

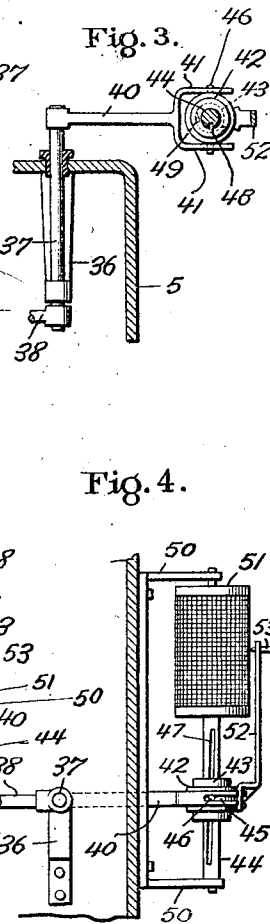
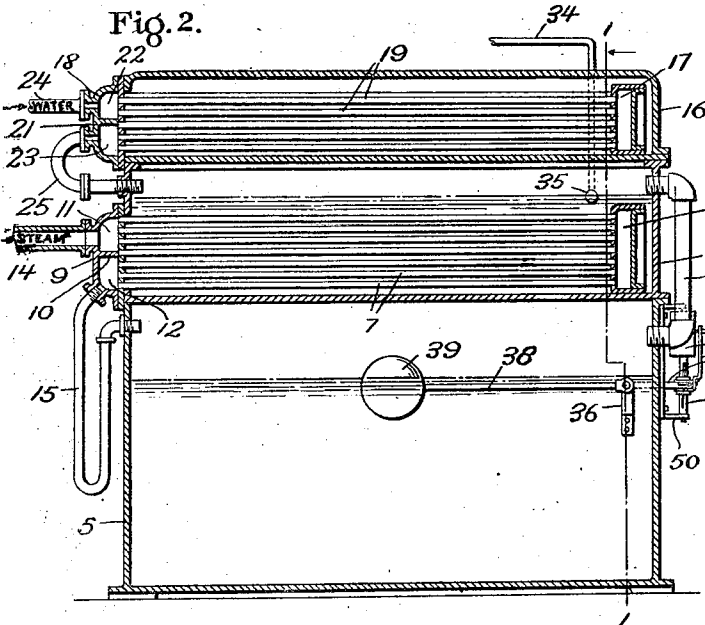
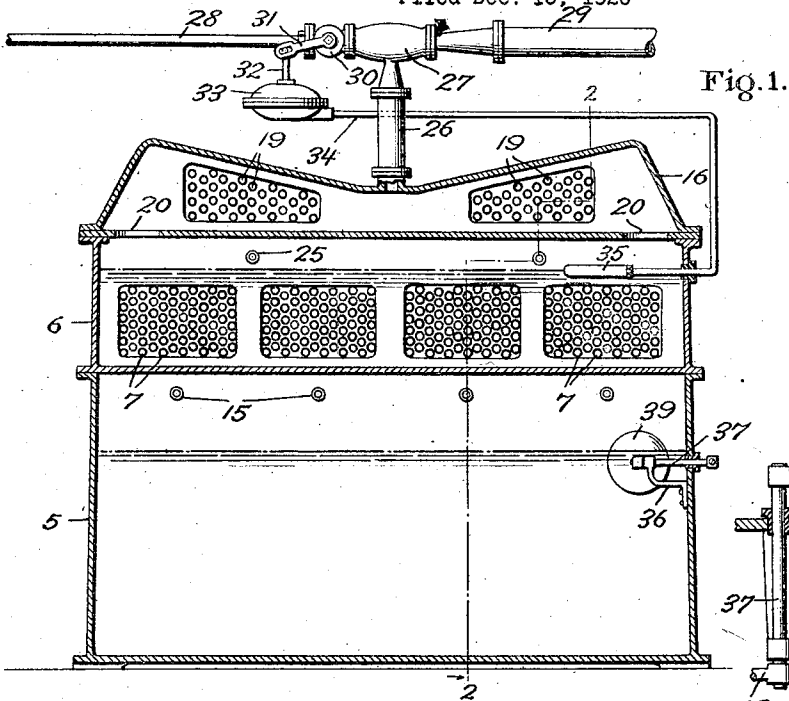
Aug. 18, 1925.

1,550,116

A. R. SMITH

FEED WATER HEATER

Filed Dec. 15, 1920



Inventor:
Arthur R. Smith.

by *Albert G. Davis*
His Attorney

UNITED STATES PATENT OFFICE.

ARTHUR R. SMITH, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

FEED-WATER HEATER.

