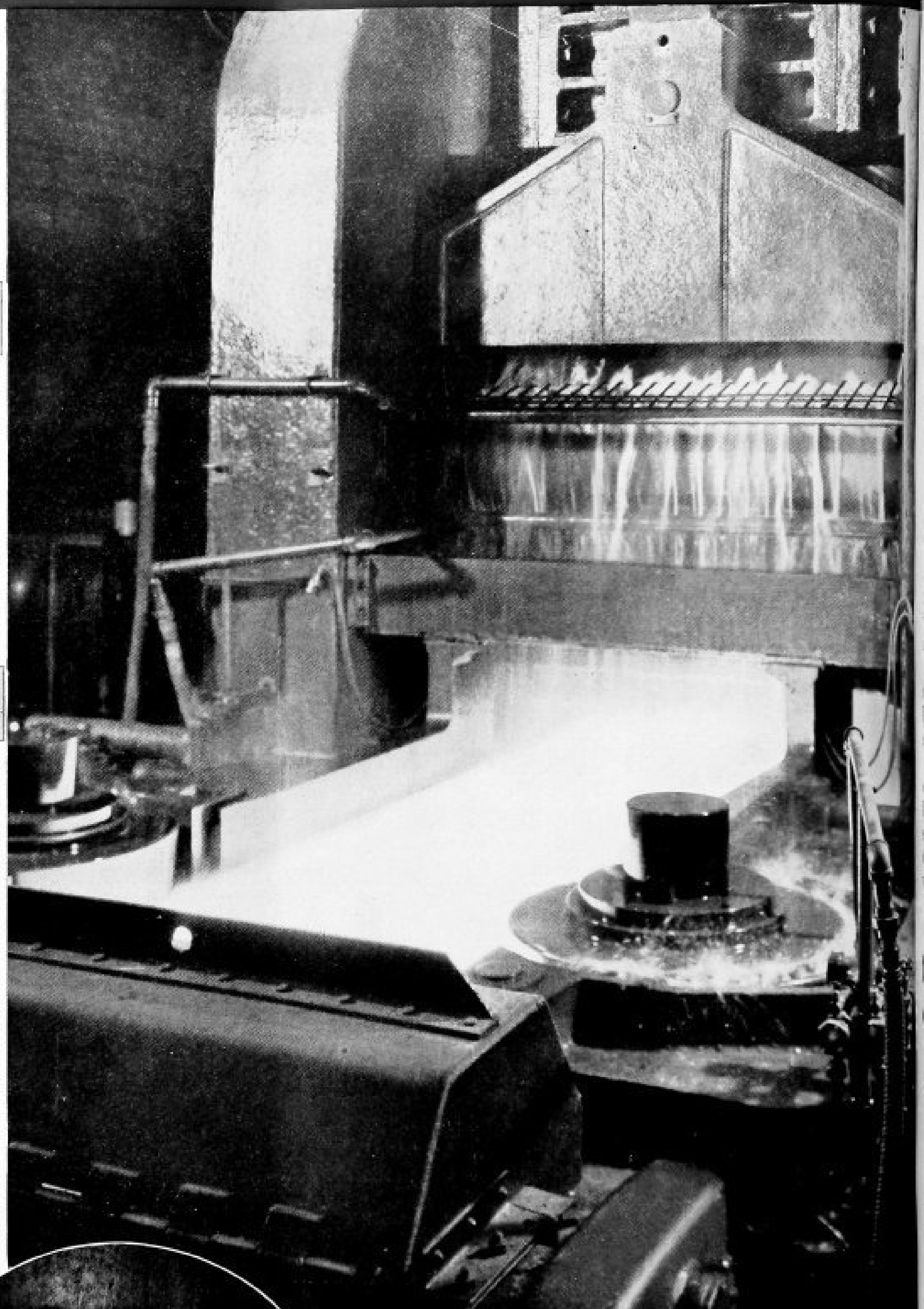


e Four High Finishing Stands give the plate its superior finish.



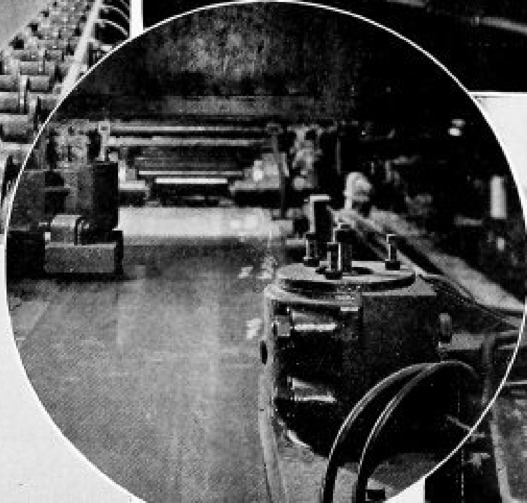
conveyor tables the plate cools off.

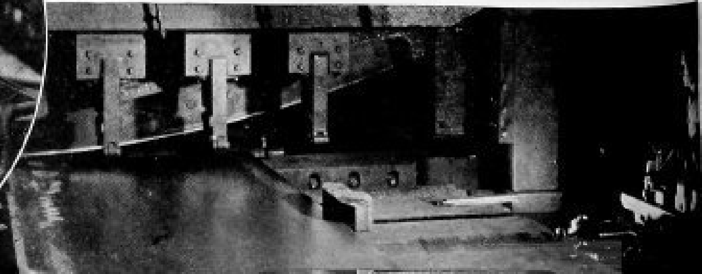
the right, electromagnets guiding a plate through the rotary shear.



These operators are craftsmen, worthy of the metal they work.

Below is a Carnegie-Illinois invention, the rocking shear, designed to eliminate shear bow.





Boiler Maker and Plate Fabricator

Shop Lighting

While the discussion of industrial shop lighting in this issue does not specifically refer to boiler shop or plate fabricating shop lighting, many of the principles outlined may to advantage be adopted by this industry. The average shop is not well lighted, in fact it is usually quite the reverse.

In most shops the problem is one of providing a general lighting system, both by natural daylight and artificial means. The space involved does not make the problem especially easy of solution since the sources of artificial light must of necessity be located at a considerable height above the working level. Then too, in the planning of older shops insufficient consideration was given to natural daylighting facilities so that a minimum of glazed areas was provided.

Where deficiencies exist in this direction natural light must be supplemented by sufficient artificial lighting to bring illumination at the working level up to an efficient standard under all conditions of weather.

These are simple suggestions but it is surprising how often even in the planning of a new shop they are overlooked or belittled. The efficiency and health of a shop staff depend to a considerable extent on the lighting facilities provided them. Production and quality of workmanship are definitely influenced by shop lighting.

National Board General Meeting

Following its policy of holding a general meeting in alternate years the National Board of Boiler and Pressure Vessel Inspectors has scheduled its eleventh meeting at the Hotel McAlpin, New York, on May 24 to 26. At the time of going to press the complete schedule of papers for the three-day sessions was not available. However, the list of papers to be presented by outstanding authorities from the inspection, insurance and pressure vessel construction field is one of the most comprehensive ever presented by any group connected with the industry.

As might be expected, welding is accorded a prominent place in the program. Unquestionably the ramifications of the subject will constitute a major part of the discussion. Published elsewhere in this issue, the subjects to be covered include practically the entire range of matters which are of concern not only to the inspectors making up the National Board but to every individual connected with the design, construction, repair or inspection of boilers and pressure vessels.

This industry is rapidly developing new types of vessels, increasingly greater in size, brought about largely by the broader design and construction possibilities of fusion welding. No more important forum is available for the dissemination of information on this and on all other phases of the developments taking place than that provided by the National Board at its general meeting. Not only for the chief inspectors who are members but for representatives from every branch of the industry, the meeting soon to be held will provide a clearing house for the many practical problems needing solution. In addition, the meeting will serve to co-ordinate the efforts of the inspection branch of the industry and promote that uniformity of pressure vessel requirements which is the primary function of the National Board.

Upswing Continues in Heavy Plate Field

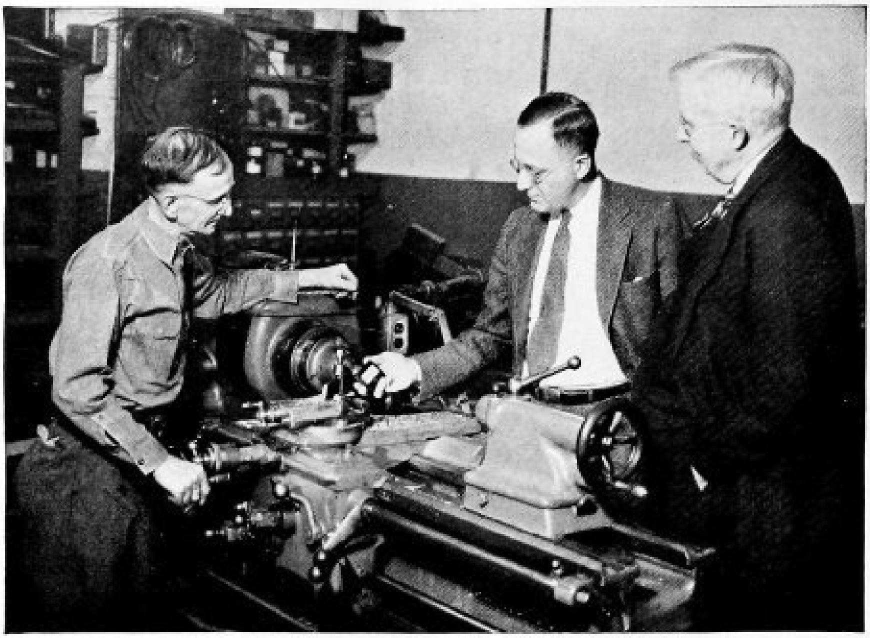
The increased demands of industry for fabricated steel plate as reflected in the reports of the Bureau of the Census, Department of Commerce, show every indication that present production may continue for some months. The principal outlets for heavy plate; namely, locomotive, ship, oil storage and refinery equipment, gas holder and blast furnace construction have all shown marked increases in the number of unfilled orders on hand.

From the last report on unfilled locomotive orders in the Boiler Maker and Plate Fabricator in the March issue, when unfilled orders for 90 steam locomotives were announced, 63 more have been placed on the list for construction, bringing the grand total of steam locomotives ordered in the first third of 1937 to 153. This is greatly in excess of the figures for the corresponding period of last year.

A study of new orders reported for fabricated steel plate reveals that a new peak of 68,890 tons since the depression was made in March. This figure when compared with the corresponding month of 1936 and 1935 shows that the heavy plate industry had on hand this year 126 percent more business than last year and 309 percent more than the year previous. In the first three months of this year, 139,663 tons of plate were purchased, as compared with 97,009 tons in the corresponding period of 1936 and 50,674 tons in 1935.

Closer analysis of the orders reported, reveals that oil storage tanks with a total of 50,096 tons, refinery material and equipment with 11,061 tons and miscellaneous unclassified outlets with 71,937 tons are absorbing the major portion of steel plate production. Gas holders and tank cars, while a source of some plate consumption, represent only a small portion of the whole and during the past three years have shown very little in the way of increased activity.

Consequently, the outlook for continued employment and business activity in the fabricating field continues bright despite indications of slight business recessions elsewhere. The replacement requirements of obsolete and worn-out equipment and facilities, deferred during the depression, alone should continue to sustain the industry for many months to come.



Using light meter to measure illumination level

Fundamentals of Industrial Shop Lighting*

Blindfold even the most skilled mechanic, and he is practically helpless. Any piece of work he attempts to do will doubtless be spoiled, and furthermore, he may injure himself or some other worker.

Workers in poorly lighted factories are, in effect, partially blindfolded. Many manufacturers who supply their employes with the best of tools and equipment fail to consider the importance of the workers' eyes and the handicap of poor lighting. The efficiency of the worker determines the efficiency of the machine, and adequate illumination is an essential factor both in high operating efficiency and preventing accidents.

It has been estimated that 15 to 25 percent of all industrial accidents are due to poor lighting. These percentages have been disputed because it is frequently difficult to determine the true cause of an accident from the report, and thus many injuries which might properly be traced to poor lighting are actually assigned to other causes. Conversely, accidents which were thought to have been caused by poor lighting may really have been due to ignorance, thoughtlessness, or some other cause. Nevertheless, many accidents are due wholly or in part to faulty illumination, and any improvements made in shop lighting are bound to result in fewer accidents.

Good lighting not only increases production efficiency and decreases the hazard of accidents but also has a great deal to do with the worker's health, comfort and happiness. Industrialists would do well to consider the fact that many workers, exposed to poor lighting conditions, have sufficiently defective eyesight to need glasses. Good lighting, therefore, is essential to minimize seeing weaknesses and to conserve man power.

Adequate daylight illumination, properly applied, is the ideal light. Diagonal light from above is generally better than from side windows only. Skylights and monitor windows should be provided wherever possible. Sawtooth roofs, with window areas facing the north, are usually less glaring than flat skylights if processes are arranged so that workers do not face window areas. Large window areas, equipped when necessary with awnings, window shades, or blinds, and diffusive or refractive glass, when not in the direct line of vision, together with light colored interiors, are desirable in every work place.

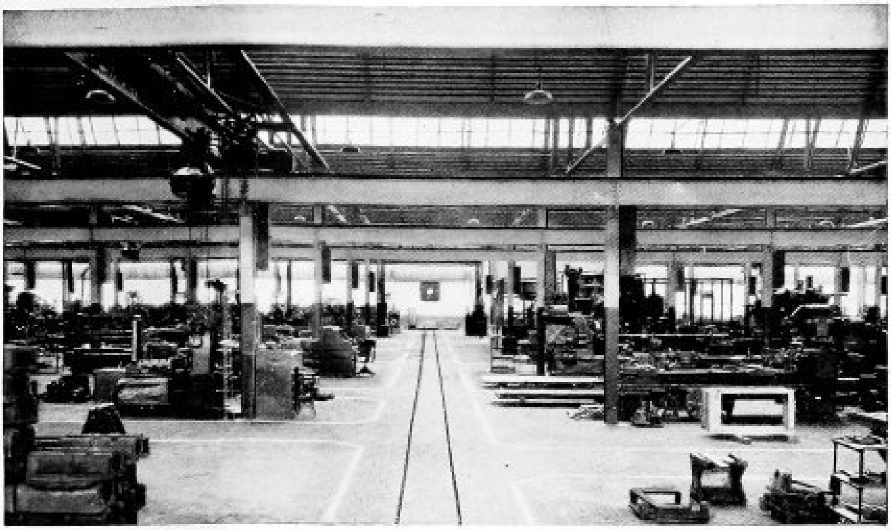
Requirements

(a) The light should be adequate for each employe, so that he can see clearly without fatigue or eyestrain. The illumination level measured in foot candles should be at least four times the minimum specified for artificial lighting. Natural lighting is frequently many times greater than this minimum. In fact, illumination of 100 foot candles or more is found near the windows in almost any shop.

(b) The skylights and windows should be so spaced and located that daylight conditions are fairly uniform over the working area. Poor lighting usually results if the ratio between floor and window area is greater than 6 to 1. In most modern daylight factories the ratio is between 5 to 1 and 3 to 1.

(c) To avoid glare from direct sunlight, diffusing glass, suitable shades or other means of obscuring the sun's direct rays should be installed where necessary.

* From information supplied by the National Safety Council, Chicago; full details are given in Safe Practices Pamphlet No. 22.



An example of carefully planned use of natural light. Note light colored interior to aid in general diffusion and elimination of dark areas

(d) The best skylight is useless if covered with dust. A periodical cleaning schedule is necessary.

Industrial plants one story in height and with large floor areas should be equipped with skylights properly designed and so located as to afford uniform distribution of daylight.

One of the most important things to consider in connection with vertical sash installations is the selection of glass that will reduce glare to a minimum and afford uniform distribution of natural light.

Considerable scientific work has been done in developing glass for industrial buildings. There are various types of glass for skylights of the single or double pitch design and for monitor and sawtooth skylights. To be most efficient, a glass designed for the specific type of construction should be employed. The same applies to vertical sash glazing. A type of glass should be used which will reduce glare without too great absorption of light. The ideal glass is one which reduces glare by complete diffusion.

The windows and skylights of factories and shops soon become covered with dirt and dust, and the natural light is often decreased below the level needed for safety and efficiency. Thus, regular window-cleaning should be a part of the routine of every establishment.

Artificial Lighting

Artificial light is required in factories and shops about 20 to 50 percent of the total working hours, not including overtime or night work. Where night work is carried on, the artificial lighting problem must receive added consideration. With the many improvements and developments in illumination it is possible to obtain satisfactory lighting in any industry with equipment that is economical, reliable and safe. The basic requirements are:

(a) Adequate illumination for every man in the shop.

(b) All lighting equipment selected and installed to avoid eyestrain.

(c) Lights placed so sharp shadows will be avoided on important parts of work and lamps equipped with reflecting and diffusing devices to soften shadows and avoid glare.

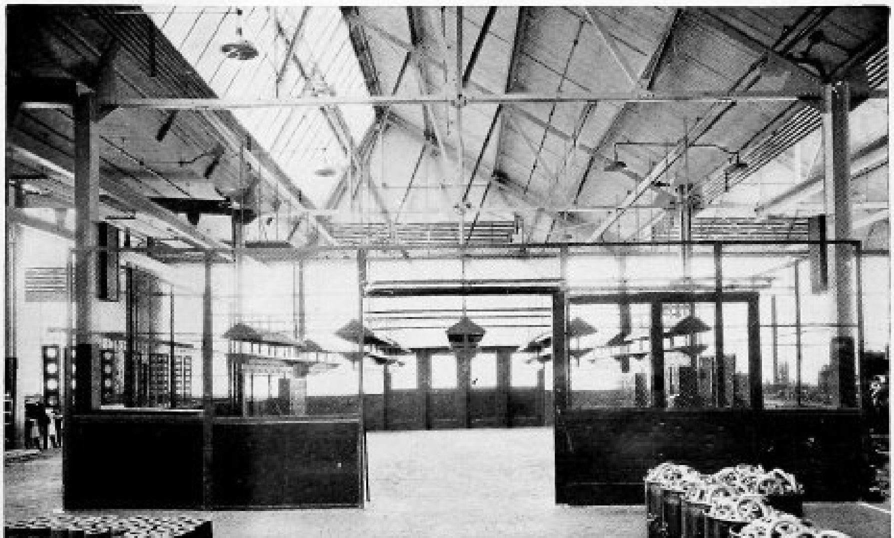
(d) An installation giving a general distribution of illumination throughout the area wherever possible, thereby avoiding the use of individual lights except where the severity of the visual task dictates their use.

The three systems of lighting used in industry are:

(a) Local lighting

(b) General lighting

(c) General lighting plus



Excellent natural lighting. Note even distribution of light from saw-tooth roof windows and side glassed areas to all points

Local Lighting. This system of lighting provides an individual light for each worker. It is the oldest variety, but it is rapidly being supplanted by general lighting. One of the chief reasons for this change is that though local lighting provides a seeming abundance of illumination on the work, it nevertheless leaves the surrounding areas in comparative darkness. Under such conditions the pupil of the eye must readjust itself every time the employe looks up from and back at his work. This increases eye strain as well as the hazard of accident.

General Lighting prevails where the entire area, instead of each individual job, is lighted to a satisfactory level. It eliminates areas of semi-darkness and increases eye comfort and worker efficiency.

General Lighting Plus is a combination of general lighting plus supplementary lighting. It is used in those locations where the severity of the visual task dictates a higher level of illumination than can economically be provided by the general lighting system alone. The supplementary lighting units may be located at or near the ceiling or on machines and so directed as to build up the illumination at the designated point.

There are at least 6 important factors that must be taken into consideration to secure the best results from any lighting system:

(a) Voltage
(b) Wiring
(c) Illumination level
(d) Reflectors
(e) Room conditions and maintenance
(f) Lamps

Most industrial lighting systems are designed to operate at either 110, 115, or 120 volts. In the past a considerable number operated at 200 to 260 volts but such systems have been so rapidly reduced in numbers that today less than 2 percent of the lamps sold are in this higher voltage classification.

While there are certain advantages in the use of higher voltage, the disadvantages are so great that one thoroughly familiar with them never hesitates when allowed a choice of the two systems. The higher voltage permits the use of smaller wires with a consequent lower initial cost of installation and under certain conditions loss of lamps by theft may be decreased.

Room Condition and Maintenance

Since the walls and ceiling receive a great amount of light from reflectors, it is important that these surfaces be finished in a light, flat color so that the illumination is diffused and re-reflected where it will reach the working areas in the shop. Dark colors such as deep greens, reds, or oak shades, absorb a large percentage of light. Where such finishes exist, faulty design of the lighting system is frequently and unjustly blamed for insufficient illumination.

To get most of the useful light from a system the surfaces above eye level should be covered with a good flat white paint. Avoid the use of high glosses or enamels, as they produce glare and eye strain. However, over a period of six or twelve months these white painted wall surfaces take on a coat of dust, smudge or grease, and ordinarily this layer will escape notice of a person daily occupied in the shop. As a result this coat of dust and dirt becomes a heavy absorber of light, and the reflecting characteristic of the white paint is materially reduced.

To renew the painted surfaces the walls should be washed with a sponge, using plenty of cold water and soft soap. Starting at the top and working downward, wash surfaces evenly and thoroughly to avoid streaking.

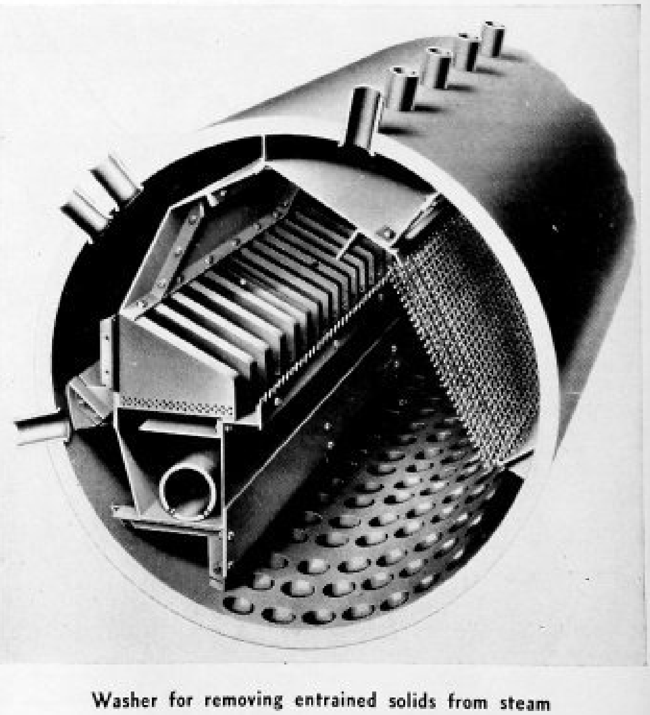
So many sizes and styles of lamps are available today that the selection of suitable ones for a given location is a matter of considerable importance. In general lamps should be selected for their efficiency, durability, and quality of illumination.

Combustion Engineering Develops Bubble Type Steam Washer

A steam washer has been developed by Combustion Engineering Company, Inc., New York, which functions on the principle of removing entrained solids from the steam by forcing it to bubble through clean feed water. This washer has been subjected to long and extensive tests under regular operating conditions in one of the large power stations, and as a result of the satisfactory performance a number of subsequent installations have been made.

Referring to the illustration, the feed water enters the trough at the lower left through the longitudinal perforated pipe and spills over the notched weir. Mounted over the trough are a series of compartments, or hoods, open at the bottom and left and having perforations near the bottom of the side walls. These hoods are joined together by plates at the left and over them is bolted a continuous plate which extends to the top of the drum. Thus the steam entering the drum through the tubes at the left is compelled to pass into the hoods and out through the apertures, and bubbles through the feed water, in which operation the entrained solids are removed. The actual washing of the steam is obtained not alone by bubbling through the water but also by the violent mixing of steam and water between the elements as created by the velocity of steam through the perforations. The construction is such as to prevent commingling of the feed water with the water in the drum.

The washer is so located as to leave space for ready access for cleaning without removing it from the drum. However, should it be desired for any reason to remove the washer this may be readily done in sections, as the parts are bolted together.



Washer for removing entrained solids from steam

Design of Thimble-Tube Boilers*

By E. F. Spanner

There are two distinct aspects of thimble-tube boiler design. The one is concerned with the problem of designing and arranging thimble-shaped watertubes so that they will most effectively obstruct a stream of hot gas and "comb" the heat from it. The other is concerned with the utilization of the heat abstracted from the stream of hot gas by the thimble tubes for steam-raising or water-heating purposes.

It is convenient to give first consideration to the second of these aspects.

It is some twelve years since the author was first associated with the late Thomas Clarkson in the development of thimble-tube boiler designs for service in waste-heat recovery on board ship. At that time Clarkson was demonstrating the "impulsive generation" of steam with an apparatus which was exhibited—when the author first saw it—at the Shipping, Engineering, and Machinery Exhibition at Olympia in 1925.

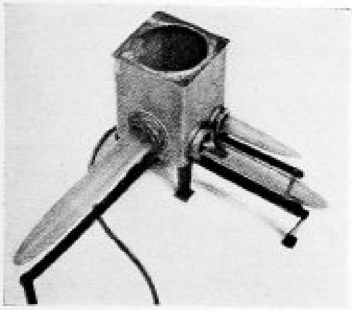


Fig. 1.—Experimental apparatus used on impulsive steam generation

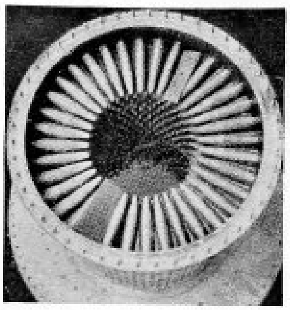


Fig. 2—Interior of tube nest showing spiral plate

This apparatus undoubtedly demonstrated the existence of the phenomenon of impulsive generation of steam, and, since that time, there has been widespread acceptance and persistent advancement of the claim that such a type of steam generation is a characteristic feature of the operation of thimble-tube boilers for steam raising. Further, that this feature is one of vital importance, since it renders thimble tubes immune from scale formation.

During the past twelve years a large number of boilers have been marketed on these claims, and it has only been recently that, as the result of fresh investigation and research, results and data have been accumulated which indicate that the impulsive generation of steam plays little or no part in the practical operation of thimble-tube boilers.

The apparatus with which the author's recent experiments were carried out is shown in Fig. 1. It consisted of a heavy tin vessel fitted to take glass tubes having their open ends sealed into circular holes, so arranged that free access was provided for water from the vessel into each of the thimble tubes. Underneath and along the length of each thimble tube a gas pipe line was fitted pierced with a series of holes. A gas and air supply was led to each pipe line, the burners and orifices being adjusted so that a series of bunsen flames was obtained all along the length of the tube. Portable screening devices enabled different sections of these burners to be cut off.

For the author's tapered-tube experiments three sizes of tubes were used.

One 7 inches long with a 1¼-inch base diameter, a ¾-inch point diameter, and 3 inches of taper.

One 11 inches long with a 1½-inch base diameter, a ¾-inch point diameter, and 3½ inches of taper.

One 14 inches long with a 2-inch base diameter, a 1-inch point diameter, and 4½ inches of taper.

The objective of the experiments was to reproduce the phenomena demonstrated by Clarkson, and to supplement the results he obtained by determining the effect upon the impulsive generation of steam in a thimble tube of:

(1) The rate at which heat was transferred to the thimble tube as a whole.

(2) The comparative rate of transmission of heat to the thimble tube from point to point along its length.

(3) The taper of the thimble tube.

(4) The diameter of the point of the thimble tube.

(5) The base diameter of the thimble tube.

(6) The total length of the thimble tube.

A series of qualitative experiments carried out in three stages enables the following results to be placed on record.

(1) It was established that impulsive generation of steam in a thimble tube held with axis horizontal does not start until water entering the tube is practically at steam temperature. While the temperature of the water is being raised prior to the beginning of steam generation there is a constant flow of water into and out from the thimble tube, due to the effect of the taper.

After steam temperature has been reached, steam begins to form along the whole length of the tube, bubbles detaching themselves and drifting out from the open end in a persistent but irregular fashion. Gradually the point at which bubble formation first shows itself moves towards the closed end of the tube until a stage is reached when there is practically a concentration of steam generation towards the point of the tube. A kind of surging wave profile then appears in the water-level along the tube, and, finally, "impulsive generation" starts, practically clearing the tube of water at each impulse.

If, now, the rate of application of heat to the tube is reduced, impulsive generation ceases, and is replaced by steam formation all along the length of the tube. A high rate of heat transfer is necessary to maintain impulsive steam generation.

(2) It is possible to stimulate the impulsive generation of steam to a marked degree by concentrating heat towards the point. Alternatively, it is possible entirely to prevent the impulsive generation of steam by giving little heat to the tube point.

(3) Taper is essential in thimble-tube boilers of annular form for purely geometrical and constructional reasons.

Taper encourages impulsive steam generation, but is not essential to the presence of this phenomenon. Impulsive generation of steam can easily be produced in a closed tube of parallel profile.

(4) Impulsive generation of steam is facilitated by decrease of point diameter.

* Abstract of paper presented at the Spring Meetings of the Seventy-eighth Session of the Institution of Naval Architects, March 18, London.

(5) Small tubes greatly improve the prospects of securing impulsive generation of steam. Increase in the ratio "heating surface/water content" results from the use of small tubes, and this is obviously of advantage in thimble-tube boilers. With the apparatus shown in Fig. 1 it was impossible to produce impulsive generation in the largest tube of 2 inches diameter.

(6) If there is impulsive generation at the point of the thimble tube the length factor is of little account. An experimental thimble tube has produced spasmodic impulses up to a length/diameter ratio of about 7, which ratio could certainly have been much increased without the conditions breaking down.

Briefly, these experiments confirmed Clarkson's experiments with small tubes, and provided data indicating that the difference in tube profile introduced by the author was helpful towards securing impulsive steam generation. The results suggested serious doubt, however, as to the practical possibility of creating impulsive generation conditions in large tubes, or in small tubes working at pressures appreciably above atmospheric pressure. It was not practicable to explore the matter quantitatively by means of the apparatus available, and recourse was therefore made to mathematical investigation of the conditions necessary to support the idea of impulsive generation.

It was assumed that, at each impulse, the amount of steam generated in the tube must at least be sufficient entirely to expel the whole of the water in the tube. On this basis is proved a simple matter to establish by calculation the possibility of securing impulsive steam generation in a small tube 1 inch in diameter and 6 inches long at atmospheric pressure, and at rates of heat transfer well within the region of practical achievement.

On the chosen assumptions, if the diameter of the tube is doubled and the length of the tube is allowed to remain unaltered, the rate of heat transfer per square foot of heating surface must be doubled in order to secure impulsive steam generation. If the length of the tube is doubled, and it be assumed that the steam-raising effect of that half of the tube nearest the open end is of practically no value for securing impulsive generation, it can be shown that the rate of heat transfer per square foot of tube surface must be increased to approximately four times the first figure to secure impulsive generation at the same rate.

That Clarkson himself was aware of the limitations of the claims made for impulsive generation, and that he had experienced the formation of scale in the thimble tubes of his boilers, is evidenced by the fact that, in all the designs for which he was personally responsible, he maintained a vertical baffle plate in the water space. The purpose of this baffle was twofold:

(1) To insure that water did not enter the thimble tubes until it was at steam temperature, thus reducing the tendency to form scale in the thimble tubes.

(2) To promote conditions which would permit the water to lie quiescent in the tubes while picking up latent heat, thus encouraging the impulsive generation of steam in the thimble tubes.

Any admission of water below steam temperature upsets the quiescent state in the thimble tubes and militates against impulsive generation.

In spiral flow waste heat and direct-fired boiler designs such chances as there are of securing impulsive generation are catered for, as far as is possible, by careful selection of tube diameters and tube profiles, and by special design and arrangement of the combustion chamber. The largest tubes used in spiral-flow boilers have a base diameter of only 2½ inches, and a point diameter of 1½ inches, while, wherever possible, smaller tubes are used of 2-inch and 1½-inch diameter with points of diameter of 1 inch and ¾ inch respectively. Further, as will be noted from the illustration of a tube nest, Fig. 2, great care is taken to insure that there shall be intensified scrubbing of the hot gases along the tapered thimble-tube points.

As for the combustion chambers in spiral flow boilers the lack of an intermediate water baffle, as rightly insisted upon by Clarkson, is compensated for by the provision of an ample area of radiant heating surface extending well below the level of the lowest row of thimble tubes. Sufficient of this plain surface is provided to account for roughly 60 percent of the total evaporation, and to insure that all the water at and above the lowest line of thimble tubes shall be at steam temperature, feed being admitted at the bottom of the boilers.

As a result of these improvements direct-fired boilers to the author's designs are especially suitable for steam-raising, using indifferent and even hard and dirty waters. Deposit comes down where it can best be dealt with, and there is little or no possibility of burning out the thimble tubes.

It should be pointed out that the tube profiles chosen by the author greatly assist the maintenance of a high rate of heat transfer in simple water heaters. In such heaters it is of the first importance that water should be induced to flow into the tubes, from the main annular body of water, in order to preserve a large temperature differential between the water and the heating medium. This flow is set up very strongly by the well-tapered point profiles adopted by the author, with the result that excellent results have been obtained in practice with coal-fired, coke-fired, and gas-fired water-heating units of spiral-flow design.

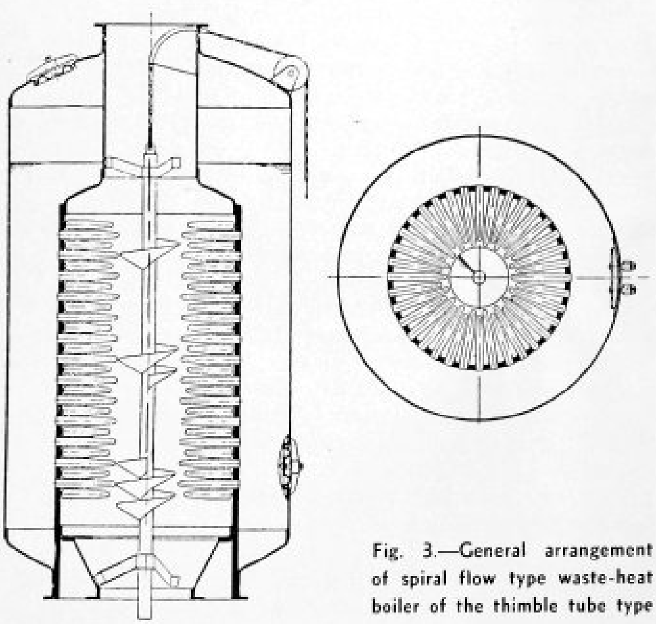


Fig. 3.—General arrangement of spiral flow type waste-heat boiler of the thimble tube type

Practical Design

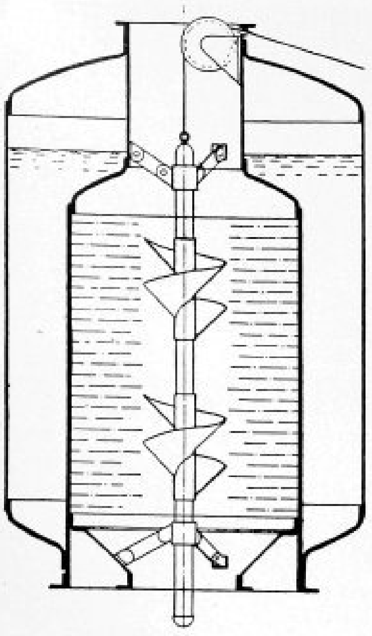
Strength, Size, and Weight.—The author's waste-heat boiler proposals provide for:

(1) The use of tubes of small base diameter having straight sections of varying lengths and closed ends sharing a common tapered profile.

