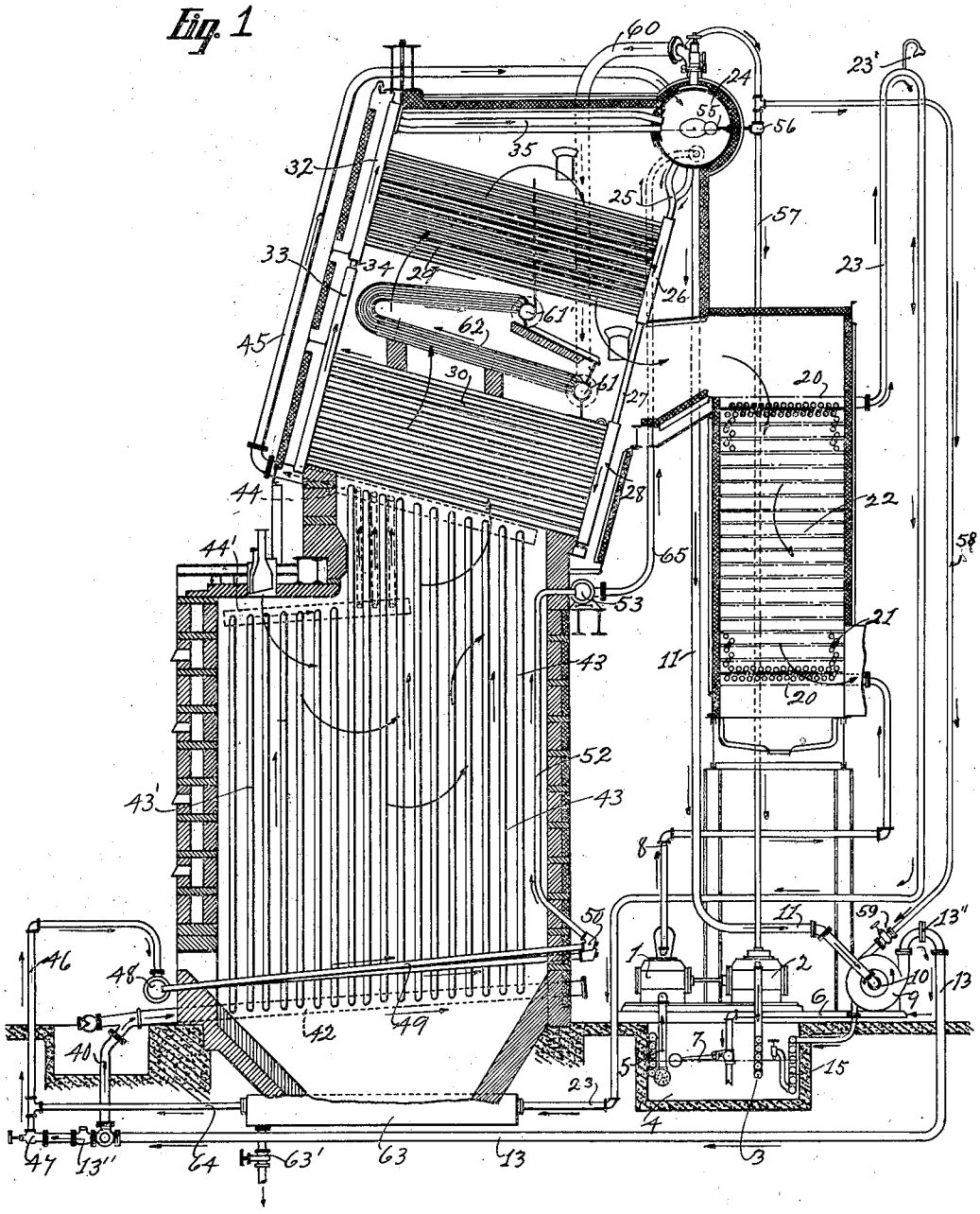
Sept. 19, 1933. C. E. LUCKE 1,927,095

TRIPLE CIRCUIT WATER TUBE BOILER

Filed Jan. 3, 1927 5 Sheets-Sheet 1

Fig. 1



Charles E. Lucke INVENTOR

BY

Gifford & Scull ATTORNEYS

Sept. 19, 1933. C. E. LUCKE 1,927,095

TRIPLE CIRCUIT WATER TUBE BOILER

Filed Jan. 3, 1927 5 Sheets-Sheet 2

Fig. 2.

