

June 13, 1933.

C. E. LUCKE

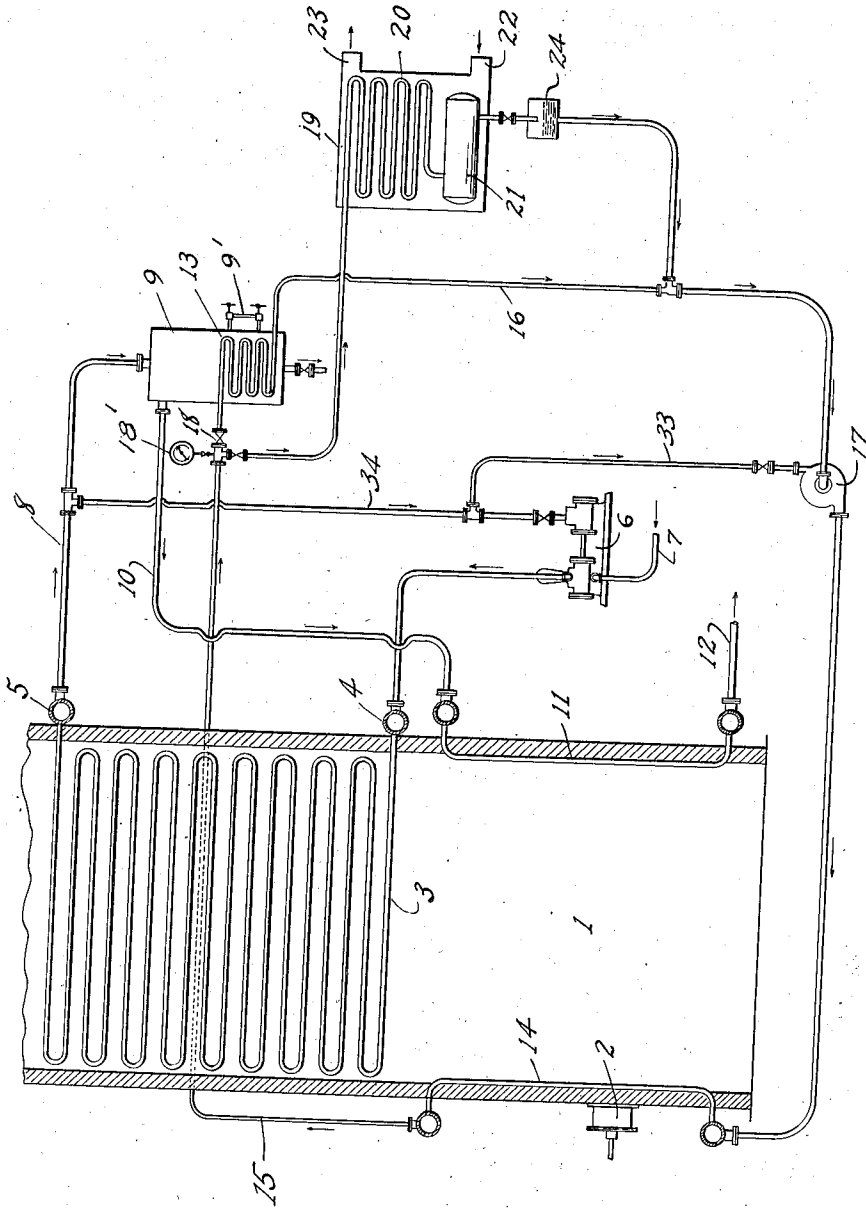
1,914,140

HIGH PRESSURE BOILER

Filed Aug. 20, 1930

3 Sheets-Sheet 1

FIG. 1



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3 Sheets-Sheet 2

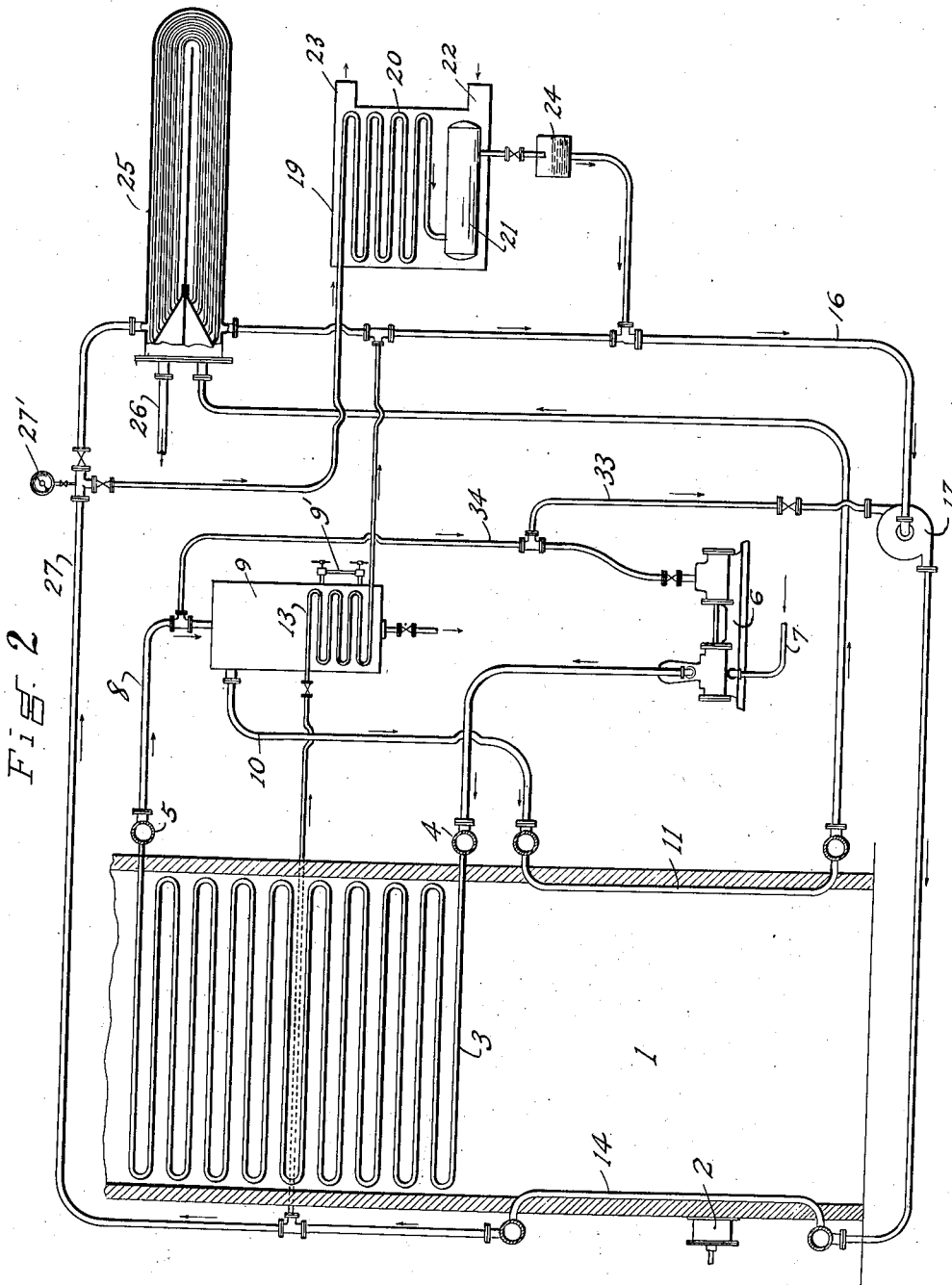


FIG. 2

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3 Sheets-Sheet 3

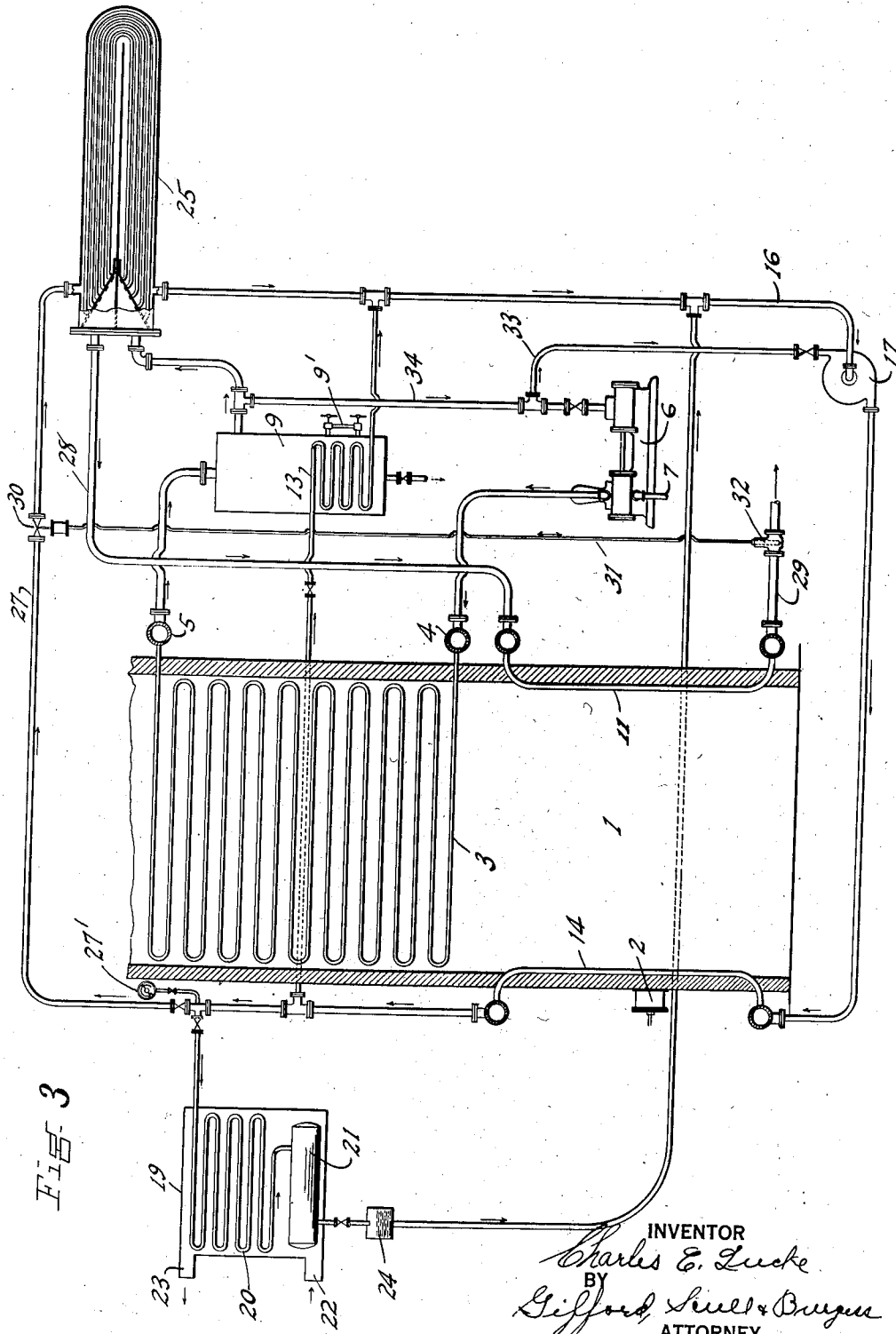


Fig. 3

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HIGH PRESSURE BOILER

Application filed August 20, 1930. Serial No. 476,494.

This invention relates to a novel and improved boiler, particularly of the high pressure type, and the novel features will be best understood from the following description and the annexed drawings, in which

Figs. 1, 2 and 3 illustrate three selected embodiments.

Referring first to Fig. 1, I have shown the invention as employed in connection with a furnace having a combustion chamber 1 heated by a burner 2. The boiler 3 is disposed above the furnace combustion chamber and is here shown as having an inlet 4 and an outlet 5 which are connected together with a continuous heating element or conduit. In this illustration, this conduit is shown as formed of a plurality of parallel tubes connected by return bends and, for the sake of simplicity, I shall hereinafter refer to the boiler as comprising a continuous conduit, meaning by that expression any arrangement which furnishes a continuous passage for water from the inlet to the outlet. It is also to be understood that the headers which are shown as comprising the inlet and outlet respectively, are connected by a plurality of conduits, although for the sake of simplicity only one conduit will be referred to hereinafter.