(2) The obtaining of progressive proportioning with a tube plate drilled in a regular manner, either by variation of the intermediate tube lengths or by the use of spiral divisional plates, and

(3) The securing of close scrubbing of the gases along the tapered part of the tube points.

Spiral-flow boilers also have the further advantages:



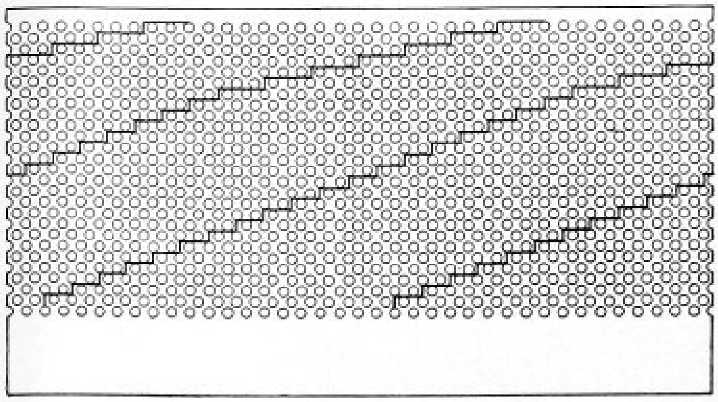


Fig. 4.—Section and plan showing spiral divisional plates

(4) That on a given tube plate diameter a larger area of heating surface can be provided by one row of thimbles in a tube nest according to the author's design than would otherwise be possible.

(5) That as a direct consequence a single row of tubes in a spiral-flow boiler can provide a given area of thimble-tube surface on a smaller diameter than would otherwise be possible.

(6) That since these advantages are secured by using tubes having comparatively small base diameters and specially profiled points, it follows that while preserving the same standard of tube strength and the same facilities for access and cleaning, it is possible to secure an efficient tube nest with a vertical height in a spiral-flow boiler very much less than is necessary in an ordinary thimble-tube boiler using tubes of greater base diameter.

In general, compared with other designs, spiral-flow waste-heat boilers permit of a greater area of heating surface being contained within a given volume, with improvement in accessibility and first cost. It should also be carefully noted that since spiral-flow boilers are designed to use small tubes, the total heating surface required in a spiral-flow boiler is less than that necessary in a boiler using larger tubes, thus tending to further economy.

The foregoing points are largely matters of simple geometry. They can easily be checked by setting out various tube nests—an exercise which brings home, very directly, the great importance attaching to matters apparently elementary in design.

The author's designs of direct-fired thimble-tube boilers provide two distinctive constructional features:

(1) An annular, water-jacketed, combustion chamber, the furnace plate of which leads upwards into a thimble-tube nest, and downwards to form a supporting skirt, and

(2) Variations in the diametral dimensions of the furnace and tube plate producing strategically disposed, circumferential stiffening enabling the furnace tube plate scantlings to be kept down to very moderate dimensions. These points are additional to the advantages resulting from the use of a spiral-flow tube nest for combing the heat from the gaseous products of combustion.

Various practical designs of spiral-flow waste-heat boilers can now be considered.

Straight-through Boilers.—The simplest design is that shown in Fig. 3. This is a straight-through boiler progressively proportioned to maintain an efficient heat recovery rate for the whole length of the tube nest, and arranged so that access to the tube nest is by means of the spiral deflector control gear.

Spiral-flow Boilers.—Illustrated in Fig. 4 is another design generally similar to that in Fig. 3, save that, owing to the introduction of spiral divisional plates, the control effect of the central deflector is greatly increased, the extent to which the passage of the gases through the boiler may be facilitated by movement of the deflector being very much greater in Fig. 4 than in Fig. 3.

Dry-bottom Boilers.—A typical dry-bottom design is shown diagrammatically in Fig 5. In boilers of this type the water-space is of entirely annular form, so that strength and convenience of overhaul are secured on minimum weight and dimensions. This type of unit is capable of proving extremely useful in the layouts of large marine Diesel installations in which opportunity can be taken to bring the gas to the boiler from two separate sets of cylinders in one engine. Tangential entry assists turbulent flow, and minimizes loss in back pressure. Further, this boiler is exceptionally useful for engines required to run under conditions necessitating that the gas side of the thimble-tube nest should be freely capable of inspection and cleaning.

Alternative Purpose Boilers.—The necessity of meeting steam requirements in port led to the production of a design of boiler suitable for running on waste heat while at sea, and capable of giving any required output of steam under oil-firing in port. A design meeting these

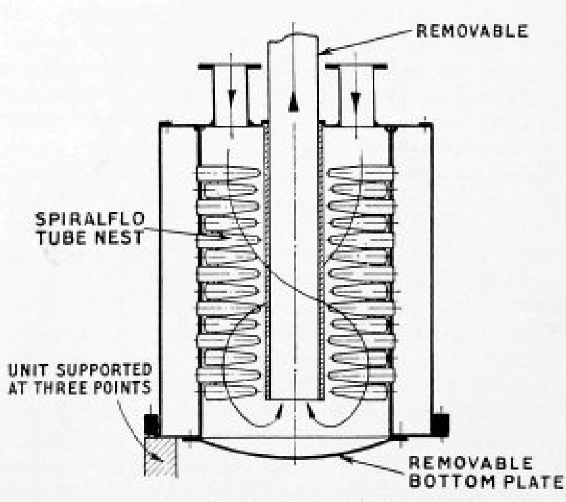


Fig. 5.—Dry bottom design

requirements is shown in Fig. 6. Attention is drawn to the arrangement of the lower part of the boiler. This "Atlas" design, as it has been christened, has the following important features:

(1) It requires extremely simple brickwork.

(2) The water-space is exceptionally well arranged, and insures that the thimble tubes shall only receive water

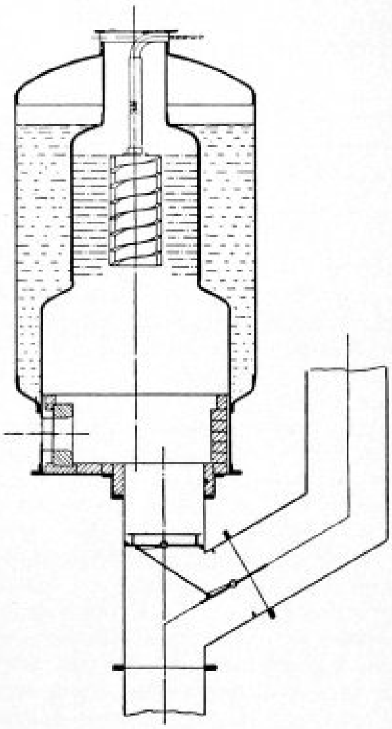


Fig. 6.—Alternative purpose boiler

at an already high temperature. This is a very important point in contributing towards scale-free operation, as already explained.

(3) The furnace volume provided is very large, and insures that combustion shall be complete before the lowest rows of thimble tubes are reached. Fear of thimble tubes being burned out is thereby entirely eliminated.

(4) The design is excellent from the strength point of view, the two circumferential lines of stiffness afforded by the upper and lower inner crowns, together with the line of support afforded by the outer lower crown enabling the tube-plate and furnace-plate scantlings to be kept down to very moderate figures. It is advantageous also that the lower crown plate is convex outwards instead of inwards.

Multiflow Units.—In many large vessels, apart altogether from the main machinery, numbers of Diesel-driven auxiliaries are fitted from all of which there is a constant loss of useful heat in their exhausts In the past it has been an extremely difficult matter to secure heat recovery from these auxiliaries for the simple reason that an individual heat-recovery unit was required on each engine with a full equipment of steam mountings, the total cost putting the proposition out of court on the score of expense. The introduction of multiflow spiral flow drowned units has entirely changed this position, it being possible, now, to bring several engine exhausts to one such unit, provide them with independent passages through the spiral-flow tube nest, thus obtaining the steam-raising values of the several streams of exhaust gas while occupying a minimum of space and involving a minimum of cost. These units are very light in weight, conveniently installed, and are so relatively inexpensive in first cost and maintenance that there is every argument in favor of their extensive adoption. Fig. 7 shows such a multiflow steam boiler.

The paper goes on to describe additional types of thimble-tube, waste-heat boilers including the calorifier, oyster type and watertube type.

When designing a thimble-tube boiler for direct firing, factors enter into the problem which do not arise in the case of simple waste-heat boiler designs. These may conveniently be tabulated as follows:

(1) Firing arrangements for solid, liquid, or gaseous fuels must be simple and easily operated.

(2) Sufficient floor area and volume must be provided in the fire-space for the proper combustion of the fuel, and controls provided for insuring admission of the correct amount of air.

(3) Water-cooled furnace surface must be arranged around the combustion-space so that the maximum possible amount of heat will be transferred to the water by direct radiation from the incandescent fuel and high temperature furnace gases.

(4) The lowest rows of thimble tubes must be sufficiently far above the center line of the burners, or, alternatively, above the surface of the bed of coal or coke fuel, to obviate all danger of these tubes being burnt, although scale may be deposited in them. This is a very important point when bad water conditions have to be provided against.

(5) The thimble-tube nest provided for combing the heat from the gaseous products of combustion must be adequate for this duty, and must be carefully propor-

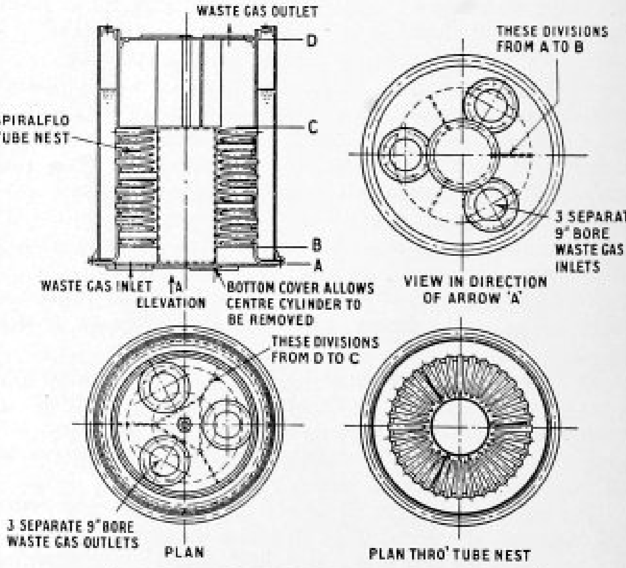


Fig. 7.—Multiflow unit arranged to take separate discharges from three engines

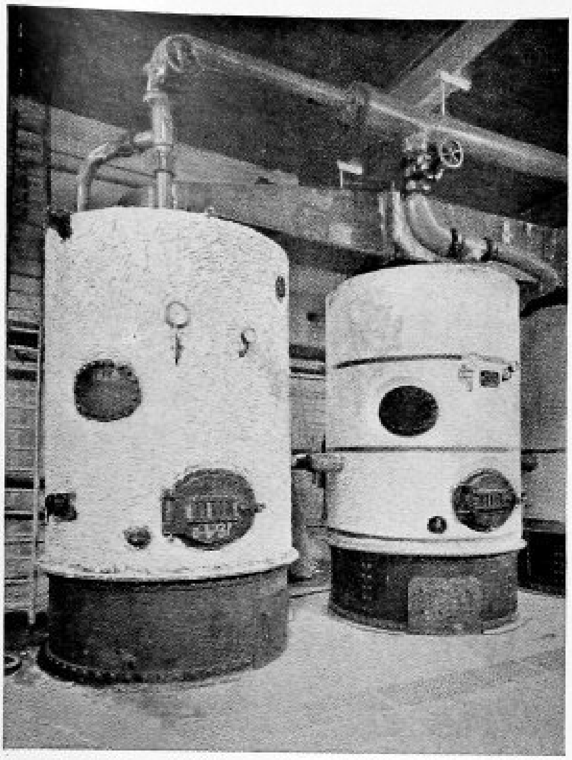


Fig. 8.—Battery of three coke-fired central heating boilers burning 16 pounds of coke per square foot of grate area; efficiency 85 percent

tioned to provide good "scrubbing" towards its upper end. It is merely wasteful to multiply thimble-tube heating surface without maintaining good forced convection conditions by gradually restricting the clear area available for the gas flow.

Fig. 8, shows a battery of three spiral-flow water heaters originally designed for coal, but running very successfully on coke.

The work which has been done during the past two years or so in the improvement of thimble-tube waste-heat boilers and water heaters, and in the invention of new designs of direct-fired thimble-tube boilers, makes it possible to offer hope of considerable saving in weight, space, and cost in waste-heat recovery and auxiliary boiler installations. Old standards of size, weight, and cost have been entirely superseded. A well-designed spiral-flow waste-heat unit can generally be relied upon to recover its cost in little over a year, even in an unpromising case.

Ingersoll-Rand Announces Small Compressors

Ingersoll-Rand Company, New York, has announced a new line of fractional horsepower air compressors. These units are made in ¼ and ½-horsepower sizes, and are very compact and neat in appearance. They have automatic start and stop control, are equipped with a new style seamless steel tank, and an improved check valve.

When furnished for single phase current they are equipped with a brushless capacitor type motor and a built-in automatic protection switch giving underload and over-voltage protection. They are rated for 150 pounds per square inch maximum pressure, but may be set for lower pressures, or may be equipped with a reducing valve for still lower pressures.

The ¼ and ½-horsepower units are available on a 2.4-cubic foot tank. This unit is less than 35 inches high. The ½-horsepower size is also available on a 4.6-cubic foot tank in either vertical or horizontal mounting.

National Board to Meet at New York, May 24

The Eleventh General Meeting of the National Board of Boiler and Pressure Vessel Inspectors will be held at the Hotel McAlpin, New York, N. Y., May 24 to 26. This Board was organized in 1919 for the purpose of securing uniform approval of specific designs of boilers and pressure vessels through the adoption by various states and cities of one code of rules and of one standard stamp to be placed on boilers and pressure vessels constructed in accordance with such rules.

There will be morning and afternoon sessions on each of the three days. All of the sessions will be open to those interested; registration will be required but there will be no charge therefor.

Major changes in the construction and design of boilers and pressure vessels are being made, together with the development of new materials contemplated in their construction and these changes and new materials are the basis on which the program for this meeting has been developed. The subjects to be discussed are of utmost importance and interest to engineers, manufacturers and operators of these vessels and the papers will be presented by foremost authorities on the various subjects. A partial list of these subjects follows:

Welding Problems in Connection with High Tensile Strength Low Alloy Steel.

Use of Non-Ferrous Alloys in the Construction of Pressure Vessels.

Use of Ferrous Alloys in the Construction of Pressure Vessels.

Latest Developments of Steam Generating Plants.

Design and Testing of Safety Valves.

Welding of Power Plant Piping.

The Non-Destructive Inspection of Welded Pressure Vessels.

Developments of Forced Circulation Boilers.

Water Problems in High-Pressure Boilers.

Welding of High Strength Copper Alloys.

Operating Problems of Modern Large Steam Generating Units.

General Problems in the Repair by Welding of Boilers, Pressure Vessels and Pipe Lines.

General Problems of Welding in Light of Today's Experience.

Welding of Alloys.

Necessity of Maintaining High Standards for Welded Vessels.

Safe Operation of Low-Pressure Steam Boilers and Hot Water Vessels.

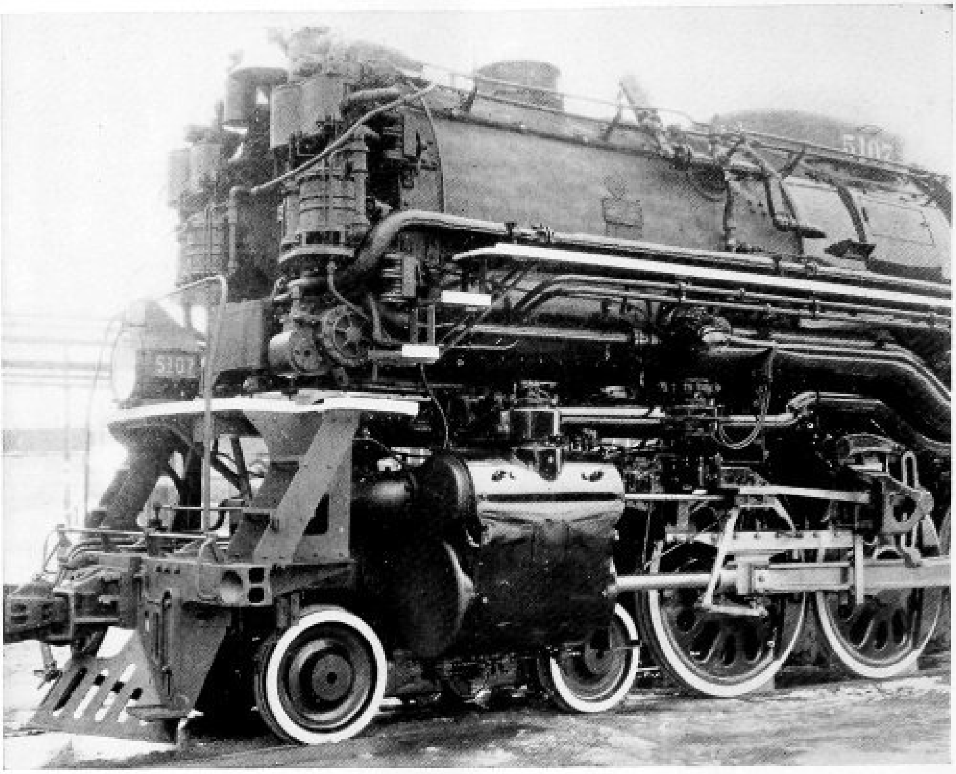
Avoidance of Furnace Explosions.

A Special Committee has prepared an exhibit which will be of great interest, showing among other things:

Examples of Sound and Defective Welding.

Examples of Failures Experienced in Operation.

Examples of New Construction and Design of Boilers and Pressure Vessels.



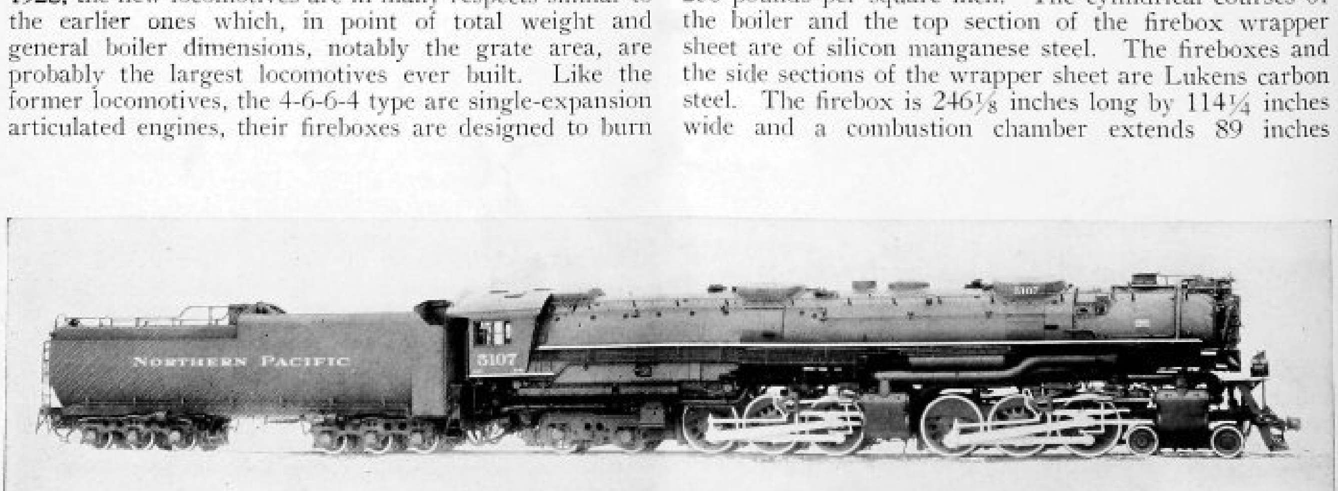
Front end of Northern Pacific 4-6-6-4 type locomotive

Northern Pacific places in operation

High-Speed Freight Locomotives

At the end of last year the Northern Pacific received from the American Locomotive Company twelve 4-6-6-4 type articulated locomotives for high-speed freight service. While of somewhat smaller capacity than the 2-8-8-4 type locomotives, the first of which was built in 1928, the new locomotives are in many respects similar to the earlier ones which, in point of total weight and general boiler dimensions, notably the grate area, are probably the largest locomotives ever built. Like the former locomotives, the 4-6-6-4 type are single-expansion articulated engines, their fireboxes are designed to burn Rosebud coal on grates of unusual size, and the steam-pipe connections to the front and rear cylinders are similar.

The boiler of the 4-6-6-4 locomotive is of the straight-top radial-stay type and carries a working pressure of 250 pounds per square inch. The cylindrical courses of the boiler and the top section of the firebox wrapper sheet are of silicon manganese steel. The fireboxes and the side sections of the wrapper sheet are Lukens carbon steel. The firebox is 246⅛ inches long by 114¼ inches wide and a combustion chamber extends 89 inches



The Northern Pacific high-speed freight locomotive

Comparison of the General Dimensions of the Northern Pacific 4-6-6-4 and 2-8-8-4 Type Freight Locomotives

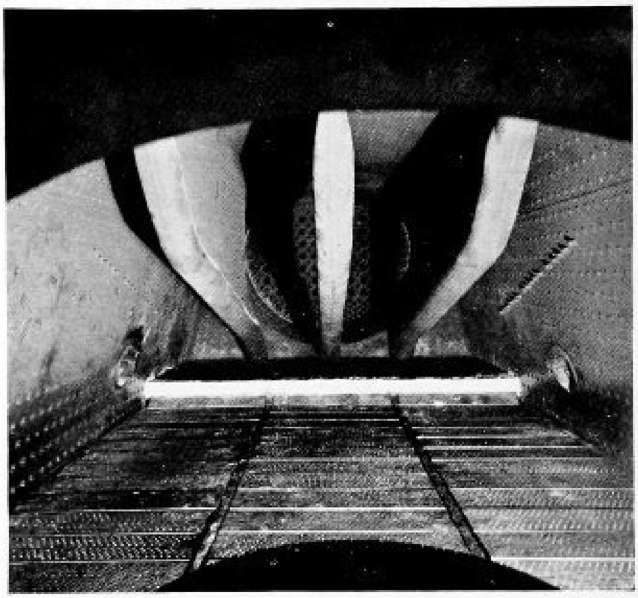
	4-6-6-4	2-8-8-4
Builder	American	American
Year built	1936	1928
Rated tractive force, lb.	104,500	139,900
Booster tractive force, lb.	......	13,400
Total tractive force, lb.	104,500	153,300
Weight on drivers, lb.	435,000	554,000
Total engine weight, lb.	624,500	715,000
Total engine and tender weight, lb.	1,023,000	1,116,000
Cylinders—number, and diameter and stroke, in.	4—23 x 32	4—26 x 32
Boiler pressure, lb.	250	250
Grate area, sq. ft.	152.3	182
Total evaporative heating surface, sq. ft.	5,832	7,673
Superheating surface, sq. ft.	2,114 (Type A)	3,219 (Type E)

General Dimensions and Weights of the Northern Pacific 4-6-6-4 Type Locomotives

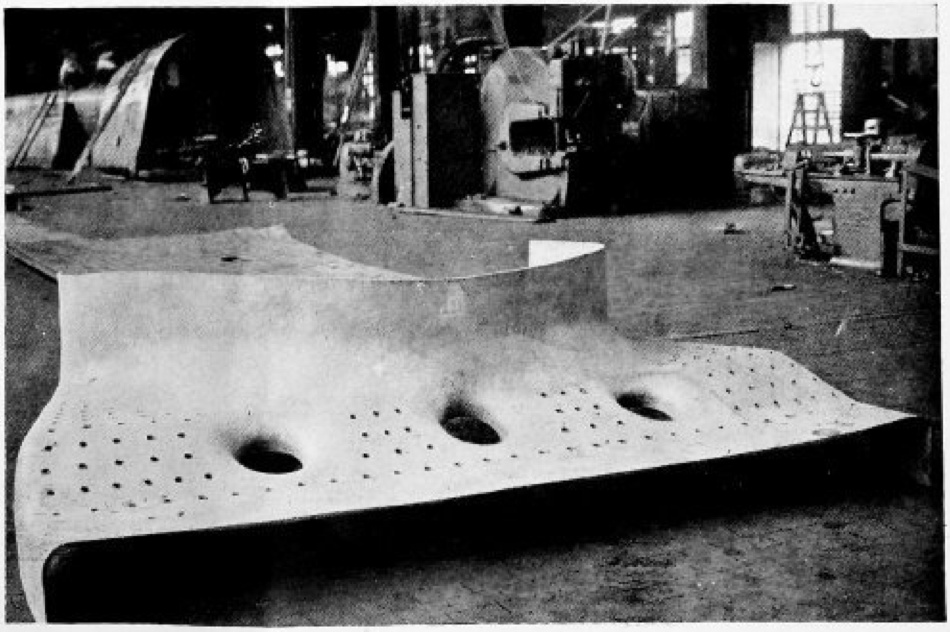
Railroad	Northern Pacific
Builder	American
Type of locomotive	4-6-6-4
Road class	Z-6
Road numbers	5100-5111
Date built	1936
Service	Frt.
Rated tractive force, engine	104,500
Weights in working order, lb.:	
On drivers	435,000
On front truck	73,000
On trailing truck	116,500
Total, engine	624,500
Tender	398,500
Wheel bases, ft. and in.:	
Driving	35—1
Rigid	12—2
Engine total	61—10
Engine and tender total	113— 8
Driving wheels—diameter outside tires, in.	69
Cylinders—number, and diameter and stroke, in.	4-23 x 32
Valve gear, type	Walschaert
Maximum travel, in.	7½
Boiler:	
Steam pressure, lb.	250
Diameter, first ring, inside, in.	96⅜
Firebox length, in.	246⅛
Firebox width, in.	114¼
Combustion chamber length, in.	89
Thermic syphons, number	3
Tubes, number and diameter, in.	192—2¼
Flues, number and diameter, in.	73—5½
Length over tube sheets, ft. and in.	23—0
Fuel	Rosebud coal
Grate area, sq. ft.	152.3
Heating surfaces, sq. ft.:	
Firebox and combustion chamber	626
Syphons	213
Firebox, total	839
Tubes and flues	4,993
Evaporative total	5,832
Superheating (Type A)	2,114
Combined evaporative and superheating	7,946
Feedwater heater	Worthington Type 6SA
Tender:	
Style	Semi-Vanderbilt
Water capacity, gal.	20,000
Fuel capacity, tons	27
Trucks	6-wheel

forward in the barrel of the boiler. The grates are 192 inches long; the remaining 54 inches at the front end of the firebox is separated from the grates by a Gaines wall and sealed to form additional combustion space. The arch is supported on three Nicholson thermic syphons, the necks of which are 8 inches in diameter. The grates are of the Northern Pacific rocking pin-hole type developed to burn the Rosebud coal which is high both in moisture and in ash and of relatively low heating value. The coal is fired by a Standard modified Type B stoker, which is of the same general design and size as that installed on the 2-8-8-4 type locomotives. The smokebox is fitted with the railway's standard Cyclone spark arrester.

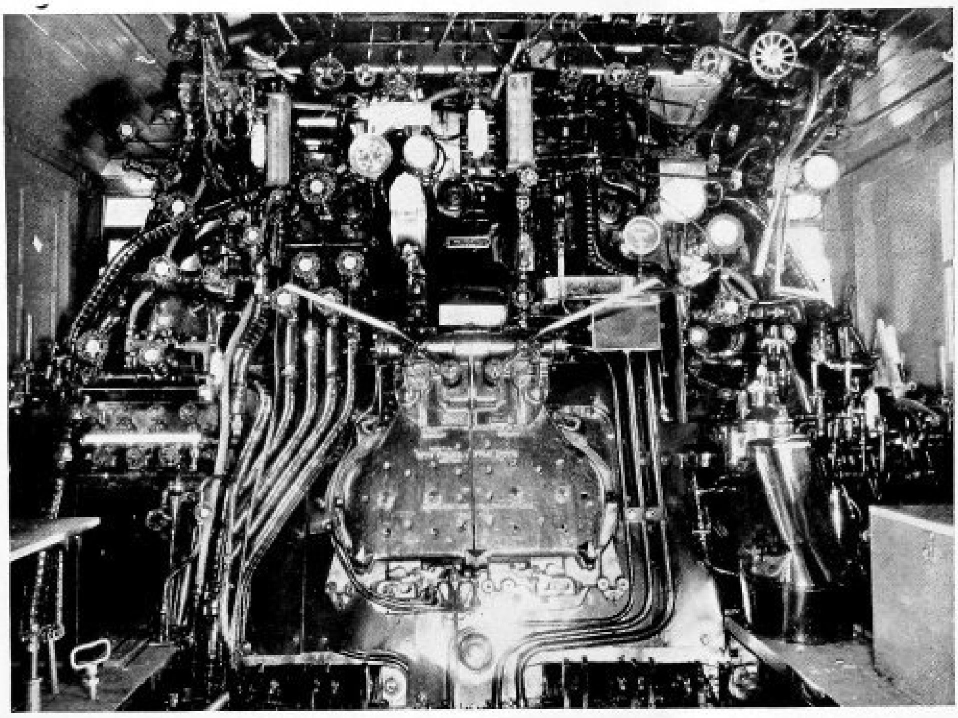
Flannery type MX flexible staybolts are applied in the breaking zones in the corners and along the tops of the side sheets, and in three of the lower rows of radial stays. A complete installation of flexible staybolts is applied around the combustion chamber. The tube sheets are laid out for the Type A superheater, in the



Looking inside the firebox



Throat sheet of Northern Pacific locomotive boiler in process of fabrication in the boiler and plate shop of the American Locomotive Company



Back view of Northern Pacific locomotive boiler showing arrangement of gage and test cock piping, operating gages, throttle and other valves, and the like

header of which is included the American front-end throttle. All of the locomotives are fitted with Worthington No. 6SA feed-water heaters, and the boilers are equipped with Barco low-water alarms. Blow-off cocks are of the Wilson pneumatic type, two of which have connections to pipes in the boiler for sludge removal and discharge into a muffler on top of the boiler.

Two 8½-inch cross-compound air compressors and the hot-water pump are mounted on the smokebox front, which is of cast steel with the brackets for the pump and strap portion of the Okadee hinge cast integral. Two sand boxes of large capacity are applied on top of the boiler. The running boards are Safkar type plates. The air-brake equipment is Westinghouse No. 8-ET.

The tender tank is of the semi-Vanderbilt type with a coal capacity of 27 tons and a water capacity of 20,-000 gallons. The tender frame is of the General Steel Castings water-bottom type, and the tank is of welded construction throughout. The coal space is fitted with a Standard Stoker coal pusher.

The tender trucks are of General six-wheel equalized type and are fitted with Timken roller bearings. The truck clasp brakes are of the Simplex unit-cylinder type.

The principal dimensions and data are shown in one of the tables.

National Safety Council Gives Advice on Goggles

Safe Practices Pamphlet No. 14 of the National Safety Council, Inc., devoted to goggles, is based on the accident-prevention experience of a number of employers. It is not to be confused, therefore, with Federal, state, or insurance requirements or with national safety codes. It answers briefly the questions, "When should goggles be worn?" and "What kind of goggles should be worn?" and describes such elements of goggles for various uses as frames, eyecups, lens containers, connectors between lenses, side shields, attachment devices, and lenses. Brief comments on sterilization and tests are included.

In a section devoted to the problem of getting men to wear goggles, sometimes a difficult procedure, it is suggested that after the question, couched in positive rather than negative form, "Can an eye be injured on this job?" has been answered in the affirmative, an order should be issued by the executive head of the company stating the facts and specifying what types of goggles are to be used. After such an order has been issued it must be rigidly enforced.

The purpose and importance of wearing goggles should be explained to the men. Instances where the use of goggles has saved the sight of fellow workers or of workers in other plants should be referred to. Where possible, a photograph of a worker with the goggles which have saved his sight, and an account of the accident, may well be posted on the shop bulletin boards. Reference is sometimes made in the company's magazine to causes of eye accidents, their number, and how such accidents may be prevented.

In one large plant, after an order was issued that goggles were to be worn in certain places and during certain operations, all supervisors, regardless of their position in the organization, the safety man, and all visitors to that plant set a good example by wearing goggles in compliance with the order.

The method of supplying goggles differs in various plants. In some instances the main supply for all shops is kept in the main supply department. In other cases the various shops maintain their own supplies. For the sake of uniformity it is better to have the main supply kept in a central department. However, it is important that each shop keep on hand, always ready for use, an adequate supply of the goggles needed in that shop. A sufficient supply of repair parts should also be kept in each shop unless there is a central goggle-repair department, or unless the broken goggles are periodically returned to the manufacturer for repairs.

When a man will not wear goggles, in violation of orders, and after every effort has been made to explain the necessity of his so doing and to provide goggles that are suitable and comfortable, he should be disciplined.

Improved Boiler for British Locomotives

By G. P. Blackall

A very interesting modification to the four-cylinder 4-6-0 type *Lord Nelson* class locomotives, with the object of improving the power-weight ratio, has recently been carried out by R. E. L. Maunsell, chief mechanical engineer of the Southern Railway of England. A locomotive of this type and class has been fitted with an enlarged boiler having a round-topped firebox, but giving a slightly smaller total heating surface.

Introduced into service at the end of 1926, the *Lord Nelson* class locomotives are slightly heavier and more powerful than the company's well-known *King Arthur* class, the drive of the four cylinders being divided between two axles, and the angles of the cranks being so arranged as to give eight separate impulses per revolution of the wheels, with the object of obtaining more uniform torque and more regular firebox draft than is possible in a four-cylinder engine arranged with quartered cranks.

The boiler of *Lord Nelson* class locomotives is of Belpaire type, the firebox water space stays being of steel in the fire area, with nuts on the fire side and ordinary riveted copper stays elsewhere. The tubes are of moderate length, and the superheater header is of Maunsell type with air relief valves. The boiler mountings, at the time the locomotives were introduced, were of entirely new design.

Hitherto, the only modification to the class was incorporated in the *Lord Hawke*, in 1928, when the boiler barrel was lengthened by 10 inches.