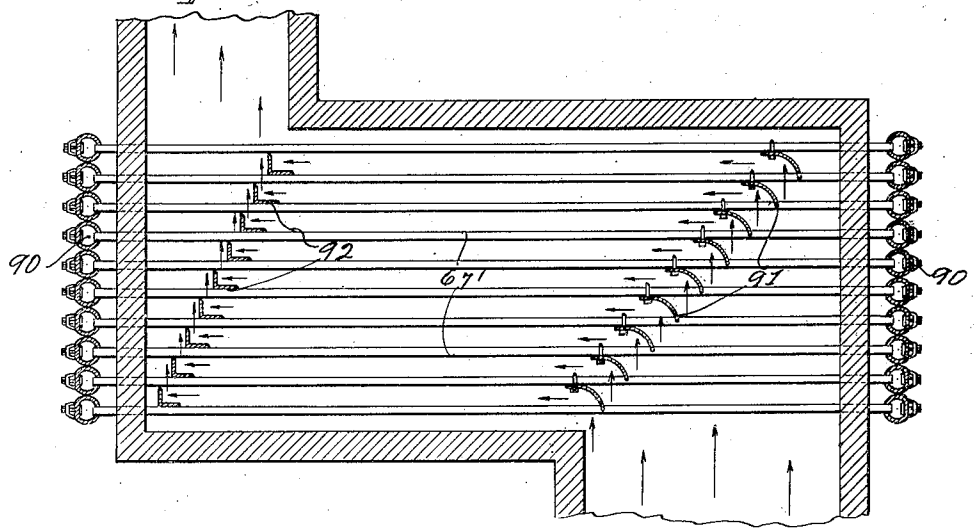


Fig. 3.

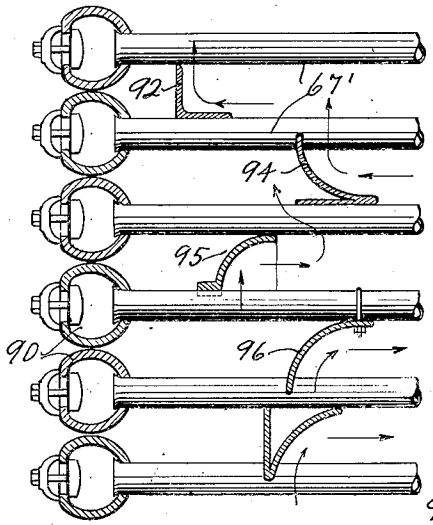
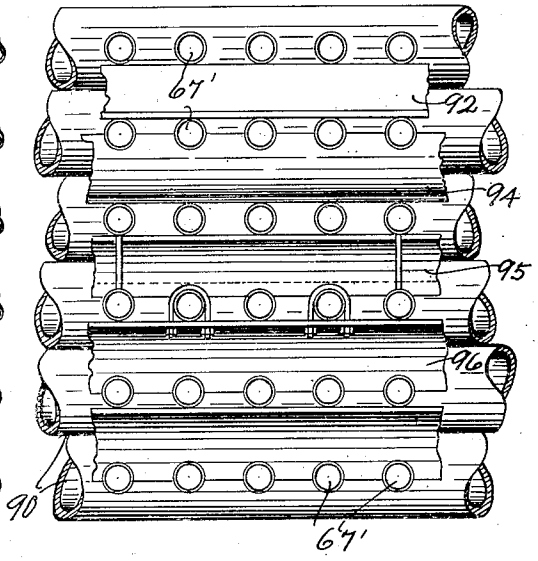


Fig. 4.



