

Dec. 9, 1941.

O. HARTMANN

2,265,481

HEAVY DUTY HIGH PRESSURE DRUMLESS BOILER

Filed Dec. 30, 1938

3 Sheets-Sheet 1

Fig. 1.

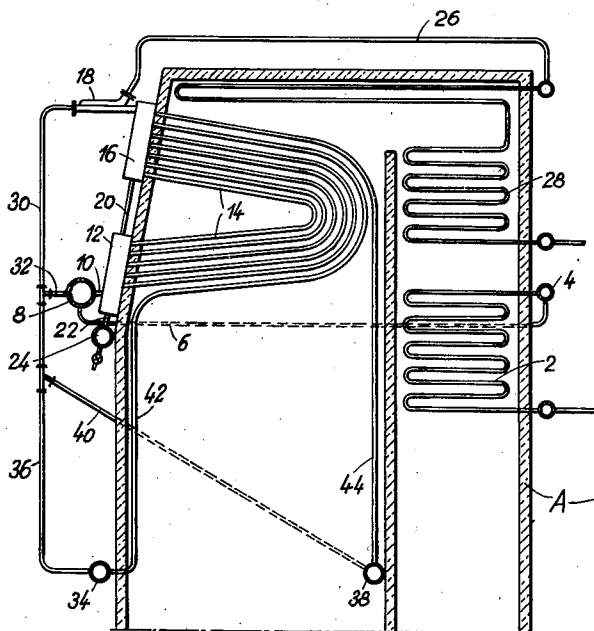


Fig. 2.

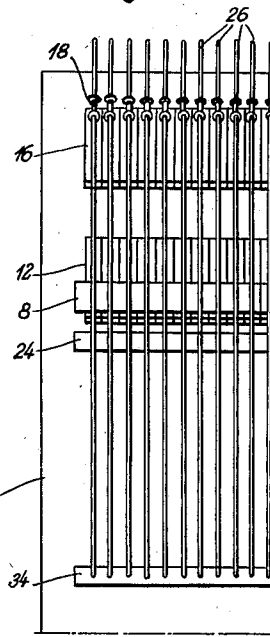
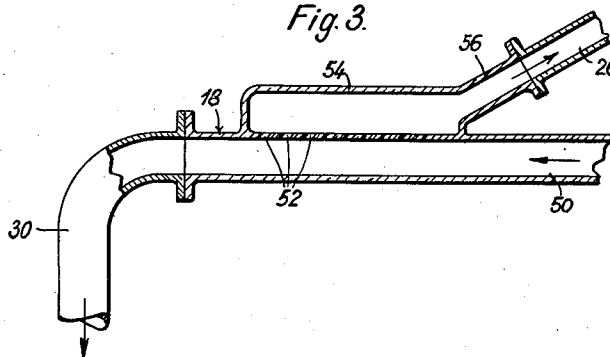


Fig. 3.



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3 Sheets-Sheet 2

*Fig. 4.*

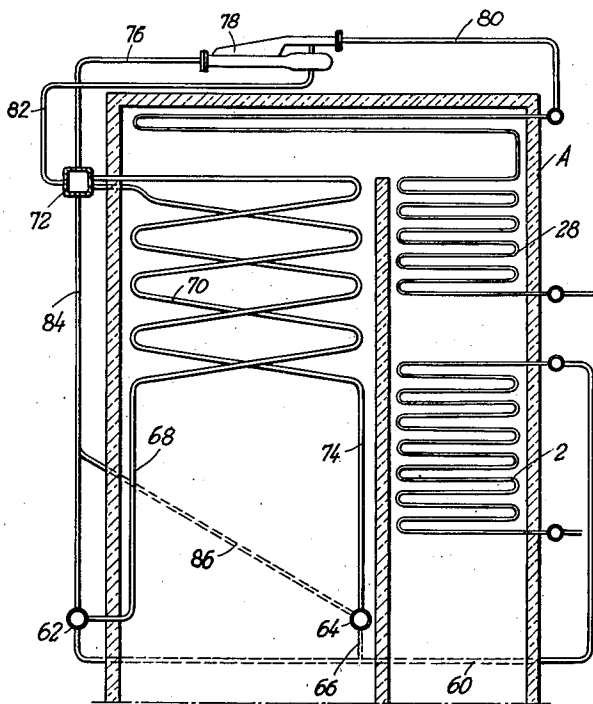
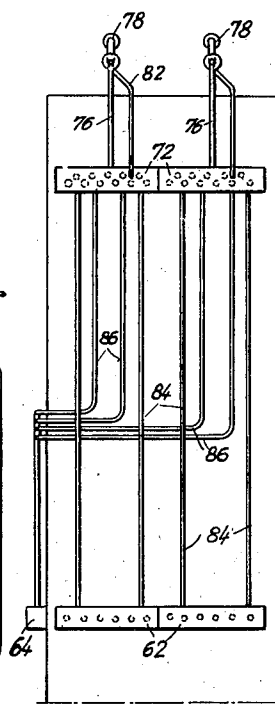