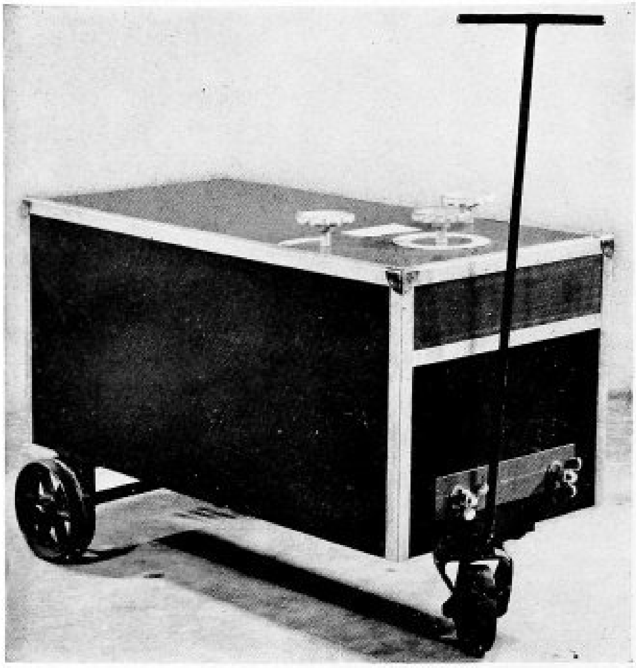
In the present modification, the enlargement of the boiler has been accomplished without appreciably increasing the total weight of the locomotive, by constructing the shell of the boiler of 2 percent nickel steel plates. Furthermore, the *Lord Nelson* class locomotives have Vibrac alloy steel motion parts, and the use of higher tensile steel for the boiler in the case of the modified locomotive is another stage in the improvement of the power-weight ratio. The tractive effort remains at 33,500 pounds.

Another detail of the improvement is that the heating surfaces and volume of the copper firebox have been considerably augmented by the addition of a combustion chamber extending into the barrel. This has had the effect of shortening the distance between tube plates and has led to the introduction of 1¾-inch diameter tubes. The superheater surface has been increased, and the elements are of the Sinuflo type. Actually, the total heating surface is slightly decreased in the new boiler, as will be seen by reference to the accompanying table.

The weight of the locomotive in working order is 85 tons 12 cwt., as against 84 tons 16 cwt., with the original boiler, and the respective empty weight is 77 tons 5 cwt., as compared with 77 tons 2 cwt., with the original boiler. The total weight of the locomotive and tender, as modified, is 142 tons 6 cwt., in working order and 106 tons 17 cwt., empty. The first locomotive to be thus modified is the *Lord Howe*.

Table Showing Difference in Heating Surface Due to Boiler Modifications

Boiler,	Firebox type,	Working pressure, pounds per square inch	Tubes, diameter, inches	Length between tube plates,	Heating surface, square feet				
					Small tubes	5¼-in. flues	Fire-box	Total	Super-heater
Original	Belpaire	220	2	14 feet 2 inches	1359	544	194	2097	399
New	Round top	220	1¾ and 2	13 feet	979	628	246	1853	460



Weaver "Andora" electric welding machine

New Type Arc Welder Developed

A new development in the field of arc welding has recently been introduced by James M. Weaver, Monroe, Mich. This new electric arc welder, called the Weaver "Andarc" welder, employs an entirely original electric circuit upon which complete patent rights have been secured.

Without the use of rectifying tubes, motor and generator, acids or chemicals, or, as a matter of fact, any hitherto known means of rectification, this equipment is claimed to produce approximately thirty to fifty percent rectified current. For the first time a welder is offered to the industry that utilizes percentages of both alternating and direct current and obtains a result showing the successful combining of both.

The Weaver welder, unlike the conventional transformer types on the market today, will use bare as readily as coated electrodes. Unlike many types in use, this equipment does not employ high frequency currents, but operates on 60-cycle current.

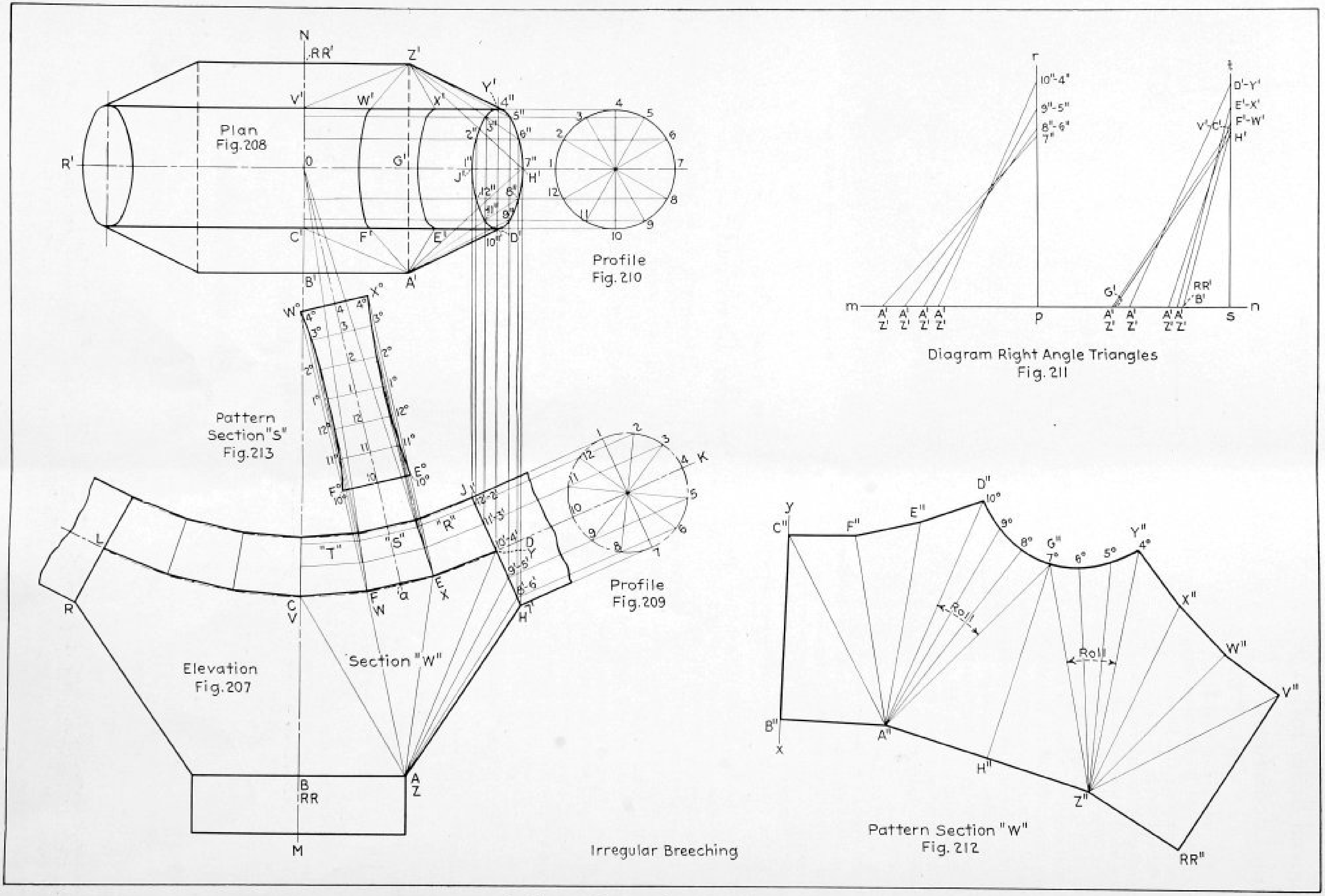
This machine is controlled by a positive switch giving twenty-eight different heats and a long and short arc. This fact is claimed to provide flexibility that makes it practical for all types of work.

Lincoln Increases Philadelphia Sales Staff

Announcement has been received from The Lincoln Electric Company, Cleveland, O., of two appointments to the sales staff of its Philadelphia office, 401 North Broad Street.

The new appointments include William Sivyer, graduate of the University of Illinois, and B. B. Ross, graduate of Kentucky Weslayan College.

Mr. Sivyer and Mr. Ross will assist O. P. Lang, H. H. Stahl, L. J. Cogan of the Philadelphia office, which is under the management of George R. Johnson.



Development of patterns for an irregular breeching

Practical Plate Development—XXIV

Irregular Breeching

By George M. Davies

The irregular breeching to be developed is shown in Fig. 207, the elevation, and Fig. 208, the plan view.

The irregular breeching consists of a square inlet with two circular outlets, these outlets being joined at the top with a semicircular arc. The radius of the semicircular top is the same as the radius of the circular outlets.

For convenience in laying out the development, allowances for thicknesses of plates have been omitted and the outline shown has been taken on the neutral axis of the plates. No provision has been shown on the patterns for seams or for welding.

The first step in the development is to complete the plan view of the circular outlets.

An examination of the elevation and plan views indicates that the center line *M-N* divides the breeching into two symmetrical halves. For this reason, a development of one-half of the breeching will be all that is necessary, as a duplicate of the pattern developed will complete the full pattern of the breeching.

Draw the line *D-K* perpendicular to *J-H* from the point *D*, which bisects *J-H*, and on the line *D-K* draw the profile of the circular outlet as shown in Fig. 209. Divide this profile into any number of equal parts, the greater the number of equal parts taken, the more accurate the final development. In this case twelve parts were taken and the intersections numbered from 1 to 12 as shown. Then parallel to *D-K* draw lines through the points 1 to 12 extending same into the elevation, Fig. 207, cutting the line *J-H*. Number these intersections from 1′ to 12′ as shown.

Next extend the center line *R′-H′* of the plan view, Fig. 208, and on it draw the profile of the circular outlet as shown in Fig. 210. Divide this profile into the same number of equal parts as was taken in the profile, Fig. 209, and number the intersections from 1 to 12, the numbers corresponding to the same numbers in the profile, Fig. 209.

Parallel to the center line *R′-H′* of the plan, Fig. 208, draw a line through the point 2 of the profile, Fig. 210, and extend it into the plan view. Then parallel to the center line *M-N*, draw a line through the point 2′ of the elevation extending this line into the plan and cutting the line just drawn to locate the point 2″ of the plan, Fig. 208.

In like manner, parallel to the center line, *R′-H′* of the plan, Fig. 208, draw a line through the point 3 of the profile, Fig. 210, and extend this line into the plan view. Next parallel to the center line *M-N*, draw a line through the point 3′ of the elevation and extend it into the plan so as to cut the line just drawn and locate the point 3″ of the plan, Fig. 208. Continue in this manner until the points 4″, 5″, 6″, to 12″ to 1″ are located. Connect the points 1″ to 12″ with a line to complete the plan view of the circular outlets.

The next step is to divide the elevation and plan of the breeching into sections that can be developed.

Divide the arc *D-C* into any number of equal parts. Three are taken in this case and numbered by divisions *C, F, E, D*, and *V, W, X* and *Y* as shown. Connect the points *E* and *F* with the center *O*, dividing the top into three equal parts or sections as "*R*", "*S*" and "*T*". These sections are equal and a development of one will be suitable for the other two.

Now parallel to the center line *M-N*, draw lines through the points *C, F, E, D* and *V, W, X, Y* and extend them into the plan to locate the points *C′, F′, E′, D′* and *V″, W″, X′, Y′* in the plan view, Fig. 208. Connect the points *C-F, F-E* and *E-D* of the elevation, Fig. 207.

The portion of the breeching below the semicircular top, as section "*W*", can be developed in one piece.

Connect the points *A-C, A-F, A-E, A-D, A-9′, A-8′, A-H* of the elevation, Fig. 207, with solid lines, and also the points *A′-C′, A′-F′, A′-E′, A′-D′, A′-9″, A′-8″, A′-7″, Z′-V′, Z′-W′, Z′-X′, Z′-Y′, Z′-5″, Z′-6″, Z′-7″* of the plan, Fig. 208. These lines represent the surface lines of the object and in order to make a development of section "*W*" the true lengths of these surface lines must be obtained.

In order to determine the true length of the surface lines of section "*W*", a series of right angle triangles must be constructed.

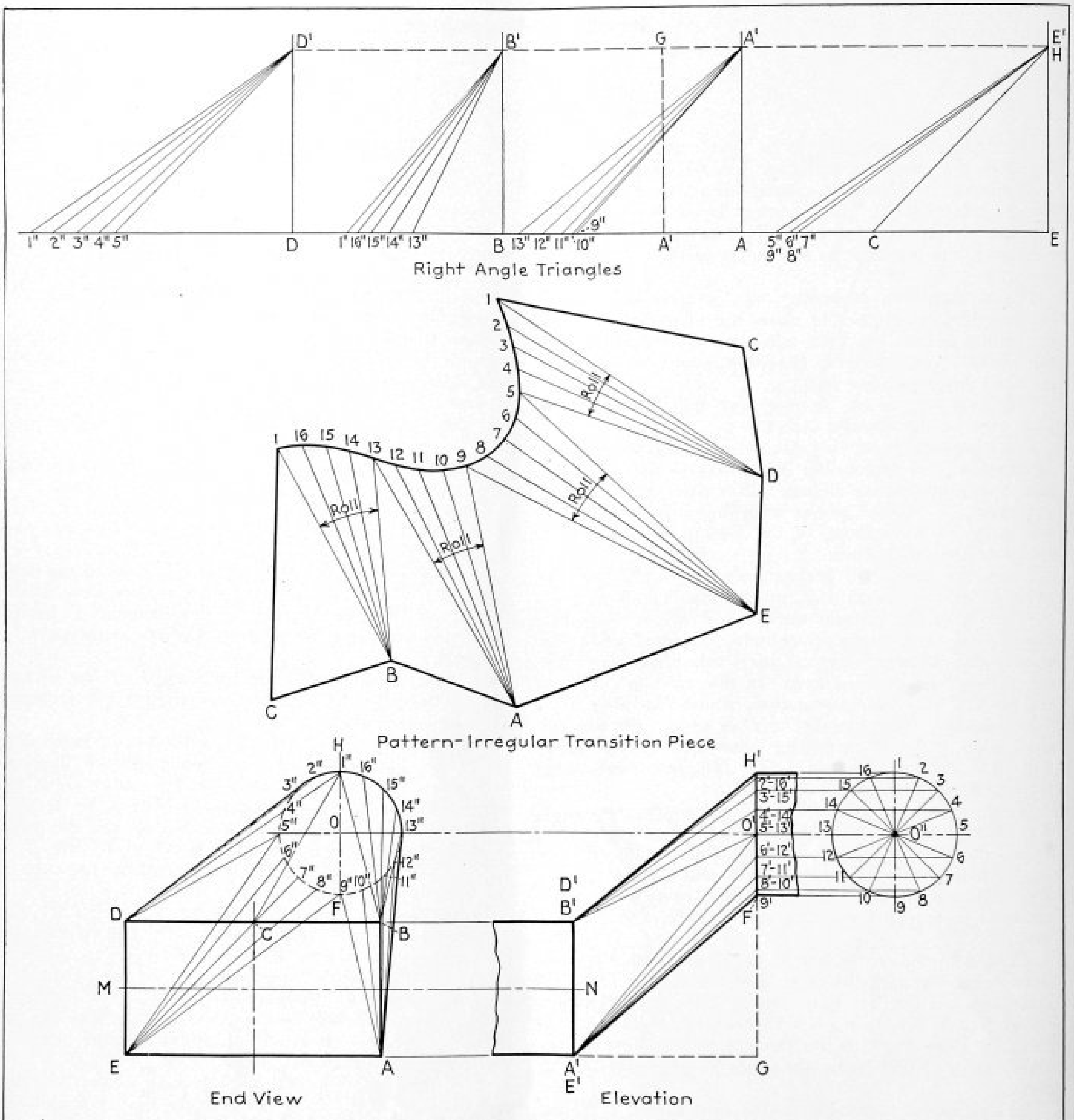
On any line as *m-n*, Fig. 211, erect the perpendicular *p-r* at *p*. Then on the line *m-n*, step off the distance *p-A′* equal to the distance *A′-7″* of the plan and on the perpendicular step off the distance *p-7″* equal to the perpendicular distance between the line *A-B* and the point 7′ of the elevation. Connect the points *A′-7″*, Fig. 211, with a line which will be the true length of the surface line *A-7′* of the elevation.

In like manner, step off on the line *m-n*, Fig. 211, the distance *p-A′* equal to the distance *A′-8″* and on the perpendicular step off the distance *p-8″* equal to the perpendicular distance between the line *A-B* and the point 8′ of the elevation. Connect the points *A′-8″*, Fig. 211, with a line which will be the true length of the surface line *A-8′* of the elevation. Continue in this manner using the distances *A′-9″, A′-10″, Z′-7″, Z′-6″, Z′-5″* and *Z′-4″* of the plan, Fig. 208, for the bases of the triangles and the vertical distances between the line *A-B* and the points 9′, 10′, 7′, 6′, 5′ and 4′ in the elevation, Fig. 207, for their corresponding altitudes.

On the line *m-n*, Fig. 211, erect the perpendicular to *s-t* at *s*. Step off on the line *m-n*, the distance *s-A′* equal to the distance *A′-C′* of the plan, Fig. 208, and on the perpendicular, step off the distance *s-C″* equal to the perpendicular distance between the line *A-B* and the point *C* of the elevation, Fig. 207.

Connect the points *A′-C′* with a line which will be the true length of the surface line *A-C* of the elevation, Fig. 207. Continue in this manner, using the distances *A′-F′, A′-E′, A′-D′, Z′-V′, Z′-W′, Z′-Y′* of the plan, Fig. 208, for the bases of the triangles and the vertical distances

Problem No. 17 - - - Correct Layout



Problem No. 17, appeared on page 73 of the March issue. The correct solution is published herewith to provide readers with an opportunity to check their work

between the line *A-B* and the points *F, E, D, V, W, X* and *Y* in the elevation, Fig. 207, for the corresponding altitudes.

Then on the line *m-n*, step off the distance *s-G'* equal to the distance *G'-H'* of the plan, Fig. 208, and on the perpendicular, step off the distances *s-H'* equal to the perpendicular distance between the line *A-B* and the point *H* of the elevation, Fig. 207. Connect the points *G'-H'*, Fig. 211, with a line, which will be the true length of the surface line *G'-H'* of the plan, Fig. 208.

In a similar manner, step off the distance *s-B'* and *s-RR'* equal to *B'-C'* and *V'-RR'* of the plan, Fig. 208, and *s-C'*, *s-V'* equal to the perpendicular distance between the line *A-B* and the points *C* and *V* of the elevation, Fig. 207. Connect the points *C'-B'* and *V'-RR'* with lines which will be the true length of the surface lines

B-C and RR-V of the elevation, Fig. 207; thus the true length of all the surface lines of section "W" are obtained.

Development of Pattern for Section "W"

To develop the pattern, draw any line as x-y, Fig. 212, and on this line step off the distance B"-C" equal to the distance B'-C', Fig. 211. With B" as a center and with the trams set equal to the distance B-A of the elevation, scribe an arc. Then with the point C", Fig. 212, as a center and with the trams set equal to the distance C'-A', Fig. 211, scribe another arc cutting the arc just drawn, locating the point A", Fig. 212.

With A", Fig. 212, as a center and with the trams set equal to A'-F', Fig. 211, scribe an arc and with C", Fig. 212, as a center and with the trams set equal to the distance C-F of the elevation scribe a second arc, cutting the arc just drawn to locate the point F", Fig. 212.

Continue in this manner, making the distances A"-E" and A"-D" equal to A'-E' and A'-D', Fig. 211, and the distances F"-E" and E"-D" equal to the distances F-E and E-D of the elevation, Fig. 207, until the line A"-D", Fig. 212, is drawn.

Then with A", Fig. 212, as a center and with the trams set equal to the distance A'-9", Fig. 211, scribe an arc, and with D", Fig. 212, as a center and with the trams set equal to the distance 10-9 of the profile, Fig. 209, scribe another arc, cutting the arc just drawn and locating the point 9°, Fig. 212. Continue, making the distances A"-8°, A"-7° equal to the distances A'-8" and A'-7", Fig. 211, and the distances 9°-8° and 8°-7° equal to the distances 9-8 and 8-7 of profile, Fig. 209, until the line A"-7°, Fig. 212, is drawn.

With A" as a center and with the trams set equal to the distance A'-G' of the plan, Fig. 208, scribe an arc; then with G", Fig. 212, as a center and with the trams set equal to the distance G'-H', Fig. 211, scribe a second arc so as to cut the arc just drawn and locate the point H", Fig. 212, thereby completing the pattern to the line G"-H".

The pattern from this point on is a duplicate of the pattern so far completed and is obtained by using the corresponding distances from the diagram of right angle triangles, Fig. 211, the elevation and plan, Figs. 207 and 208, and the profile, Fig. 209, thus completing the pattern of section "W". A duplicate of the pattern added on along the line V"-RR" would complete a full pattern of the lower portion of the breeching.

Development of Pattern for Section "S"

Bisect the distance F-E of the elevation, Fig. 207, locating the point *a*. Connect *a* with the center O.

On the line O-*a*, step off the distance 10-11, 11-12, 12-1, 1-2, 2-3, 3-4, as shown in Fig. 213, equal to the distances 10-11, 11-12, 12-1, 1-2, 2-3, 3-4 of the profile, Fig. 209. Erect perpendiculars to the line O-*a* at the points 10, 11, 12, 1, 2, 3 and 4 and extend them on both sides of the line O-*a* as shown in Fig. 213.

Next draw lines parallel to the line E-K through the points 10, 11, 12, 1, 2, 3 and 4, Fig. 209, and extend them into the elevation, Fig. 207, cutting the line O-E. Further extend these lines parallel to the line E-F, Fig. 207, cutting the line O-F.

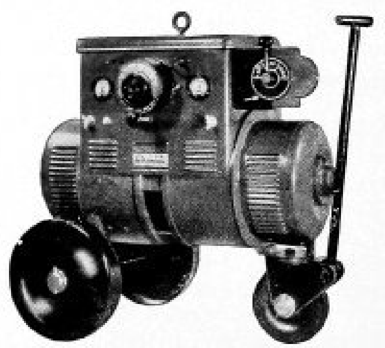
Parallel to the line O-*a*, draw lines through the points where the line drawn from point 10, Fig. 209, cuts the lines O-E and O-F and extend these lines into Fig. 213 so as to cut the line drawn through point 10, Fig. 213, and locate the points 10° on each side of the line O-*a*. In like manner, parallel to the line O-*a*, draw lines through the points where the line drawn from point 9, Fig. 209, cuts the lines O-E and O-F and extend these lines into Fig. 213, cutting the line drawn through point 9, Fig. 213, and locating the points 9° on each side of the line O-*a*. Continue in the same manner as shown in Fig. 213 until all the points 12°, 1°, 2°, 3° and 4° on each side of the line O-*a* are located. Connect these points with lines to complete the pattern of section "S". Patterns for sections "T" and "R" are duplicates of this pattern.

(To be continued)

Current-Saving Motor Control on Welders

A new development in arc welding was announced at the National Metal Show in Cleveland by The Hobart Brothers Company, Troy, O., manufacturers of Hobart "Simplified" arc welders. The new Hobart Serial MN current-saving models embody (in addition to an improved type of wheel mounting with low center of gravity) what is termed as selective motor HP Control.

Only 1/3 the usual starting current is required; the power factor of the machine and its efficiency are materially improved, and it is possible to use the equivalent of a motor of one-half the horsepower rating for welding in ranges up to 1/2 to 2/3 the rated capacity of the generator.



Welder with current-saving features

The manufacturer's announcement claims that the results are (1) welding current costs are cut 30 percent to 50 percent in average work, (2) power company penalties due to poor power factor of equipment are avoided, (3) expensive re-wiring of many plants is eliminated, and (4) idling and light load power losses are cut in half.

Power factor of the equipment is improved in the light load ranges so that it is 90 percent or better in all practical welding ranges, whereas with ordinary equipment the power factor does not approach 90 percent until the load approaches 2/3 rated capacity.

The operation of the selective motor HP control is simple and is accomplished as easily as the mere starting of ordinary welding machines, by using only one hand. A convenient latch locks the handle in the low position, where only half the rated motor horsepower is used for starting and for welding up to 1/2 the rated generator capacity in continuous manual arc welding (up to 2/3 rated capacity for intermittent welding). When it is desired to operate at higher rates, a convenient lever releases the handle for turning easily to the high position, where the full rated horsepower of the motor is available for full load and overload welding. At the same time it is possible, when so desired, to start and weld in the high position without turning the handle to the low setting at any time.

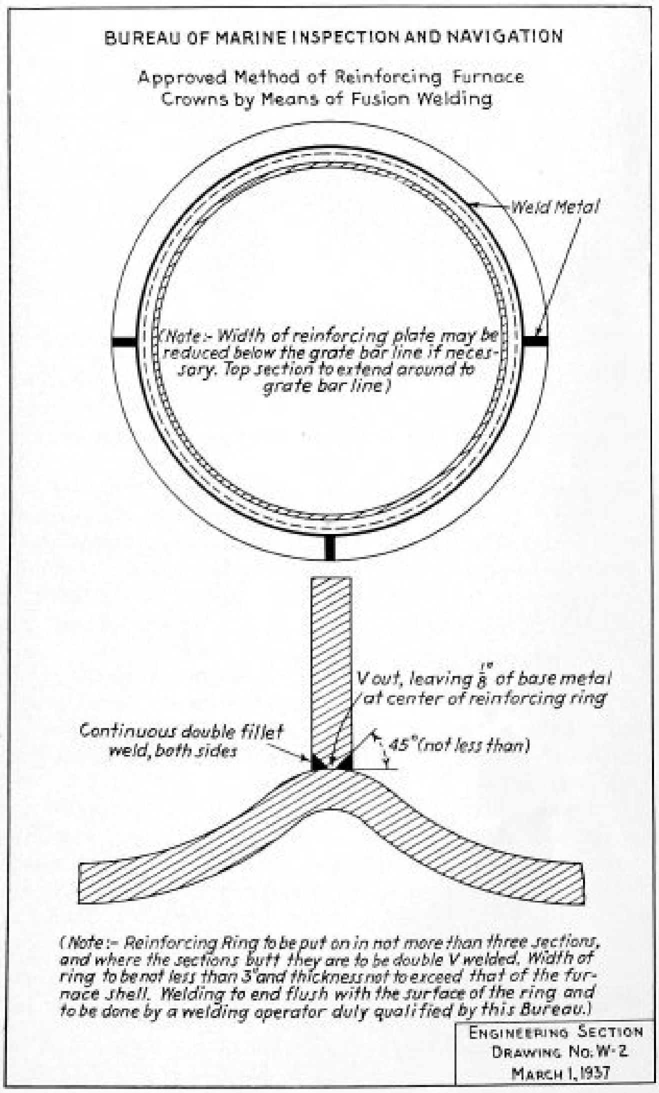
The new series MN current-saving models are available in 75 amperes—1½ to 3 horsepower, 100 amperes—2½ to 5 horsepower, 150 amperes—5 to 10 horsepower, 200 amperes—7½ to 15 horsepower, 300 amperes—10 to 20 horsepower, 400 amperes—12½ to 25 horsepower and 600 amperes—20 to 40 horsepower.

Approved Method for Repairing Furnace Crowns

In Circular Letter No. 151 to boiler manufacturers, shipbuilders, contractors, U. S. supervising, traveling, local and assistant inspectors, the Bureau of Marine Inspection and Navigation has issued details of an approved method for repairing furnace crowns.

Accompanying this letter is a sketch (illustrated) designated as drawing No. W-2 showing the method for reinforcing furnace crowns which have become distorted. The procedure for applying this method of repair is as follows:

The furnace crown where distorted should be pumped back as nearly to a circular form as it is possible to attain. It should be measured and a template made con-



forming to the shape of the furnace crown. From the template, plates should be formed to make a complete ring to envelop the furnace. This ring should be in two, if possible, but not more than three sections. The upper section should encircle the top half of the furnace. The edges shall be attached to the furnace crown and be beveled to an angle of not less than 45 degrees on each side of the ring to permit attachment by a double fusion weld, the weld to be continuous around the periphery of the furnace, and the sections joined by butt welding, as shown in the sketch.

This repair must be done by welding operators who have passed the qualification tests of the Bureau, and the use of an approved shielded electrode is required.

If necessary, the sections of the reinforcing ring below the center line may be reduced to permit clearance where stays are installed or where the shell is too close to the crown of the furnace to permit the full section to be used.

The letter was signed by H. C. Shepheard, assistant director of the Bureau.

Manufacturers to Assist Welding Program

Recognizing the important functions of the American Welding Society as a technical spokesman for the welding industry, the National Electrical Manufacturers Association, electric welding section, at its January, 1937, meeting, voted to furnish financial support for the expansion program which the American Welding Society recently proposed. A matter of immediate importance is the co-ordination of tests of men, machines and filler metal, so as to relieve some of the unnecessary burden which a great duplication of test requirements has brought about. It is also very desirable to increase the membership of the society, and especially to secure members from a larger number of industrial companies.

A. E. Gibson, after an enviable record as head of the Cleveland section, accepted the presidency of the American Welding Society with the understanding that he wished to enlarge both its membership and its activities. The society is not equipped financially to carry out some of these desirable projects from current income, but the National Electrical Manufacturers Association welding section has expressed its confidence in the future of the society and in Mr. Gibson's leadership, by this recent action. They will underwrite the new American Welding Society program to the extent of $10,000. At the March meeting of the National Electrical Manufacturers Association welding section a co-ordinating committee was appointed to work with the management committee of the American Welding Society and to make this fund available as it is required for support of the new activities.

Power Piping Company Changes Hands

The Blaw-Knox Company has acquired the property and business of the Power Piping Company, Pittsburgh, W. P. Witherow, president of the Blaw-Knox Company, announced recently.

The Power Piping Company was organized in 1916, and has been engaged in the design, manufacture, and erection of piping for power plants, oil refineries, sewage plants, water works and industrial plant usages for all pressures and purposes. In 1934 it added a sprinkler division, and the company has been a material factor in this industry since that time.

External Corrosion of Pressure Vessels

By J. P. Morrison*

Corrosion of ferrous surfaces is a prolific source of weakness in pressure vessels of all kinds, but it can be decreased by "good housekeeping," since serious external wasting develops only after a considerable lapse of time. External corrosion may be traced, invariably, to moisture in contact with surfaces exposed to the atmosphere, and, if there is soot, ash, or dirt present, especially in an idle period, the deterioration of the metal is more rapid. Obviously the dangers from external corrosion are minimized if surfaces are kept both clean and dry.

Surfaces sprayed with water or steam, such as from a leaking tube, handhole gasket or soot blower, are sure to give trouble if the spraying action is permitted to continue. For instance, it was necessary recently to remove six bent tube type boilers from service because the shell plates for the entire length of the mud drums had been dangerously reduced in thickness by the action of soot blowers. The blowers had become so disarranged that they no longer rotated properly and were so located in recesses in the bridge walls that they discharged against the shell plates when steam was turned on.

In watertube boilers of the bent tube type, external corrosion occurs mostly on tube surfaces near the tube sheet or header, or on those tubes which support baffles where soot and fly ash can accumulate. Unless those surfaces, as well as the surfaces of the plates which the tubes enter, are thoroughly cleaned, the corrosion will continue, necessitating new tubes and perhaps causing a violent failure. Another danger point is in the steam circulating tubes which support the roof of the boiler setting, since they invariably become coated with material of a corrosive nature if moisture is present. Of course, tight baffles, a tight building roof and tight valve stems do much to avoid the corrosion of the circulating tubes, but cleaning and periodic inspections are absolutely necessary if trouble is to be avoided.

In general, if a tube which has corroded until its wall thickness, over a section having any dimension equivalent to the tube diameter, is not greater than 75 percent of the original wall thickness, it is too thin to be depended upon, and should be replaced with a new tube.

External corrosion has been responsible for so many boiler explosions, because of failure of the lower drum heads, as to make their examination absolutely necessary. By far the greatest hazard exists in the blank heads, which, as has been frequently pointed out, should never be embedded in the setting walls. Of approximately 6500 drum heads once concealed in setting walls, 10 percent were found to be corroded appreciably and about 1 percent were in a very dangerous condition and no longer serviceable. Had any of these boilers failed in service, the property damage would have been severe and there probably would have been loss of life. There have been a number of such failures in the past.

The mud drums of bent tube watertube boilers, the lower drums of vertical watertube boilers, and the rear headers and mud drums of horizontal watertube boilers, all suffer from external corrosion, as do also the ends of the tubes and nipples entering those parts. The bottom wrapper sheet and rivet heads of the front and rear headers of box header type watertube boilers suffer from corrosion where the soot and ash which accumulate are moistened because of tube cap leakage or from any other cause.

Investigation of the condition of a vertical straight tube type boiler in a recent case led to the discovery that the heads of the crown bar bolts were worthless, although the oxide of iron that had formed gave the bolt heads the appearance of being full size. However, a tap of a hammer was sufficient to dislodge the rust and expose the weakened condition of the crown bolts. The lower ends of many of the tubes were so reduced in thickness that they were no longer dependable, so new tubes, as well as new bolts, were required.

Boiler operators can do much to assist the inspectors in the constant program of safety being waged by all industry. Preparation of a boiler for inspection should include removal of soot, ash, and rust from the tube sheets, headers, and other surfaces wherever moisture may be present. It is particularly important not to neglect the less accessible parts as it is often at such locations that serious corrosion is progressing.

While watertube boilers are subject to external corrosion, they are by no means the only vessels seriously affected by this menace. The upper tube sheet of the vertical tubular boiler, particularly those of the submerged type, always accumulate some soot which, in connection with atmospheric moisture, will produce the corrosive conditions necessary to cause deterioration and ultimately require extensive repairs.

The grates of a vertical tubular boiler or of a locomotive type boiler may hold wet ash in contact with the firebox sheets, and the resulting corrosion may cause such a reduction in thickness that patching or other repair must be made to prevent a disastrous failure.

In one recent case, the shell of a vertical boiler on a locomotive crane formed a part of the coal bunker and, of course, the moist coal caused the shell plate to corrode. Unfortunately, the coal was not removed to permit a thorough examination of the shell plate until leakage had developed.

In another case, an opening in the lagging and jacket of a vertical tubular boiler was not of sufficient size to permit a proper examination of the plate surrounding the handhole. Leakage at the handhole gasket resulted in excessive corrosion of the shell plate, which a thorough inspection would have disclosed.

External corrosion of horizontal return tubular boilers is usually local in character and is caused by leakage of some kind, particularly around manholes and handholes. Of course, if there are places where soot and ash can accumulate in the presence of moisture, corrosion is almost inevitable. When such corrosion occurs in places which are difficult of access, the dangers of neglect are

* Assistant chief inspector, Hartford Steam Boiler Inspection and Insurance Company; from an article in *The Locomotive*.

apt to be particularly serious. The tubes of horizontal return tubular boilers are subject to corrosion when they become coated with siliceous and carbonaceous substances which in periods of idleness collect moisture. Dangerous corrosion results. There are on record many instances of tubes corroded to a point where they have collapsed.