Charles E. Lucke INVENTOR

BY

Gifford & Seull ATTORNEYS

Sept. 19, 1933. C. E. LUCKE 1,927,095

TRIPLE CIRCUIT WATER TUBE BOILER

Filed Jan. 3, 1927 5 Sheets-Sheet 3

Fig. 6

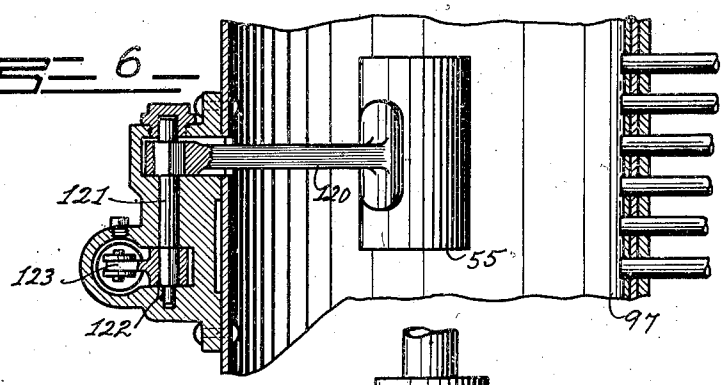
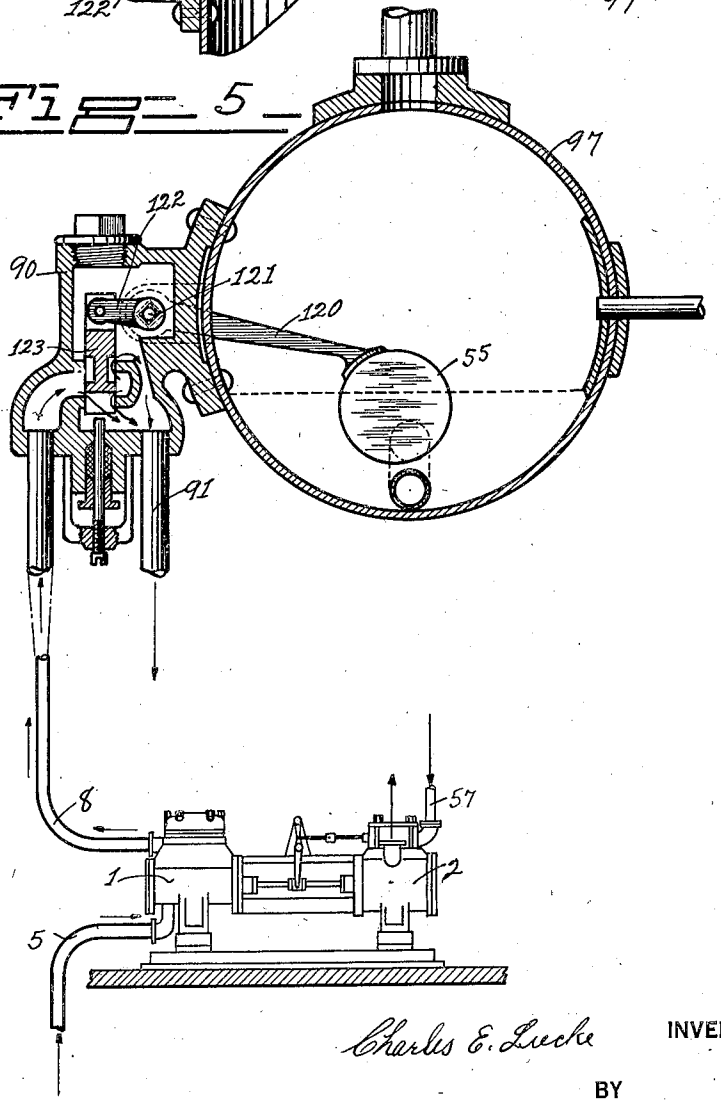


