Oct. 20, 1964 J. F. SEBALD 3,153,329

MEANS FOR REMOVING NON-CONDENSIBLE GASES FROM BOILER FEEDWATER IN A POWER PLANT

Filed May 7, 1962 2 Sheets-Sheet 1

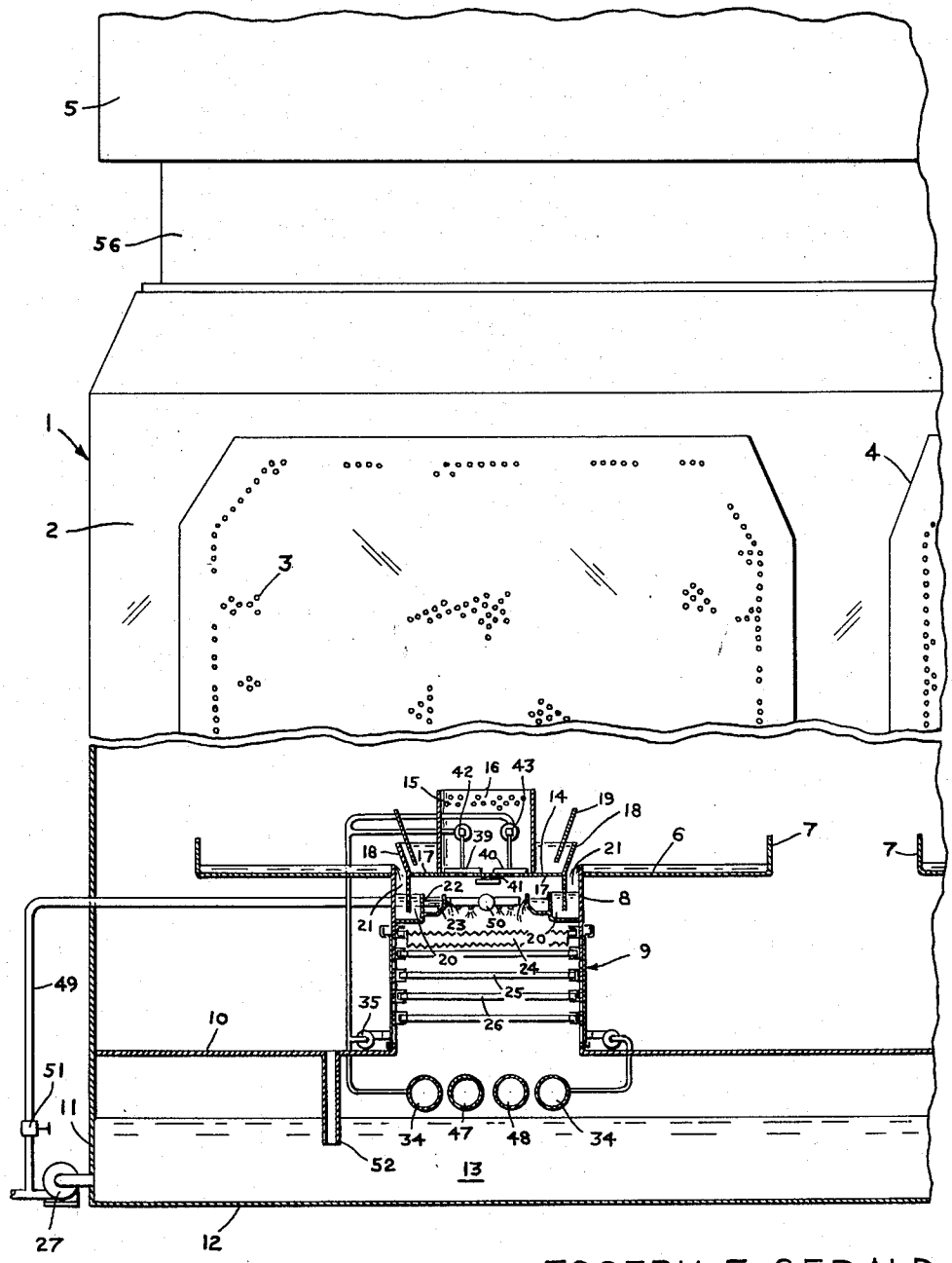


FIG. 1

JOSEPH F. SEBALD
INVENTOR.

