Oct. 10, 1961 P. BOCK ET AL 3,003,479

STEAM AND AIR BOILER WITH HEATING SURFACE OF SMALLEST LOAD

Filed Oct. 8, 1953 2 Sheets-Sheet 1

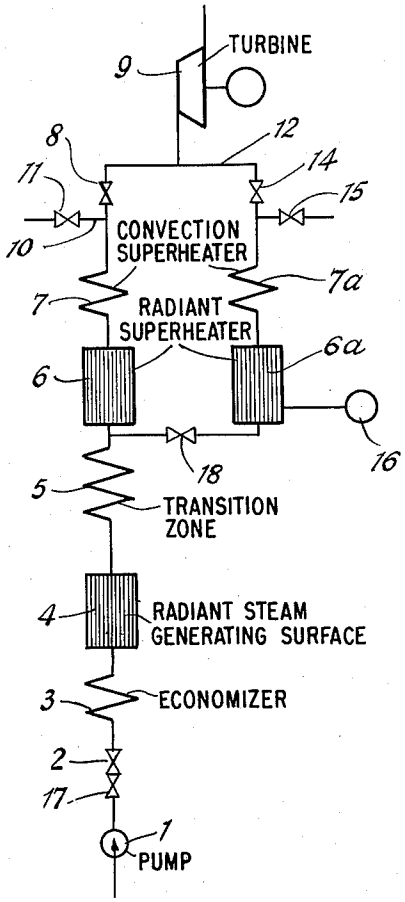


FIG. 1

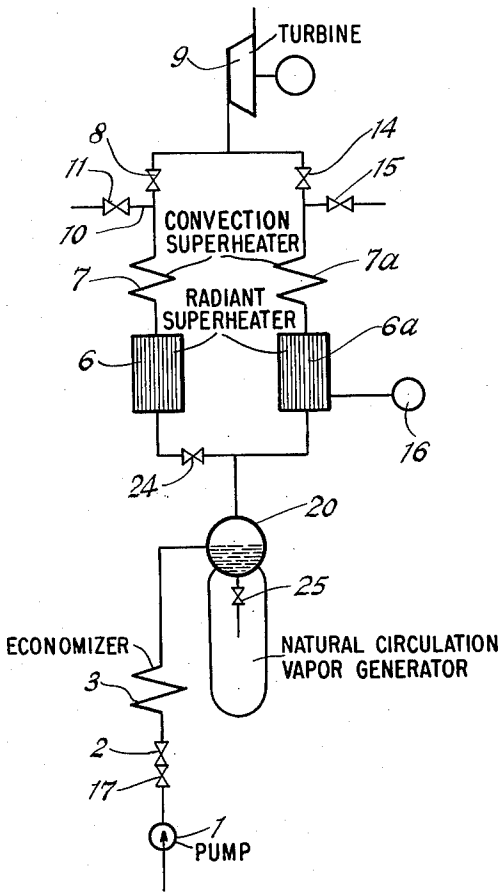


FIG. 2

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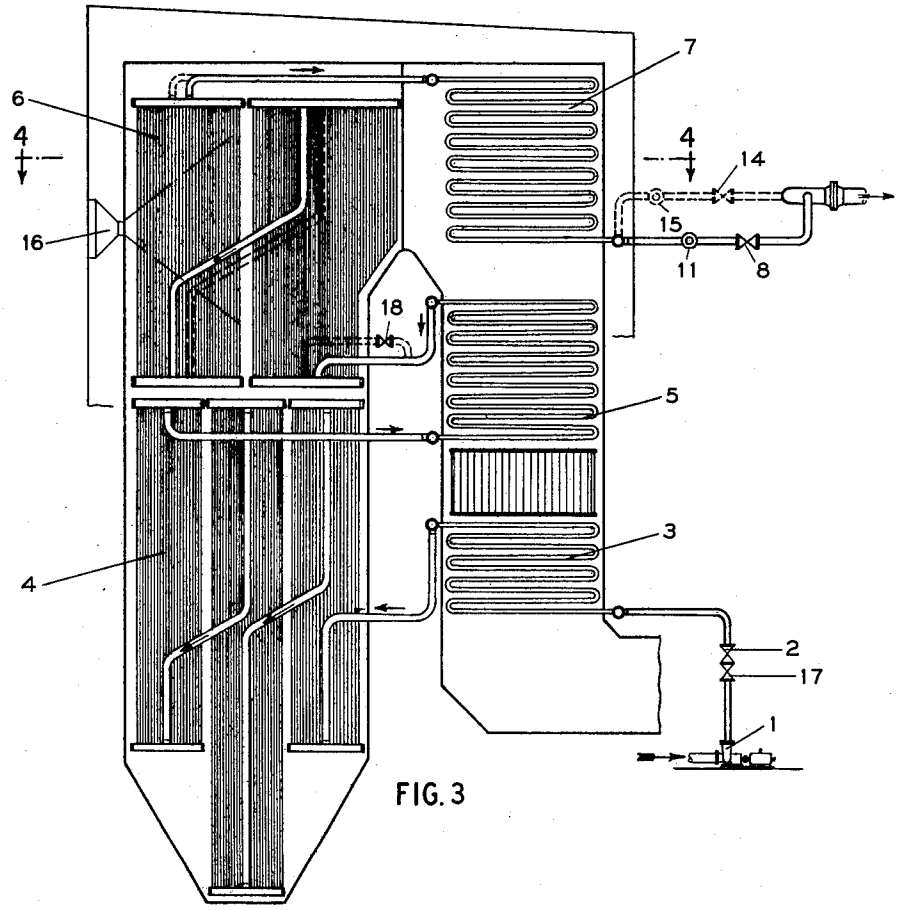


FIG. 3

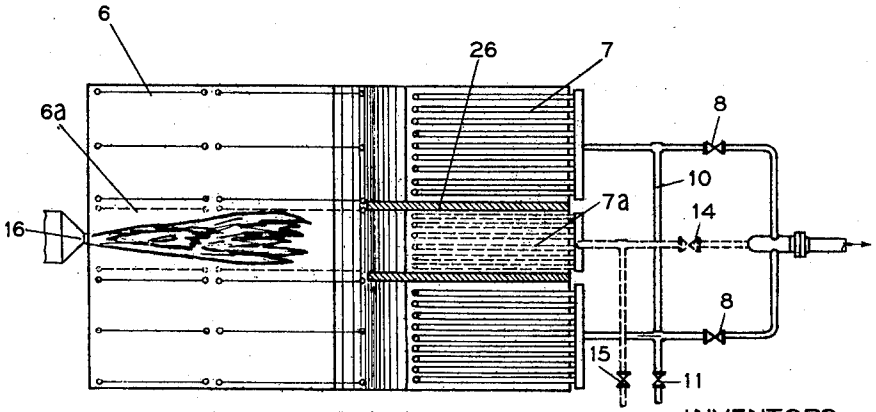


FIG. 4

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STEAM AND AIR BOILER WITH HEATING SURFACE OF SMALLEST LOAD

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3 Claims. (Cl. 122—1)

The subject of the invention is a steam and air boiler of a type which permits operation at the smallest load demanded of the unit.

In the construction of power plants, for reasons of economy, preference is given more and more to unit power plants, that is, the construction of one turbine with one or two boilers serving it. At starting up of the unit power plants, it is desirable to adapt the steam generation to the limited steam demanded for warming up the turbines. This smallest load is about five percent (5%) of the maximum load and is considerably under the usual values.

To meet such low load, prior art units have had to operate at higher load and throw away the excess. This excess was condensed in the starting condensers and by this a great part of the produced heat was eliminated into the cooling water.

The smallest load of five percent (5%) is so low that it creates unsafe flow instability problems which preclude the use of a conventional boiler for such purposes. People tried to avoid these difficulties by erecting a special starting boiler, but because of its limited utilization the starting boiler was too expensive.