Fig. 5



Charles E. Lucke INVENTOR

BY

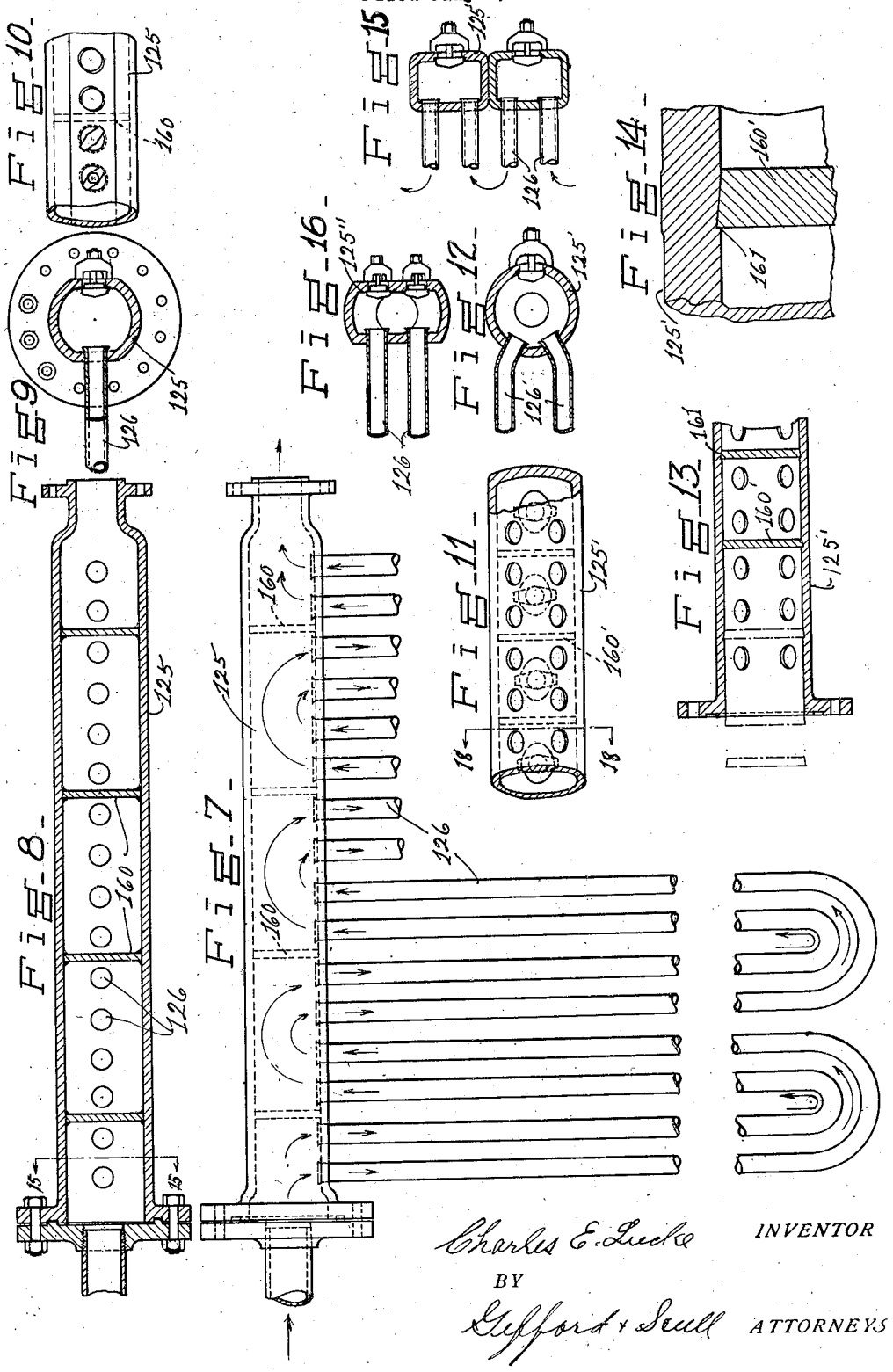
Gifford & Scull

ATTORNEYS

Sept. 19, 1933. C. E. LUCKE 1,927,095

TRIPLE CIRCUIT WATER TUBE BOILER

Filed Jan. 3, 1927 5 Sheets-Sheet 4



Charles E. Lucke INVENTOR

BY

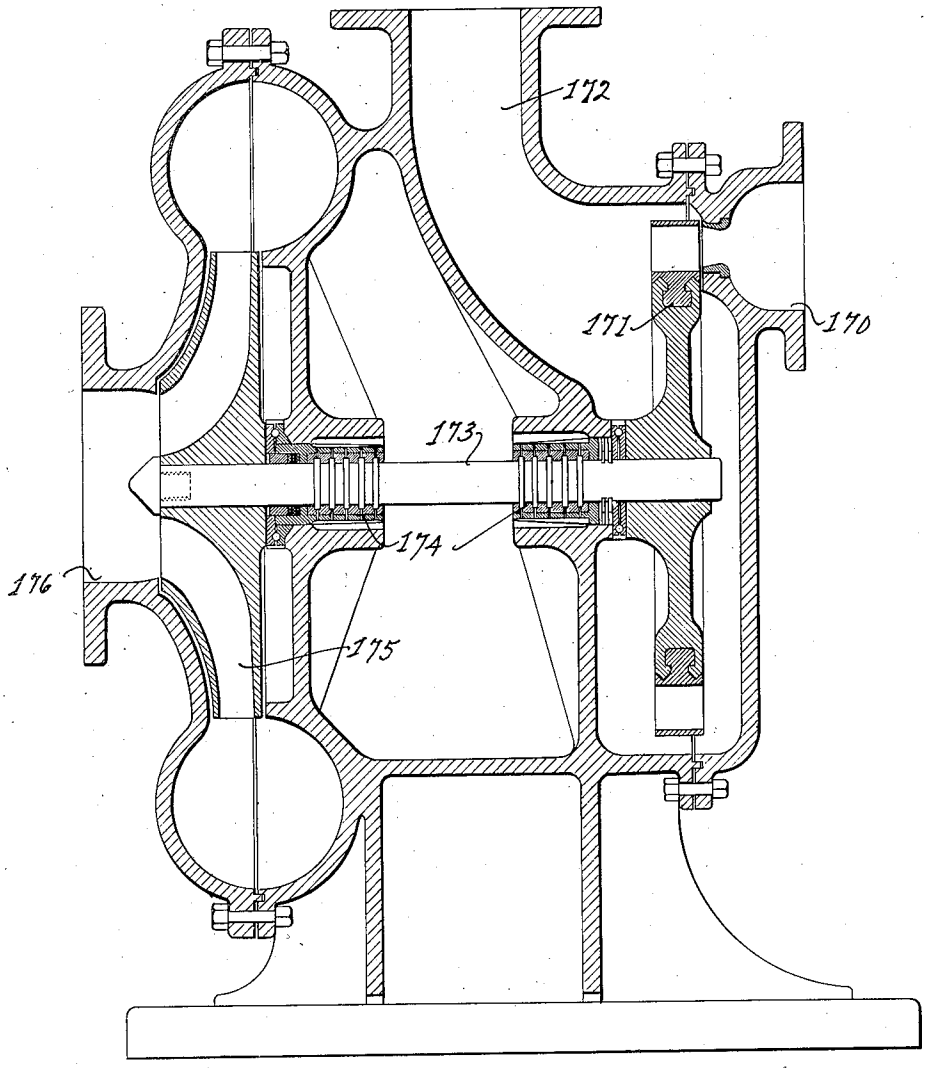
Gifford & Scull ATTORNEYS

Sept. 19, 1933. C. E. LUCKE 1,927,095

TRIPLE CIRCUIT WATER TUBE BOILER

Filed Jan. 3, 1927 5 Sheets-Sheet 5

Fig. 17.



Charles E. Lucke INVENTOR

BY

Gifford & Scull ATTORNEYS

Patented Sept. 19, 1933 1,927,095

UNITED STATES PATENT OFFICE

1,927,095

TRIPLE CIRCUIT WATER TUBE BOILER

Charles E. Lucke, New York, N. Y., assignor to The Babcock & Wilcox Company, Bayonne, N. J., a corporation of New Jersey

Application January 3, 1927. Serial No. 158,471

7 Claims. (Cl. 122—235)

This invention relates to steam boilers, and more particularly to a steam boiler constructed and arranged to take advantage in the most efficient way of the intense combustion and large heat output of modern furnaces.