Fig. 5.



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3 Sheets-Sheet 3

*Fig. 6.*

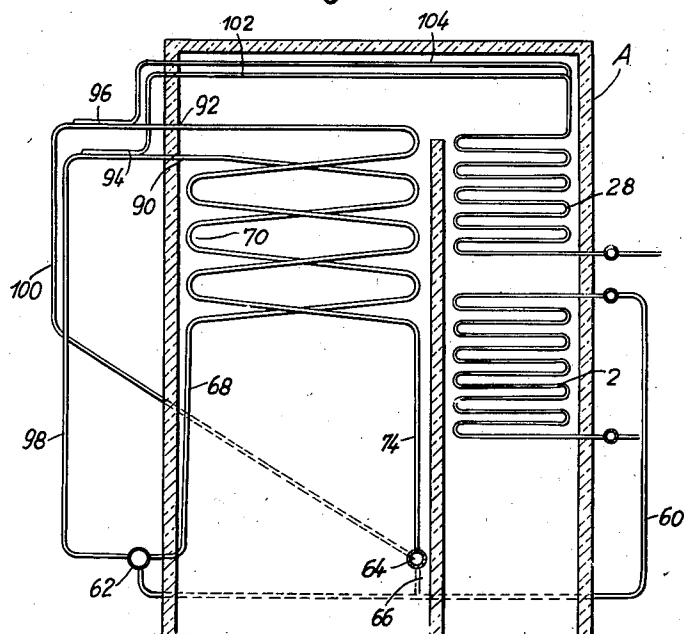
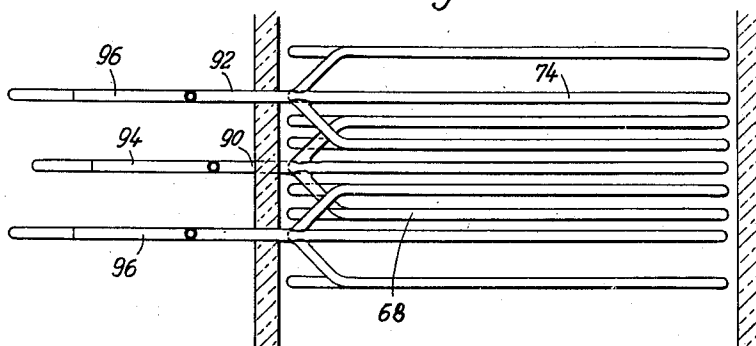


*Fig. 7.*



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## UNITED STATES PATENT OFFICE

2,265,481

## HEAVY DUTY HIGH PRESSURE DRUMLESS BOILER

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In Germany January 17, 1938

7 Claims. (Cl. 122-489)

This invention is directed to a heavy duty high pressure drumless boiler.

It is an object of the invention to produce an inexpensive and reliable high pressure drumless boiler.

A further object of the invention is to produce a high pressure heavy duty drumless boiler in which the conventional steam drums are replaced by individual steam and water separators, which separators are made relatively small in size and of simple construction.

Another object of the invention is to produce a high pressure heavy duty drumless boiler in which the vaporizer tubes are arranged in groups, and the conventional drum is replaced by individual steam and water separators which are attached, respectively, to each group of vaporizer tubes.

A further object of the invention is to produce a heavy duty high pressure drumless boiler which can operate without benefit of water free of salt, and without condensers and steam transformers, and in which boiler means are provided for blowing off deposits of sludge or scale.