To meet the demands expected from the unit power plants and avoid the mentioned disadvantages, the invention proposes to arrange a smallest load furnace in one part of the heating surface of the boiler which is touched by the flue gases of the main furnace, this part of the heating surface is partly or totally connected in parallel to the remaining part of the boiler.

The advantage of the construction of the invention, lies in the fact that a smallest load can be handled without additional heating surfaces. This smallest load portion provides a unit capable of lower loads than other units have reached to date. Thus, at starting, the steam generation is adapted to the steam demand of the turbine and water loss and heat loss have been avoided. Moreover, now it will be possible to feed the connected turbine in the unit with no-load steam during the warming up period or on stand-by.

The invention will now be described, by way of example, with reference to the accompanying diagrammatic drawings in which:

FIGURE 1 illustrates a forced flow once-through boiler for steam or air in agreement with the invention;

FIGURE 2 illustrates a natural circulation boiler;

FIGURE 3 is a semi-schematic vertical side view of a unit as shown in FIGURE 2; and

FIGURE 4 is a plan view of the unit of FIGURE 3 at the line 4—4.

In FIGURE 1 of the drawings, number 1 marks the feed water pump wherefrom the water is pumped through the shut-off valve 2 and conducted to the single flow boiler consisting of the economizer 3, the radiation heat and steam generating surface 4, the transition heating surface 5, the radiation superheater 6 and the convection superheater 7. The generated steam streams through the shut-off valve 8 to the turbine 9. The starting line 10 with shut-off valve 11 serves for starting the boiler.

The minimum load furnace is shown at 6 and in FIGURES 1 and 2 serves for heating the radiation superheater part 6*a* and the following convection superheater part 7*a*. The dimensions of these smallest load heating surfaces 6*a* and 7*a* connected in parallel to the single flow boiler are adapted to the smallest load as desired.

The mode of operation of the just described single flow boiler used as steam generator is as follows when starting:

When the single flow boiler consisting of the heating surfaces 3 to 7 is filled with water, water is pumped through the line 12 through the smallest load heating surface 6*a* and 7*a* and discharged through the starting line with valve 15. The valve 8 is closed and valve 18 regulates the quantity of vaporizable liquid that flows through the smallest load heating sections 6*a* and 7*a*. The quantity of the fed water nearly corresponds to the desired smallest load. Then the smallest load furnace 16 is put into operation and arranged in such a manner that the generated steam reaches the temperature of superheated steam necessary to heat the turbine. With valve 15 you can position the wanted pressure. By opening valve 14 and correspondingly closing valve 15, the steam necessary for heating is lead to turbine 9.

When the turbine is ready to deliver load, the single flow boiler 3 to 7 is started by the starting line fitted with valve 11 and when the desired value of the steam is reached also connected to the turbine 9 by opening valve 8 and correspondingly closing valve 11. By this, the main furnace of the single flow boiler also heats the smallest load heating surface 6*a* and 7*a*. The smallest load furnace therefore must correspondingly be reduced and then cut off. In case the end temperatures of the single flow boiler should not exactly harmonize the share of water quantity can be regulated by moving valve 13 while valve 2 is open. Feed water regulation valve 17 serves for the total regulation of the water.

In the natural circulation boiler in FIGURE 2, the drum is completely filled during the work with smallest load of the heating surfaces 6*a* and 7*a*; the water flows through the drum. During this time, valve 24 is closed. When the operation with the smallest load is finished, the drum is emptied to the normal water level through valve 25. Valve 24 is opened and the boiler is started in the same way as the usual natural circulation boiler.