BY David A. Bobis
Atty

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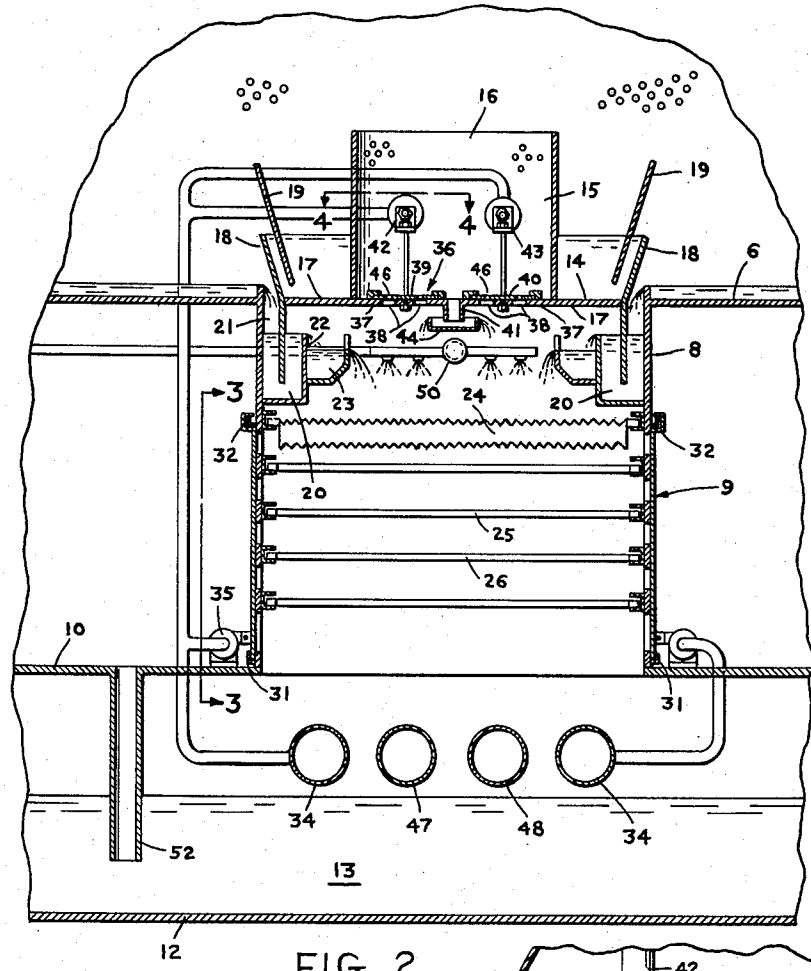


FIG. 2

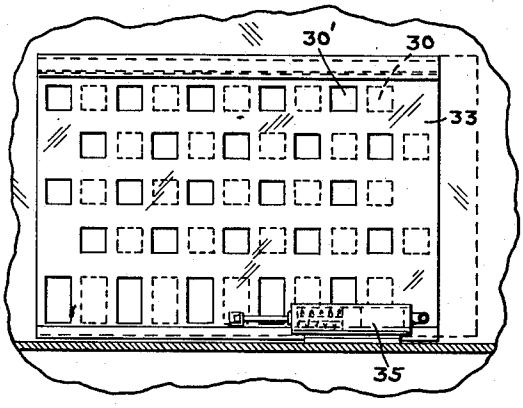


FIG. 3

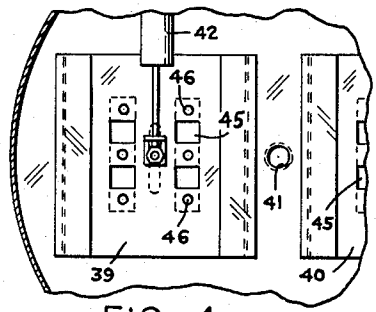


FIG. 4

JOSEPH F. SEBALD
INVENTOR.