Evidences of corrosion in the form of flakes of rust or iron oxide should serve as warning that tubes in any type of boiler are becoming thinner. The determination of the exact condition of tubes is often difficult, but where there is an uncertainty it is justifiable to have one or two tubes removed for the purpose of determining the general condition.

While cast iron is generally less susceptible to corrosive action than soft rolled steel, external corrosion is also a problem of importance with respect to cast iron objects. External surfaces of many cast iron boilers receive little or no maintenance with the result that the operating life of the object is shortened and its safety while in operation decreased. A dry, clean, well lighted boiler room is just as important for the good maintenance of heating boilers as it is for power boilers, not only because of the direct benefit to the boiler, but also because of the good influence on the attendant. As in the case of steel, the presence of moisture or dirt, or both, leads to corrosive attack on cast iron, so that the elimination of any leak, no matter how slight, is good practice. Surfaces exposed to the products of combustion are affected rapidly by corrosion when moisture from any source is present, especially if those surfaces are coated with soot.

Serious leakage should make itself evident by the telltale path of the water, even though the surfaces are dry when examined. A slight leak, however, is more difficult to locate. Sometimes the contraction of a cooling boiler may close capillary openings through which water escapes when the boiler is in service. Thus corrosive action is furthered throughout periods of service, and even when there are evidences of the leakage with the boiler idle, much experience is necessary to determine the exact opening.

There is also the danger from the accumulation between rigidly held parts of iron oxide in an amount which may crack the parts of the metal under stress. This accumulation in some cases may be due to a slight leakage from push nipple or threaded connections, but because the difficulty occurs most frequently when the boiler room is damp during an idle period, the iron oxide in general is attributed to the presence of atmospheric moisture and not leakage.

With cast iron boilers used for hot water supply service, in which a fire is kept throughout the year, cleanliness is extremely important if corrosion is to be checked. Frequent cleaning of the heating surfaces is especially helpful.

In addition to trouble with boilers, external corrosion is a problem with many other kinds of pressure vessels. When objects are so located that rubbish and dirt may accumulate against them, there is likely to be serious corrosion, but, as in the case of boilers, presence of moisture is the governing factor. This does not mean that wetness must be apparent, for considerable amounts of moisture, absorbed from the atmosphere or otherwise, may be present without being very evident.

Allowing unheated boilers or other vessels to stand when filled with water or other liquid will cause "sweating." As a body of water in the vessel cannot change temperature as rapidly as atmospheric changes occur, whenever the outside temperature rises, condensation on the exterior surfaces of the vessel is almost inevitable. Some corrosion must result, and if there is soot or other foreign substance present, the rate of corrosion will be greatly increased. Unless there is a real necessity for keeping idle vessels filled, they should be emptied when not in use.

Recent accidents to such objects as rendering tanks, cookers, air tanks and water tanks demonstrate in ways that are both convincing and costly that neglect of cleanliness and the growth of external corrosion have serious results.

This whole problem of external corrosion requires constant watchfulness on the part of every one connected with any vessels constructed of ferrous materials. Gradual wasting may not make itself troublesome until replacements are necessary, but to permit conditions conducive to the continuation of external corrosion eventually leads to increased operating expense, and, if serious accidents occur, to extensive property damage and loss of life.

American Welding Society Appoints New Manager

A. E. Gibson, president, The American Welding Society, New York, announced on May 17, the appointment of Warner S. Hays as manager. Mr. Hays brings to the Society an unusual combination of experience and background in engineering, sales, publishing, membership development and association management. He is a past president of the American Trade Association Executives, a member of the Philadelphia Rotary Club, The Yale Club of New York and is on the Executive Committee of the Yale Engineering Association. He is also a former officer of the National Industrial Advertisers.

Warner S. Hays

Following his graduation from Yale Sheffield Scientific School, Mr. Hays went to work for the General Electric Company at Schenectady and Pittsfield, spending several years in the testing and engineering departments. Leaving the General Electric Company, Mr. Hays became purchasing agent and assistant general manager of the Interurban and Traction Lines, Rockford, Ill., and later of the Light, Power and Traction lines of DeKalb and Sycamore, Ill.

Following these activities Mr. Hays became circulation and field manager of McGraw Publishing Company, New York. After the publishing experience, he began preparing for a managership of a foreign sales office with the Vacuum Oil Company, but the world war interrupted, and he became an officer in the construction division of the United States Army.

Since the war, Mr. Hays has maintained his own consulting, engineering and association executive office in Philadelphia. He has served many individual firms, the Government, and industries on personal relations, reorganizations, association management, advertising and merchandising surveys and has conducted campaigns for technical or engineering as well as trade associations.

Communication

Boiler Construction and Calculation

To the Editor:

In connection with the question "Butt Straps of Vertical Tubular Boiler" in the Question and Answer section of the January issue of Boiler Maker and Plate Fabricator, the reason for eliminating the inside strap in a butt-seam boiler is to assist the circulation of the water in this particular area. Since a single strap on the outside of a boiler shell that is staybolted to the furnace sheet will always exceed the allowable working pressure, it is better to remove or eliminate the inside strap and thus eliminate excessive work and complications in designing the joint.

The load is carried by the staybolts in this particular area and wooden plugs will even suffice insofar as strength is concerned. In making calculations on this kind of a boiler, the seam is not considered in calculating the working pressure, i. e., the seam in the shell where staybolts are installed. However, care should be exercised to see that the boiler has double straps beyond the area of the staybolts. There is no theory of hydraulics involved in this question, so that idea may be dispensed with, as respects this type of boiler.

Shell Plate Stresses

In regard to the item in the same issue on "Calculations of Shell Plate Stress" in a vertical tubular boiler, I have presented below an example concerning the problem which I believe will solve the question in respect to the calculation of safe working pressures on vertical tubular boilers.

Problem: Assuming an A.S.M.E. standard boiler, three years old and in good condition, as in Fig. 1, the following methods must be used to calculate the working pressure according to the A.S.M.E. Code. The question of tube sheet staying is dispensed with.

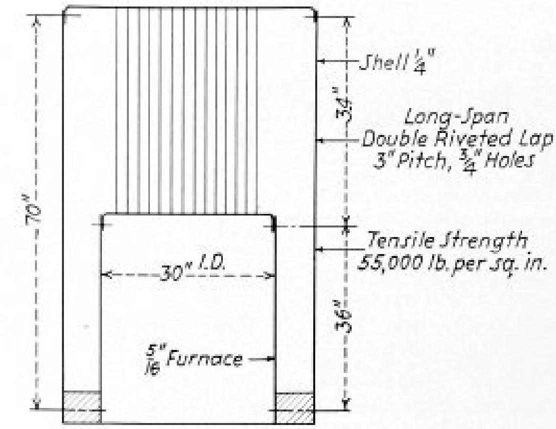
Solution: The first step is to calculate the efficiency of the longitudinal joint (see the A.S.M.E. Boiler Code, Example A-3, Appendix—Efficiency of Joints). It will be noted that in this type of joint there are three methods of failure, which are as follows:

A = strength of solid plate $= P \times t \times TS = 3 \times 0.25 \times 55{,}000 = 41{,}250$ pounds per square inch.

B = strength of plate between rivet holes $= (P - D)\ t \times TS = (3 - 0.75)\,0.25 \times 55{,}000 = 30{,}937$ pounds per square inch.

C = shearing strength of two rivets in single shear $= n \times s \times a = 2 \times 44{,}000 \times 0.441 = 38{,}875$ pounds per square inch.

D = crushing strength of plate in front of two rivets $= n \times d \times t \times c = 2 \times 0.75 \times 0.25 \times 95{,}000 = 35{,}625$ pounds per square inch.



Data for calculating butt straps of vertical tubular boiler

Where:

TS = tensile strength stamped on plate, pounds per square inch.
t = thickness of plate, inches.
P = pitch of rivets, inches, on row having greatest pitch.
d = diameter of rivet after driving, inches = diameter of rivet hole.
a = cross-sectional area of rivet after driving, square inches.
s = shearing strength of rivet in single shear, pounds per square inch.
S = shearing strength of rivet in double shear, pounds per square inch.
c = crushing strength of mild steel, pounds per square inch.
n = number of rivets in single shear in a unit length of joint.

It will be seen that the joint fails between rivet holes, and, therefore, the efficiency is as follows:

$$\frac{30{,}937\ (B)}{41{,}250\ (A)} = 0.75 = \text{efficiency of joint.}$$

Before making any further calculations it is always best to refer to the Code and Par. 17, 18 and 20 should be consulted when the boiler is of standard construction. If these requirements are satisfied, then proceed as follows:

To calculate the working pressure on the shell, see Par. 180, which is:

$$\frac{55{,}000 \times 0.25 \times 0.75}{18 \times 5} = 114 \text{ pounds per square inch}$$

with a factor of safety of 5.

Note, however, that Par. 188, item (b), limits the maximum allowable working pressure to 100 pounds per square inch, which gives a factor of safety of 5.7.

On this kind of a boiler the furnace sheet and the staybolting must be considered. In this case, the furnace is not supported by staybolts, so the pressure allowance would be as follows (See Par. 240, Formula 1, of the A.S.M.E. Code):

$$\frac{51.5}{30.625}\Big((18.75 \times 5) - (1.03 \times 36)\Big) = 95 \text{ pounds}$$

per square inch.

On the other hand, if the boiler were to be built for 100 pounds pressure, it would be necessary to either increase the thickness of the furnace plate or revert to staybolting.

Therefore, referring to Table P-9 of the A.S.M.E.

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Reg. U. S. Pat. Off.

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Code, we find that staybolts pitched 5¼ inches by 5¼ inches for 5⁄16-inch plate will give an allowable working pressure of 100 pounds. This staybolt pitch is calculated from Par. 199, and by transposition of this formula, we have:

$$p = \sqrt{\frac{C \times T^2}{P}} = \sqrt{\frac{112 \times 5^2}{100}} = 5\tfrac{1}{4} \text{ inches, pitch.}$$

However, the problem is not completed, as it is also necessary to calculate the size of the staybolts for 100 pounds pressure (for details of staybolts, see Par. 200). It will be observed from Table P-10 that a stress of 7500 pounds is allowed for the staybolts in question. Therefore, the area supported by the bolt times the working pressure, divided by the stress allowed equals the area of the bolt, or:

$$\frac{5.25^2 \times 100}{7500} = 0.3674 \text{ square inches.}$$

The diameter of the bolt will equal the square root of the area divided by 0.7854, or:

$$\sqrt{\frac{0.3674}{0.7854}} = 0.68 = \text{diameter at the bottom of the thread.}$$

On referring to Table A-1, a ⅞-inch diameter bolt with an area of 0.419 square inches (if a 3⁄16-inch tell-tale hole is included, the area of the bolt would be 0.391 square inches) would be allowed a maximum stress of 3144 pounds, or 2937 pounds with a tell-tale hole. It will be noted that these values fall within the limit allowed by the above-mentioned table; for example, using the lesser stress, namely 2937 pounds and dividing by the area supported by the bolt minus the area of the bolt and hole, we have the pressure, or:

$$\frac{2937}{5.25^2 - 0.391} = 107 \text{ pounds.}$$

Without the tell-tale hole, the pressure would be:

$$\frac{3144}{5.25^2 - 0.419} = 115 \text{ pounds.}$$

It will, therefore, be noted that in making calculations for this type of boiler all methods of failure must be considered before a safe working pressure may be allowed.

Buffalo, N. Y. JOHN J. TIMMONS.

Trade Publications

MOTOR DRIVEN WELDERS.—The Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa., has recently published a pamphlet describing the Westinghouse Flexarc motor driven welders and bare generators. Application, construction, specifications and performance curves for single-operator 200, 300 and 400 ampere welders are included.

ENGINE DRIVEN WELDERS.—Westinghouse engine driven welders, single-operator 200, 300 and 400-ampere sets, are described in a recent publication of the Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa. The publication includes performance curves of the welder, fuel consumption curves of the engines and general descriptions of the welders and power units.

POWER HOISTS.—The Harnischfeger Corporation, Milwaukee, Wis., has issued a new bulletin called "P & H Hoists." Profusely illustrated with more than 25 industrial application photographs, the bulletin describes the added advantage in handling "off the floor." It contains the treatment of both general and specific problems in the industrial handling field. Information on ratings, operating ranges and structural features are included.

STEAM GENERATORS.—A new catalogue just issued by Combustion Engineering Company, Inc., New York, describes its type VU steam generator which is of standard construction complete in sizes ranging from 15,000 to 250,000 pounds of steam per hour capacities and for any steam pressures up to 1000 pounds per square inch. The catalogue is fully illustrated with both exterior and cutaway views of the unit, line drawings and detailed sectional views of burners, also details of furnace wall construction, mills, etc.

Questions and Answers Pertaining to Boilers

This department is maintained for the purpose of helping those who desire assistance on boiler and plate fabricating problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless special permission is given to do so.

By George M. Davies

Calculation of Nozzle Reinforcement

Q.—Will you kindly illustrate by an example the method and procedure to be followed in determining the amount of reinforcement necessary for the nozzle illustrated in Fig. 1? A. G.

A.—The rules for determining the reinforcement for nozzle openings in the heads of unfired pressure vessels

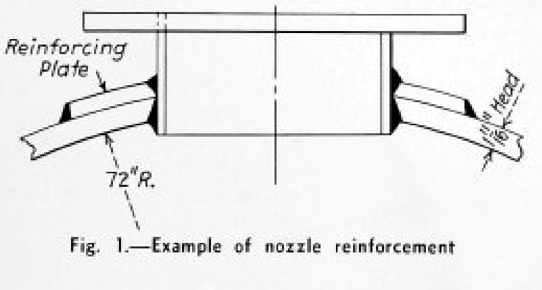

Fig. 1.—Example of nozzle reinforcement

are the same as for the shell, and are covered in Par. U-59b of the Unfired Pressure Vessel Code.

An example of the method and procedure to be followed in determining the amount of reinforcement necessary for an 18-inch O. D. nozzle is given in the appendix of the Unfired Pressure Vessel Code, Par. UA-14.

Boiler Tube Welding

Q.—I am a subscriber to your publication and want to ask for some information, namely, which of two methods of welding tubes in a boiler is better? In the first case, the tubes are rolled but not beaded and are welded to the tube sheet. In the second case, the tubes are rolled and beaded and then welded to the tube sheet.

Two sketches are shown which will probably make the question clearer than I can in words. Your opinion will be appreciated.—H. M.

A.—The sketches submitted with the question are illustrated in Figs. 1 and 2.

The method illustrated in Fig. 2 is the better of the two practices described as the holding power of the tube in supporting the tube sheet is not dependent upon the strength of the weld. The weld in this case is used as a seal.

The question does not state to what type of boiler these tubes are to be applied. This information is important, as the A. S. M. E. Code requires that the tubes are to be beaded under the following conditions:

A firetube boiler shall have the ends of the tubes firmly rolled and beaded, or rolled, beaded and welded around the edge of the bead. Where the tubes do not exceed 1½ inches in diameter, the tube sheet may be chamfered or recessed to a distance at least equal to the thickness of the tubes and the tubes rolled into place and welded.

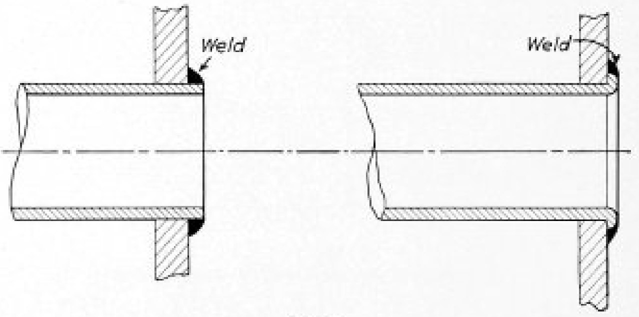

Fig. 1

The ends of all tubes, suspension tubes and nipples shall be expanded and flared not less than ⅛ inch over the diameter of the tube hole on all watertube boilers and superheaters, or they may be flared not less than ⅛ inch, rolled and beaded, or flared, rolled and welded.

Tubes may be seal welded into fittings or headers for both boilers and superheaters after they have been expanded and flared, provided the material in the fittings or headers does not contain carbon in excess of 0.30 percent.

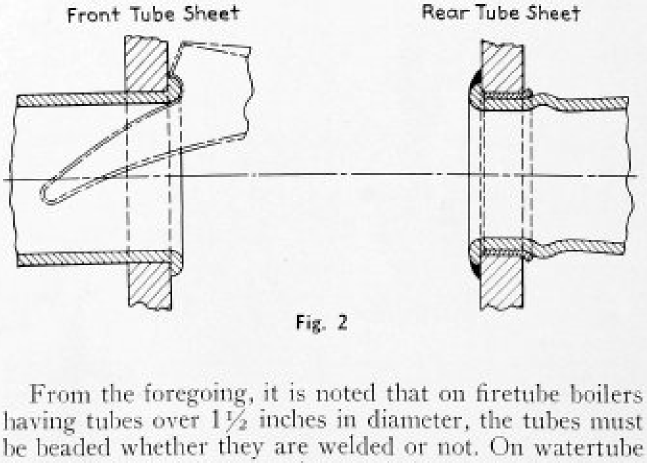

Fig. 2

From the foregoing, it is noted that on firetube boilers having tubes over 1½ inches in diameter, the tubes must be beaded whether they are welded or not. On watertube boilers and superheaters, the regulations require that the tubes must be flared in all cases whether beaded or welded, which eliminates the method illustrated in Fig. 1, in that the tube is not flared.

Locomotive boiler practice is shown in Fig. 3, wherein all tubes in the rear tube sheet are rolled, expanded, beaded and welded, and in the front tube sheet the tubes are rolled and 10 percent of the small tubes are beaded.

A.S.M.E. Code Flange Design

Q.—Will you kindly illustrate by an example, the method and procedure to be followed in designing a flange suitable for A.S.M.E. Code for Unfired Pressure Vessels?

In Fig. 1 we have shown a typical example. We desire to know the thickness of the flange and number and size of bolts required to conform to the conditions imposed. A. G.

A.—The thickness of flange and number and size of bolts required for the nozzle illustrated in Fig. 1 should conform to the American Standards as given in Tables A-5 to A-8 in the appendix, for the maximum allowable working pressure and temperature of the requirements of Par. P-12, A. S. M. E. Power Boiler Code.

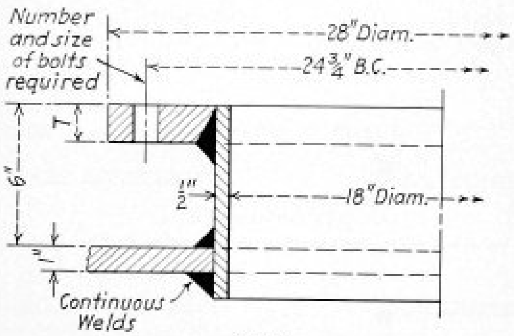

Fig. 1

STEEL FLANGED FITTINGS AND COMPANION FLANGES
300 POUNDS PER SQUARE INCH WORKING PRESSURE

The following table is taken from the American Standard B-16e-1932.

Nominal Pipe Size Inches	Outside Diameter of Flange Inches	Thickness of Flange Minimum Inches	Diameter of Bolt Circle Inches	Number of Bolts	Size of Bolts Inches	Metal Thickness of Fitting Minimum Inches
2	$6\frac{1}{2}$	$\frac{7}{8}$	5	8	$\frac{5}{8}$	$\frac{1}{4}$
$2\frac{1}{2}$	$7\frac{1}{2}$	1	$5\frac{7}{8}$	8	$\frac{3}{4}$	$\frac{1}{4}$
3	$8\frac{1}{4}$	$1\frac{1}{8}$	$6\frac{5}{8}$	8	$\frac{3}{4}$	$\frac{9}{32}$
$3\frac{1}{2}$	9	$1\frac{3}{16}$	$7\frac{1}{4}$	8	$\frac{3}{4}$	$\frac{9}{32}$
4	10	$1\frac{1}{4}$	$7\frac{7}{8}$	8	$\frac{3}{4}$	$\frac{5}{16}$
5	11	$1\frac{3}{8}$	$9\frac{1}{4}$	8	$\frac{3}{4}$	$\frac{3}{8}$
6	$12\frac{1}{2}$	$1\frac{7}{16}$	$10\frac{5}{8}$	12	$\frac{3}{4}$	$\frac{3}{8}$
8	15	$1\frac{5}{8}$	13	12	$\frac{7}{8}$	$\frac{7}{16}$
10	$17\frac{1}{2}$	$1\frac{7}{8}$	$15\frac{1}{4}$	16	1	$\frac{1}{2}$
12	$20\frac{1}{2}$	2	$17\frac{3}{4}$	16	$1\frac{1}{8}$	$\frac{9}{16}$
14 O. D.	23	$2\frac{1}{8}$	$20\frac{1}{4}$	20	$1\frac{1}{8}$	$\frac{5}{8}$
15 O. D.	$25\frac{1}{2}$	$2\frac{1}{4}$	$22\frac{1}{2}$	20	$1\frac{1}{4}$	$\frac{11}{16}$
18 O. D.	28	$2\frac{3}{8}$	$24\frac{3}{4}$	24	$1\frac{1}{4}$	$\frac{3}{4}$
20 O. D.	$30\frac{1}{2}$	$2\frac{1}{2}$	27	24	$1\frac{1}{4}$	$\frac{13}{16}$
24 O. D.	36	$2\frac{3}{4}$	32	24	$1\frac{1}{2}$	$\frac{15}{16}$

In order to maintain a standard flange connection, I would use a 28-inch O. D. flange, $24\frac{3}{4}$-inch diameter bolt circle, flange thickness $2\frac{3}{8}$-inch, with 24 $1\frac{1}{4}$-inch bolts for the nozzle illustrated in Fig. 1.

Layout Using Large Arcs

Q.—Referring to the illustration below, when laying out an arc with a very large radius, as in the camber in a tapered shell course, or a large cone, how are the distances *x-y-z* found when *h* has already been determined? Also how is *h* determined?

I am familiar with the rule that gives $x = 15/16 \times h$, $y = 12/16 \times h$ and $z = 7/16 \times h$, but on some arcs when h = 20 inches ± and C = about 25 inches ± this method, I have found, does not produce a true arc. When the angle at the center from which the arc would be struck is more than 30°, it is more noticeable.

I have used the above method successfully when h = 3 inches or less and C is large. B. H.

A.—The sketch submitted with the question is illustrated in Fig. 1 with the exception that the radius R was not shown.

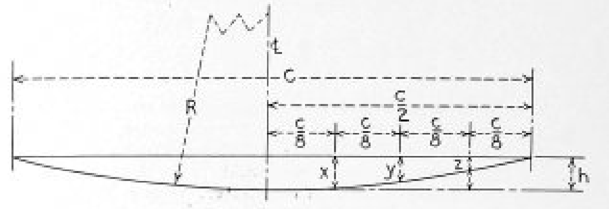

Fig. 1

In order to determine dimension h it is necessary to know the radius R in addition to the chord C, Fig. 1.

Fig. 2 illustrates a right conical course in which

A = diameter of large end of conical course.
B = diameter of small end of conical course.
F = length of course.
R = generating radius of whole cone.

$$a = \frac{A}{2}$$

$$b = \frac{B}{2}$$

then

$$E = \sqrt{F^2 + (a - b)^2}$$

and

$$R = \frac{Ea}{a - b}$$

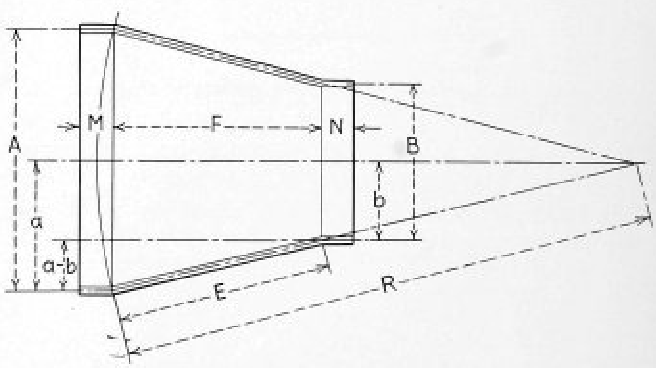

Fig. 2

Referring to Fig. 1,

$$h = R - \sqrt{R^2 - \left(\frac{C}{2}\right)^2}$$

$$x = h - \left(R - \sqrt{R^2 - \left(\frac{C}{8}\right)^2}\right)$$

$$y = h - \left(R - \sqrt{R^2 - \left(2 \times \frac{C}{8}\right)^2}\right)$$

$$z = h - \left(R - \sqrt{R^2 - \left(3 \times \frac{C}{8}\right)^2}\right)$$

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Office of Industrial Recovery Committee,
15 Park Row, New York
Secretary—H. E. Aldrich.

Steel Plate Fabricators Association

President — Merle J. Trees, 37 West Van Buren Street, Chicago, Ill.

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

States

Arkansas	Missouri	Rhode Island
California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maine	Oklahoma	District of Columbia
Maryland	Oregon	Panama Canal Zone
Michigan	Pennsylvania	Territory of Hawaii
Minnesota		

Cities

Chicago, Ill.	Los Angeles, Cal.	Memphis, Tenn.
Detroit, Mich.	St. Joseph, Mo.	Nashville, Tenn.
Erie, Pa.	St. Louis, Mo.	Omaha, Neb.
Evanston, Ill.	Scranton, Pa.	Parkersburg, W. Va.
Houston, Tex.	Seattle, Wash.	Philadelphia, Pa.
Kansas City, Mo.	Tulsa, Okla.	Tampa, Fla.

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

States

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

Cities

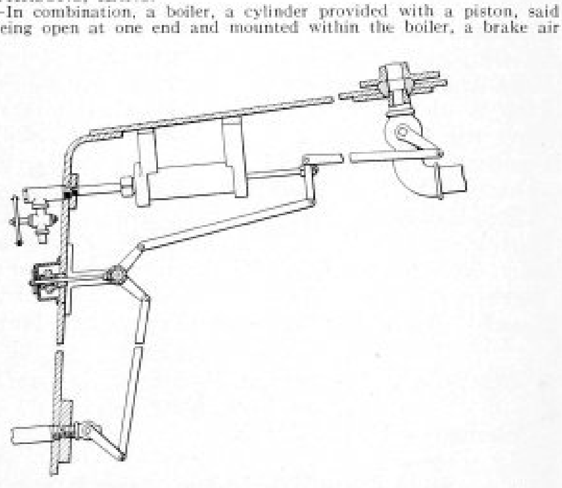
Chicago, Ill.	Memphis, Tenn.	St. Louis, Mo.
Detroit, Mich.	Nashville, Tenn.	Scranton, Pa.
Erie, Pa.	Omaha, Neb.	Seattle, Wash.
Kansas City, Mo.	Parkersburg, W. Va.	Tampa, Fla.
	Philadelphia, Pa.	

Selected Patents

Compiled by Dwight B. Galt, Patent lawyer, Earle Building, Washington, D. C. Readers desiring copies of patents or any information regarding patents or trade marks should correspond directly with Mr. Galt.

1,925,581. SAFETY SHUT-OFF FOR LOCOMOTIVES. ELIJAH W. BAYES, PARSONS, KANS.

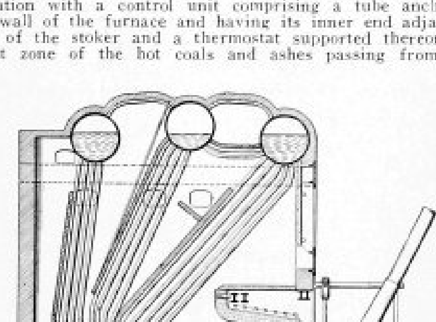
Claim.—In combination, a boiler, a cylinder provided with a piston, said cylinder being open at one end and mounted within the boiler, a brake air



supply line communicating with the cylinder at its opposite end, a steam outlet conduit having a valve therein, and a connection between the valve and the piston whereby the valve is closed when the piston is actuated by the steam pressure of the boiler. Three claims.

1,920,572. FURNACE GRATE STOKER CONTROL. WILLIAM A. LACKE, CHICAGO, ILL., ASSIGNOR, BY MESNE ASSIGNMENTS, TO PULLMAN CAR & MANUFACTURING CORPORATION, A CORPORATION OF DELAWARE.

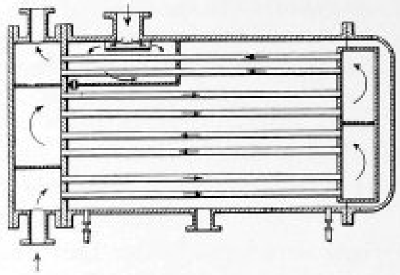
Claim.—In grate stoker mechanism for feeding fuel through a furnace, the combination with a control unit comprising a tube anchored at one end in the wall of the furnace and having its inner end adjacent the discharge end of the stoker and a thermostat supported thereon within the radiant heat zone of the hot coals and ashes passing from the stoker,



of means associated with said unit for shielding the thermostat from the enveloping heat of the furnace and ashpit, and a solenoid in series with the thermostat and so placed with respect to said stoker mechanism as to cause reduction of speed thereof upon closure of said circuit, said tube at its wall end being open to the atmosphere whereby the thermostat supported upon its inner end will be swept by air drawn there through and in the path of heated materials discharged from the stoker. Four claims.

1,894,760. FEED WATER HEATER. GERALD D. DODD, OF PLAINFIELD, NEW JERSEY, ASSIGNOR TO FOSTER WHEELER CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

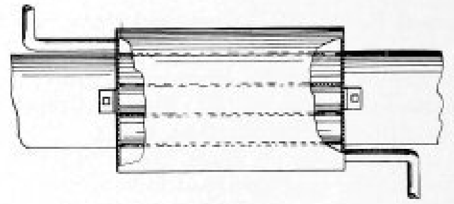
Claim.—A feed water heater comprising a shell, a feed water inlet, a feed water outlet, means comprising a plurality of parallel tubes forming a path of flow of water from the inlet to the outlet, the heater having a steam space around the tubes, means comprising a baffle within said shell transverse to said tubes and a baffle parallel to said tubes, said baffles forming a chamber in said steam space in heat transfer relation with said path of flow at an advanced point of flow, an inlet for steam to said chamber, an aperture for admitting steam from the chamber into the remainder of the steam space, means to drain con-



densate from said chamber into said remainder of the steam space and means to drain condensate from said remainder of the steam space. Two claims.

1,925,032. FUEL HEATER. EDWIN M. DUNNER, POLK, OHIO.

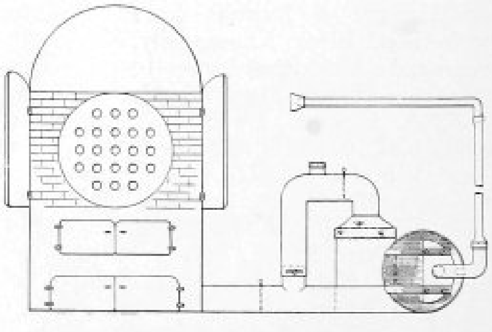
Claim.—A fuel conditioner of the class described comprising a casing adapted to surround an exhaust pipe, the casing having inlet and outlet means for the fuel, a clamp on the casing intermediate ends to secure the casing about an exhaust pipe, and means acting counter to the clamp to abut the exhaust pipe, said clamp and last mentioned means coacting to adjustably secure the casing



to the exhaust pipe according to the degree of heating desired for the fuel, the second mentioned means comprising a bracket on each end of the casing, screw members threaded in the brackets and adapted to abut the exhaust pipe. One claim.

1,926,930. BOILER CLEANING APPARATUS. CHARLES BACHER, NEW YORK, N. Y.

Claim.—The combination with a tube boiler and its setting, of a blower, a pipe connecting said blower with the lower part of the boiler setting for conducting air under pressure from the blower to the combustion space of said boiler setting, a receptacle, a second pipe connected to the first-mentioned



pipe and to the receptacle, a valve in said first pipe between the boiler setting and the point of connection of the second pipe, a valve in the second pipe, the second pipe having a capped opening between the valve therein and the connection of the second pipe with the first mentioned pipe and a detachable tube leading from the air inlet end of the blower and adapted to be placed at the ends of the boiler tubes. One claim.

Boiler Maker and Plate Fabricator

Final Issue of Boiler Maker and Plate Fabricator

With the June issue, BOILER MAKER AND PLATE FABRICATOR as a separate unit of the Simmons-Boardman Publishing Corporation brings to an end its career in the field of heavy plate work. For thirty-four years this publication has been devoted to the design, construction, inspection and repair of boilers of all types, pressure vessels, and miscellaneous plate fabrications, as well as to the thousand and one problems of organization management, equipment and materials that go to make up the industry. Conditions brought on by the years of depression have altered the situation materially in the field served outside railroad boiler work. In the interests of efficiency and economy this outside field, served ably by other publications, is being relinquished. Beginning in July, features of BOILER MAKER AND PLATE FABRICATOR which have dealt specifically with locomotive boiler work will be carried forward in *Railway Mechanical Engineer*. The circulation department of the Simmons-Boardman Publishing Corporation will notify all readers of the contemplated change and will further adjust all outstanding subscriptions satisfactorily. Readers in the railway field who do not already receive *Railway Mechanical Engineer* will be supplied with that publication for the duration of their subscription periods. In the power boiler and plate fabricating fields, subscribers will receive adjustments for their subscriptions on BOILER MAKER AND PLATE FABRICATOR

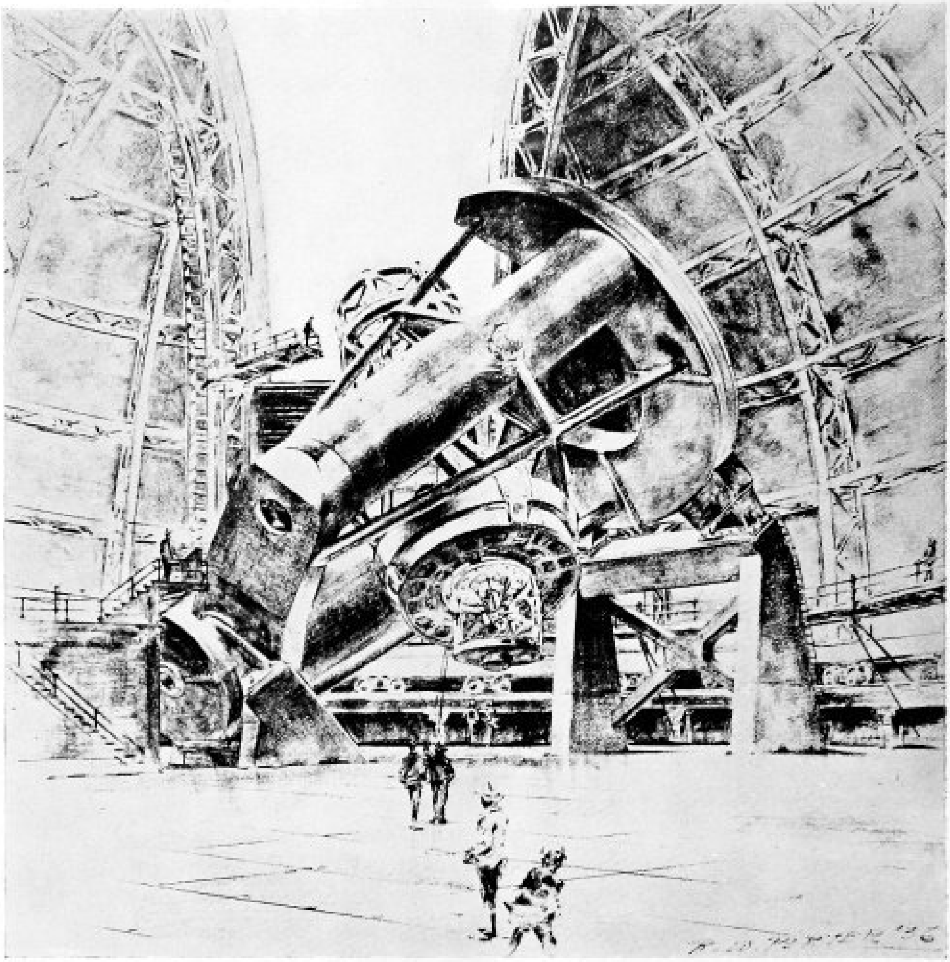


Fig. 1.—Artist's conception of the 200-inch telescope to be installed at Mt. Palomar, Cal.