Water is forced under pressure into the boiler by means of a feed pump 6 supplied from a pipe 7, and in passing through the conduit the temperature of this water is raised by means of the gases formed in the combustion chamber and passing off past the conduit to a temperature corresponding to the boiling point of water at the pressure at which the boiler is operated. The heating surface of the boiler is so arranged, however, that under all conditions of operation the water is never completely evaporated and in consequence wet saturated steam always leaves the conduit through the header 5 and the pipe 8 and enters the steam and water separator 9. In this separator the water is separated from the steam, dropping to the bottom while the dry or nearly dry steam passes through the pipe 10 to a superheater 11, here shown as of the radiant heat type, and from this superheater the steam passes

to the main 12 to be used for power or other purposes. A water gauge 9' is provided on the separator for showing the water level therein.

The water separated out from the wet steam in the separator may be evaporated by placing in the separator a heating element 13 which forms part of a circulating system containing a liquid having a relatively high boiling point, such, for example, as mercury, diphenyl or diphenyl oxide. This circulating system also includes means for heating and preferably for vaporizing the liquid, and this means may conveniently take the form of wall tubes 14 placed in the wall of the furnace. The upper end of these tubes is connected by a pipe 15 to the heating element 13, and the other end of the element 13 is connected by a pipe 16 to a pump 17 which is adapted to force liquid into the wall tubes 14.

Preferably, the liquid is vaporized in the wall tubes and then condensed in the heating element 13. Flow through the element 13 may be controlled by means of a valve 18, and also by regulating the speed of operation of the pump 17. A pressure gauge 18' is provided for showing the pressure of the vapor.

The pressure of the vapor may be further regulated by means of a condenser 19 disposed in a by-pass around the separator 9. This condenser is shown as comprising a coil 20 and a tank 21 cooled by water or some other fluid entering the condenser at 22 and leaving at 23. Condensate from the tank 21 is led to the tank 24 and thence back to the pipe 16.

By means of this arrangement, the high boiling vapor condensing in the coil 13 gives up its latent heat of vaporization to the water in the separator, thereby evaporating it and by suitably regulating the operation of the condenser, the pressure of the vapor in the coil 13 can be regulated and consequently the temperature at which the condensation of vapor takes place, is in turn regulated. The total amount of condensate is returned through the pipe 16 to the pump 17, and circulated through the closed circuit.

Referring now to Fig. 2, I have shown a different embodiment of the invention, in this form the steam from the superheater 11 being led to a second superheater 25 and thence to the main 26. The superheater 25 is heated by means of vapor by-passed from the circulating system of the high boiling point liquid through a pipe 27, the pressure of the vapor being shown by a gauge 27'. As in the first embodiment illustrated and described, pressure and consequently the temperature of the condensing high boiling vapor is regulated by means of the condenser 19. In this present embodiment only a portion of the necessary superheat is received in the radiantly heated superheater 11, the balance being received in the secondary superheater 25 and as the temperature of the condensing vapor in this superheater 25 can be closely regulated, the final temperature of superheated steam leaving through the pipe 26, to be used for power or other purposes, can be closely controlled.

Referring now to Fig. 3, still another form is shown, in which the steam from the separator is led first to the superheater 25 where it is heated by the condensing vapor from the high boiling point liquid circulating system and then is conducted through the pipe 28 to the superheater 11, from which it enters the main 29. A valve 30 is disposed in the by-pass pipe 27 through which vapor passes to the superheater 25, and the flow of fluid is controlled by this valve, the valve in turn being regulated thermostatically by means of a connection 31 from a thermostat 32 disposed in the superheated steam main 29. By this arrangement the amount of heat added to the steam in the primary superheater 25 is controlled by means of the final steam temperature so that in all cases the temperature of steam leaving through the pipe 32 is controlled within close limitations.

In Figs. 2 and 3, the same numerals have been used as in Fig. 1 to designate similar parts, although the same parts may not have been referred to specifically in the detailed description of Figs. 2 and 3.

In each of the embodiments illustrated and described, there is shown a connection 33 by which steam is led from the return pipe 34 leading to the feed pump, to the turbine (not shown) for operating the pump 17.