BY Daniel A. Bobb
Atty

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MEANS FOR REMOVING NON-CONDENSIBLE GASES FROM BOILER FEEDWATER IN A POWER PLANT

Joseph F. Sebald, Bloomfield, N.J., assignor to Worthington Corporation, Harrison, N.J., a corporation of Delaware

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This invention relates to power plants and more particularly to means associated with a surface condenser of the power plant acting to remove the non-condensible gases present in the boiler feedwater.

The need for the removal of air and other non-condensible gases from boiler feedwater has come about as a direct result of the progress that has been made in boiler and turbine design in the last two or three decades. Prior to that time boiler pressures and ratings were comparatively low and there was, therefore, no need for elaborate water treatment. When boiler pressures were stepped up and boiler ratings increased, it was found that boiler tubes failed more rapidly. In addition the formation of scale prevented the rapid transfer of heat from the tube to the water and increased the tube temperature causing it to fail.

The matter of proper removal of air and non-condensible gases has been mentioned previously in the prior art and the approaches disclosed for providing deaerated feedwater have served to reduce the problems resulting from corrosion in the boiler of the power plant.

One such prior art arrangement disclosed provides means in a condenser coacting therewith to provide an arrangement for removing non-condensible gases such as oxygen.

Specifically exhaust steam passed into the condenser was channeled to act against the condensate therein to provide the higher degree of deaeration required in high pressure and temperature installations.

On startup of these prior art units a steam source was provided to reduce the partial air pressure in the condenser and to act to remove non-condensibles from the condensate.

It was found that these prior art arrangements were impractical in certain respects and especially during start-up and failed to provide condensate of required purity for return to the boiler. Such a system is shown in U.S. Letters Patent 1,962,183.

More particularly this auxiliary steam source rather than effectively functioning to remove non-condensibles in a local area in the condenser merely blanketed the condenser in these areas and failed to achieve its intended function.

The present invention overcomes the foregoing objections by associating means with a condenser which localize the auxiliary steam supply to appreciably increase the deaeration qualities of the unit and further provides an arrangement for returning condensate collected in the storage hot well through the localized area for removal of the non-condensibles present therein.

Accordingly, it is an object of this invention to provide optimum removal of air and non-condensible gases in the boiler feedwater of a power plant during all conditions of operation including startup and shutdown.

It is a further object to provide an improved condenser that is extremely compact and will accordingly be applicable in a system confronted with space limitations.

It is another object to overcome the objections present in prior type systems and generally mentioned hereinabove.

Accordingly, with the foregoing in mind applicant provides means for removing non-condensible gases including

a recirculating means whereby feedwater collected in the storage hot well is recirculated through a deaerator-like arrangement and further provides a steam source to said deaerator-like arrangement which acts to remove these non-condensible gases during startup and until such time that the turbine is at normal operating pressures.

Other objects and advantages of the invention including the basic design and the nature of the improvements thereon will appear from the following description taken in conjunction with the following drawings, in which:

FIGURE 1 is a front view of a condenser turbine system partly in section and showing the invention contemplated herein.

FIGURE 2 is an enlarged view of the means for removing non-condensible gases as shown in FIGURE 1.

FIGURE 3 is a section of the slide member associated with the means for removing non-condensible gases and taken on line 3—3 of FIGURE 2.

FIGURE 4 is the slide member associated with the vent means of the means for removing non-condensible gases and taken on line 4—4.

Referring more particularly to FIGURE 1 of the drawings, there is shown a condenser, generally designated 1, and comprising a shell 2 including a plural set of condensing means shown as condensing tubes 3 and 4 disposed in the upper portion of the shell.

While a condenser including plural sets of condensing tubes is shown each having associated therewith the means for removing non-condensible gases contemplated by this invention, it will be evident to one skilled in the art that a condenser including one set of condensing tubes is within the teaching of the present invention.

As is well known a source of cooling water is passed through the condensing tubes to condense the exhaust steam passed into the condenser from the turbine 5 mounted in association with said condenser as by exhaust conduit 56 in any convenient fashion. The condensed feedwater is collected in a collecting means shown as a collecting hot well 6 formed beneath the condensing tubes. The collecting hot well 6 is shown as comprising a substantially horizontal tank-like arrangement including walls 7 on the outer portions thereof which are spaced relative the condensing tubes so that the condensed feedwater falls within this collecting hot well.