Application filed December 15, 1920. Serial No. 430,862.

To all whom it may concern:

Be it known that I, ARTHUR R. SMITH, a citizen of the United States, residing at Schenectady, in the county of Schenectady, State of New York, have invented certain new and useful Improvements in Feed-Water Heaters, of which the following is a specification.

The present invention relates to feed water heaters such as are used in power plants for heating the feed water prior to its being supplied to the boilers. For heating purposes it is the general practice to use low pressure steam from some suitable source, for example, exhaust steam from one or more non-condensing prime movers, although steam of a higher pressure may be used if found desirable.

In a modern power plant it is customary to take the feed water after it has been heated to a certain extent in the feed water heater and pass it through economizers to still further raise its temperature before putting it into the boilers and in this connection great difficulty has been experienced due to the air in the feed water causing rapid corrosion of the tubes of the economizers. For this reason it is desirable that the air be removed from the feed water prior to its being passed through the economizers and the object of my present invention is to provide an improved feed water heater which will accomplish this in an efficient manner.

For a consideration of what I believe to be novel and my invention, attention is directed to the accompanying description and the claims appended thereto.

In the drawing, Fig. 1 is a transverse sectional view of a feed water heater embodying my invention, the section being taken on line 1—1 Fig. 2; Fig. 2 is a longitudinal section taken on line 2—2, Fig. 1, and Figs. 3 and 4 are detail views of a recording mechanism.

Referring to the drawing, the feed water heater comprises a storage basin or tank 5 which serves in substance as a hot well, the same containing the feed water after it has been heated in the feed water heater. It is from this basin or tank that feed water is drawn to be passed through the economizers and thence to the boilers. Located above basin or tank 5 and resting on it so it forms in substance a cover for it is a comparatively

shallow pan 6 which forms a re-boiler. Extending across re-boiler 6 are heating tubes 7 which connect at their ends with headers 8 and 9, the latter being divided by a horizontal partition 10 into upper and lower chambers 11 and 12. The upper portion of re-boiler 6 is connected to tank 5 by one or more conduits 13. Connected to upper chamber 11 are one or more pipes 14 which lead from any suitable or available source of heating steam and connecting lower chamber 12 to tank 5 is a suitable number of pipes 15, each being provided with a loop to form a water seal or trap.

Located above re-boiler 6 is a condenser comprising a casing 16 provided with headers 17 and 18 connected by cooling tubes 19. Casing 16 is hermetically sealed and rests directly on and forms a cover for re-boiler 6. In the bottom wall of casing 16 are openings 20 (Fig. 1) through which the condenser is connected to the re-boiler. Header 18 is divided by a partition 21 into an upper chamber 22 and a lower chamber 23. Connected to upper chamber 22 are one or more pipes 24 for conveying feed water to the feed water heater. Lower chamber 23 is connected by one or more pipes 25 to the upper portion of re-boiler 6.

In connection with headers 8 and 17 it will be noted that they are loosely supported on the bottom walls of re-boiler or tank 6 and condenser 16. They are thus free to move to permit expansion and contraction of tubes 7 and 19. By this arrangement all strains on the headers due to expansion and contraction of the tubes are eliminated.

In operation the feed water, which, for example, may be condensate from a condenser, is fed through pipe or pipes 24 to the condenser tubes 19. The feed water passes from upper chamber 22 through the upper rows of tubes 19 to header 17 and thence back through the lower rows of tubes 19 to chamber 23 of header 18. From chamber 23 the feed water passes through pipe or pipes 25 to the tank or re-boiler 6. Steam for heating purposes is fed through pipe or pipes 14 to the upper chamber 11 of header 9 from which it passes through the upper rows of tubes 7 to header 8 and back through the lower rows of tubes 7 to lower chamber 12. From lower chamber 12 it is discharged through pipes 15 to the tank 5. The heating steam in flowing through tubes 7 is sufficient

to cause the water contained in re-boiler 6 to boil with the result that the air contained in the water is driven off. Due to the boiling of the water, there will be some steam formed and the steam and air pass through openings 20 to condenser 16. In passing over condenser tubes 19 the air is cooled to a greater or lesser extent giving up its heat to the incoming feed water. At the same time the steam is condensed and runs back into the re-boiler. The steam in being condensed by tubes 19 gives up its heat also to the incoming feed water. It will thus be seen that the feed water in passing through tubes 19 acts as cooling water to condense the steam from the re-boiler so such steam and its heat is not lost. At the same time the incoming feed water in passing through tubes 19 is heated to a considerable extent before it flows into re-boiler or pan 6. Thus none of the heat of the heating steam is wasted, that which is used in vaporizing water and driving off air in the re-boiler being recovered again in the condenser. The liberated air after passing through the condenser is permitted to escape to atmosphere.