The generating and development of high pressure steam in a large furnace where the rate of combustion is high involves a combination of conditions producing a great intensity of wall heating, and resulting in inadequate circulation if the standard form of circulation boiler is employed.

An object of this invention is to provide a steam boiler of such construction and arrangement as to permit the use of standard natural circulation boiler construction in connection with a modern furnace of great capacity and intense heating effects.

A further object is to provide a boiler of the type set forth constructed and arranged to efficiently utilize the intense wall heating of a modern furnace in such a way as to permit the use of standard boiler and economizer sections as part of the steam generating surface.

The invention will be understood from the description in connection with the accompanying drawings, in which

Fig. 1 is a vertical sectional view through a steam generator embodying the present invention;

Figs. 2 and 3 are sectional views showing details of some of the tubes and baffles in relation to gas flow;

Fig. 4 is a fragmentary side elevation showing a portion of the tubes;

Figs. 5 and 6 are sectional views showing details of the feed pump and its control;

Figs. 7 to 16, inclusive, are side and sectional views showing details of tubes and connections;

Fig. 17 is a sectional view through the circulating pump.

In the drawings reference character 1 indicates the water cylinder of a feed water pump in which the steam cylinder is shown at 2. The steam from the cylinder 2 is condensed in the coil 3 and passes into the feed water supply tank 4. A suction pipe 5 leads from the tank 4 to the water cylinder 1, and a feed water supply 6 provided with a float valve 7 leads from a source of water supply (not shown) to the feed water supply tank 4. The feed water outlet 8 leads away from the water cylinder 1 of the feed water pump.

A steam turbine 9 drives a centrifugal pump 10 for circulating water. The pump 10 receives the water to be circulated from the pipe 11 and forces it out through the pipe 13. The steam from the turbine 9 passes into the coil 15 in the tank 4, where it is condensed. The feed water passes through the pipe 8 to the header 20, and therefrom through the tubes 21 in parallel to the next header in series, and so on, to the topmost header 20, the tubes 21 extending across the hot gas flue or passage 22 and the flow of water is in general direction opposite to that of the gases. The water or mixture of steam and water flows from the topmost header 20, through the pipe 23 to the steam and water drum 24 in the manner hereinafter set forth.

The natural or gravity circulation system comprises nipples 25 from the steam and water drum 24, to the downtake headers 26 that are connected by nipples 27 to the downtake headers 28. The headers 26 and 28 are connected by inclined tubes 29 and 30 located above the furnace 31 to uptake headers 32 and 33 that are connected by nipples 34. Circulation tubes 35 connect the upper ends of the uptake headers 32 back to the steam and water drum 24.

The forced circulation system comprises a pipe 11 that leads from the water space of the steam and water drum 24 to the circulation pump 10, from which the outlet pipe 13 that is provided with valve 13' leads to water tubes divided into sets and in which circulation is established by the pump. A portion of the water passes through the branch pipe 40, thence into distributing headers 42 located on opposite sides of the furnace, then upwardly through furnace wall tubes 43 and 43' to headers 44 and 44' on opposite sides of the furnace, and through connections 45 on both sides of the furnace to the steam and water drum 24. Another portion of the water from the pipe 13 passes through the branch 46 that is provided with a valve 47, to the header 48, thence through slag screen water tubes 49 near the bottom of the furnace to the end connectors 50 and wall cooling tubes 52 to the header 53, thence through connections 54 to the headers 44, and then to the steam and water drum 24.

The feed water pump is controlled according to or by the water level in the steam and water drum 24, a float mechanism 55 being provided in this drum for this purpose, which mechanism opens and closes the valve 56 located in the steam pipe 57 that leads from the steam space of the steam and water drum 24 to the steam cylinder 2 of the feed pump.