The walls 8 of the means for removing non-condensible gases generally designated 9 are mounted in the center portion of the collecting hot well 6 and as will be evident this means for removing non-condensible gases can be fashioned as an integral part of the collecting hot well 6 or formed separately and connected thereto as by welding.

A sealing means 10 in the form of a horizontal plate extends across the lower portion of the condenser and can be connected to the bottom of the means for removing non-condensibles 9 and as an integral part of the walls 8 or as a separate member as will be evident to one skilled in the art. The sealing means 10 with the walls 11 and bottom of the condenser 12 form a storage space 13 in the lower portion of the condenser.

At the upper portion the means for removing non-condensible gases has formed a first trough 14 which comprises a bell-shaped member 15 having an opening at its upper end 16 and out-turned horizontal walls 17 with up-turned ends 18 to form the trough 14. A deflecting member 19 is connected to the up-turned ends 18 to form a means for deflecting condensed feedwater into the trough 14. A second trough 20 is formed on the inner walls of the means for removing non-condensible gases and communicates with the collecting hot well 6 through the passages 21 formed in the means for removing non-condensible gases.

The trough 20 is formed by a bell-shaped member 22 disposed in abutment with the walls 8 of the means for

removing non-condensible gases. A third trough 23 is mounted on the vertical walls of the bell-shaped member 22 to receive collected feedwater from the trough 20 to provide for a more thorough distribution of this feedwater in the interior portions of the means for removing non-condensible gases.

Trays 24, 25 and 26 are disposed on the inner portions of the means for removing non-condensible gases and connected to the wall 8 thereof in any convenient fashion and serve to provide greater distribution of the condensate flowing through the means for removing non-condensible gases so that a more effective elimination of the condensibles can be realized during operation of the means for removing non-condensible gases.

The walls 8 as is clearly shown in FIGURE 3 include a plurality of horizontal ports designated 30 which permit the passage of steam not condensed by the condensing tubes 3 into the interior portions of the means 9. In this fashion as condensate flows from the first trough 14 over the member 18 into the second trough 20 and then finally into the means for removing non-condensible gases 23 steam enters the ports 30 and passes in relation to this condensate to remove non-condensible gases therefrom as is well known in the deaerator art.

The openings 16 at the top portion of the means for removing non-condensible gases provide a vent for the steam passing through the ports 30 and upwardly through the means for removing non-condensible gases.

In this fashion condensed feedwater from the collecting hot well 6 is passed into the means for removing non-condensible gases and in relation to the steam passed into the means 9 to remove non-condensible gases therefrom so that deaerated feedwater is collected in the storage means 13 formed at the bottom of the shell 2 and then passed by the pump 27 to the boiler of the power plant (both of these last elements not shown).

As will be evident from the foregoing as well as understood by one skilled in the art removal of non-condensible gases from the feedwater means 9 is provided by passing a portion of the non-condensed steam being exhausted into the condenser from the turbine and passing this steam through the means for removing non-condensible gases in relation to the portion of this exhausted steam which is condensed and flows into the collecting hot well 6. As is further evident and particularly during startup it is possible to pass collected water from the storage means 13 to the boiler through condensate pump 27. As is obvious this feedwater collected in the storage well would not be of the required degree of deaeration and accordingly would tend to cause scale formation in the boiler.

Since the turbine requires a certain run-in time and before steam of proper temperature and pressure can be provided to the means for removing non-condensible gases as mentioned hereinabove, it is imperative that an alternative arrangement be fashioned to provide means for initially treating feedwater during the startup of the arrangement.

With the foregoing in mind applicant provides an auxiliary system for association with the means for removing non-condensible gases to provide treated feedwater on startup of the power plant. More particularly, the walls 8 of the means for removing non-condensible gases, that is the ports 30, are provided with a slide plate including openings 30' and which slide plate is mounted in tracks 31 and 32 disposed respectively at the bottom and top of the side walls 8. Slide member 33 includes a piston type arrangement connected thereto in any convenient fashion which is connected to a source of steam 34 and upon admission of steam to the piston portion thereof slide plate 33 is moved so that the openings 30 of the walls 8 are closed by the portion of the slide member 33 not including openings.