It may happen that the heating steam used in connection with the feed water heater is insufficient to heat the water in the re-boiler to a temperature at which it will boil at atmospheric pressure. To take care of this I preferably provide an arrangement for holding such a pressure in the condenser and re-boiler that the water will boil at the temperature available. To this end I provide a conduit 26 leading from condenser casing 16 and to the outer end of conduit 26 I connect a suitable pump, here shown in the form of an ejector 27, for maintaining a pressure in the condenser and re-boiler lower than atmospheric pressure. Motive fluid, such as steam, for operating the ejector is supplied through a pipe 28. The discharge tube of the ejector is indicated at 29. Controlling the admission of actuating fluid to the ejector is a valve 30 having an operating lever 31 connected to a stem 32 of a pressure responsive device 33. The pressure responsive device is arranged to be actuated in accordance with the temperature of the water in the re-boiler. To this end it may comprise a suitable diaphragm arranged within a casing and having its lower surface exposed to a pressure which varies in accordance with the temperature of the water in the re-boiler. In the present instance, the device 33 is shown as being connected by a conduit 34 to a bulb 35 located in the water at the hot end of re-boiler 6. Bulb 35 contains a suitable fluid which expands and contracts to create a pressure under the movable abutment which pressure is in accordance with the temperature in the re-boiler. With this arrangement it will be seen that in case the temperature in the

re-boiler decreases the movable abutment will actuate valve 30 to admit more motive steam to the ejector which will act to decrease the pressure in the condenser and re-boiler bringing it to a value at which the water will boil. With this arrangement, the ejector serves to remove the air liberated from the feed water.

It is sometimes desirable to keep a record of the level of the water in tank 5 and to this end I provide a recording mechanism of simple character as shown in detail in Figs. 3 and 4. Connected to a wall of tank 5 is a bracket 36 and pivoted in the outer end of bracket 36 and the adjacent wall of tank 5 is a shaft 37. On the inner end of shaft 37 is a rod 38 to which is fastened a float 39 which rides on the water in tank 5. On the other end of shaft 37 is an arm 40 having furcations 41 at its free end which straddle a sleeve 42 surrounding a collar 43 adapted to slide up and down on a shaft 44. In furcations 41 are slots 45 and sleeve 42 is provided with pins 46 which project into such slots. In shaft 44 is a diagonally extending slot 47 and on the inner surface of collar 43 is a pin 48 which rides in slot 47. Sleeve 42 is located in an annular groove in collar 43 so the same always move together in a vertical direction and sleeve 42 is connected to collar 43 by a suitable ball clutch 49, the arrangement being such that it permits collar 43 to turn relatively to sleeve 42 in one direction but prevents it from turning relatively thereto in the other direction. Shaft 44 is pivoted in bracket arms 50 carried by the wall of tank 5 and on the upper end of shaft 44 is a cylinder 51 adapted to carry a chart. Fastened to sleeve 42 is an arm 52 having a pen 53 at its upper end which rides against the chart on cylinder 51. As the level of the water rises in tank 5, float 39 will move upward thereby moving arm 40 downward which will move sleeve 42 and collar 43 along shaft 44. This lowers pen arm 52 to record the movement on cylinder 51. During this downward movement collar 43 will tend to move clockwise as seen in Fig. 3 due to pin 48 riding down slot 47 so that ball clutch 49 will be released thus permitting sleeve 42 and collar 43 to turn relatively to each other. Cylinder 51 offers a greater resistance to turning movement than do sleeve 42 and collar 43 relatively to each other and as a result cylinder 51 will remain stationary during such downward movement, collar 43 turning in sleeve 42. The pen thus traces a vertical line on the chart. When arm 52 is raised as the level of the water lowers in tank 5, collar 43 tends to turn in a counter clockwise direction thus clutching sleeve 42 and collar 43 together. Sleeve 42 and collar 43 will be prevented from so moving, however, by one of the pins 46 in sleeve 42 striking the bot-

tom of its slot 45 in the furcation 41 of arm 40. As a result during such upward movement cylinder 51 will be turned in the opposite or clockwise direction and the pen will trace a diagonal line on the chart. This makes a simple recording mechanism which requires no special mechanism for driving the chart, the motion of the device which actuates the pen arm serving also to effect the rotation of cylinder 51.