Another object of the invention is to produce a boiler composed of tube groups of equal heat efficiency, the capacity of the boiler being determined by the number of tube groups contained therein.

A further object of the invention is to produce a boiler which can be used for indirect steam generation, the boiler being of the construction as outlined in the objects set forth above.

In the prior art, heavy duty high pressure boilers necessitated the use of very heavy and bulky materials because of the high pressures generated in the boiler. In particular, the steam drum must have very thick walls to sustain the high pressures developed in modern boilers. Furthermore, in the operation of prior art high pressure boilers, it was essential, in the interests of economy, to use very pure water, inasmuch as deposits of sludge and scale would materially impair the efficiency of the boiler. Other apparatus also employed in the construction of prior art boilers were very large and cumbersome, especially in the use of condensers to reclaim the pure water, and in the use of other auxiliary equipment as steam transformers. A small compact high pressure heavy duty boiler of light weight is obtained by the instant invention in that vaporizing tubes of equal heat efficiency are formed in groups, and each group of tubes has attached thereto a tubular steam and water separator, the steam from the separators being conveyed to a superheater, in direct steam generation, and to second vaporizer tubes in indirect steam generation, while the separated water is returned to the groups of tubes to be recirculated therein. By reason of this construc-

tion, the apparatus can be arranged to provide means for blowing off the sludge and scale, and consequently a very pure feed water does not need to be supplied to the boiler, while, at the same time, the water circulation and the cooling action of the tubes is maintained. Again, the individual steam and water separators are lighter in weight than the massive steam drum heretofore employed in high pressure boilers. By having the vaporizer tubes arranged in groups, it is possible to construct boilers of any desired capacity, inasmuch as an enlarged boiler would merely consist of an increased number of units of groups of tubes. The steam and water separators and their associated parts can be cheaply produced in quantities by being formed of stamped or pressed materials, and the installation of such a boiler is simplified as the individual parts thereof can be finished in the shop and transported to the point of erection.

While in the prior art, individual vaporizer tubes have been provided with individual steam and water separating devices somewhat similar to those employed in the invention disclosed herein, no use of steam and water separators employed for groups of tubes in a high pressure boiler has been made. Likewise, although some boilers, such as indirect steam generating boilers, have their vaporizer tubes divided into tube groups, and each tube group supplied with a small steam drum, the water content of the steam and water discharged into the steam drum has been so large that the use of such tube groups is not analogous to the high pressure heavy duty boiler disclosed in the instant invention.

Means by which the objects of the invention are obtained are disclosed in the accompanying drawings, in which:

Fig. 1 is a sectional elevational view of a boiler showing the tubes arranged according to one form of the invention.

Fig. 2 is a side view of Fig. 1.

Fig. 3 is an enlarged view, partly in section, of the steam and water separator shown in Fig. 1.

Fig. 4 is a sectional view, as in Fig. 1, showing a modified form of the invention.

Fig. 5 is a partial side view of Fig. 4.

Fig. 6 is a sectional view, as in Fig. 1, showing a further form of the invention; and, Fig. 7 is a partial plan view of Fig. 6.

Similar reference characters refer to similar parts throughout the drawings.

In Fig. 1, a boiler is indicated by the walls A.

The vaporizing system consists as follows:

Feed water passes through the feed water preheater 2 into header 4, from which it is led through pipe 6 to header 8. From header 8, the water is passed through pipe 10 into collector 12. From collector 12, the water enters ad-

adjacent groups of tubes, each group comprising a series of tubes 14, preferably of small diameter, arranged in substantially a vertical plane, and of hairpin shape, these tubes 14 discharging into a second collector 16. From this collector 16, a mixture of steam and water rises and is passed to steam and water separator 18, while the separated water is returned through pipe 20 to the lower collector 12. From collector 12, a pipe 22 extends to a blow-off header 24.

From the steam and water separator 18, steam is passed through pipe 26 into superheater 28, while the separated water is conducted through pipe 30 to the header 8 through pipe 32, or to lower header 34 through pipe 36, and lower header 38 through pipe 40. From lower header 34, a tube 42 rises which is continued around the series of tubes 14, while from header 38, a pipe 44 rises which is likewise continued around tubes 14 and 42.