Welding the Mounting for World's Largest Telescope

By Norman L. Mochel*

One of the most complicated and extensive plate fabricating projects by welding now under way is that of the mounting for the 200-inch telescope to be installed on Mt. Palomar, Cal., in the next two or three years. The work of building this mounting, which weighs nearly 1,000,000 pounds, is being carried out at the South Philadelphia Works of the Westinghouse Electric & Manufacturing Company.

A general conception of the telescope, which is the world's largest precision instrument, may be gained from the artist's sketch at the beginning of this article.

The telescope tube consists of several sub-assemblies bolted together—the cage, top ring, five central panels, a bottom ring and a mirror cell. The upper and lower rings are connected to the square center section by means of I-beams. The yoke itself is composed of ten major sections plus four 2-foot diameter struts. The horseshoe forming the north girder will be the world's largest bearing journal. The assembled horseshoe with its balancing pieces will weigh 400,000 pounds.

* Metallurgical engineer, Westinghouse Electric & Manufacturing Company, South Philadelphia Works.

Manufacturing Data

Type of Construction. Hollow box sections—welded—low carbon steel throughout.

Major Dimensions. Tube 22 feet 1 inch diameter, 45 feet long. Consists of upper ring, lower ring, 3 box panels in center, 2 south center sections, connecting structural shapes. Total weight 150,000 pounds.

Cage 22 feet 1 inch diameter, 12 feet long. Consists of upper and lower rings, 8 columns, I-beam braces. Weight 26,000 pounds.

Yoke: Horseshoe, north end outside diameter 46 feet; inside diameter 24 feet, thickness 4 feet. Weight 350,000 pounds. Side girders, two 10 feet 6 inches outside diameter, 50 feet long and 1-inch thick metal. South end beam, 46 feet by 10 feet, 6 inches by 5 feet. Weight 370,000 pounds.

Total weight of mounting 900,000 pounds, 450 tons.

The decision to employ arc-welding so extensively in the construction of tube and mounting of the 200-inch telescope for Mount Palomar is another outstanding example of the confidence in the welding art, that has been developed in the minds of engineers in many fields of activity. There is nothing of an experimental nature in the adoption of welded construction for the various members of the telescope.

In the case of the telescope, steel plates, bars, structural shapes and a few steel forgings have been welded together to form the member parts. The size and shape of these member parts naturally reflect the general design, but have also been influenced by such practical considerations as the availability of material, machining facilities, transportation, and the necessity for minimizing internal stresses and resulting distortions.

It must be understood that the various member parts are prepared by machining for bolting together at Mount Palomar. Frequent references to all-welded construction may have given the erroneous impression that member parts were to be joined on location by welding. The writer has encountered this impression with many persons who inquired of the matter. It is true that in many large engineering structures, member parts have been and are being joined by welding on location. However, in such cases, invariably the construction and intended service are such as to tolerate distortions that would take place during welding or during the useful life of the apparatus, or in which the presence of variable and unknown degrees of internal stress are of little concern. Obviously such conditions could not be tolerated in the construction now under discussion.

In any discussion of welding, one is naturally interested in the materials that are to be used, and that must submit to welding. Again one encounters an erroneous impression, that a telescope must be constructed largely of special alloys that have low expansivity. While it is true that some materials of this type are used in connection with the mirror and other optical parts, most of the material used for the tube and mounting is quite ordinary mild carbon steel.

In all cases, plates, bars and structural shapes have been rolled by one supplier from specially selected heats, to give the greatest possible uniformity of composition. Plates less than 1½ inches thick were made of the usual flange quality of steel plate, similar to that covered by A. S. T. M. Specification A-70. All such steel for the tube was made from a single heat, specially melted for the purpose. Plates 1½ inches thick and greater were rolled from silicon-killed steel poured into hop-top ingots, to guarantee soundness of section. This steel is similar to grade "A," A. S. T. M. Specification A-150. Two carbon-molybdenum steel forgings are used in building up the declination bearing housing.

It is interesting, in connection with the materials used, to note that each outer band for the three sections of the horseshoe required a piece of plate 4½ inches thick by 60 inches wide by 47 feet long. These pieces were accurately formed to desired curvature under the 12,000-ton forging press at Bethlehem.

Arc welding only has been employed and, in all cases, heavily coated electrodes of the mineral-coating or slag-producing type were used. These were of but two makes; both of the highest quality available.

It is well recognized today that electrodes can be devised that will best meet some given condition of deposition. Full advantage of this has been taken and three kinds of electrodes, as regards position of deposition,

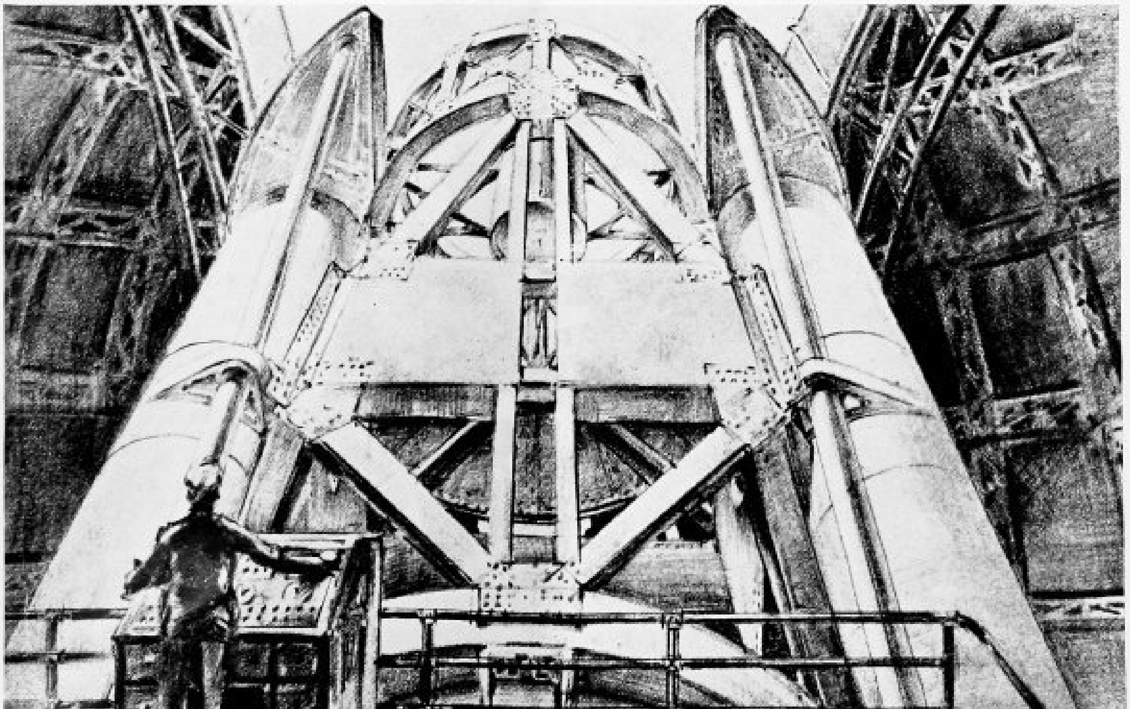
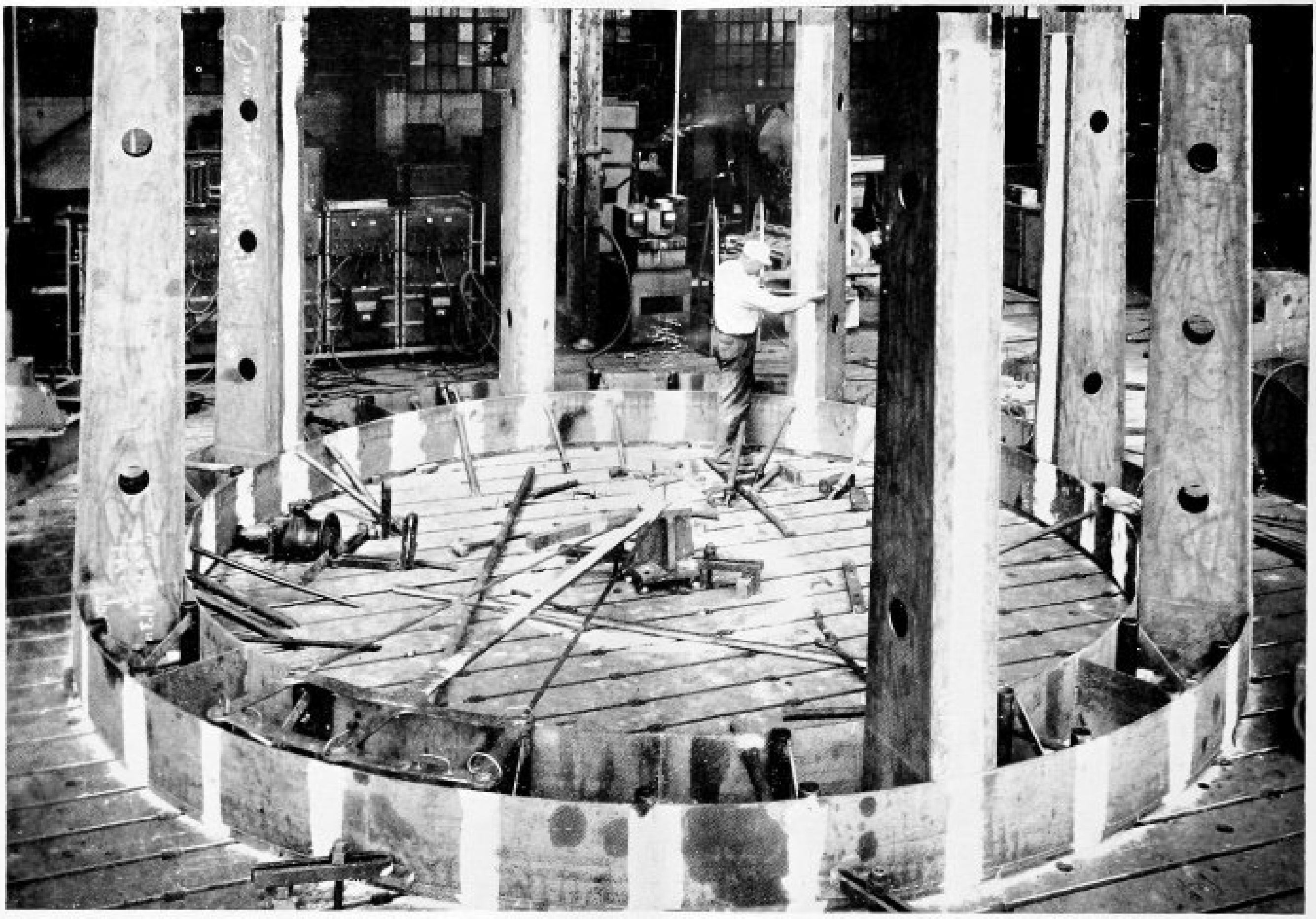


Fig. 2.—A "preview" of the telescope with an operator at the control stand



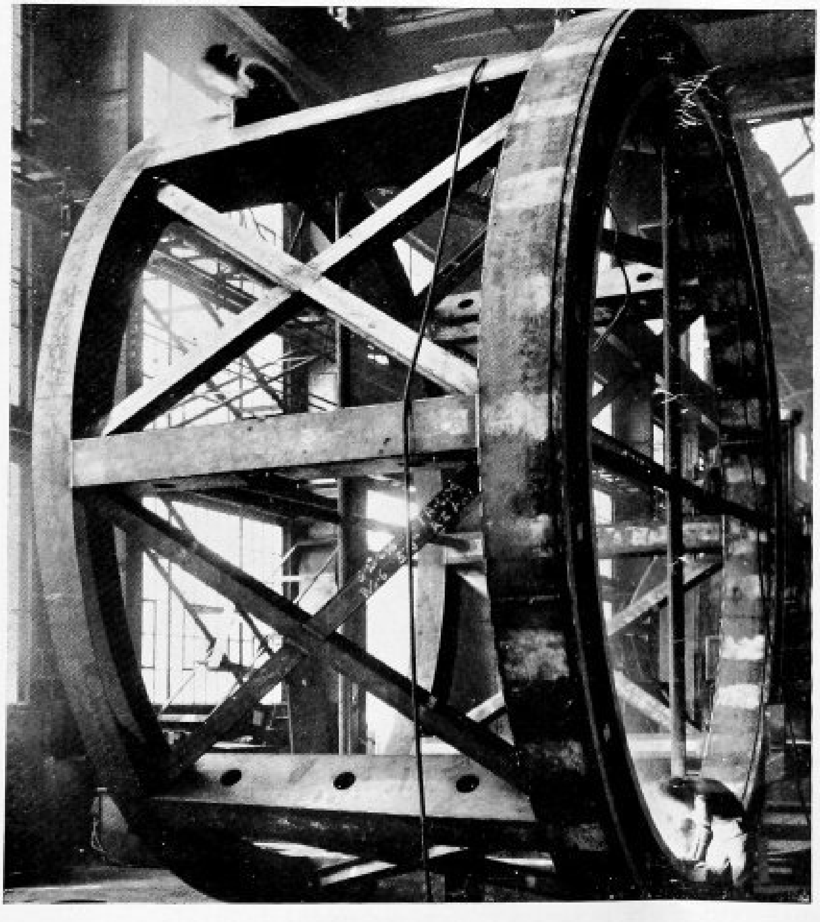
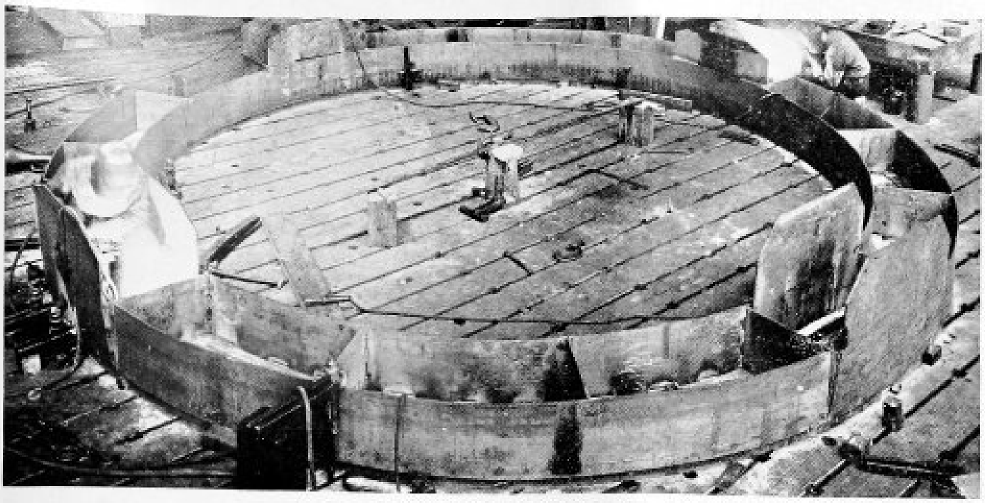


Fig. 3.—Fabrication of the bottom ring and uprights of the prime focus cage. Fig. 4.—(Left) Work of fabricating the prime focus cage nearing completion, with welders supplying the finishing touches



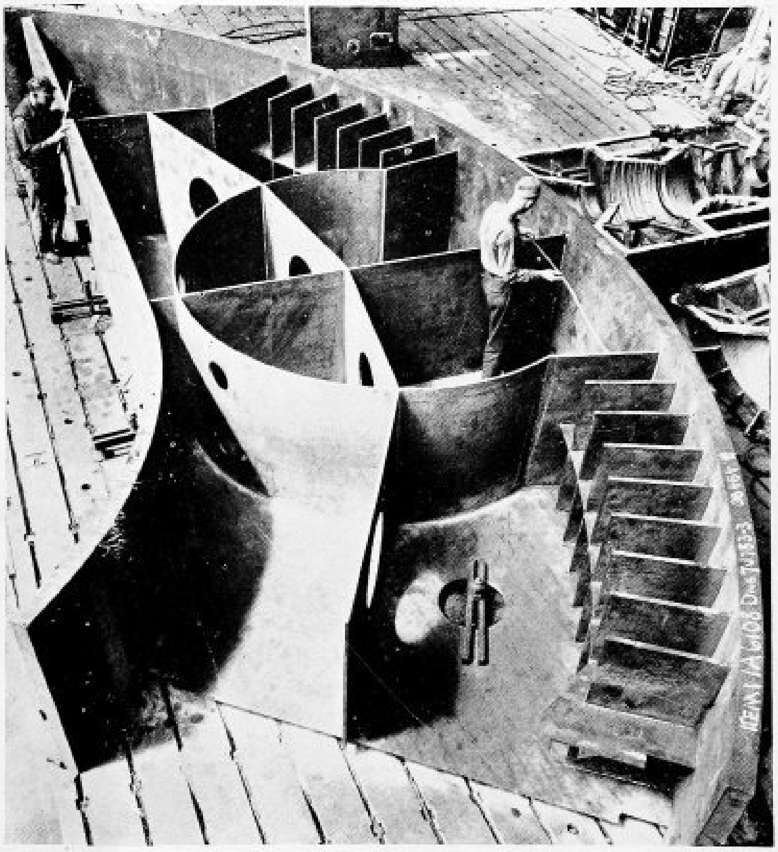
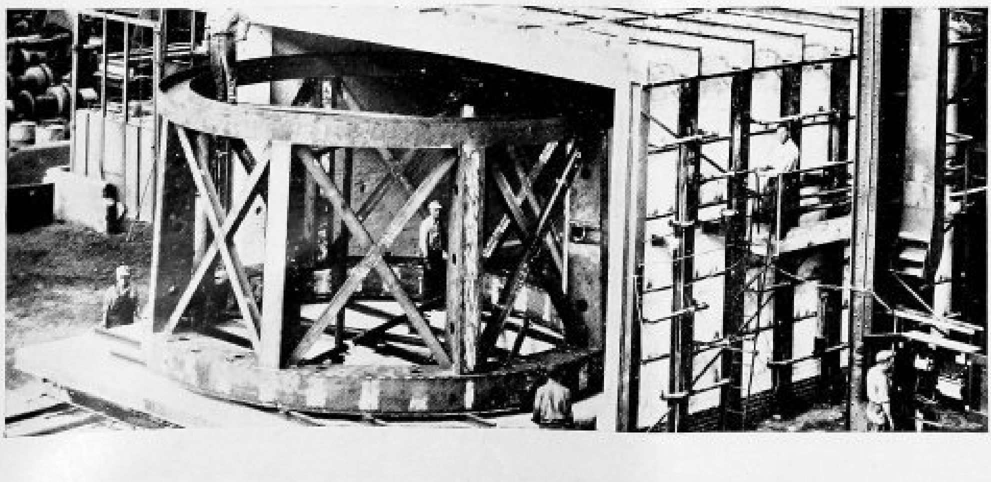


Fig. 5.—Fabrication of the upper end ring of the main tube section. Two welders are working on opposite sides simultaneously to better distribute heating and cooling effects. Fig. 6.—(Right) Early stage in the construction of one section of the yoke horseshoe. Fig. 7.—(Bottom) Prime focus cage being moved into the annealing furnace



have been used. One was used for all down-hand butt welds; another for all down-hand or horizontal fillet welds; and yet another for welds that of necessity had to be made in a vertical position. Overhead welding has been avoided.

In our regular work at South Philadelphia, we are called upon to qualify our welders to a variety of codes and specifications. For example, we have had construction under way on our floors at practically the same time requiring that we meet the A. S. M. E. Boiler Code for Unfired Pressure Vessels, and A. P. I.-A. S. M. E. Code for Unfired Pressure Vessels for the Petroleum Industries, the U. S. Navy, the Bureau of Marine Inspection and Navigation, American Bureau of Shipping, the Pressure Piping Code, and the requirements of two well-known insurance companies. Of necessity, we have developed all-inclusive codes and process specifications of our own, so that qualification under our own more extensive requirements qualifies an operator to perform under any of the above codes and specifications.

Operators performing welding on the telescope tube and mounting have qualified under the outlined system, and are welders of the highest type.

The electrodes used in this welding are of such nature that they behave equally well with direct current or alternating current welding apparatus. Both direct current and alternating current units are available at South Philadelphia and both have been used throughout. The alternating current welding was found to be especially useful for welding into corners.

All welding on the tube parts and to date on the horseshoe has been manual welding. The two declination bearing housings were produced using automatic welding for the longitudinal and external circumferential welds.

In welding such large parts as those being described, careful study and planning of the work is very important. There is a best place to start, and a best sequence of operations. One does not have an opportunity to practice with a first few and thus develop a final technique. There are no trial pieces to be thrown away. In the case of some parts, there is but one piece of a kind to make; in others, there are two like pieces.

For welding such large structures as those under discussion, large leveled floor plates are of absolute necessity. The need for ample space, for proper supporting, and of firm foundation will be obvious from an examination of a number of the illustrations accompanying this article.

The welding of the tube parts and the progress to date on the first horseshoe section can probably best be described by the use of illustrations showing the several parts, and supplemented by comments in passing.

Fig. 3 shows a stage in the fabrication of the prime focus cage. The lower main ring of the cage was formed on the floor plate and the uprights, formed elsewhere as detail parts, assembled as shown. The ring is approximately 22 feet in outside diameter and the cage is roughly 12 feet long with the top ring in place. The gage for controlling the proper radius and for accurately locating the pieces of tubing that are in evidence, will be noted. The simple method for supporting and clamping the ring both inside and out is shown. The welding art has certain advantages over other methods of fabrication when it comes to supporting and clamping down, as clamping block, struts, stays, etc., can always be attached exactly where wanted by welding. They are readily removed later. The use of intermittent welding will be noted in most of the parts.

In Fig. 4, the prime focus cage is nearing completion, so far as welding is concerned. The forming of the "X" members from "I" beams will be noted, the method of joining by welding being plainly shown. Crossed tubular supporting members at each ring have been welded in place to hold securely the rings in shape during handling to and from the annealing furnace, and during annealing.

In Fig. 5, work is in progress in the manufacture of the upper end ring of the tube, the ring to which the prime focus cage will be secured. This ring is approximately 22 feet outside diameter. It will be noted that two welders worked on opposite sides simultaneously, to better distribute heating and cooling effects.

Fig. 6 shows early stages in the fabrication of one of the end sections of the horseshoe. This horseshoe has an outside diameter of approximately 46 feet. Reference has already been made to the size of plate used to form the outer band. The one side plate was first formed.

The internal plates, reinforcing members, etc., were fitted in place and secured by tack weldings. After properly fitting the cellular or box-like structures that fasten to the outer band and fixing the various component parts by welding a bar across them, they were removed from the main part and welded under the most ideal conditions on the floor. This had a double advantage. It permitted turning them in any position to get the best welding, and it avoided setting up undue heating and stressing of the main members by the considerable amount of welding necessary. There were five of these sub-assemblies; two are shown in place in Fig. 6 and spaces for the other three may be readily appreciated. While this was under way, welding was carried out on the larger reinforcing members shown in Fig. 6. Welding was started at the center and worked outward. At the time shown, the welding of these members was practically completed. The five sub-assemblies were then moved back into position and welded in place.

All of the telescope parts have been carefully annealed to relieve internal stresses. It is standard recognized practice to stress-relieve welded mild carbon steel structures by heating slowly in a suitably constructed furnace to a temperature of 1100/1200 degrees F., holding for a period of time proportioned on the basis of at least one hour per inch of thickness and then cooling slowly in the furnace.

In order to stress-relieve thoroughly the telescope parts, we have used a double annealing cycle, heating to 1150/1200 degrees F., holding for a period of three hours for the first one inch of thickness plus an additional hour for each additional one inch thickness or fraction thereof, followed by a slow cooling in the furnace until the temperature has fallen below 600 degrees F.; and then repeating this cycle in its entirety and cooling below 300 degrees F. before the furnace doors are opened.

Fig. 7 shows the prime focus cage being moved into the annealing furnace. The furnace shown was especially constructed to anneal the telescope parts. The work rests on a car type bottom for ease of operation. A special type of gas burner was used that gives a quieter acting flame and avoids long hot flames impinging upon the work. Burners are also located in the truck or car at the front of the furnace to avoid a cold spot at the front. The door or front cover of the furnace is made in sections that hang from the roof and tightly seal the furnace. Baffles of heat insulating bricks were built up at four points where the circumference of the cage came too close to the walls and the burners to prevent undue or rapid heating at those points. Thermocouples were in actual contact with the work and continuous autographic records were made

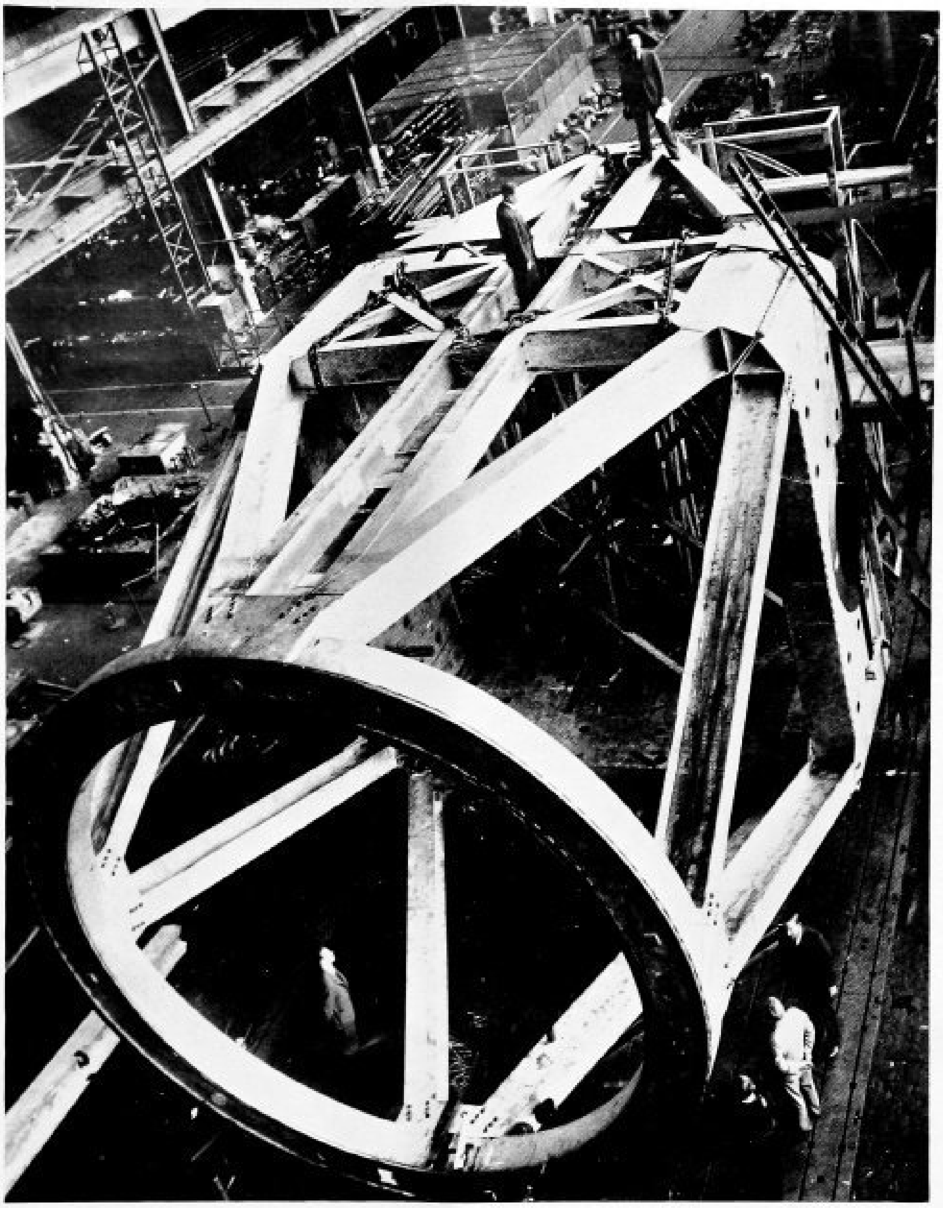


Fig. 9.—The completed tube which will carry the 200-inch mirror and form the barrel of the telescope. Fig. 8.—(Right) Main section of the tube partially assembled

from four thermocouple locations throughout all annealing periods.

The following summarizes the treatment of the prime focus cage, as an example:

12 hours heating to 1160 degrees F.
6 hours holding at 1150/1160 degrees F.
11 hours cooling to 600 degrees F.
10 hours reheating to 1150 degrees F.
6½ hours holding at 1150/1160 degrees F.
42 hours cooling to 125 degrees F.

Reference was made earlier, in commenting on Fig. 4, to the crossed tubular supporting members at each end. If one closely examines Fig. 7 it will be noted that additional tubular members were placed in an upright position between the crossed members to prevent their sagging and possibly distorting the ring sections during annealing. Also, blocks were placed on the car floor underneath the lower crossed members to prevent their sagging. Supporting of support members is just one item of the care that must be used in such work.

One is naturally interested in the results of the welding, how closely were the parts held to size throughout welding and annealing. Four indications will be cited.

When the prime focus cage was placed on the boring mill to face the lower end where it bolts to the top ring of the tube, the departure from roundness was not greater than 1/16 inch.

When the top ring of the tube was placed on the mill to face the upper end, which takes the prime focus cage, the departure from roundness was of the order of 3/32 inch.

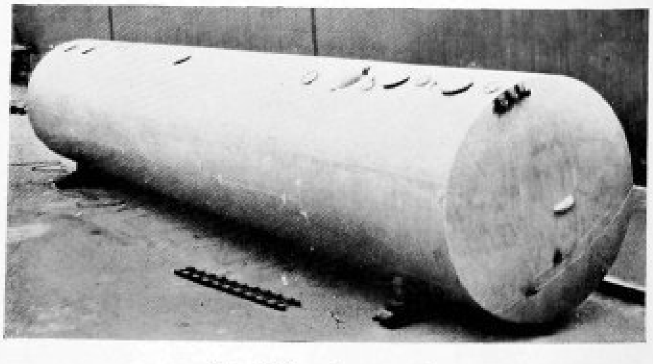
Fig. 8 shows the partially assembled tube. At the lower right, the bolted joint of the two panel sections will be noted. These two flanges were not machined on the edge or outside surface, yet at no place in four such joints was there more than 3/16 inch difference between two mating flanges along these outside unmachined surfaces. In general, the joints were much closer than this figure. The joint faces were, of course, machined to a definite fit. There was very little difference in thickness of the mating flanges.

Referring further to Fig. 8, when the top ring was lowered into place, the four gussets that bolt to the "A" frames were found to be accurate as to position within approximately 1/16 inch. The finished tube is shown in Fig. 9.

All parts are carefully cleaned prior to painting by sand blasting. A priming coat of aluminum paste in varnish is first applied. This has been considered more desirable than a red or blue lead or a red oxide primer, so that as scratching occurs in handling or later in service, the objectionable appearance of blue or red streaks will not be in evidence. A high grade eggshell synthetic resin enamel of light gray color will be used for the second coating.

All-Welded Salvage Floats Built in Argentina

Destined for use in salvaging vessels, the huge float illustrated was built in a South American shipyard with North American products. The float was built by the Argentina government in its shipyard at Buenos Aires, using electric welding equipment manufactured by The Lincoln Electric Company, Cleveland, O. The float is 19 meters (over 62 feet) in length by 3½ meters (approximately 11½ feet) in diameter and weighs 28 tons. The shell of the float is fabricated of 3/8-inch plate reinforced from the inside by nine rings of steel and a veritable net work of cross and lateral bracings. Fusing the various pieces of steel together into one single unit required more than one ton of arc welding electrode.



All-welded salvage pontoon

New Hydraulic Scaffold Is Traveling Elevator

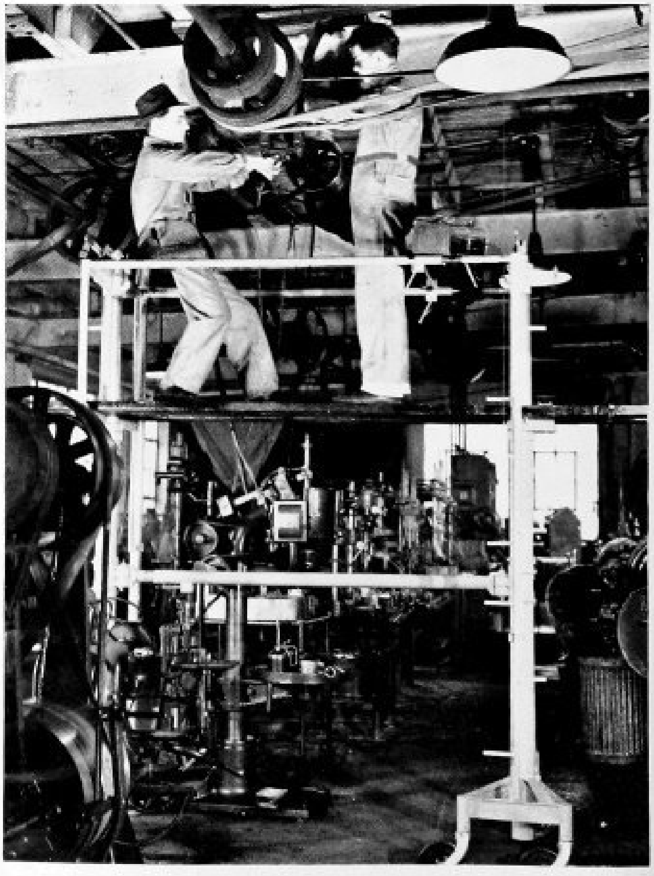
A demountable hydraulic scaffold that may be raised, lowered, extended or contracted, and driven from one vantage point to another by mechanical means actuated from the working platform, appears destined to put new flexibility, speed, economy and safety into a long list of shop, factory and building maintenance situations.

The new scaffold, called "DecoVator," is made entirely of steel; it is light in weight and its parts are easily disassembled and transported.