It will be seen from a consideration of my device that it comprises essentially three sections; a lower section which serves as a storage tank or basin; an intermediate section which serves as a heating element or pan re-boiler, and a top section which serves as a condenser for conserving the heat of the steam liberated from the re-boiler. The arrangement is such that during operation there is just sufficient steam liberated from the water in the re-boiler pan to keep the water in mild agitation so that the air is allowed to pass up to the surface and free itself. The device is simple and compact in structure and serves to remove the air from the water in a most efficient and economical manner.

In the foregoing specification I have particularly described my invention as used in connection with steam and water as this is the ordinary application, but it will be understood that the apparatus is adapted for use in connection with other fluids.

In accordance with the provisions of the patent statutes, I have described the principle of operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof, but I desire to have it understood that the apparatus shown is only illustrative and that the invention may be carried out by other means.

What I claim as new and desire to secure by Letters Patent of the United States, is:—

1. The combination with a storage tank to which water is supplied, of means for freeing the water of air before it enters the tank, said means comprising a pan for holding a supply of water, heating means for the pan for boiling the water therein, said means having a heating fluid inlet and an outlet, said outlet being connected with the tank, a conduit connecting the pan with the tank, said conduit providing an overflow outlet for the pan, a condenser connected with the pan to receive vapors therefrom, and cooling means in the condenser for condensing the vapors, said means having a cooling fluid inlet and an outlet.

2. In an apparatus of the character described, the combination of a storage tank, a pan located directly above the tank and forming a re-boiler, a condenser located above the pan for condensing vapors therefrom, said pan and condenser being in direct

communication whereby the vapors when condensed in the condenser return to the pan, means for supplying heating fluid to the re-boiler to boil the liquid contained therein, means for supplying cooling fluid to the condenser, and means for removing air from the condenser.

3. In an apparatus of the character described, the combination of a storage tank, a pan located directly above the tank and forming a re-boiler, a condenser located above the pan for condensing vapors therefrom, said pan and condenser being in direct communication whereby the vapors when condensed in the condenser return to the pan, means for supplying heating fluid to the re-boiler to boil the liquid contained therein, means for supplying cooling fluid to the condenser, and means for maintaining a desired pressure in said re-boiler.

4. In an apparatus of the character described, the combination of a tank, a pan located on the top of the tank, conduit means connecting the upper portion of the pan to the tank, heating means in the pan, means for conveying a heating medium to said heating means, a condenser located on top of said pan, said pan and condenser being in communication with each other whereby the vapors when condensed in the condenser return to the pan, and means for conveying cooling medium to said condenser and from the condenser to said pan.

5. In an apparatus of the character described, the combination of a storage tank, a pan located directly above the tank and forming a re-boiler, a condenser located above the pan for condensing vapors therefrom, means for supplying heating fluid to the re-boiler and cooling fluid to the condenser, and automatically controlled pump means for maintaining a desired pressure in said re-boiler.

6. In a feed water heater, the combination of a storage basin, a pan located on it, heating tubes in said pan, said tubes being connected at one end to the basin, conduit means connecting the pan to the basin, a condenser located on the pan, cooling tubes in the condenser, said cooling tubes being connected at one end to said pan, and means for supplying heating steam to the heating tubes and cooling water to the condenser tubes.

7. In a feed water heater, the combination of a storage basin, a pan located on it, heating tubes in said pan, said tubes being connected at one end to the basin, conduit means connecting the pan to the basin, a condenser located on the pan, cooling tubes in the condenser, said cooling tubes being connected at one end to said pan, means for supplying heating steam to the heating tubes and cooling water to the condenser tubes, and pump means having its suction side

connected to said pan for maintaining a desired pressure therein.

8. In a feed water heater, the combination of a storage basin, a pan located on it, heating tubes in said pan, said tubes being connected at one end to the basin, conduit means connecting the pan to the basin, a condenser located on the pan, cooling tubes in the condenser, said cooling tubes being connected at one end to said pan, means for supplying heating steam to the heating tubes and cooling water to the condenser tubes, pump means having its suction side connected to said pan for maintaining a desired pressure therein, and means responsive to the pressure in said pan for regulating said pump means.

9. The combination with a storage tank to which water is supplied, of means for freeing the water of air before it enters the tank, said means comprising a pan for holding a supply of water, heating means for the pan for boiling the water therein, a condenser casing mounted above and in direct communication with the pan, a cooling coil in the condenser casing, a conduit means connecting the pan to the cooling coil, and means for supplying the water to be stored to the cooling coil where it serves as cooling medium after which it flows to the pan through said conduit means.