As shown in Fig. 2, each group of tubes 14 may be mounted in substantially the same vertical plane, and each group connected to its respective collectors 12 and 16, and steam and water separator 18. The series tubes 42 on one side of the combustion chamber and the series tubes 44 on the other side of the combustion chamber form tube walls which protect respectively the walls of the combustion chamber, and are subjected to radiant heat, while the series of tubes 14 are subjected to the incandescent gases rising from the combustion chamber. All the tubes in any one group should have approximately the same heat efficiency in order to maintain a proper water circulation in the tubes. It is to be noted, however, that all the tubes 14 and the bent portions of the tubes 42 and 44, can lie either in one vertical plane, or in two parallel vertical planes. In the latter case the tubes are relatively staggered as usual with boiler tube bundles.

The header 10 provides a common water reservoir for the tubes 14 lying in their respective adjacent vertical planes, and the collector 24 provides a common blow-off for sludge removal for all the adjacent collectors 12. The capacity of the boiler depends upon the number of tube groups contained therein.

The construction of the tubular steam and water separator 18 is shown in detail in Fig. 3. The steam and water enters the tube 50, and in passing therethrough, the steam rises and escapes through perforations 52 formed in the upper wall of the tube, where it is collected in chamber 54. From this chamber, the steam passes through conduit 56 into the conduit 26, from which it goes to the superheater.

The water separated from the steam passes through the tube into pipe 30, from whence it is re-circulated through the vaporizer tubes.

In a second embodiment of the invention illustrated in Fig. 4, the boiler is again shown with walls A. Water passes from the preheater 2 through pipe 60 into lower headers 62 and 64, the connection to header 64 being made by a branch pipe 66. From lower header 62, a number of adjacently placed individual vaporizer tubes, illustrated by the tube 68, rise adjacent one wall of the combustion chamber, and form a cooling wall therefor. In the upper part of the combustion chamber, these tubes are bent, as shown at 70, to traverse the combustion chamber, and then the tubes are passed into a collector 72, it being noted that one collector is provided for each group of six tubes, as illustrated in Fig. 5.

From the header 64, a second series of tubes 74

74 rises, which tubes are arranged as tubes 68 and are discharged at their upper ends into collector 72. As shown in Fig. 5, groups of these tubes extend into the separate collectors 72, each collector thus receiving a group of tubes 68 and a group of tubes 74.

From each collector 72, the steam rises and is passed through pipe 76 into a tubular steam and water separator 78, one steam and water separator being provided for each collector 72. This separator may have the form of the tubular separator illustrated in Fig. 3.

This construction has the advantage of the collectors 72 being arranged in line with each other, as compared with the vertically displaced collectors 12 and 16 of Fig. 1.

From the steam and water separator, the steam is passed through pipe 80 to superheater 28, while the separated water is passed through pipe 82 back to the collector 72. Water received in collector 72 is passed through pipe 84 down to lower header 62, and is passed from pipe 84 to header 64 through branch pipe 86.

A further modification of the invention is shown in Fig. 6, wherein, within the furnace walls A, as shown for Fig. 4, the water is passed from water preheater 2 through pipe 60 to lower headers 62 and 64, from which the water goes through vaporizer tubes 68 and 74. However, the tubes 68 and 74, respectively, are, as shown in Fig. 7, arranged in groups, as, for example, groups containing three tubes each, and the tubes 68 are combined into a single tube at 90, while the tubes 74 are combined into a single tube 92, and the steam and water contained in these tubes lead to individual tubular steam and water separators 94 and 96, respectively, as shown in Fig. 6. From steam and water separator 94, the separated water is led back to header 62 through pipe 98, while the separated water from tubular separator 96 is passed through pipe 100 to header 64. The steam from tubular separators 94 and 96 is passed respectively through pipes 102 and 104 to the superheater 28. This structure has the advantage in that the tubular steam and water separators can be located in superimposed rows.