In its assembled state, the DecoVator scaffold provides its own ladder as well as benches for tools and materials, and the complete lifting and traveling mechanism. The "reach" of the hydraulically raised and lowered platform is considerable; one DecoVator model is from 2 feet 8 inches in the lowest position to a height that will enable a man to work comfortably up to 16 feet. For a second model the low point is 3 feet 2 inches and men can service work up to 22 feet high.

The platform is elevated by the worker upon it at the rate of eight feet per minute, and lowered at 10 feet per minute. The entire scaffold structure, which comes with rubber-tired wheels, may be jockeyed from above, in any direction, at a ground speed of 50 feet per minute.

The manufacturer of this device is the DecoVator Scaffolding Corporation, Detroit, Mich.



A DecoVator scaffold in operation

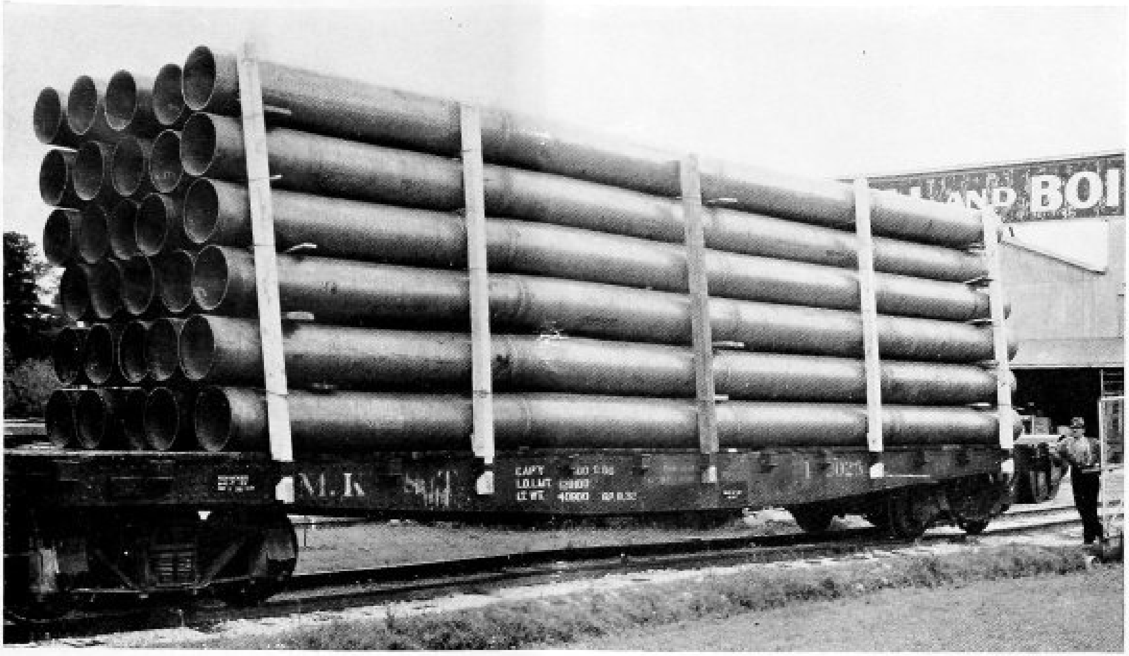


Fig. 1.—A carload of steel pipe manually fabricated by the shielded arc process of welding

The Weldability of Steel

The day when the use of the arc welding process was left in the hands of a single craftsman who represented research, design, technical supervision and labor, is over. The study of the arc welding process breaks down into two fields, the arc itself and the welding equipment which creates it, and the metals to be welded. Until recently all research was concentrated upon the first field. It soon became apparent with the observation of phenomena within the arc that the metals to be welded were of considerable importance.

All research has pointed toward faster production of stronger and more ductile welds. The factors which may affect welds have been discovered to be: Oxidation; vaporization; non-metallic inclusions; changes in structure; gas solubility; high coefficient of expansion; hot shortness; thermal conductivity.

These factors are met by the use of the shielded arc, the use of proper electrodes and fluxes, proper welding procedure and the selection of metals most suitable for welding.

We know that steel in its molten state has a great affinity for oxygen and nitrogen and that the steel deposited by the arc must be protected. The shielded arc process,* which utilizes a heavily coated electrode and suitable source of welding current, has, in a large measure, answered this problem. The coating, burning in the arc less rapidly than the electrode melts, forms in effect a crucible around the arc, protecting it for almost its entire length. The edge of the coating, burning in the arc, gives off gases which shield the arc from the harmful effects of the air. The residue from the burning coating leaves a layer of slag which protects the weld while cooling.

Not only does this process produce welds of remarkable physical characteristics but it allows a tremendous and quite economical increase in welding speed. The welds so made in mild steel have tensile strength of 65,000 to 75,000 pounds per square inch, ductility of 25 to 30 percent in two inches and resistance to corrosion better than mild steel. Oxide and nitride inclusions are eliminated. Specific gravity is 7.82 to 7.86 as compared with 7.86 for mild steel. Fatigue resistance is 28,000 to 30,000 pounds per square inch, while that of mild rolled steel itself is only 28,000. Resistance to impact of shielded arc weld metal is 50-80 foot pounds (Izod).

In order to insure these results research was directed at the metals themselves. One manufacturer, using the shielded arc process in production, suddenly noticed that he was having trouble in the welding department. The machines were checked and found perfect. There was no flaw in the technique or the electrodes.

The trouble was finally traced down to the metal which was being welded. It was discovered that the trouble had begun with a new shipment of steel. This steel was of such analysis as to affect materially its weldability and the speed of welding.

To secure the best quality weld and the highest welding speeds, it is desirable to control the metal which is melted. In the case of a joint consisting largely of melted electrodes, it is the electrode which is important. The

* Process developed by The Lincoln Electric Company, Cleveland.

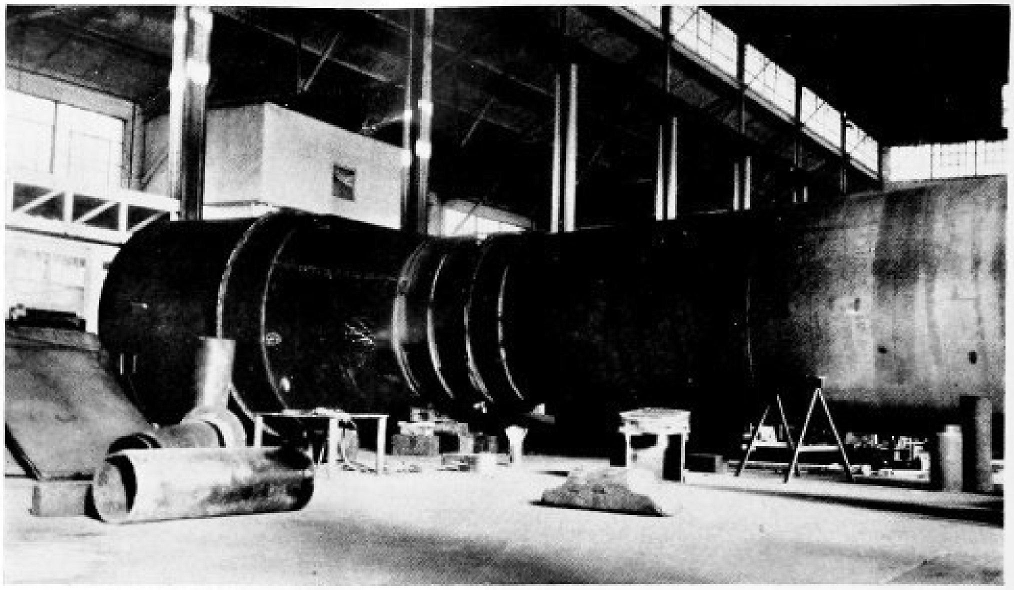


Fig. 2.—Welded Venturi meter for measuring the flow of water in the San Fernando, Cal., penstock. The meter was fabricated of ½-inch plate and is 37 feet long and 8 feet 3 inches in diameter at the ends

electrode manufacturer can, and does, control the characteristics of this metal so that the results can be relied upon. Then the control of the base metal is not so important. Where the joint consists entirely of melted base metal, or even where it is largely composed of base metal, the control of the composition of the weld metal is in the hands of the purchaser of the steel.

To sum up, in a weld such as that shown in Fig. 4, the weldability of the steel affects the weld to a minimum degree, since the joint is composed largely of deposited metal. In the case of a joint like that in Fig. 5, the weldabilty of the parent metal becomes more important.

In the case of a joint such as that shown in Fig. 4, where the automatic carbon arc process is ordinarily used, it is possible to obtain reasonably good welds in ⅜-inch plate at a speed of some 60 feet per hour (actual welding time). This applies to the use of ordinary mild steel. If steel of the proper analysis is used, as will be discussed later, the speed will be approximately 75 feet per hour, an increase of 25 percent. To sum up, it is not impossible to get good welds with run-of-the-mill steel, but better welds, faster speeds and lower welding costs can be obtained with the right steel.

Excellent results are obtained by the manual process through the use of a properly shielded arc and electrodes of exact specifications. This is the reason why joints which require large amounts of weld metal have such fine qualities. It follows that it would also be helpful to balance the elements in the steel which come under the arc. Then joints without large amounts of deposited metal will be equally sound.

For example, if you want greatest ductility it is best to keep the carbon content of the parent metal below 0.12 percent. To get high tensile strength and ductility it is absolutely necessary to shield the arc to prevent oxidation of the weld metal.

To get a highly desirable, ductile weld metal it is necessary to oxidize out only a small amount of carbon. This is easily done in the high temperatures of the arc. If we use a joint of the V type, beveling the plates in preparation for welding, this process will be successful even on high silicon structural steel of 0.30 percent carbon and 0.30 percent silicon content. However, if a plain butt joint (Fig. 4) is made in this type of steel the silicon might interfere with the oxidation of the carbon. It becomes obvious that the most economical types of joint

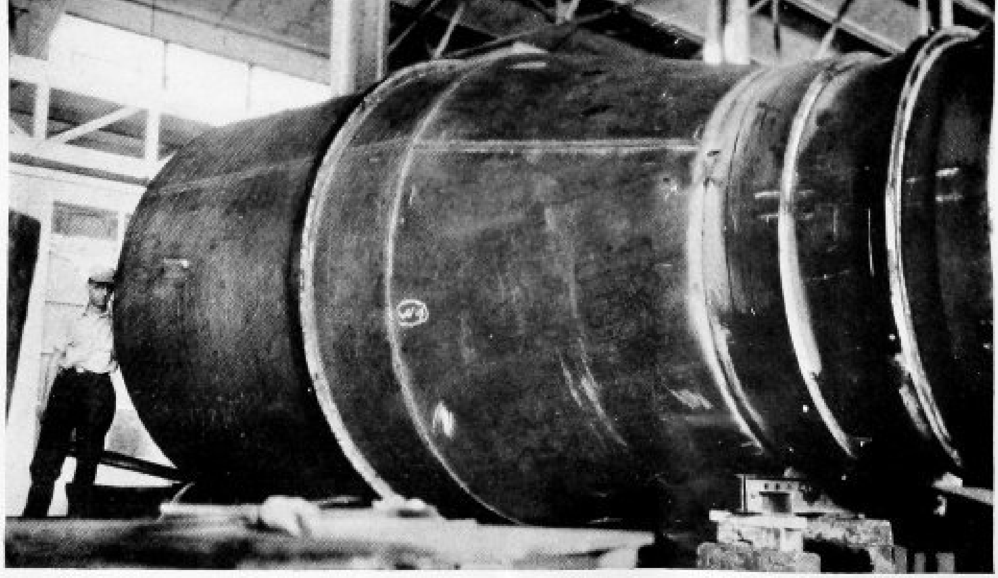


Fig. 3.—A close-up view of the shell of the San Fernando penstock showing welded girth seams and longitudinal butts

are often undesirable if the steel is not of good weldability.

Now all commercial grades of steel are weldable except high carbon spring and tool steels. The amount of carbon is, however, not the sole determining factor. Silicon and aluminum are two elements frequently found in general purpose steels and they should be in limited quantities to insure the most economical welding.

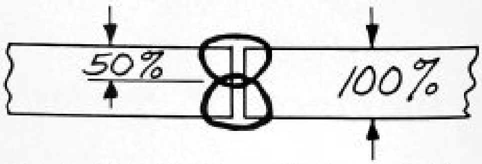


Fig. 4.—Plain butt weld, welded from both sides

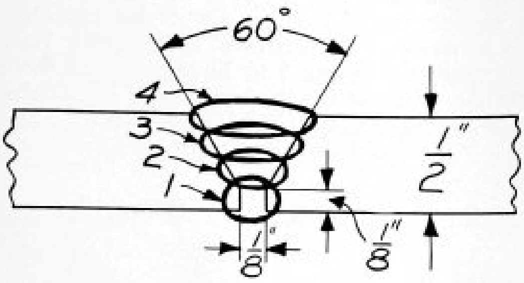


Fig. 5.—V'd butt weld

Careful research indicates the following analysis of steels for arc welding at high speeds:

Analysis of General Purpose Steel

	Percent Recommended	Percent Limits
Carbon	0.20	0.15 to 0.25
Manganese	0.45	0.35 to 0.60
Silicon	0.04	*0.07 maximum
Sulphur	...	0.05 maximum
Phosphorus	...	0.045 maximum
Aluminum	* none added	* not over 2 ounces per ton added to steel

The maximum welding speed for soft steel, which permits considerable cold forming, will generally be less than that for the higher carbon general purpose steel.

Analysis of Steel for Considerable Cold Forming

	Percent Recommended	Percent Limits
Carbon	(as high as practical)	0.07 to 0.15
Manganese	0.40	0.35 to 0.55
Silicon	...	*0.05 maximum
Sulphur	...	0.05 maximum
Phosphorus	...	0.045 maximum
Aluminum	* none added	* not over 2 ounces per ton added to steel

Analysis of 0.40 Carbon Steel

	Percent Recommended	Percent Limits
Carbon	0.40	0.35 to 0.45
Manganese	0.80	0.60 to 0.90
Silicon	0.07	*0.10 maximum
Phosphorus	...	0.045 maximum
Sulphur	...	0.055 maximum
Aluminum	* none	* not over 2 ounces per ton added to steel

* The above limits for silicon and aluminum do not apply provided the ratio of silicon to aluminum used in ladle or molds is not less than 5 to 1 or greater than 15 to 1.

The 0.40 percent carbon steel should be heat treated after welding if best results are to be obtained.

Any one who is using arc welding extensively will want to get the most out of an already efficient process and in the case of weldability of steel research has already pointed out the way.

New Fillet Welding Electrode Designed

A new electrode which eliminates necessity of multiple pass welding in production of fillet and lap welds in many applications, and which permits production of such welds without undercutting or overlap, is announced by The Lincoln Electric Company, Cleveland, O. Fillet welds up to 3/8 inch in size with one plate vertical, can be produced in one pass with the electrode. The welds are claimed to show no undercutting at the vertical plate and no overlap at the horizontal plate.

The new electrode, designated as "Fleetweld 8," is the result of considerable research and experiment by Lincoln engineers to develop an electrode which would simplify fillet welding and improve its quality and economy.

The electrode is heavily coated for welding by the shielded-arc process. The welds produced are smooth and dense with notably high physical properties. The tensile strength of the weld metal as deposited is 68,000 to 72,000 pounds per square inch. Ductility is 20 percent to 30 percent elongation in 2 inches as deposited, and 30 to 36 percent stress relieved. Other properties claimed, include resistance to fatigue, and impact and corrosion characteristics equal to or better than mild steel. Fleetweld 8 comes in 14 and 18-inch lengths. The 14-inch lengths are made in 3/8-inch, 5/16-inch, 1/4-inch, 3/16-inch and 5/32-inch sizes, while the 18-inch lengths come only in the 3/8-inch, 5/16-inch and 1/4-inch sizes. The electrode will be found of particular value by firms whose products require production of high quality fillet and lap welds to meet requirements of maximum speed and economy.

Fabrication project in which new fillet electrodes were employed

Practical Plate Development — XXV

Elbow Intersected by a Cylinder

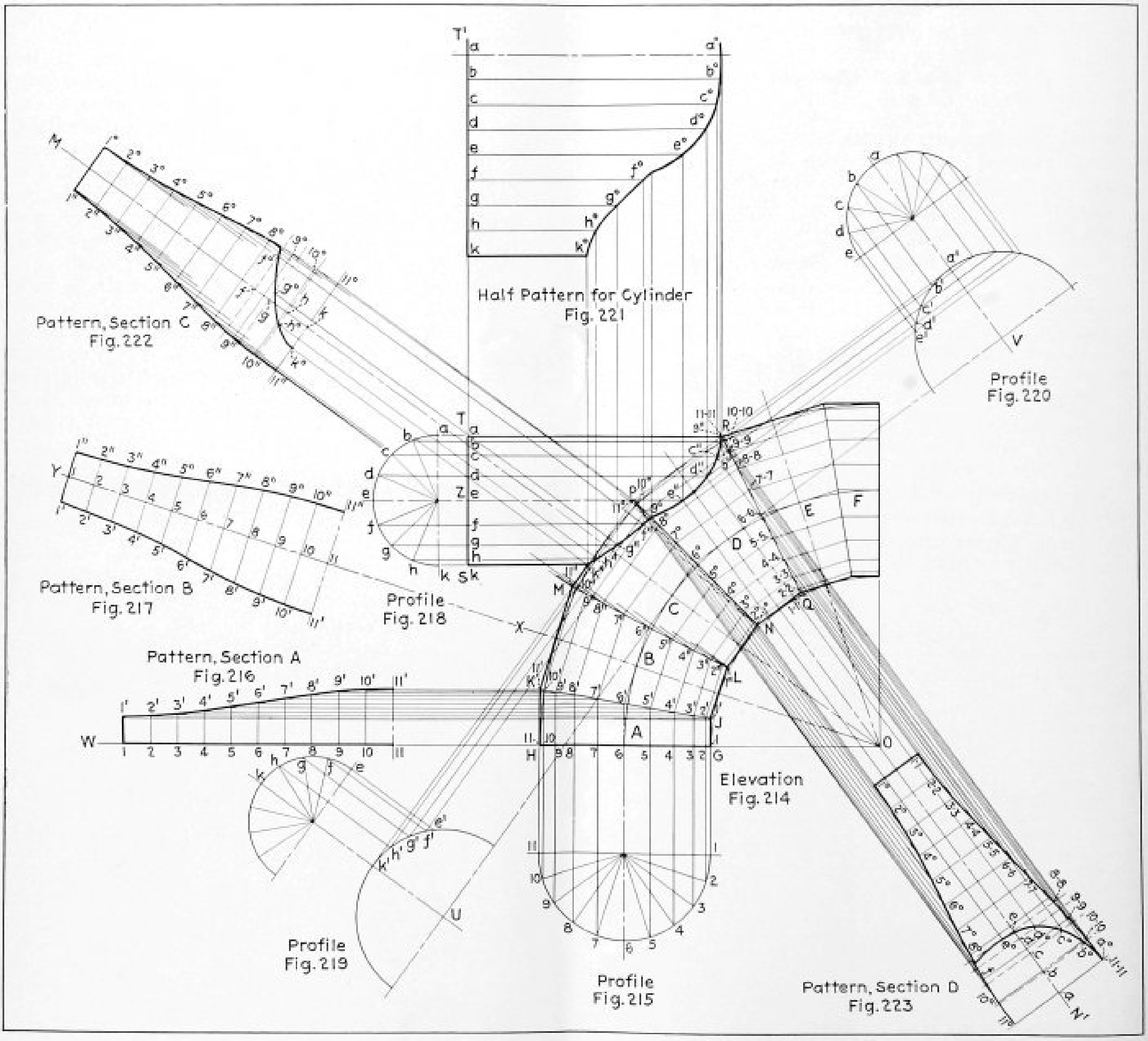
By George M. Davies

The cylinder intersecting the elbow to be developed is illustrated in the elevation, Fig. 214, and consists of a 90-degree elbow intersected by a horizontal cylinder.

For convenience in laying out the development, allowances for the thickness of plates have been omitted and the outline shown has been taken on the neutral axis of the plate. No provision has been shown on the patterns for seams or for welding.

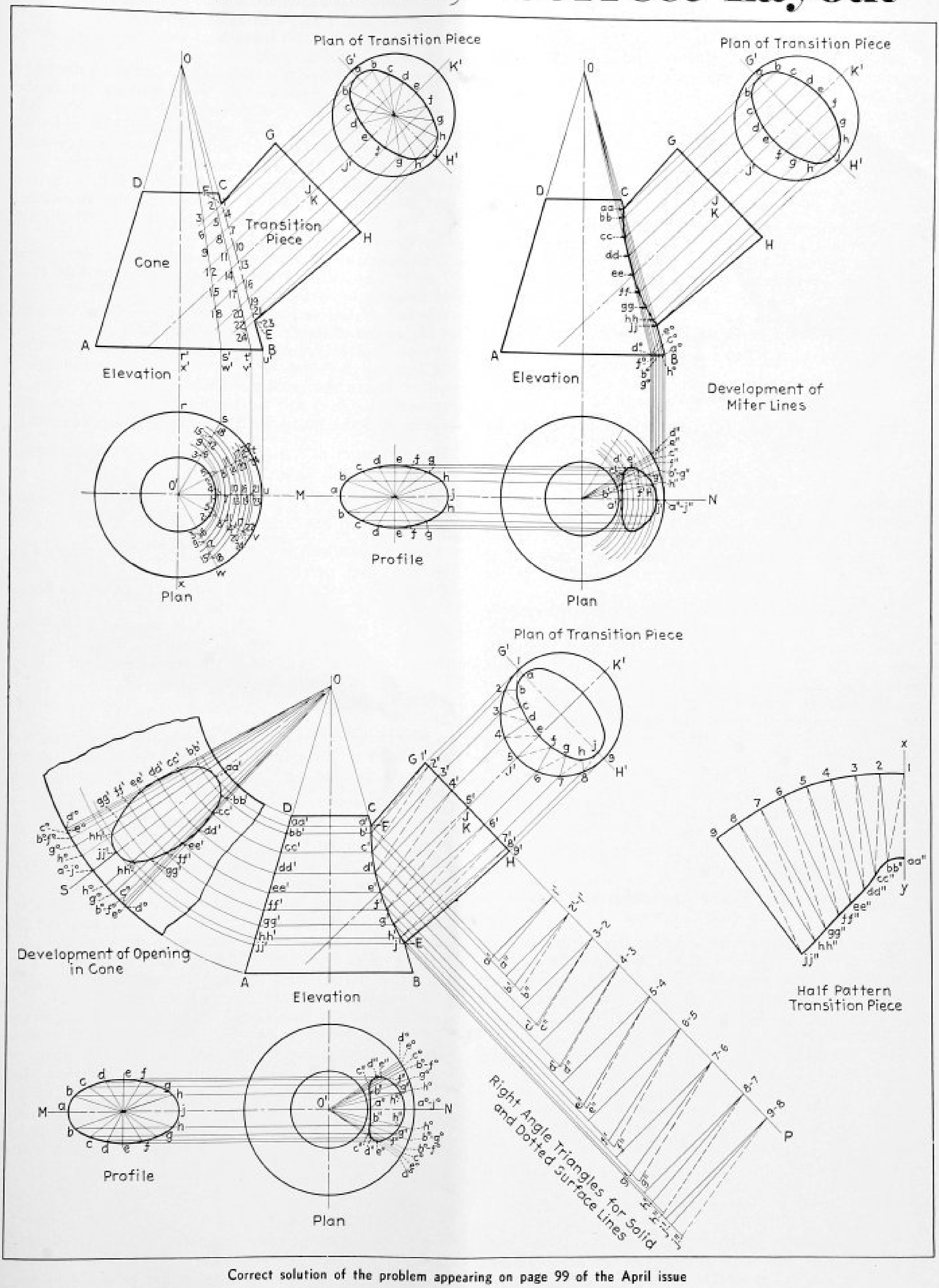
The elbow is divided into six sections, four full sections and two half sections, as shown in the elevation.

On the center line of the elbow draw the profile as shown in Fig. 215. Divide this profile into any number of equal parts, the greater the number of equal parts taken the more accurate the final development, ten being taken in this case. Number the division points from 1 to 11 as shown. Then parallel to the center line, draw lines through the points 1 to 11 and extend these lines into the elevation cutting the base line *H-G* and the miter line *J-K*. Number the intersections on the base line



Layout of elbow intersected by a cylinder

Problem No. 18.—Correct Layout



Correct solution of the problem appearing on page 99 of the April issue

H-G from 1 to 11 and on the miter line *J-K* from 1′ to 11′ as shown.

Pattern for Section "A"

Extend the base line *H-G* to *W* and on *H-W* step off ten spaces equal to the divisions taken in the profile, Fig. 215. Number these from 1 to 11 as shown in Fig. 216. Erect perpendiculars to *H-W* at the points 1 to 11, Fig. 216. Then parallel to *H-W* draw a line through the point 1′, Fig. 214, and extend this line into Fig. 216, cutting the perpendicular drawn at the point 1 and locating the point 1′, Fig. 216. Also, parallel to *H-W* draw a line through the point 2′, Fig. 214, and extend it into Fig. 216, cutting the perpendicular drawn at the point 2 to locate the point 2′, Fig. 216. In the same manner, locate the points 3′ to 11′. Connect the points 1′ to 11′ with a line completing the half pattern of section "*A*." A duplicate of this half pattern will make a complete pattern of section "*A*."

Section "*F*" is a duplicate of section "*A*" and therefore a pattern of section "*A*" is suitable for section "*F*."

Development of Section "B"

Parallel to *K-M*, draw lines through the points 1′ to 11′ and extend these to cut the miter line *L-M* and locate the points 1″ to 11″.

The line *O-X* bisects section "*B*." Extend *O-X* to *Y*, Fig. 217. On *X-Y* step off ten equal spaces equal to the spaces taken in the profile, Fig. 215. Number these divisions from 1 to 11 as shown in Fig. 217. Erect perpendiculars to the line *X-Y* through the points 1 to 11, Fig. 217, and extend them on both sides of the line *X-Y*.

Then parallel to the line *X-Y*, draw a line through the point 1′, Fig. 214, and extend this line to cut the perpendicular drawn to the point 1, Fig. 217, and locate the point 1′, Fig. 217. In like manner locate the points 2′ to 11′, Fig. 217. Also parallel to the line *X-Y*, draw a line through the point 1″, Fig. 214 and extend it to cut the perpendicular drawn to the point 1, Fig. 217, and locate the point 1″, Fig. 217. In like manner, locate the points 2″ to 11″, Fig. 217.

Connect the points 1′ to 11′ and 1″ to 11″, Fig. 217, completing the half pattern of section "*B*." A duplicate of this half pattern added along the line 11′-11″ will make a complete pattern of section "*B*." Section "*E*" is a duplicate of section "*B*" and therefore a pattern of section "*B*" is suitable for section "*E*."

Obtaining the Miter between the Elbow and the Cylinder

On the center line of the cylinder *P-Z*, draw the half profile of the cylinder as shown in Fig. 218. Divide this profile into any number of equal parts, the greater the number of equal parts taken the more accurate the final development. Eight parts were taken in this case. Number the divisions from *a* to *k* as shown.

Then parallel to *P-Z*, draw lines through the points *a-k* in the profile, Fig. 218, and extend these lines, cutting the line *S-T*. Number these intersections from *a* to *k* as shown. Extend these lines into the elevation.

Next parallel to the line *M-P*, draw lines through the points 1″ to 11″, Fig. 214, and extend to cut the line *P-N* and locate the points 1° to 11°, Fig. 214, as shown.

Extend 6°-6″ and at any point as *U* draw the half profile of the elbow as shown in Fig. 219. At *U* erect a perpendicular to the line 6″-*U*, and on any point on this perpendicular draw a half profile of the cylinder as shown. Divide this half profile into the same number of parts as was taken in the profile, Fig. 218, and number half of the divisions from *e* to *k* as shown in Fig. 219. Then parallel to the center line *U-k*, draw lines through the points *h*, *g*, *f* and *e*, Fig. 219, and extend them cutting the profile of the elbow and locating the points *e*′, *f*′, *g*′, *h*′ and *k*′, Fig. 219.

Parallel to the line 6″-*U*, draw a line through the point *k*′, Fig. 219, and extend it into the elevation, cutting the line drawn parallel to *P-Z* through the point *k*, Fig. 218, and locating the point *k*″ of the elevation, Fig. 214. In like manner, parallel to the line 6″-*U*, draw a line through the point *h*′, Fig. 219, and extend this line into the elevation to cut the line drawn parallel to *P-Z* through the point *h*, Fig. 218, and locate the point *h*″ of the elevation, Fig. 214. In like manner locate the points *g*″ and *f*″ as shown.

Next parallel to *P-R*, draw lines through the points 1° to 11° and extend these lines cutting the line *Q-R* and locating the points 1-1 to 11-11.

Extend 6°-6-6 and at any point as *V* draw the half profile of the elbow as shown in Fig. 220.

Proceed in the same manner as in the profile, Fig. 219, locating the points *a*″, *b*″, *c*″, *d*″ and *e*″ of the elevation. Connect the points *a*″ to *e*″ and *f*″ to *k*″ with a line and this line will be the miter line between the cylinder and the elbow in the elevation, Fig. 214.

Development of the Pattern for the Cylinder

Extend the line *S-T* of the elevation, Fig. 214, to *T*′ and on this line step off eight spaces equal to the spaces of the profile, Fig. 218. Number these divisions from *a-k* as shown in Fig. 221.

Erect perpendiculars to the line *T-T*′ at the points *a-k*, Fig. 221, and parallel to the line *T-T*′, draw a line through the point *a*″, Fig. 214, and extend this line so as to cut the perpendicular to the point *a*, Fig. 221, and locate the point *a*°, Fig. 221. Also parallel to the line *T-T*′, draw a line through the point *b*″, Fig. 214, and extend this line so as to cut the perpendicular to the point *b*, Fig. 221, and locate the point *b*′, Fig. 221. In like manner, locate the points *c*°, *d*°, *e*°, *f*°, *g*°, *h*° and *k*°, Fig. 221.

Connect the points *a*° to *k*° with a line completing the half pattern of the cylinder. A duplicate of this pattern laid along the line *a-a*° will complete the pattern of the cylinder.

Pattern for Section "C"

The line *O-M*′ bisects section "*C*." Section "*C*" is developed in the same manner as section "*B*." After obtaining the pattern for section "*C*" it is necessary to develop the cutout for the intersection of the cylinder.

On *O-M*′ from the line 11″-11°, Fig. 222, step off the distances *k-h*, *h-g* and *g-f* equal to *k*′-*h*′, *h*′-*g*′ and *g*′-*f*′ of the profile, Fig. 219. Then parallel to 11″-11°, Fig. 222, draw dotted lines through the points *h*, *g* and *f*, extending them on both sides of the line *O-M*′.

Parallel to the line *O-M*′, draw a line through the point *h*″ of the elevation, Fig. 214, and extend it into Fig. 222 cutting the dotted line through the point of location of *f*°, Fig. 222. In the same manner locate the points *g*°, *h*° and *k*°.

Connect the points *f*°, *g*°, *h*° and *k*° with a line completing the half pattern of section "*C*." A duplicate of this pattern added along line 11″-11° will make a complete pattern of section "*C*."

Pattern for Section "D"

The line *O-N*′ bisects section "*D*." Section "*D*" is then developed in the same manner as section "*B*." After obtaining the pattern for section "*D*," it is necessary to develop the cutout for the intersection of the cylinder.

On $O\text{-}N'$ from the line 11°-11-11, Fig. 223, step off the distances $a\text{-}b$, $b\text{-}c$, $c\text{-}d$ and $d\text{-}e$ equal to $a'\text{-}b'$, $b'\text{-}c'$, $c'\text{-}d'$, $d'\text{-}e'$ of the profile, Fig. 220. Then parallel to 11°-11-11, Fig. 223, draw dotted lines through the points b, c, d and e extending on both sides of the line $O\text{-}N'$.

Parallel to the line $O\text{-}N'$, draw a line through the point b'' of the elevation, Fig. 214, and extend this line into Fig. 223 cutting the dotted line through the point b and locating the point $b°$, Fig. 223. In the same manner locate the points $a°$, $c°$, $d°$, and $e°$.

Connect the points $a°$, $b°$, $c°$, $d°$ and $e°$ with a line completing the half pattern of section "*D*." A duplicate of this pattern added along the line 11°-11-11 will make a complete pattern for section "*D*."

With the conclusion of this long series of Plate Development problems and layouts which have been a feature in Boiler Maker and Plate Fabricator since the issue of March 1935, the author wishes to express his earnest hope that readers have been able to derive information that will be useful to them in solving future practical problems of plate layout which they may encounter.

(*The end.*)

The "Iron Horse" a Heavy Drinker

Approximately 600 billion gallons of water are required annually to quench the thirst of the "Iron Horse" and for other purposes in connection with the operation of the railroad systems of this country, according to the Association of American Railroads.

This quantity of water, the A. A. R. statement says, would be sufficient to fill a channel one hundred yards wide and nine feet deep, extending from New York to San Francisco, Calif., and return. If spread over the ground to a depth of one foot and frozen, it would provide a skating rink nearly 54 miles square. It would meet the needs of the inhabitants of New York City for two years, or a city the size of Washington, D. C., for seventeen years. In volume and weight, the quantity of water used by the railroads each year is greater than all other materials combined.

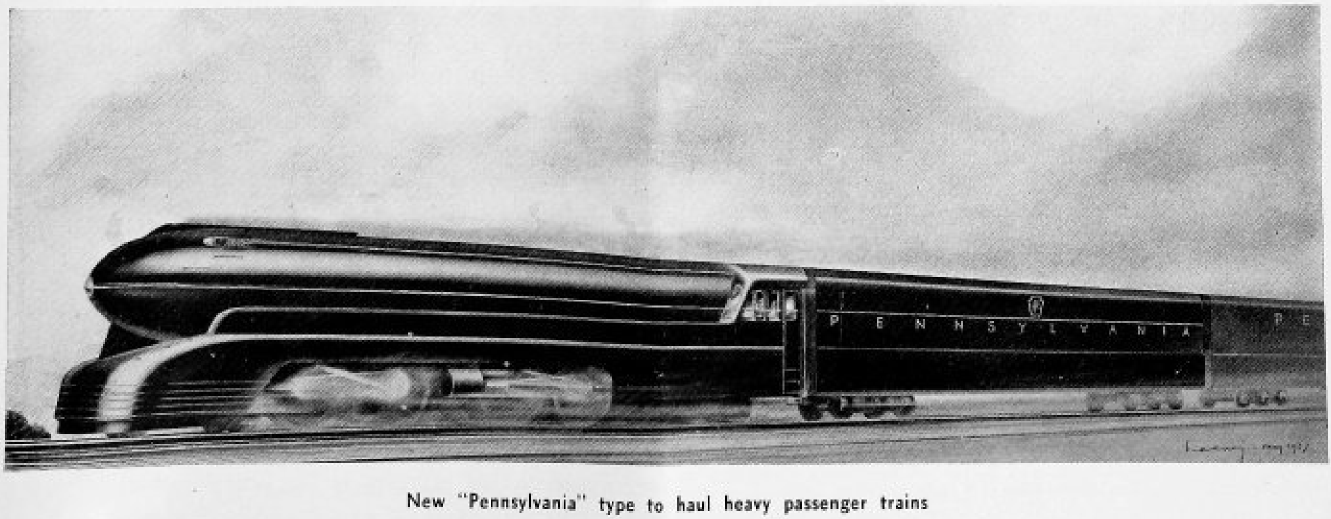
More than one-half of the water required is used for steam purposes. By the chemical treatment of this water to remove harmful ingredients which cause rust and scale to form on the inside of locomotive boilers, the railroads "have brought about increased safety and efficiency in operation as well as a saving of millions of dollars annually."