The circulating pump is driven by the steam turbine 9 which receives its steam through pipe 58 that is provided with the hand regulating valve

59 and it exhausts through the condensing coil 15 in the supply water tank 4.

Steam is delivered from the steam space of the steam and water drum 24, through the pipe 60, to the superheater header 61, thence passes through the superheater tubes 62 to the header 61', thence to the steam main.

The feed water passes through the pipe 23 that extends upwardly and is provided with a reverse bend in which an air valve 23' is located to prevent siphoning. The pipe 23 leads to a mud drum 63 that is provided with a blow-off 63'. A pipe 64 leads from the mud drum to the header 48, from which water screen tubes 49 lead across the lower portion of the furnace to end connectors 50, thence through furnace wall tubes 52 to the header 53, from which a pipe 65 leads to the steam and water drum 24. Some of the circulating water is admitted to the header 48 through the valve 47 from the circulating water pipe 13.

Circulating water passes from the outlet pipe 13 of the circulating pump to connections 40, 42, 43, etc., in exactly the same way, through tubes and headers, as above described in connection with Fig. 1 and designated by the same reference characters. A check valve 13'' is provided to prevent feed water from entering the circulating pipe 13.

In the illustration, Fig. 2, the feed water tubes 67' are located in a bend in the gas flue and are shown as connected to headers 90 on each side. In this modification, curved guide vanes 91 are slightly displaced in two directions one from another to receive and to evenly direct the gases longitudinally of the tubes, and angle iron guide vanes 92 are located near the other ends of the tubes and are similarly displaced so as to receive and evenly distribute the gas on its way out. Such guide vanes prevent the tendency of gases to concentrate on one side of a large passageway at a bend.

In the modification in Figs. 3 and 4 are shown guide vane 92 of angle iron form and the guide vanes 94, 95 and 96 of various forms, on an enlarged scale. The guide vanes are suitable for diverting the gases into the proper channels without disturbing equalization of flow where the general direction of the stream is changed.

The float 55 and valve 90 for controlling the rate of flow of feed water is shown in detail in Figs. 5 and 6. The float 55 is rigidly connected by the arm 120 that extends through an opening in the side of the drum 97 to a shaft 121 and carries an arm 122 attached to the valve 123 that can be moved to open or close the passage from the outlet pipe 8 of the feed water pump to the pipe 91.

Figs. 7 to 16 show details and modifications of arrangements of headers and tubes through which the feed water is forced before it reaches the steam and water drum 24. The feed water enters the header 125 that may be provided with partitions 160. The tubes 126 are connected to the headers 125, and water is caused to circulate through the same, as most clearly shown in Fig. 7. Figs. 9 to 16 show the manner in which the tubes are connected to the headers.

In the modification shown in Figs. 11 to 14, the header 125' is provided with partitions 160' that are beveled around their peripheries, so as to fit in recessed portions 161 at spaced intervals on the inside of the header 125'. In this modification two parallel rows of tubes 126' enter the header 125' along radial lines, the ends of the tubes being slightly bent for this purpose. In the modifications shown in Figs. 15 and 16, the headers 125'' are shown with the opposite walls parallel so that two rows of straight tubes may be readily inserted in the wall opposite the hand-hole fittings. In Fig. 15, the portions of the headers between the parallel walls are flat so that the headers will rest against each other with their sides contacting, while in Fig. 16, the portions of the header between the parallel walls are rounded or arcuate shaped.

A circulating pump that may be used is illustrated in detail in Fig. 17. Steam from the steam space of the steam and water drum enters through the inlet 170 and drives the steam turbine 171 and passes through the outlet 172 to the steam main. The turbine 171 is connected by means of the shaft 173 carried in bearings 174 to the centrifugal pump 175 which causes water that is to be circulated to be drawn in through the inlet 176 and forced into the set or sets of circulating tubes.