In each of the modifications, it is noted that the vaporizer tubes form protecting walls for the lower portions of the walls of the combustion chamber, that the tubes are arranged in groups, either in adjacent vertical planes, as shown in Fig. 1, or in adjacent groups in the same plane, as shown in Figs. 4 to 7. The tubular steam and water separators are created as individual lightweight units, one unit being provided for each group of tubes, thus dispensing with the heavy steam drum used in the prior art. All the tubes in the same group receive approximately the same heating, and in combustion chambers where unequal heating exists, all the highly heated tubes can be connected together, and all the poorly heated tubes can be connected together. In the latter instance, care must be exercised that individual collectors are provided for the assemblies of highly heated tubes and the assemblies of poorly heated tubes, so that a proper circulation of the feed water and the return water from the steam and water separators can be maintained. It is further noted that the steam and water separators are, in each instance, located outside of the walls A of the boiler.

With the various constructions described, a high pressure heavy duty boiler can be obtained without the employment of heavy and expensive parts as used in the prior art. Likewise, water-

washing drums, condensers, or economizers to recover pure salt-free water need not be added to the boiler equipment. Also, other auxiliary equipment, such as steam reheaters and forced circulation pumps, are not necessary. Generally, the use of all auxiliary equipment is avoided, especially such equipment as takes up space, and results in power losses, such as the 6% to 10% loss taking place in converting steam from high to low pressure. When used for indirect steam generation, the steam sides of the tubular steam and water separators are connected to the heating elements of the secondary steam generating system.

Having now described means by which the objects of my invention are obtained, what I claim is:

1. In a heavy duty high pressure drumless steam boiler, a vaporizing system comprising a plurality of vaporizer tubes arranged in tube groups, a separate collecting conduit for each group of tubes, individual steam and water separators for and joined to said conduits, each separator including a substantially horizontally disposed tubular portion for conducting a steam and water mixture and a steam takeoff portion joined outwardly of said tubular portion, and means for conducting the water from said separator to the tube group for that separator for recirculation therethrough.

2. In a heavy duty high pressure drumless steam boiler having a combustion chamber, a vaporizing system comprising a plurality of vaporizing tubes having the lower portions thereof forming cooling walls for the lower section of said combustion chamber and having their upper portions crossing said combustion chamber, a plurality of conduit means for joining said tubes together as separate groups of tubes, individual steam and water separators for and joined to said conduit means, each separator including a substantially horizontally disposed tubular portion for conducting a steam and water mixture and a steam takeoff portion joined outwardly of said tubular portion, and means for conducting water from each separator to the lower portions of said tubes for recirculation therethrough.

3. In a heavy duty high pressure drumless steam boiler having a combustion chamber, a

vaporizing system comprising a plurality of vaporizing tubes mounted within said chamber, a plurality of collectors mounted outwardly of said chamber and each collector being connected to a group of said tubes, individual steam and water separators for and joined to said collectors, each separator including a substantially horizontally disposed tubular portion for conducting a steam and water mixture and a steam takeoff portion joined outwardly of said tubular portion, means for conducting water from each separator for recirculation through said tubes, and means for conducting water from each collector for recirculation through said tubes.

4. In a heavy duty high pressure drumless steam boiler having a wall enclosing a combustion chamber, a vaporizing system comprising a plurality of groups of vaporizing tubes within said chamber and having their upper ends projecting through said wall outwardly of said chamber, a plurality of tubular collectors, each collector being joined to the ends of the tubes in a group of tubes, individual steam and water separators for and joined to said collectors, each separator including a substantially horizontally disposed tubular portion for conducting a steam and water mixture and a steam takeoff portion joined outwardly of said tubular portion, and means for recirculating water in said separators and collectors through said tube groups.

5. In a heavy duty high pressure drumless steam boiler as in claim 4, each group of said tubes comprising first tubes forming cooling walls for the lower portion of said chamber and forming vaporizing tubes extending transversely of the upper portion of said chamber, and other tubes of hairpin shape co-planar with said first tubes in the upper portion of said chamber.

6. In a heavy duty high pressure drumless steam boiler as in claim 4, said projecting ends lying in substantially parallel horizontal planes, and said tubular collectors being axially aligned.

7. In a heavy duty high pressure drumless steam boiler as in claim 4, said projecting ends lying in substantially parallel horizontal planes, said tubular collectors being axially aligned, and said separators lying in a common horizontal plane above said collectors.

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