Chemical treatment of water began on the railroads of this country about 1891. The statement points out that since that time, through scientific research, improved methods of counteracting the effects of the various harmful ingredients to be found in water have been developed. By improving the quality of water used for steam purposes, along with the many improvements that have been made in locomotive construction, locomotive efficiency has been greatly increased. Not only has it resulted in the increased conservation of fuel, but the life of locomotive fireboxes and flues has been doubled, and in many instances trebled, while the number of miles between engine failures due to boiler conditions is now more than five times as great as it was eight years ago. In the latter connection there is cited a report recently made by one large road which operates under typical conditions existing today. The report shows that in 1935 the road had no engine failure in more than 25,000,000 engine-miles, and that there had been only one engine failure caused by water quality in 80,000,000 miles in the past four years. Similar results have been reported by other railroads.

Pennsylvania Developing New Steam Locomotive

The Pennsylvania, in co-operation with a committee of engineers of the Baldwin, American and Lima locomotive companies, is now developing a new type of steam locomotive to be known as "The Pennsylvania Type," it is announced by M. W. Clement, president of the road. A development of the conventional coal-burning steam type, to cost little more to build, operate and maintain than present locomotives of lesser capacity, the new unit will be capable of hauling a 14-car passenger train at 100 miles an hour and will render service comparable to the motive power on the electrified eastern lines of the road.

This type will be the largest, fastest, and most powerful steam engine ever designed primarily for passenger service on the Pennsylvania. Having the same general appearance as the streamlined type of heavy steam passenger locomotive now in service, the new locomotive, a 4-4-4-4 type, will carry two pairs of cylinders on a rigid frame, each pair providing power for four driving wheels. The tender, mounted on two six-wheel trucks, will have a maximum capacity of 25,000 gallons of water and 26 tons of coal.



New "Pennsylvania" type to haul heavy passenger trains

Chief Inspector Reports Southern Pacific Accident*

On April 11, 1937, about 7:10 p.m., near Randolph, Ariz., the water column steam pipe in the cab of Southern Pacific Company locomotive 4322 failed while the locomotive was hauling west bound passenger train No. 3 at an estimated speed of 60 miles per hour. The engineer and fireman were severely scalded.

When the steam pipe failed the engineer and fireman were driven from the cab and escaped through their respective side windows using the longitudinal handholds and steps along the sides of the cab to reach the running boards. The fireman, not knowing what pipe had failed, attempted to shut off the escaping steam by closing the turret valve which was accessible from outside of the cab, but failing to stop the flow of steam he attempted to get into the cab through the left gangway to find the engineer and to shut off the throttle and apply the brakes. He found the engineer's seat box blown into the gangway but could not proceed further on account of the cab being filled with steam. The fireman then proceeded toward the front end of the locomotive where he found the engineer who had reached the front end of the locomotive and was opening the brake pipe angle cock to apply the brakes.

When the train was brought to a stop the engineer was found to be severely scalded on both legs. The fireman then climbed over the tender from the rear and closed the fuel oil line safety cut-out valve; while doing this he inhaled steam, his injuries being principally due to this cause.

The water column steam pipe was a copper pipe 44 inches in length, 1½ inches outside diameter, wall thickness ⅛ inch. Failure occurred at the water column connection by the breaking off of the flange of the joint sleeve. The sleeve was made of cast brass, 1¾ inches outside diameter and 1 inch in length, with the integral joint flange ¼ inch thick and 2$\frac{1}{16}$ inches in diameter. The steam pipe extended through the sleeve flush with the end thereof and was not belled or flanged over. The brazing that had been applied to secure the sleeve to the pipe had penetrated only about ¾ inch from the top of the sleeve and the integrity of the joint therefore was dependent upon the strength of the sleeve which failed at the fillet joining the sleeve and its flange.

A heavy deposit of bronze had been applied to the pipe by fusion welding immediately above the sleeve in an attempt to repair a circumferential crack extending around about one-fourth the circumference of the pipe immediately above the top edge of the sleeve. Investigation disclosed that the locomotive had been cut out of service on east bound passenger train No. 44 at Yuma, Ariz., on April 7, 1937, (four days before this accident occurred) because of a crack in the water column steam pipe, and the welding was apparently applied at that time. The steam pipe joint at the water column connection was deeply indented on the forward sector while the opposite sector did not show any distortion, indicating that the collar had not fitted square on the joint at the time of application of the pipe, it probably having been thrown out of line or warped when the welding was applied. Marks on the pipe indicated that a wrench or similar tool had been used to spring the pipe into line, and this no doubt put an undue strain on the pipe and collar when the coupling nut was tightened.

So far as could be ascertained from the daily inspection reports, some of which were missing or had not been filed, and from the engine crew having charge of the locomotive at the time of the accident, there was no indication of leakage at the joint prior to the failure which occurred.

The carrier's standard practice requires that the inside of the joint sleeves be chamfered, that the copper pipe extend through the sleeve and be flanged over the end to form a mechanical joint of the Van Stone type, and that the sleeve be brazed to the pipe. This practice was not followed in the application of the failed sleeve nor in the application of the sleeve on the other end of the pipe.

The futility and danger of attempting to repair cracks in copper steam pipes by the application of fusion welding has been repeatedly called to the attention of the carriers in annual reports of this Bureau. Aside from the liability of overheating the material and leaving it in less serviceable condition than before the welding was applied there is the ever present probability that a crack extending through the wall of the pipe at one point may be and in all likelihood is merely an indication that extensive cracks are present on the interior surface of the pipe in question.

This accident was caused by the failure of a joint sleeve that was improperly applied and inadequately brazed to the copper pipe. Installation of the pipe under initial strain was a contributing cause.

* Report of the Chief Inspector, Bureau of Locomotive Inspection, to the Interstate Commerce Commission.

Boiler Explosion Wrecks Mine Buildings

Sundays are quiet days at the ——— mine in West Virginia. No coal comes to the surface, and only a few men are on duty. Their work is for maintenance and safety purposes and they go about it quietly and carefully. January 24 was such a Sunday. Included in the maintenance work on that day was the operation of a steam-driven hoist which was used when the motor-driven main hoist was idle.

Providing steam for the hoist engine was a 72-inch diameter horizontal tubular boiler. On week-days this boiler heated water for about 100 shower baths, but on Sundays, when the main power plant was idle, it was used to make steam at 55 pounds pressure. The boiler was thus operating on January 24 when it exploded, the blast wrecking the boiler house and killing four men. A subsequent fire so damaged the adjacent substation and the electrical equipment installed there that the mine, which employed several hundred men, was shut down for two days until a temporary source of power was secured.

While the explosion and fire damaged buildings and equipment in an amount estimated at approximately $50,000, the mine tipple itself and the main hoist escaped extensive injury, a circumstance considered unusually fortunate.

The accident occurred after the top shell plate of the boiler became unduly thin because of hidden external corrosion which attacked the metal under the brick insulation. *The Locomotive.*

Steel and Tubes Changes New York Office

Steel and Tubes, Inc., Cleveland, O., has announced recently that its New York district sales offices will be located at a new address, 4103 Chrysler Building, New York City. L. M. Hogan, district sales manager, will continue in that capacity at the new location.

Loeffler Boilers for Italian Steamship

A comprehensive paper before The Institute of Marine Engineers, London, on March 9, by S. McEwen, described the modernization work recently carried out on the steamship *Conte Rosso*, the major item of which was the installation of a superposed Loeffler high-pressure steam generating plant designed to develop an additional 5000 shaft horsepower. Details of this installation follow in part:

The steamship *Conte Rosso* is a passenger ship of 18,500 gross tons, built by Messrs. William Beardmore & Company at the Dalmuir Works for the Lloyd Sabaudo Company of Genoa and now operated by the Company under the name of Messrs. Lloyd Triestino of Trieste.

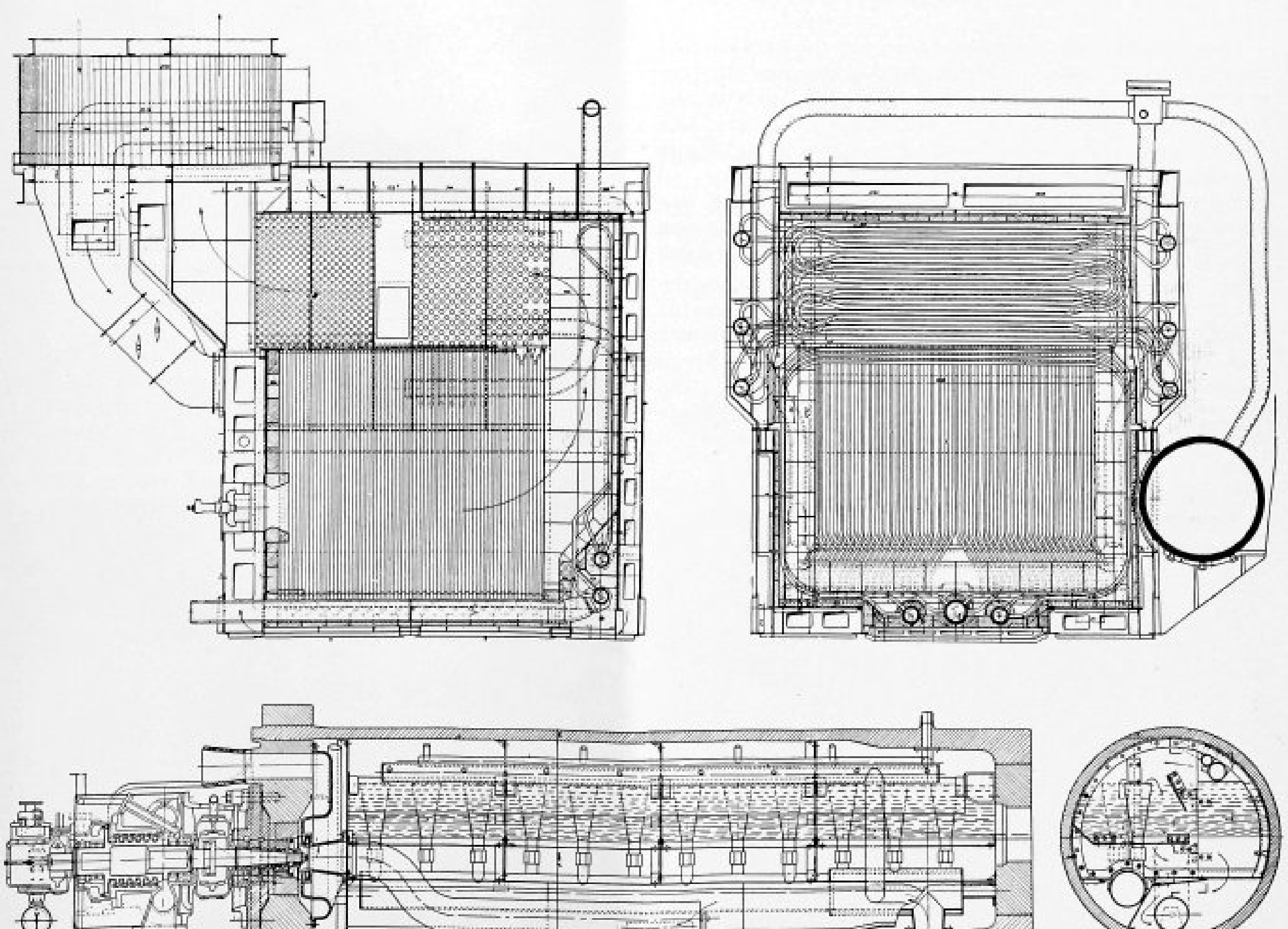
In March, 1936, the vessel was placed in the hands of Messrs. Cantieri Reuniti dell Adriatico for general overhaul and redecoration. The provision of an open-air swimming pool with sun-bathing terraces, in addition to many other amenities, entitles the ship to be included in the class of luxury liners.

As part of the reconstruction work it was arranged to increase the power developed by 5000 shaft horsepower from 17,000 shaft horsepower to 22,000 shaft horsepower and by this means to increase the speed of the ship by 1½ knots.

The original boiler equipment included six double and two single Scotch marine boilers generating steam at a pressure of 200 pounds per square inch superheated to a temperature of 572 degrees F. One single-ended boiler, which had a maximum capacity of 16,000 pounds of steam per hour, was removed and in its place a Loeffler marine boiler was installed capable of generating at normal rate 44,000 pounds of steam per hour at a pressure of 1850 pounds per square inch and a temperature of 890 degrees F. The maximum rate provided for was 55,000 pounds of steam per hour.

The Loeffler boiler unit was manufactured by Messrs. Vitkovice Mines, Steel & Ironworks Corporation, Vitkovice, Moravska-Ostrava, Czechoslovakia. It was installed by them under the direction of Messrs. Cantieri Reuniti dell Adriatico.

The ship has two propeller shafts, and the original turbine equipment which is retained consists of high and low-pressure turbines with reversing stages coupled through gearing to each propeller shaft. The new turbine installation consists of two super-pressure units



Details of the construction of the Loeffler boilers installed in the steamship Conte Rosso

manufactured by Messrs. Escher Wyss of Zurich, one for each propeller shaft and coupled thereto through new gearing forming an extension of the existing gearing. The two super-pressure turbines work in series, that is, all the high-pressure steam from the Loeffler boiler is delivered to one turbine which exhausts at a pressure of 660 pounds per square inch to the second turbine. The exhaust steam from the second turbine passes through a steam-to-steam reheater and is delivered to the principal steam main at a pressure of 200 pounds per square inch and a temperature of 572 degrees F.

To obtain the additional power required it was decided to superimpose a super-pressure steam plant on the existing equipment to an extent which would avoid any modification to the existing turbine, condenser and auxiliary equipment and which could be accommodated within the confines of the existing boiler and engine rooms.

The installation of the high-pressure plant together with the general overhaul referred to was completed towards the end of August, 1936, and by the courtesy of Messrs. Lloyd Triestino and of the chief engineer of that company—Dr. Ing. Alfredo Fabri—the author was permitted to be present during the preliminary trials of the new plant, to make the journey with passengers from Trieste to Genoa and subsequently to continue his observations during the run from Genoa to Naples on the outward passage of the ship from Genoa to Shanghai.

The preliminary trials were confined to those which were necessary to comply with the safety regulations required by the insurance societies; viz., Registro Italiano and Lloyd's Register of Shipping, before permission could be given for passengers to be carried.

These preliminary trials provided for the operation of the plant while maneuvering in the Adriatic and the subsequent inspection of all parts subjected to heat and pressure, the discharge of the full output of the Loeffler boiler through the safety valves for a period of twenty minutes and the instantaneous cut-off of the supply of steam to the high-pressure turbine when the boiler was operating at full load. These trials being made, the ship was able to leave Genoa for Shanghai on its scheduled date.

PERFORMANCE DATA OF STEAMSHIP CONTE ROSSO

Output 22,280 shaft horsepower

LOEFFLER BOILER PLANT	
Boiler output	44,000 lb. per hr.
Superheated steam pressure	1850 lb. per sq. in.
Superheated steam temperature	890 degrees F.
Superheated steam temperature of steam leaving radiant superheater	770 degrees F.
Temperature of feed water—boiler inlet	250 degrees F.
Temperature of feed water leaving economizer	464 degrees F.
Stack temperature	300 degrees F.
CO_2	12 percent
Efficiency of Loeffler boiler	90 percent
First H.P. Turbine	
Output	1300 shaft horsepower
R.p.m.	9200
Steam pressure inlet	1780 lb. per sq. in.
Steam temperature inlet	880 degrees F.
Steam pressure exhaust	668 lb. per sq. in.
Steam temperature exhaust	644 degrees F.
Second H.P. Turbine	
Output	1300 shaft horsepower
R.p.m.	9200
Steam pressure inlet	655 lb. per sq. in.
Steam temperature inlet	644 degrees F.
Steam pressure exhaust	213 lb. per sq. in.
Steam temperature exhaust	428 degrees F.
Circulating Pump Turbine	
Output	260-360 horsepower
R.p.m.—normal load	9200-10,100
H.P. Feed Pump Driving Turbine	
Output	285-356 horsepower
R.p.m.	9400-9900
Scotch Marine Boiler Plant	
Superheated steam pressure	200 lb. per sq. in.
Superheated steam temperature	572 degrees F.
Feed water inlet temperature	210 degrees F.

On these trials the oil consumption of the new plant was calculated to be 0.836 pound per shaft horsepower per hour, as compared with a consumption for the old plant of 0.935 pound per shaft horsepower per hour.

Since the super-pressure plant was put into commission several round trips have been made between Genoa and Shanghai, so that there has been ample time to observe all details of performance, particularly those which are of major importance to the owners. Generally it can be stated that no difficulties whatever have been encountered which could be attributed to the use of high-pressure high-temperature steam; the power developed by the super-pressure sets is greater than that which was guaranteed, with the result that the guaranteed increase of speed of the ship has been exceeded by one-half knot. The acceptance tests have proved that all the performance guarantees had been fulfilled.

After continued operation a thorough examination of the combustion chamber disclosed a most satisfactory condition. There were no ash or coke deposits on the heating surfaces nor could any deterioration of the tubes be detected. The condition of the boiler was such as to impress the operating staff most favorably.

Notwithstanding the use of a relatively small evaporating drum and the high degree of salt concentration obtained on occasions, no trouble whatever has been experienced due to carry-over of salts with the steam.

The installation of one Loeffler boiler in the space occupied by one single Scotch marine boiler has increased the steaming capacity of the boiler plant by 13.5 percent; it has increased the power developed about 30 percent, while the fuel oil consumption per shaft horsepower for the whole power plant both old and new together has been reduced by 10 percent.

Champion Develops New Welding Rod

The Champion Rivet Company, Cleveland, O., has developed, and is now offering to the trade a heavily coated shielded arc electrode for welding low alloy and higher carbon high tensile steels.

This electrode is known as Champion Blue Devil-85. It can be used in any position—flat, vertical and overhead, and is scientifically and specifically designed to weld effectively and produce welded joints having all the individaul characteristics inherent in such steels as —Cor-ten, Man-ten, Sil-ten, Chromansil, Hi-Steel, 79-90, Yoloy, R.D.S., and HT 50, also carbon molybdenum steel, silicon killed plate (A.S.T.M. 149 and 150) and the low nickel content steels.

Massive Pressure Vessel Built in Shipyard

The pressure vessel illustrated on the front cover is a fractionating tower fabricated in the shops of the Sun Shipbuilding & Dry Dock Company, Chester, Pa. This massive vessel, built to the A.S.M.E. rules for Class 1 welded pressure vessels, is 88 feet long and 12 feet 1¼ inches in diameter and is of all-welded construction. All welded circumferential and longitudinal seams were X-rayed. The illustration shows the vessel ready for X-ray inspection. After welding operations were completed, the tower was placed in a large annealing furnace in one piece.

Combating Scale and Corrosion

The principal cause of corrosion is electro-chemical. All metals have a tendency to go into solution in water, displacing an equivalent amount of hydrogen, or metal. This tendency to go into solution varies with different metals, and, in addition, is affected by a number of other factors, such as temperature, acidity, and so forth. For all practical purposes, a vessel containing water, such as a boiler, may be regarded as a storage battery, with the water acting as the electrolyte. This electrolytic action, obviously, is greatest when the vessel is constructed of more than one kind of metal; yet even when only one kind of metal is involved the electrolytic action persists, because of temperature variations, and the fact that fabricated metal is never homogenous.

This brief explanation shows that corrosion is unavoidably present, and is the inherent, natural characteristic of water containers made of corrosible metal. To protect these corrosible metal containers, it is necessary to prevent corrosion, or control it.

Attempts to prevent corrosion have been made since the early days of civilization, and the corrosible metal surfaces were insulated from direct contact with water by a number of non-corrosible substances, such as paint, pitch, enamel, or plating with nobler metals. At best, these methods were merely palliatives; they still are. Nor do they offer a solution to the many vexing problems confronting modern steam power plant operation: scale, slime and algae.

The Kirkaldy system takes into consideration the *causes* of corrosion, rather than its effects. Instead of fighting, or attempting to fight, the immutable natural laws, it merely directs them to serve its purposes. It controls corrosion, confining it to bars of metal placed into the water for that purpose—martyrs deliberately sacrificed to corrosion so that the vessel itself may endure.

With the Kirkaldy system installed, the power plant units containing water still remain, in effect, a storage battery, or rather an electroplating tank with the polarity reversed. Boilers, condensers, pumps, heaters, and pipe lines, having normally positive polarity, are now cathodic, or negative. At the positive pole, or anode, are the "martyrs"—the corrosible metal electrodes placed within the water and electrically insulated from the power plant units.

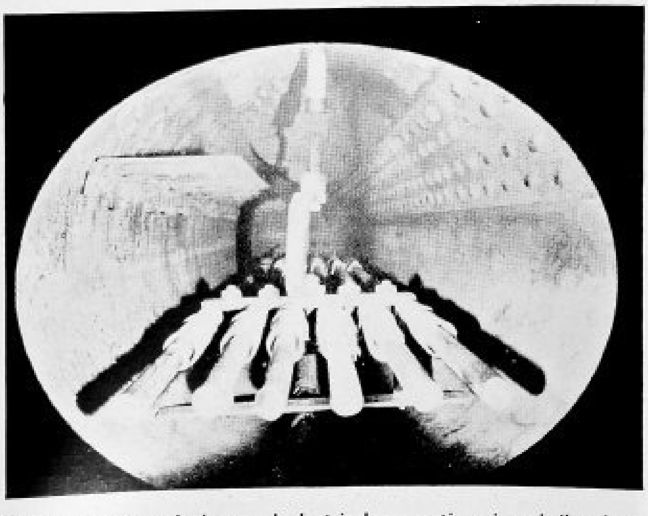
This reverse polarity is maintained by a weak direct current supplied by a motor generator and controlled at a small switchboard.

The system is claimed to accomplish more than corrosion prevention as scale and slime cannot adhere to the cathodic walls of the power plant equipment. Acid radicals, such as carbonate, sulphate and silica, which are necessary in building up the scale, are electrically carried to the anodes, and away from the power plant unit surfaces. If scale is already present when the installation is made, the thin film of liberated hydrogen, which will form on the cathodic walls of the power plant units, will gradually loosen the scale and then remove it altogether. Particles of slime and vegetable matter cannot gain a foothold on the cathodic walls of the power plant units. They are repelled electrically, just as a pith ball is repelled by a charged stick of sealing wax.

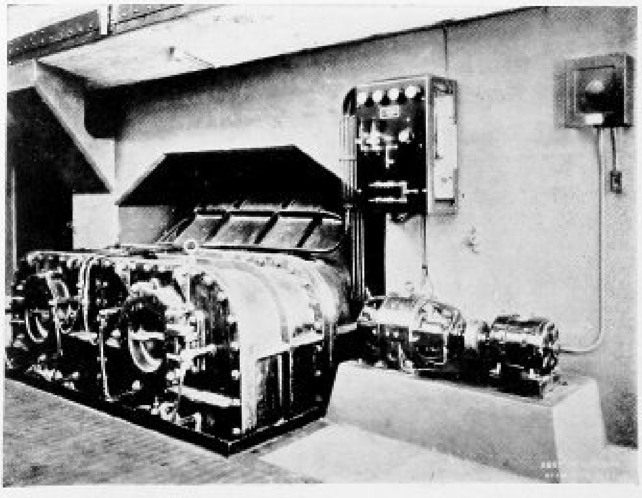
The possibility of preventing corrosion electrolytically on a commercial basis has been widely explored in the last fifty years. However, considerable practical knowledge of the many variable factors involved was needed before a commercially satisfactory method of such electrolytic protection could be evolved. The Kirkaldy system, developed and patented by Alexander Kirkaldy, provides automatically controlled protection, fully compensated for these variable factors.

The installation is extremely simple, and consists of a number of suitable anodic bars or disks (mild steel or carbon), mounted within but electrically insulated from the power plant units; an electric motor-generator; an automatic current controller; a control switchboard; and necessary wiring to complete the circuit. The operating norms are calculated on the basis of total power plant surface to be protected, anodic surface available, anode material, chemical composition and electrical conductivity of the water, and other factors. After the current controller is adjusted to the determined values, the operation is automatic.

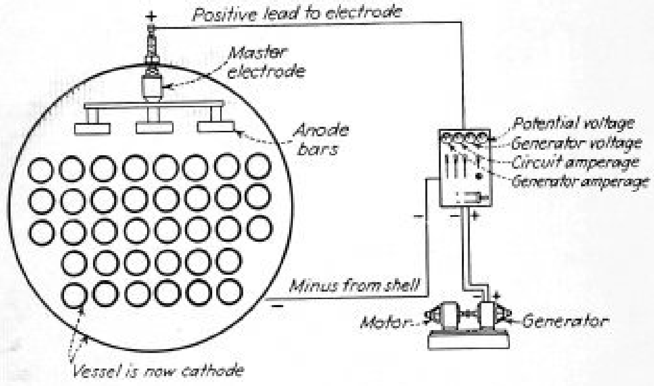
The voltage required is from 5 to 10 volts, depending



Installation of anode bars and electrical connections in a boiler drum



Kirkaldy system for combating corrosion installed on a condenser



Wiring details of a Kirkaldy system on a boiler

on conditions, and current consumption is negligible: from 0.4 kilowatt hours per day per 1000 square feet of protected surface with salt water, to 2.0 kilowatt hours per day per 1000 square feet with fresh water.

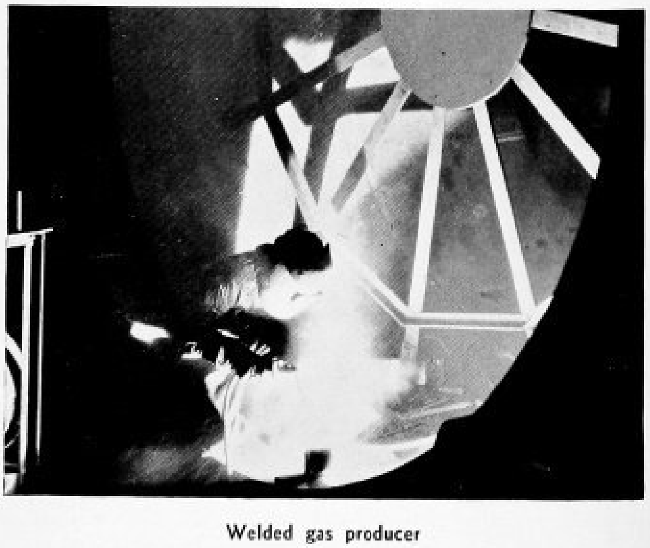
In carefully conducted prolonged tests on a number of installations in the United States and Canada extremely gratifying results have been uniformly obtained. Power plant maintenance costs were substantially reduced and expensive scale and slime removal operations replaced by infrequent flushing out of residue. The most significant factor was the sustained improvement of heat transfer efficiency, resulting in much lower fuel consumption.

The equipment is manufactured by Electrolytic Metal Protection, Inc., New York.

Welding on Gas Producer Shell

Appearing as some weird spirit, part spider part firefly, spinning its web in its own eerie light, the arc welding operator fuses steel to steel in the manufacture of the 11-foot diameter water cooled shell of an automatic gas producer at Wellman Engineering Company, Cleveland, O. The shell of this gas producer is high tensile, corrosion-resisting low alloy steel known as "Cor-ten."

It is to encourage the use of industry's most modern materials and to stimulate the application of most efficient processes for applying such materials in manufacture and construction, that The James F. Lincoln Arc Welding Foundation, Cleveland, has set up a fund of $200,000 to promote scientific study of arc welding.



Welded gas producer

Chicago Power Show Opens in October

New types of power plant equipment and the latest machinery for the numerous industries which utilize mechanical engineering will be featured at the Chicago Exposition of Power and Mechanical Engineering, October 4 to 9, 1937. Increased purchasing power and the changing economic order as well as new discoveries, inventions and the productive methods employed to offset obsolescence will be reflected in the dynamic presentation of man's most recent harnesses for horsepower.

Attendance at the Exposition will be restricted to those admitted by invitation or registration. No tickets will be sold. This policy insures an attendance made up of those directly interested in the industrial developments presented. Advance indications are that many representatives of the utilities producing and distributing power in its various forms will attend.

The Chicago Exposition is being conducted by the International Exposition Company, which over a long period of years has managed successfully the National Exposition of Power and Mechanical Engineering at Grand Central Palace in New York. There is no connection between the management of this exposition and those of any previous power shows in the Chicago area.

Equipment on display at the Exposition will include the following classifications: fuels, combustion equipment; refractories; steam generating equipment; steam distribution; accessories; piping and fittings; prime movers; pumps and hydraulic equipment; electric generators and motors; electrical transmission, distribution, and control devices; power transmission accessories; instruments of precision tools and machine tools; power driven units; materials handling systems; factory air conditioning equipment; lubricants; refrigerating machinery; operation and maintenance materials.

Ninety-One Percent of Metal Show Space Sold

Ninety-one percent of the exhibit space at the 19th annual National Metal Show, to be held October 18 through 22 in the Atlantic City Auditorium, has already been contracted for by 189 industrial companies, W. H. Eisenman, managing director, announced recently. Mr. Eisenman is also national secretary of the society sponsoring the Show, the American Society for Metals.

The Atlantic City Auditorium provides an ideal site for this year's Metal Show. All exhibits will be on one floor, which is unencumbered by pillars or posts that would interfere with a broad view of all exhibits.

The National Metal Congress, held in conjunction with the Metal Show, convenes on the second floor of the Auditorium. Five international societies will co-operate in this event, holding their conventions and technical sessions during the entire week. The co-operating societies are, in addition to the American Society for Metals, the Iron and Steel and Institute of Metals divisions of the American Institute of Mining and Metallurgical Engineers, the American Welding Society, American Society of Mechanical Engineers and the Wire Association.

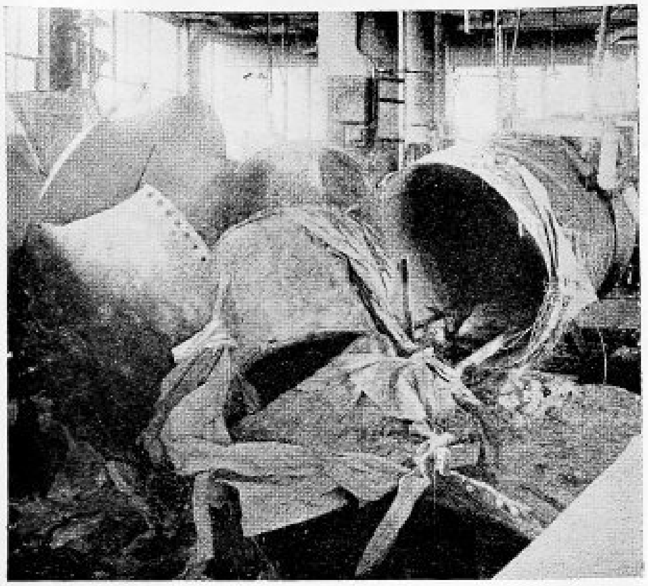


Fig. 1.—Wreckage of vulcanizer after explosion

Vulcanizer Explodes Because of Corrosion

How corrosion can bring about the rapid wasting of a steam pressure vessel when acid is present in water within the vessel is illustrated by a recent vulcanizer explosion at an eastern manufacturing plant. The manufacturing procedure requires that some of the material to be processed be subjected to steam and rotated in such a way that it is kept wet by passing through water at the bottom of the vessel. Acids from the processed material are absorbed by the water, vaporized and circulate throughout the vessel. This condition was blamed for the corrosion which caused the accident and a loss of several thousand dollars.

Fig. 1 shows the wreckage. Fig. 2 is a side view of a section from a seam, showing clearly the serious wasting of the plate and the rivets. Fig. 3 is a view looking down on the seam on the inside of the vessel.

The vulcanizer was manufactured in 1934 and was 48 inches in diameter and 13 feet long. It was made up of two courses of $\frac{5}{16}$-inch plate with a single riveted girth seam and double riveted lap seams. When the vessel exploded at its normal operating pressure of about 100 pounds per square inch, the outer lap of the rear course tore along a line about ¾ inch from the edge of the inner lap and parallel with the girth seam. The fracture extended through the girth seam and then tore almost all the way around the other course.

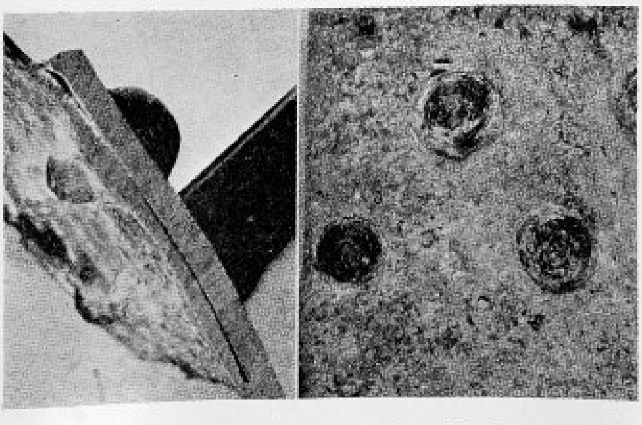


Fig. 2.—(Right) Side view of a seam section. Fig. 3.—(Left) View looking down on plate from inside

Although the vessel had been in use for only two years, the plate had been reduced on the average to about half of its original thickness.

The vessel was destroyed by the explosion, its contents were badly damaged, asbestos was scattered throughout the large room, (120 feet by 165 feet) and condensed steam saturated all the equipment there. Many panes of glass were broken and the metal sash supporting them was bent. Of the 22 men in the room at the time 20 escaped without injury.

The difficulties in the operation of such vulcanizers arise directly from the use to which they are put. Because the process accomplishes the desired result on the material used, the solution of the difficulty is being sought in a metal which will be more corrosion and acid resistant. Until this is developed, the safety of such vessels can be checked only by frequent inspections and the drilling of test holes, as is done with vessels subject to the erosive action of stirring devices or with such vessels as digesters where chemicals or erosion may thin the plate.—*The Locomotive.*

A.B.M.A. Holds Joint Meeting at Skytop

The annual meeting of the American Boiler Manufacturers' Association was held from June 6 to June 9, 1937, at Skytop Lodge, Skytop, Pa. The meeting was featured by an address by Fred J. Perkins, a member of the Cleveland law firm of McKeehan, Merrick, Arter and Stewart. Mr. Perkins has made an exhaustive study of the Wagner bill and was able to impart a very clear and comprehensive interpretation of this important industrial legislation to the assembly. Mr. Perkins spoke on the morning of June 7 during the general session of the association. In the evening of the same day meetings were held by the H.R.T. branch (Boiler Manufacturing Industry), with H. E. Aldrich, chairman; the A.B.M.A. associate members, with D. Robert Yarnall, chairman; and the Stoker branch, with E. R. Stone, chairman.