10. The combination with a storage tank to which water is supplied, of means for freeing the water of air before it enters the tank, said means comprising a pan for holding a supply of water, heating means for the pan for boiling the water therein, a condenser, conduit means connecting the pan to the condenser, means for supplying the water to be stored to the condenser where it serves as cooling medium after which it flows to the pan, a conduit for conveying steam to the heating means, and a conduit for conveying condensate from the heating means to the tank.

11. In a feed water heater, the combination with a storage tank to which water is supplied, of means for freeing the water of air before it enters the tank, said means comprising a shallow pan for holding a supply of water mounted on and forming a cover for the tank, an overflow conduit for the pan connecting said pan with the tank, a plurality of heating tubes extending across the interior of the pan, means for supplying heating fluid to said tubes, conduit means connecting the heating tubes with the tank for conducting heating fluid from the heating tubes to the tank, means forming a liquid seal in said last-named conduit means, a condenser casing having a bottom wall which rests on and forms a cover for the pan, said casing being in direct communication with the pan, a plurality of cooling tubes extending across the interior of the

condenser casing, means for delivering the water supply for the tank to said tubes, conduit means connecting said tubes with the pan for conducting said water from the cooling tubes to the pan, said conduit means connecting with the pan adjacent the bottom wall of the condenser, means for maintaining in the condenser casing a pressure lower than atmospheric pressure, and means for automatically recording the level of the water in the tank.

12. In a feed water heater, the combination with a storage tank to which water is supplied, of means for freeing the water of air before it enters the tank, said means comprising a shallow pan for holding a supply of water mounted on and forming a cover for the tank, an overflow conduit for the pan connecting said pan with the tank, a plurality of heating tubes extending across the pan, headers to which the tubes are joined at their ends, certain of said headers slidably resting on the bottom of the pan, certain other of said headers being secured to the pan, partitions within said last-named headers providing therein upper and lower chambers, means for supplying heating fluid to the upper chambers, conduit connections between the lower chambers and the tank, means forming a liquid seal in each of said conduit connections, a condenser casing having a bottom wall which rests on and forms a cover for the pan, said casing being in direct communication with the pan through openings in the bottom wall, headers in the condenser casing, a plurality of cooling tubes connecting the headers, certain of said headers slidably resting on the casing bottom wall, certain other of said headers being secured to the pan, partitions within said last-named headers providing therein upper and lower chambers, conduits connected to the upper chambers for receiving the water supply for the tank, conduits connecting the lower chambers with the interior of the pan adjacent the bottom wall of the condenser, means for maintaining in the condenser casing a pressure lower than atmospheric pressure, and means for automatically recording the level of the water in the tank.

13. In combination, a storage tank, a heating coil supplied with a heating fluid, said coil having a discharge outlet connected with the tank, a pan in which said heating coil is located providing therewith a re-boiler, a cooling coil supplied with cooling liquid, said coil having a discharge outlet directly connected with the pan, a conduit providing an overflow outlet for the pan connected with the tank, a casing in which the cooling coil is located providing therewith a condenser, a bottom wall for the casing forming a cover for the reboiler pan, said wall having openings providing direct communication between the reboiler pan and the con-

denser, a temperature-responsive device in the reboiler pan, and a pump means for the condenser controlled by said temperature-responsive device.

- 5 14. In combination, a storage tank, a heating coil supplied with a heating fluid, said coil having a discharge outlet connected with the tank, a pan in which said heating coil is located providing therewith a reboiler, 10 a cooling coil supplied with cooling liquid, said coil having a discharge outlet directly connected with the pan, a conduit providing an overflow outlet for the pan connected with the tank, a casing in which the cooling 15 coil is located providing therewith a condenser, a bottom wall for the casing forming a cover for the reboiler pan, said wall having openings providing direct communication between the reboiler pan and the con- 20 denser, a temperature-responsive device in the reboiler pan, an ejector having a suction inlet connected with the condenser casing, a conduit supplying motive fluid to the ejector, a valve in said conduit, and means for oper-

ating said valve connected with and controlled by the temperature-responsive device. 25

15. In an apparatus of the character described, the combination of a reboiler for holding a supply of water, said reboiler having inlet and outlet means for water admission and discharge, heating means connected with the reboiler for boiling the water therein, a condenser in communication with the re-boiler for receiving vapors therefrom and 35 condensing the same, drain means for the condenser providing said communication whereby condensed vapors are returned to said reboiler therethrough, cooling means in the condenser casing connected with the inlet means of the reboiler, and a suction means 40 connected with the condenser casing for maintaining therein a pressure lower than atmospheric pressure and for removing non-condensable vapors and air therefrom. 45

In witness whereof, I have hereunto set my hand this 13th day of December, 1920.

ARTHUR R. SMITH.