In each embodiment there is a boiler of the once-through type, and by the arrangements shown it is possible to operate the boiler so as to discharge wet saturated steam therefrom at all times, completing the evaporation by heat derived from a source other than the gases used for heating the boiler. By always discharging from the boiler steam containing water, it is insured that the tubes of the boiler will not become overheated, which would be the case should complete evaporation take place in the boiler.

I claim:—

1. A steam generator including a furnace and at least one long series conduit, a pump delivering liquid to one end of said conduit for a single passage therethrough in greater quantity than can be converted into vapor thereby, a vapor and liquid separator receiving the discharge from said conduit, a heated circulating system independent of the aforesaid conduit for adding heat to the excess liquid collected in the separator and whereby the same is converted into vapor, and a superheater in the furnace receiving the vapor.
2. A steam generator including a furnace and at least one long series conduit, a pump delivering liquid to one end of said conduit for a single passage therethrough in greater quantity than can be converted into vapor thereby, a vapor and liquid separator receiving the discharge from said conduit, a radiantly heated circulating system independent of the aforesaid conduit for adding heat to the excess liquid collected in the separator and whereby the same is converted into vapor, and a radiant superheater in the furnace receiving all of the vapor.
3. A steam generator including a furnace and at least one long series conduit, means delivering liquid only to the hottest end of the conduit for a single passage through said conduit and in an amount in excess of the ability of the same to convert the liquid into vapor, a vapor and liquid separator receiving the discharge from the other end of said conduit, a radiantly heated vapor generating system independent of the aforesaid assembly and transmitting its heat to the excess liquid in the separator, a superheater receiving the combined vapor generated in the conduit and by the conversion of excess liquid into vapor, and means for regulating the pressure in the independent system to control the amount of excess liquid converted into vapor.
4. A steam generator including a furnace and at least one long series conduit, a pump delivering liquid to one end of said conduit for a single passage therethrough in greater quantity than can be converted into vapor thereby, a vapor and liquid separator receiving the discharge from said conduit, a radiantly heated circulating system independent of the aforesaid conduit for adding heat to the excess liquid collected in the separator and whereby the same is converted into vapor, a convection superheater receiving steam from the separator and heated by the radiantly heated circulator system, a superheater in the furnace receiving all of the vapor, and means actuated by the temperature of the radiantly heated superheated steam to control the admission of heating fluid from the radiantly heated circulating system to the convection superheater to thereby control the temperature of said steam leaving the convection superheater.

5. The method of operating a once through vapor generator system including a fluid conduit, a separator and a radiantly heated independent heat transfer system, which
5 comprises passing a liquid a single time through the conduit in an amount in excess of the ability of the same to convert the liquid into a vapor, separating the vapor and liquid to leave the scale forming materials in
10 the separated liquid, transferring the radiant heat of the furnace to the excess liquid by passing a non-scaling high boiling point liquid through the independent system including the separator, whereby the excess liquid
15 is also converted into substantially solid free vapor and passing all of the vapor through a radiantly heated superheater included in the aforesaid fluid conduit.

6. The method of operating a once through
20 vapor generator system including a fluid conduit, a separator and a radiantly heated independent heat transfer system, which comprises passing water a single time through the conduit in an amount in excess of the
25 ability of the same to convert the water into steam, separating the steam and water to leave the scale forming materials in the separated water, transferring the radiant heat of the furnace to the excess water by passing
30 a non-scaling high boiling point liquid through the independent system including the separator, whereby the excess water is also converted into substantially solid free steam, passing all of the steam through a
35 radiantly heated superheater included in the aforesaid fluid conduit, and controlling the pressure of the independent heat transfer system to regulate the amount of heat transferred thereby.

40 7. The method of operating a once-through vapor generator system, including a fluid conduit, a separator and an independent heat transfer system associated with said separator, which consists in passing a liquid having
45 scale forming properties a single time through the fluid conduit in an amount in excess of that which can be converted into vapor during the single passage there-through, passing the excess liquid and the
50 vapor from the conduit to the separator, and supplying a circulating medium to the independent heat transfer system which is free of scale forming material to maintain a high heat transfer efficiency in said system, the
55 independent heat transfer system converting the excess liquid in the separator into vapor at a location where the scale resulting from the concentration of the liquid may be easily removed from the vapor generator
60 system to thereby minimize the scale deposited in the fluid conduit.

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