It will be understood that in operation, the circulation pump may be controlled so as to establish any desired rate of circulation through the forced circulation tubes, by hand adjustments or automatically. Consequently the safety of tubes against overheating is assured, and this is especially important for tubes so located as to be most intensely heated, or in such a position as to make it difficult to secure a sufficiently vigorous natural circulation. This includes cases in which it is inconvenient or expensive to connect some tubes to the steam and water drums so as to secure a good natural circulation. It is often desirable in meeting special working conditions, especially in boilers where weight and space must be kept at a minimum to use tubes of smaller diameter than is practicable or safe with natural circulation. In such cases, these small tubes may be connected to the delivery of the circulating pump which will force the circulation and assure safety, thus permitting a wider latitude of design than is possible without such forced circulation.

I claim:

1. The combination with a boiler furnace having a combustion chamber of a plurality of wall tubes positioned along the walls of said chamber for absorbing the radiant heat thereof, a natural circulation boiler section located in the path of gas flow and including a steam and water separator, a circulating pump for forcing water under pressure into said wall tubes, a connection for delivering water to said circulating pump from said separator, means for delivering steam and water from said wall tubes to said separator, a feed pump and means for delivering feed water from said feed pump to said wall tubes.

2. The combination with a boiler furnaces having a combustion chamber of a plurality of wall tubes positioned along the walls of said chamber for absorbing the radiant heat thereof, a natural circulation boiler section located in the path of gas flow and including a steam and water separator, a circulating pump for forcing water under pressure into said wall tubes, a connection for delivering water to said circulating pump from said separator, means for delivering steam and water from said wall tubes to said separator, an economizer, a feed pump for delivering feed water to said economizer and means for conveying feed water from said economizer to said wall tubes.

3. The method of operating a vapor generator having a furnace with a plurality of mainly radiantly heated wall tubes, a natural circulation

section in the path of gas flow, and a vapor and liquid separator, which includes the steps of delivering liquid to the wall tubes always in excess of their ability to convert the same into vapor, passing the fluid therefrom to the vapor and liquid separator, recirculating the unvaporized liquid in both the wall tubes and natural circulation section, and adding liquid to the wall tubes to replace that converted into vapor.

4. The combination with a boiler furnace having a combustion chamber of a plurality of vertical wall tubes positioned along the walls of said chamber for absorbing the radiant heat thereof, a natural circulation boiler section located in the path of gas flow and including a steam and water separator, a circulating pump for forcing water under pressure into said wall tubes, a connection for delivering water to said circulating pump from said separator, means for delivering steam and water from said wall tubes to said separator, a feed pump and means for delivering feed water from said feed pump to said wall tubes.

5. The method of operating a vapor generator having a furnace with a plurality of mainly radiantly heated wall tubes, a natural circulation section and a forced flow feed section in the path of gas flow, and a vapor and liquid separator, which includes the steps of initially delivering make-up liquid only to the forced flow feed section in the path of gas flow, passing the fluid therefrom through the wall tubes, delivering the outflow from the wall tubes to the vapor and liquid separator, naturally recirculating a portion of the separated liquid through the natural circulation section, and forcing a portion of the separated liquid through the wall tubes in conjunction with the make-up liquid hereinbefore referred to in amounts sufficient to bring the total liquid forced through the wall tubes to a volume in excess of their ability to convert the same into vapor.

6. The combination with a steam boiler furnace having a combustion chamber, of a plurality of substantially vertical wall tubes positioned along a wall of said chamber for absorbing radiant heat, economizer tubes arranged to be heated by heating gases from said furnace, conduit means arranged to deliver the discharge from said economizer tubes to the lower ends of said wall tubes, and pump means for forcing feed water first through said economizer tubes and then into the lower ends of said wall tubes.

7. The combination with a steam boiler furnace having a combustion chamber, of a plurality of substantially vertical wall tubes connected in parallel and positioned along a wall of said chamber for absorbing radiant heat, a steam and water separator, a conduit for delivering steam and water from said wall tubes to said separator, an economizer having groups of convection heated tubes connected in series, conduit means externally of said separator arranged to deliver the discharge from said economizer tubes to the lower ends of said wall tubes, and pump means for forcing feed water first through said economizer tubes and then into the lower ends of said wall tubes.

CHARLES E. LUCKE.