Following the general session of the Boiler Manufacturing and Affiliated Industries in the morning of June 8, the Superheater, Air Preheater and Economizer, and Pulverizer branches held technical sessions. The annual banquet was held that evening.

The following day, June 9, the Watertube branch, under the chairmanship of H. E. Aldrich, was in session in the morning and afternoon.

Milwaukee Section of American Welding Society Elects New Officers

K. L. Hansen, prominent authority on modern electric arc welding and associated with the Harnischfeger Corporation, Milwaukee, was recently elected chairman of the Milwaukee section of the American Welding Society at a meeting held on May 27. Mr. Hansen is widely known to men in the electrical world and has been very active for many years in connection with the American Society of Electrical Engineers, as well as the younger American Welding Society.

Harold Falk of the Falk Corporation, Milwaukee, Wis., was elected vice-chairman of the Milwaukee section of the society.

Boiler Maker and Plate Fabricator

Reg. U. S. Pat. Off.

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BUSINESS MANAGER: Warner Lombard.

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Communication

All-Welded Stack

To the Editor:

We notice in an article on page 332 of the December, 1936, issue of Boiler Maker and Plate Fabricator you refer to the erection of an all-welded smokestack, in which it is stated that it is thought to be the tallest pre-fabricated steel stack ever erected.

It might be of interest to know that the Grand Trunk Railway, now a part of the Canadian National Railways, erected a 130-foot steel stack, all pre-fabricated, four feet in diameter, with an 85-foot wooden gin pole made up of several pieces spliced together, with the necessary pulley blocks, weighing slightly over ten tons, at our Turcot roundhouse, in Montreal, Quebec, in 1919. It was pulled up by a locomotive.

Sorry we are unable to send a photograph of the installation, as the stack has since been replaced by a brick stack.

Toronto, Ont. — R. J. Needham.

Trade Publications

CO_2 Meters.—The Brown Instrument Company, Philadelphia, Pa., has just published a new catalogue on Brown CO_2 meters. This new catalogue, No. 3005, covers the complete line of Brown indicating and recording CO_2 meters, as well as the combined CO_2 and flue-gas temperature recorders.

Donkey Boilers.—The Spanner Thimble Tube Boilers Ltd., London, England, has prepared recently a pamphlet listing and describing the Spiralflo Atlas boilers for coal, coke, oil or gas fueling with outputs ranging from 500 to 7000 pounds of steam per hour and working pressures up to 150 pounds per square inch.

Furnace Controls.—A folder entitled "Standardizes Quality in the Heat Treatment of Metals" has recently been issued by the Brown Instrument Company, Philadelphia, Pa. This folder describes the advantages of using Brown analy-graph in heat treating processes. This device records the minute changes in the chemical composition of furnace atmosphere, etc. A description of the Brown Protectoglo system is also included.

Arch Construction.—The George P. Reintjes Company, Kansas City, Mo., furnace wall and arch manufacturer, has recently issued a bulletin, No. 201, describing the latest development of a simplified arch construction. This construction requires fewer shapes of tile and castings, is flexible in application, has freedom of expansion, and is universally applicable to any arch steel work.

Mercury Lighting.—A catalogue describing many types of industrial lighting equipment for use with 200 and 400-watt high-intensity mercury-vapor lamps has been published by the Westinghouse Electric and Manufacturing Company, Cleveland, O. Combination mercury-incandescent units are also described. Included is information on designing an installation, choosing mounting heights, spacing and size of units, etc.

Smootharc Welders.—"The Arc Welding of Tomorrow" is the title of the smootharc welder bulletin recently released by the Harnischfeger Corporation, Milwaukee, Wis. The bulletin outlines the advantages gained by the use of the internally-stabilized arc and tells just what single-current control means to the operator and what improvement it makes on the finished welded product. Clear action illustrations show many Smootharc models in use.

Walworth Valves.—The first issue of "Walworth Today," a bimonthly magazine published by the Walworth Company, New York, manufacturer of valves, fittings, pipes and tools, is now being distributed. Featured in this publication are illustrations showing a number of recent outstanding developments in this line and practical methods used to hook up various jobs. A lead article, "Creep Testing of Metals," is the first of a series on laboratory technique in developing new products in the industry.

Insulating Brick.—A new folder prepared by Johns-Manville, New York, entitled "Lower Furnace Operating Costs with Johns-Manville JM-20 Insulating Brick" illustrates twelve of the modern types of industrial furnaces for which this insulating brick has been developed. The drawings show clearly the application of this brick to each of the twelve types. A table giving the heat losses transmitted through firebrick walls bare and firebrick walls insulated with JM-20 brick is given, as well as descriptions of the physical properties of the insulating composition itself.

Questions and Answers Pertaining to Boilers

This department is maintained for the purpose of helping those who desire assistance on boiler and plate fabricating problems. Inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless special permission is given to do so.

By George M. Davies

Parker Tapers

Q.—You no doubt are acquainted with the Parker taper as used on such tools as button sets, snaps, belling tools, etc. Can you advise us the originator of this Parker taper? If so, could you give us the name and address of the firm who are the originators? Would be pleased to hear from you at your earliest convenience. E. E. S.

A.—I would suggest that you get in touch with the Parker Appliance Company, 10320 Berea Road, Cleveland, O., in connection with this question.

Bagging of Tubular Boilers

Q.—We are after some information with respect to the bagging of horizontal return tubular boilers. We should like to read a full treatise on causes and effects of bags, what happens after the bag has been driven back into place, the stresses in the bag joint especially with reference to the yield point and the tensile strength of the metal and in fact any other points that could be brought up.

If you could bring this up in your Questions and Answers Department, or have some one write an article, we should certainly appreciate this matter which we think is of widespread interest. R. J. R.

A.—Bulges in boiler plate are usually serious weaknesses. It is often possible to make repairs which will permit the continued safe use of the vessel. In order to design such repairs, however, it is necessary to know exactly what caused the bulge and to determine definitely whether the plate is weakened over more than a small area. The cause and extent of the defect, therefore, are important because there are certain conditions which make the scrapping of the affected plate the only safe remedy.

It is a fundamental fact that bulged or distorted boiler plates are the result of stresses greater than the metal could withstand without change in shape. The overstressed condition may have been attributable to one of three causes.

1. Decrease in the yield point of the steel as the result of high temperature.
2. Decrease in the thickness of the plate.
3. Defective material.

The kind of bulge most frequently encountered occurs in a shell plate or drum surface which is exposed to furnace temperatures. Such a bulge is the result of overheating due to low water or the presence of scale or oil.

A bulge in the fire sheet of a horizontal tubular boiler, if caused by overheating because of oil, is frequently of considerable area, but may be more or less shallow.

The distorted area may extend longitudinally from girth seam to head seam and girthwise through an arc of 90 degrees or more. If the depth of the bulge does not exceed the thickness of the plate and the oil can be entirely eliminated, no repairs, save perhaps calking of the seams, are necessary since the reduction in the thickness of the plate has been negligible. Any effort to "set up" or to "drive back" a bulge of great area is likely to produce a number of comparatively small pockets in which sediment can accumulate—a condition which is considered more dangerous than the slightly distorted plate. If the depth of the bulge indicates a dangerous reduction in the thickness of the plate, a new fire sheet may be necessary.

When a new fire sheet is installed, the longitudinal seams must be located well above the fire line. It is good practice to attach the new sheet on one side at the original longitudinal seam of the course. On the other side, the new seam should be located so that it will "break joint" with the longitudinal seam of the adjoining course; that is, the two seams should not be at the same point on the circumference of the boiler.

The repair of bulged metal weakened by overheating, due to an accumulation of scale, is often of a less extensive nature than that described above. A coating of scale on the fire sheet of a boiler may be of considerable thickness without causing dangerous overheating of the plate. As the scale increases in thickness, a point is reached at which it ceases to be merely a cause of added fuel expense and becomes a hazard as well.

What this dangerous thickness is depends on the nature of the scale. Sometimes scale in dangerous amounts does not adhere persistently to the plate but breaks off in flakes and accumulates in a loose form.

In some cases, it may not deposit as scale at all but may remain as suspended matter that accumulates as a sludge which gradually settles on the heating surface. In either the solid or the loose form, this foreign substance within the boiler may retard the heat transfer to such an extent that overheating occurs.

In that event, the pressure tends to force the plate out of shape. Such a change frequently causes the scale to break off or to shift its position, thus permitting the water to reduce the temperature of the plate to normal. In such cases, the bulge is not of great depth, and the material has not been seriously damaged. Consequently, a crew of skilled workmen can heat the distorted part and restore the sheet to practically its original contour.

If the accumulation of scale is not dislodged when the shell plate bulges slightly, the overheating and bulging may continue until the plate ruptures and leakage develops at the apex of the bulge. Bags or bulges resembling the crown of a derby hat are not uncommon where poor feed water is used and where the boilers are not cleaned as thoroughly or as frequently as they should be.

If the depth of such a bulge is not more than 25 percent of its diameter, it may be possible to restore the plate practically to its original shape by proper heating and hammering. Even if there is no rupture at the apex of the bulge it is well to drill a hole of about 1-inch diameter at that point in order to determine the thickness of the plate and to facilitate the upsetting of the bulged metal. A welding torch, secured to a long handle, may be used to heat the plate on the outside surface while the outside surface is hammered. A cast-iron form of proper shape can be used to advantage inside the boiler as a face plate. After the bulge is "set up," the hole that was drilled in its apex should be reamed and closed with a rivet.

Lap Seam Cracking

Q. The question has arisen as to just how narrow the definition of typical lap seam cracks is. It is recognized that the usual type of cracking, extending from rivet hole to rivet hole, has been fairly well established as "typical lap seam cracking." On the other hand, there are other types of cracking in connection with lap seam boilers, as for instance those types of cracks which are in the solid sheet immediately underneath the plate lap. It is in connection with this latter type of cracking that we have sent this question.

Will you be so kind as to answer the following specific query:

Is the type of cracking found in lap seam boilers extending from rivet hole to rivet hole the only example of lap seam cracking or can this description be extended to include cracking in the solid sheet adjacent to the plate lap and on an axis parallel to the longitudinal seam of the boiler?

We are quite anxious to secure a qualified opinion because of the fact that a boiler recently developed a crack adjacent to the longitudinal seam and the question has arisen as to whether or not such a crack can be repaired by patching. The boiler in question is of the horizontal tubular type having a dome. The crack occurred in the portion of the seam adjacent to the point on the shell where the dome is attached. There was ample distance between the seam and the riveting in the dome flange although unquestionably this section of the boiler shell was more rigid than other portions of the shell along the seam. Since most state codes prohibit patching of boilers in which typical lap seam cracking has developed, it is of utmost concern that we be perfectly sure of our ground and of the proper classification of the form of cracking we have illustrated in the sketch below. A. C. L.

A.—The sketch submitted with the question is illustrated in Fig. 1.

As stated in the question, most state codes prohibit patching of boilers in which typical lap seam cracking has developed. For example:

The Industrial Code of the Department of Labor of the State of New York, Part II, Existing Installations, Power Boilers, states as follows:

The shell or drum of a boiler in which a typical "lap seam crack" is discovered along a longitudinal riveted joint for either butt seam or lap joints shall be permanently discontinued for use under steam pressure. By "lap seam crack" is meant the typical crack frequently found in lap seams extending parallel to the longitudinal joint and located either between or adjacent to rivet holes.

(In answer to the specific query, it is my opinion that the crack in the solid plate immediately underneath the plate lap is a typical lap seam crack, adjacent to the rivet holes.)

This crack is typical of lap seams and is due to grooving caused by the working of the edge of the plate into the shell, generally caused by the improper rolling of the shell at the time of manufacture, or by excessive calking.

The question of whether the boiler can be patched or should be removed from service is best settled by having it examined by a qualified inspector of the state in which the boiler is operating. His decision is usually final.

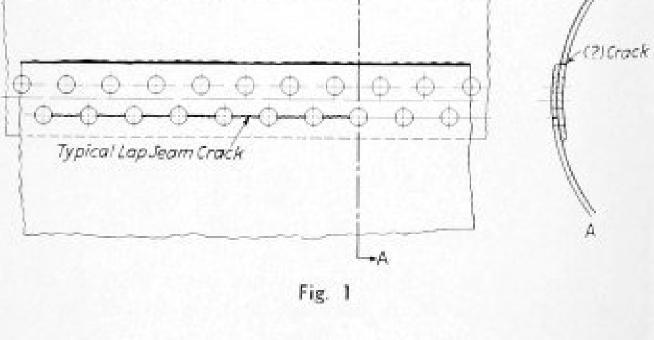


Fig. 1

Layout of Steel Hopper

Q.—I have made a crude sketch of a ¼-inch steel hopper. There are no dimensions given. It is an easy problem to lay out. Is it possible to work out a formula to get the correct bend in the valley? I use Smoley's Tables. J. T. M.

A.—I do not know of any formula for computing the valley angle of a hopper.

A typical method of determining this angle is illustrated in Fig. 2.

Through c any point on a-b draw d-e perpendicular

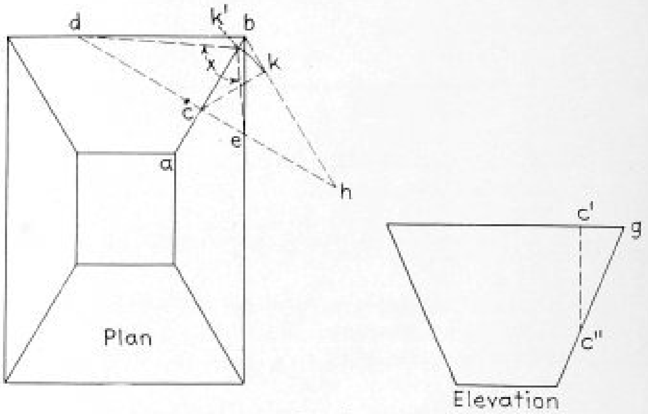


Fig. 2

to a-b and continue this line beyond e. Make c-h in the plan equal to c'-c'' of the elevation. Connect b-h. Through c erect a perpendicular to the line b-h locating the point k. With c as a center and with the dividers set equal to c-k, draw an arc cutting the line a-b at k'. Draw the lines d-k' and e-k'. The angle d-k'-e shown as angle x is the required angle.

Formula for Dished Heads

Q.—Would you furnish me with a formula for dished heads, cold made on a sectional press?

The diameters range from 24 inches to 10 feet 6 inches and the dish ranges from 24 inches to 10 feet radius. A. J. B.

A.—The radius of the blank or disk before dishing is determined as illustrated in Fig. 3.

Layout the shape of the head full size and draw the neutral axis of the plate as indicated by the dotted line.

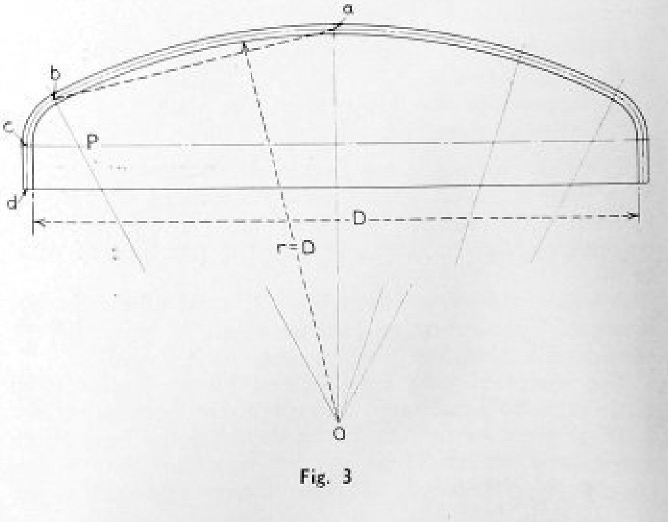


Fig. 3

Connect the center O with the center of the corner radius P extending the connecting line to cut the neutral axis of the plate at b. Draw a line at 90 degrees to the center line through the center of the corner radius P extending this line to cut the axis of the plate at c.

Point a is located where the center line of the head cuts the neutral axis of the plate.

Connect a-b with a dotted line. The radius of the blank or disk before dishing is equal to $a\text{-}b + b\text{-}c + c\text{-}d$ measured on the neutral axis of the plate as shown by the dotted line, Fig. 3.

This method may be used for obtaining the required size of the disk for heads dished hot or cold.

Laying-out Processes

Q.—I have been very much interested in the various questions and answers appearing in BOILER MAKER AND PLATE FABRICATOR but I notice that no one has asked for a recommendation as to which is the better course in laying-out. Would you please send along this information? W. F. C., Jr.

A.—The question is too general for a complete discussion in the space allotted to this department. I would recommend that you obtain a copy of "Laying-Out for Boiler Makers," published by the Simmons-Boardman Publishing Corporation, 30 Church Street, New York.

This book deals with the various methods of laying-out both in the shop and in the drafting room. It also gives a practical discussion of the methods of laying-out, in considerable detail, different types of boilers, tanks, stacks, bins and irregular sheet metal work.

Washout Plug Chaser

A simple little device which proves a great convenience in engine house work is the washout plug chaser, shown in the illustration. This labor saving device is now in use at the Joliet, Ill., shops of the Elgin, Joliet & Eastern. The threads of brass washout plugs, even when removed every 30 days, frequently become pretty well filled with lime, carbonized oil and other foreign material which is difficult to remove by ordinary hand methods, especially without some damage to the threads.

The device shown in the illustration consists simply of a hand wheel and chuck arrangement for turning the washout plug while a hand thread chaser is used to run up the thread and clean out all foreign material without removing any metal. The entire jig is mounted on a U-bracket made of 2-inch by 1¼-inch stock measuring 8 inches between the vertical sides and 6 inches high. This bracket is bolted to a supporting plate on a tool box and equipped with a 12-inch hand wheel, friction bearing and driving jaw on one side and a tail stock with a 4-inch hand wheel and ¾-inch screw on the other side to hold the washout plug in the driving jaw and also center it. The driving jaw also is equipped with a center so that the washout plug will run true. A tool rest is provided parallel to the center line of the device and on the side next to the workman. This serves as a guide and support for the hand-operated thread chaser tool as it is moved parallel to the axis of the washout plug and cleans out the threads.

Washout plug chaser

Commerce Chamber Issues Trade Association Pamphlets

Manufacturers will find of interest and value two publications just issued by the Trade Association Department of the Chamber of Commerce of the United States. They carry the following titles: "Development of Trade Associations," and "Use of Trade Association Statistics in Manufacturing."

The first pamphlet traces the evolution of the trade association movement and analyzes the development and present activities of trade associations and their services to members, as well as to the public and to the Government. This pamphlet appraises the position and significance of trade associations in the economic system, and stresses the value of trade associations to business. The growth in extent and scope of various activities of trade associations, such as trade promotion, statistical services, uniform cost accounting, and commercial arbitration, since the foundation of early trade groups in the last century to the present day, is brought out in this study.

The second publication, through examples, describes in a non-technical manner ways in which association data are applied by business men in solutions to internal problems of management. The survey cites illustrations of how production and sales statistics are used by individual concerns; for example, in appraising supply and market conditions in the industry and in determining how much to produce or to stock. A section of the pamphlet is devoted to the value of trade association cost statistics as aids to executives in their efforts to eliminate inefficiency and waste, so as to reduce costs of production and distribution. The uses of industry price statistics by individual concerns in determining the most profitable prices to be placed and in correlating available association statistics to obtain a comprehensive industry picture are treated.

Hiawatha Completes Two Years of Service

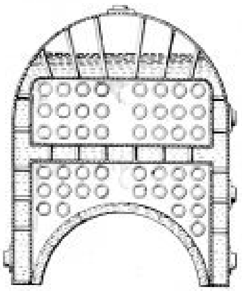
"A financial success at the tender age of two" is the expression used by the Chicago, Milwaukee, St. Paul & Pacific in calling attention to the completion of two years of service by the *Hiawatha* between Chicago and the Twin Cities on May 29. During this period the train carried more than 550,000 paying passengers, and its gross revenues exceeded \$2,600,000. During 1936, gross earnings of the *Hiawatha*, and overflow sections operated frequently, amounted to \$3.62 a train-mile. Operating costs, including interest and depreciation, were \$1.13 a train-mile, leaving net earnings of \$2.49 a mile. However, a proportionate share of track expenses, taxes, solicitation and miscellaneous costs are not taken into consideration.

Selected Patents

Compiled by Dwight B. Galt, Patent lawyer, Earle Building, Washington, D. C. Readers desiring copies of patents or any information regarding patents or trade marks should correspond directly with Mr. Galt.

1,933,229. BOILER. GEORGE A. STACEY, PHOEBUS, VA., ASSIGNOR OF ONE-HALF TO CHARLES C. CURTIS, HAMPTON, VA.

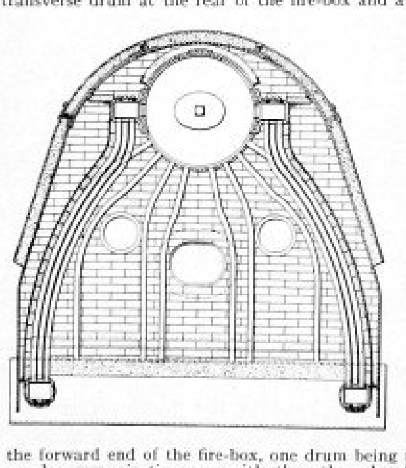
Claim.—A boiler construction comprising a combustion chamber, two upper and two lower groups of flue tubes, forwardly extending side and crown water legs, rearwardly extending side and crown water legs, a



horizontal water leg connecting the two forwardly extending side water legs and disposed between the upper and lower groups of flue tubes, a vertical medial water leg depending from and communicating with the rearwardly extending crown water leg and disposed between both the upper tube groups and the lower tube groups a horizontal water leg connecting one of the rearwardly extending side water legs and the medial water leg and disposed between one of the upper tube groups and one of the lower tube groups, and means closing communication between the combustion chamber and one of the lower tube groups. Six claims.

1,925,026. WATER TUBE LOCOMOTIVE BOILER. WILLIAM A. AUSTIN, WYNNEWOOD, PA.

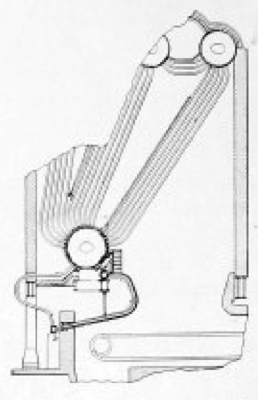
Claim.—The combination in a locomotive boiler, of a casing enclosing a fire-box and the barrel of the boiler, and having at its forward end a smoke-box; a longitudinal upper drum extending throughout the length of the fire-box and barrel; a series of longitudinal manifolds at each side of the upper drum; a lower transverse drum at the rear of the fire-box and a pair of trans-



verse drums at the forward end of the fire-box, one drum being mounted upon the other drum and communicating one with the other; longitudinal lower manifolds at each side of the fire-box; tubes at each side of the fire-box connecting the manifolds of the lower header with those of the upper header; transverse drums in the barrel of the boiler; longitudinal lower manifolds connecting the lower transverse drums and manifolds connecting the rear transverse drum of the barrel of the boiler with the upper transverse drum at the forward end of the fire-box; and a series of tubes connecting the lower manifolds with the upper manifolds. Fourteen claims.

19,455. STEAM BOILER. JOHN E. BLACK, DECEASED, LATE OF RUMSEN, N. J., BY FULLER LEHIGH COMPANY, MESNE ASSIGNEE, NEW YORK, N. Y., A CORPORATION OF DELAWARE.

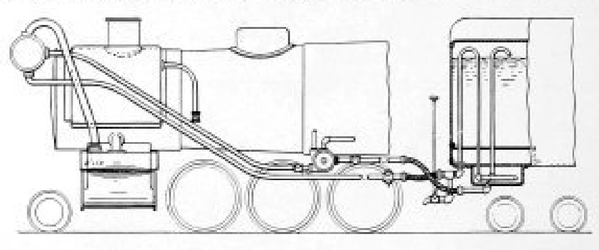
Claim.—A water tube boiler of the Stirling type having an arch below and in front of the lower drum of the boiler, cooling tubes to support said arch, a wall supported upon and extending upwardly from said arch to a point in front of said lower drum, backing plates for said wall having vertical bulb portions on the front thereof, said wall comprising tile and said bulbs engaging recesses in said tile, whereby the tile are permitted free expansion in a generally vertical direction and an angle



member connected to said lower drum, said backing plates having hooks cooperating with said angle member to form a gas seal and the plates being substantially in contact with each other to form a continuous backing for the tile. Twenty-two claims.

1,929,830. HOT-WELL PREHEATER AND CONDENSER FOR LOCOMOTIVES. EDWARD F. SULLIVAN, SOUTH PORTLAND, MAINE.

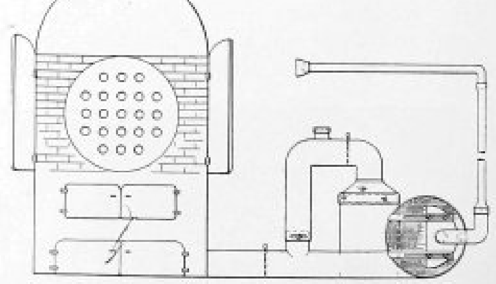
Claim.—A hot-well preheater and condenser for locomotives having a main water-supply tank and a main feed-water heater, comprising a relatively small tank disposed beneath said main water-supply tank, a pipe coil in said small tank through which hot condensate water and



exhaust steam from the main feed-water heater of said locomotive travels on its course to the said main supply tank, a discharge pipe from said coil rising through the water in said main supply tank and terminating at an elevation above the highest normal level of the water in said supply tank, a pipe through which feed-water may be discharged from said small tank, and means of communication between the interiors of said small tank and said main water-supply tank. Three claims.

1,926,930. BOILER CLEANING APPARATUS. CHARLES BACHER, NEW YORK, N. Y.

Claim.—The combination with a tube boiler and its setting, of a blower, a pipe connecting said blower with the lower part of the boiler setting for conducting air under pressure from the blower to the combustion space of said boiler setting, a receptacle, a second pipe connected to the



first-mentioned pipe and to the receptable, a valve in said first pipe between the boiler setting and the point of connection of the second pipe, a valve in the second pipe, the second pipe having a capped opening between the valve therein and the connection of the second pipe with the first mentioned pipe and a detachable tube leading from the air inlet end of the blower and adapted to be placed at the ends of the boiler tubes. One claim.

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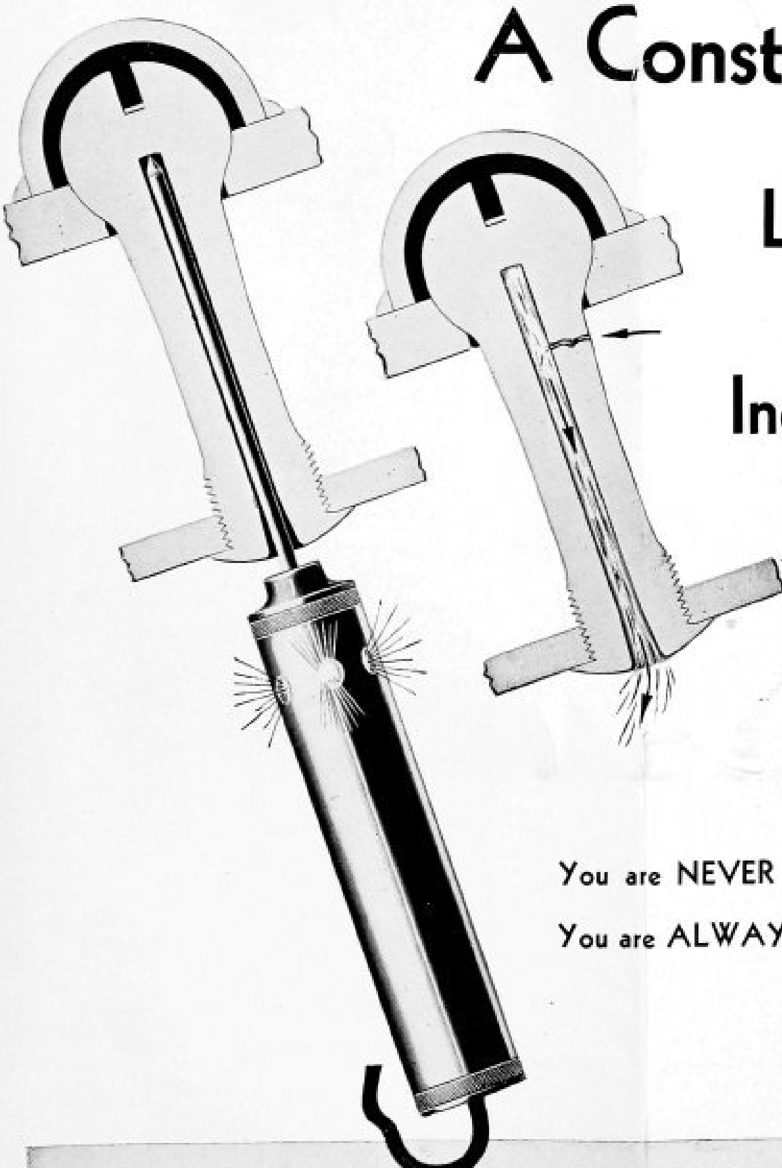

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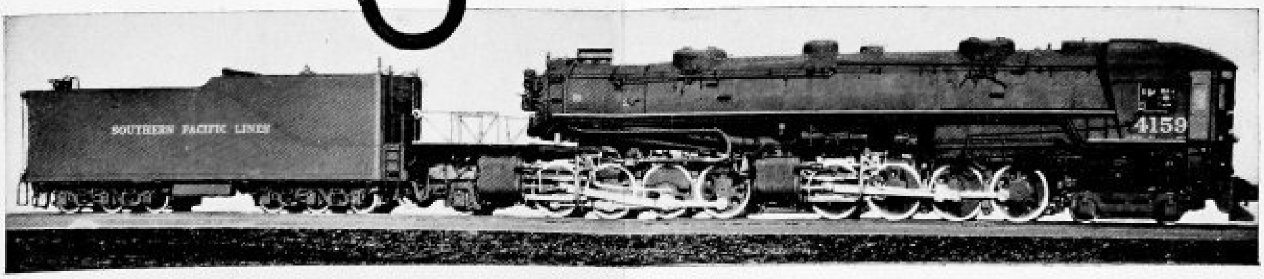

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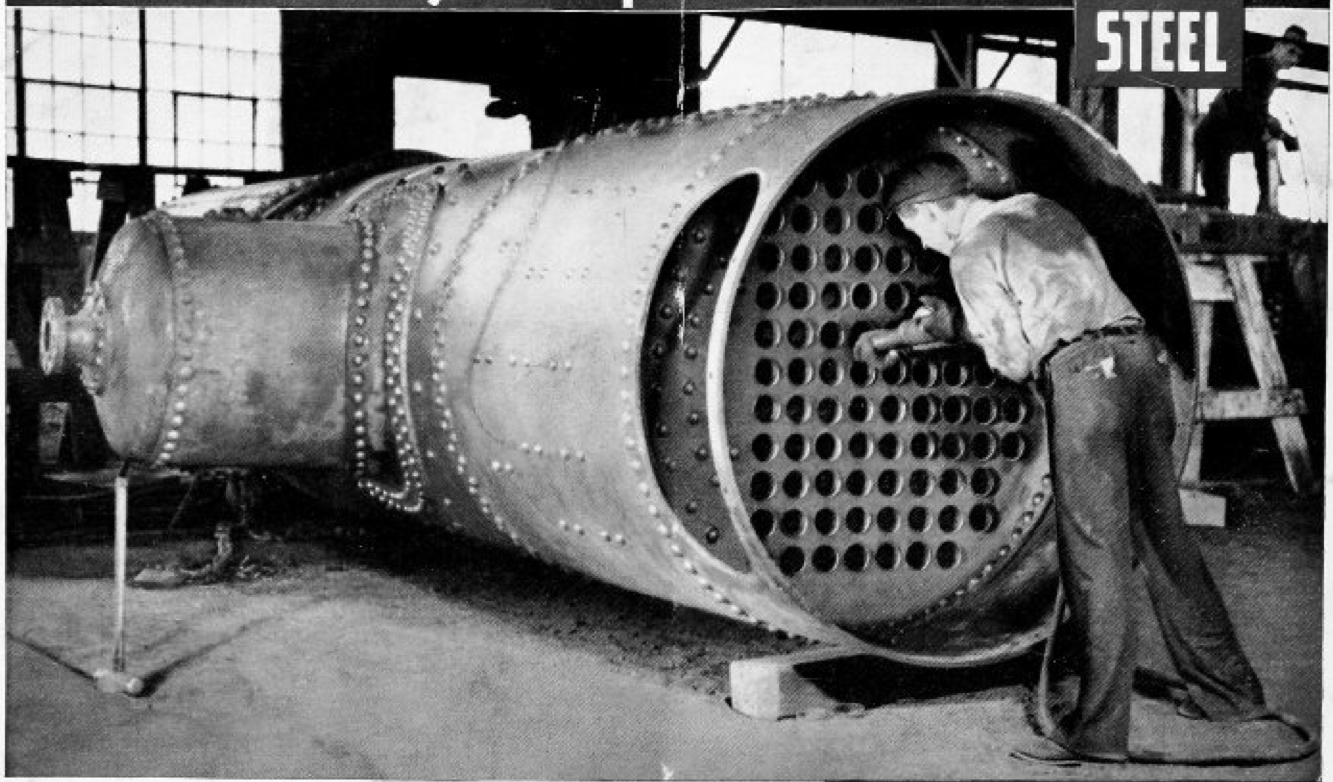

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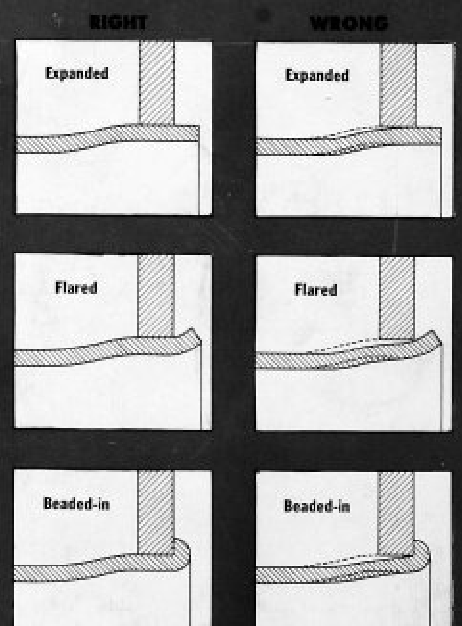

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