In order to control the flow rate of auxiliary steam

passing through the means for removing non-condensibles 9 a similar slide plate arrangement, designated 36, is fashioned at the bottom of the bell-shaped member 15.

Slide plate members 39 and 40 including large openings 45 and small openings 46 are mounted in sliding relation over plate member 37 having large openings 38.

More particularly and to permit return of condensate from bell-shaped member 15 to the means for removing non-condensibles 9, slide plate members can be of two-piece construction as mentioned above so that the inner ends of members 39 and 40 are mounted relative a water or like seal which in the preferred form comprises a portion of plate 37 and includes a vertical tube 43 opening into trough 44 all connected to bell member 15 in any suitable fashion.

With this arrangement and by maintaining suitable pressure within the means for removing non-condensibles 9 any condensate collected within bell 15 can drain to the deaerator.

On startup steam actuates piston 35 so that slide member closes the ports 30 of wall 8. At the same time pistons 42 and 43 actuate slide members 39 and 40 so that the small openings 46 are in communication with the vents 38 in the plate 37. Auxiliary steam is supplied through the conduits 47 and 48 and flows upwardly through the means for removing non-condensible gases in relation to condensate collected in the collecting hot well 6 and which is being distributed throughout the inner portions of the means 9. In order to provide for treatment of the feedwater that has collected in the storage hot well 13 a recirculating system taking the form of a conduit 49 is connected to the storage hot well 13 at one end and to the spray means 50 at the other end. Pump 27 can be used to recirculate this feedwater collected in storage well 13 simply by providing a line downstream of the pump wherein it flows through the feedwater to the boiler feed pump and opening the valve 51 in the vertical conduit going to the collecting hot well.

As will be evident to the skilled technician in this art, control of this initial phase of deaeration can be manually accomplished as described hereinabove or conveniently tied into the control room of the power plant and the system caused to operate as contemplated as soon as the turbine extraction pressure and temperature required for deaeration has been reached.

In this connection the operation will be clear in that exhausted steam from the turbine flows through the openings 30. At normal operation plate 33 and slide plates 39 and 40 will be in a position whereby steam can flow through the walls 8 and upwardly through the means 9 and out the openings 38 in the plate and the large openings 45 in the slide members 39 and 40 to provide maximum steam flow through the means for removing non-condensible gases. This steam passes in association with condensate that has collected in the collecting hot well and flows into trough 20 to trough 23 and is distributed throughout the inner portion of the means for removing non-condensible gases by the trays and slots 24, 25 and 26.

Although this invention has been described with reference to specific cycles and apparatus, it will be appreciated that a wide variety of changes may be made within the ability of one skilled in the art without departing from the scope of this invention. For example, a venting means 52 is provided to permit condensate that may have collected on the sealing means 10 to flow into the storage well 13. The components of the apparatus may be reversed, certain features of the invention may be used independently of others, and equivalents may be substituted for the apparatus, all within the spirit and scope of the invention as defined in the appended claims.

What is claimed is:

1. A condenser including means for removing non-condensible gases from the boiler feedwater in a boiler feedwater system of a power plant; said power plant including a turbine having means for discharging exhaust,

said condenser spaced relative said turbine to receive exhaust therefrom; condensing means disposed in the condenser and to condense a portion of the exhaust from said turbine, a collecting means disposed beneath said condensing means and spaced relative said condensing means to receive the portion of exhaust condensed by said condensing means; said means for removing non-condensible gases comprising a member having upper and lower ends, the upper end of said means for removing non-condensible gases connected to said collecting means to receive condensed exhaust therefrom, sealing means in said condenser and connected to the lower end of the means for removing non-condensible gases to cause the portion of said exhaust not condensed by said condensing means to pass through said means for removing non-condensible gases and in relation to the portion of the exhaust condensed by said condensing means to remove non-condensibles therefrom, a storage means in the condenser and beneath said means for removing non-condensible gases to collect feedwater from said means for removing non-condensible gases, and pumping means connected to the storage means to pass feedwater to the boiler feedwater system.

2. The apparatus claimed in claim 1 including a conduit interconnecting said storage means to said means for removing non-condensibles through said pumping means to pass feedwater from said storage means to said means for removing non-condensibles at predetermined periods.

3. The apparatus claimed in claim 2 including an auxiliary heat source connected to said storage means and said auxiliary heat source including means for passing steam upwardly to the inner portion of said means for removing non-condensible gases.

4. The apparatus claimed in claim 1 including a drain means mounted in said sealing means to permit condensed exhaust to pass into said storage means.

5. The apparatus claimed in claim 4 wherein said means for removing non-condensible gases includes a first trough disposed at the upper portion thereof, a second trough connected to said first trough and extending around the interior portions of the means for removing non-condensible gases, means disposed at the upper portion of said means for removing non-condensible gases and spaced relative said condensing means to cause a portion of condensed exhaust to flow into said first trough, directing means connected to said collecting means and spaced relative said condensing means to cause the remaining portion of said condensed exhaust to flow into said second trough, said first trough disposed relative said second trough to pass condensed exhaust thereto and said second trough disposed on the inner portion of said means for removing non-condensible gases to distribute said condensed exhaust in the interior portion thereof.

6. The apparatus claimed in claim 5 wherein said means for removing non-condensible gases include openings to permit flow of exhaust therethrough in relation to the condensed exhaust.

7. A condenser including means for removing non-condensible gases from the boiler feedwater in a boiler feedwater system of a power plant; said power plant including a turbine having means for discharging exhaust, said condenser spaced relative said turbine to receive exhaust therefrom; condensing means disposed in the condenser and to condense a portion of the exhaust from said turbine, a collecting means disposed beneath said condensing means and spaced relative said condensing means to receive the portion of exhaust condensed by said condensing means; said means for removing non-condensible gases comprising a member having upper and lower ends, the upper end of said means for removing non-condensible gases connected to said collecting means to receive condensed exhaust therefrom, sealing means in said condenser and connected to the lower end of the means for removing non-condensible gases to cause a portion of said exhaust not condensed by said condensing means to pass through said means for removing non-condensible gases and in relation to the portion of the exhaust condensed by said condensing means to remove non-condensibles therefrom, a storage means in the condenser and beneath said means for removing non-condensible gases to collect feedwater from said means for removing non-condensible gases, an auxiliary means connected to the means for removing non-condensible gases to operate said means for removing non-condensible gases on startup of said power plant comprising a conduit interconnecting said storage means to said means for removing non-condensible gases and said conduit including a pump operative for a predetermined period of time to return feedwater to said means for removing non-condensible gases, an auxiliary heat source connected to said storage means and said auxiliary heat source including means for passing steam upwardly through the inner portion of said means for removing non-condensible gases, a movable closing member connected to said means for removing non-condensible gases operative to preclude passage of exhaust from said turbine through said means for removing non-condensible gases, and a vent means connected to the top portion of said means for removing non-condensible gases to vent steam passing through said means for removing non-condensible gases to said condenser.

8. The apparatus claimed in claim 7 including a drain means mounted in said sealing means to permit condensed exhaust to pass to said storage means.

9. The apparatus claimed in claim 8 wherein said means for removing non-condensible gases includes a first trough disposed at the upper portion thereof, a second trough connected to said first trough and extending around the interior portion of the means for removing non-condensible gases, means disposed at the upper portion of said means for removing non-condensible gases and spaced relative said condensing means to cause a portion of condensed exhaust to flow into said first trough, directing means connected to said collecting means and spaced relative said condensing means to cause the remaining portion of said condensed exhaust to flow into said second trough, said first trough disposed relative said second trough to pass condensed exhaust thereto and said second trough disposed on the inner portion of said means for removing non-condensible gases to direct said condensed exhaust in the interior portion thereof.

10. The apparatus claimed in claim 9 including slide members disposed relative the vent means and the openings in said means for removing non-condensible gases and motor means operative to adjust said slide members according to the desired type of operation.

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