FIGS. 3 and 4 illustrate semi-schematically a vapor generating and superheating unit constructed according to the diagram of FIG. 2 in which case the small load heating portion (6*a* and 7*a*) is arranged in parallel with the main radiant heated superheater 6 and convection superheater 7. The arrangement of this unit may be best understood by describing the operation of the unit. Normally, feed water is sent to the unit by the feed pump 1 into the economizer section 3 which extends across the entire width of a convection heating gas pass. The heated water then passes into radiant heated water cooled sections 4 which line the walls of the lower portion of a radiant furnace chamber. These sections are arranged as vertical panels in which the heated liquid rises to the top of the panel and then is conducted by unheated downcomers, as indicated by the arrows, to an adjacent panel where the liquid again flows upwardly and eventually the heated liquid, which is partially vaporized, passes into the transformation heating surface 5 where the liquid is completely converted to steam. The transformation heating surface extends across the entire width of the convection pass. Upon leaving the transformation heating surface 5, a branch line containing a valve 18 conducts a part of the steam to the smallest load radiant heated portion 6*a* while the main bulk of steam goes to the parallel flowing superheater 7. The superheater 6*a* is arranged in the upper part of the furnace chamber as tube panels (shown dotted) in which the tubes are in

line as platens, on either side to form a space therebetween wherein a small load furnace chamber is formed and into which a special burner **16** may be fired to create hot gases for start-up purposes. These hot gases give up heat only to the panel sections *6a* before leaving the furnace chamber and pass into the downpass as it flows over the convection superheater *7a*. This fluid which is heated in section *6a* passes over into the section *7a* before passing out through either valve **14** on the way to the turbine **9** or valve **14** to an exhaust system. In normal operation of the vapor generating and superheating unit illustrated, valves **8**, **14** and **18** are open so that the small load heating portion operates in parallel as a normal portion of the superheater of the unit; however, when it is desired to start-up the unit valve **8** of the main superheater section is closed so that the only cooling fluid flow is through the economizer, radiant heated section **4**, transformation section **5** and the small load superheater sections *6a* and *7a*. The burner **16** is fired to create the hot gases and the small amount of vaporizable liquid flowing is heated, vaporized and superheated in the sections *6a* and *7a* in such a way to be completely independent from the rest of the steam generating unit. The refractory division walls **26** on either side of the convection superheater portion *7a* assure that the hot gases leaving the furnace, heat only the convection superheater. Thus, there is shown a small load heating section integral with a once-through vapor generator yet arranged such that it may be fired and heated independent from the rest of the steam generator.

In accordance with the invention, the smallest load heating surface can be formed by each other part of the heating surface. At any rate the kind of the smallest load heating surface is determined by the construction of the boiler or its furnace.

The smallest load furnace can be separated according to one's liking by the walls of the tubes or by refractory material. An especially suitable separation is possible when a superheater is arranged which is formed by walls of tubes and the smallest load furnace is placed between two of such adjoining walls of tubes.

A by-pass may be arranged if the flue gases of the smallest load furnace are not wanted to stream through the succeeding heating surfaces.

We claim:

1. A vapor generating and superheating unit comprising wall means forming a gas flow chamber; economizer, vapor generating and vapor superheating sections disposed in said chamber; a start-up minimum load portion including said economizer section and parts of the vapor generating section and of the vapor superheating section; said economizer section and said parts of the vapor generating section and of the vapor superheating section being connected for serial flow of fluid therethrough; means connecting said minimum load portion in parallel flow relation with the remaining parts of said vapor generating section and said vapor superheating section; first combustion means supplying high temperature gases to said chamber to normally heat said sections; said minimum load portion being of a size to provide the minimum load vapor requirements for said unit; means for flowing all of the vaporizable fluid supplied for start-up through said minimum load portion to generate superheated vapor therein during the start-up of the unit; and second combustion means arranged to fire only said minimum load portion during start-up.

2. A vapor generating and superheating unit comprising wall means forming a gas flow chamber; economizer, vapor generating and vapor superheating sections disposed in said chamber; a start-up minimum load portion including said economizer section and parts of the vapor generating section and of the vapor superheating section; said economizer section and said parts of the vapor generating section and of the vapor superheating section being connected for serial flow of fluid therethrough; means connecting said minimum load portion in parallel flow relation with the remaining parts of said vapor generating section and said vapor superheating section; first combustion means supplying high temperature gases to said chamber to normally heat said sections; said minimum load portion being of a size to provide the minimum load vapor requirements for said unit; means for flowing all of the vaporizable fluid supplied for start-up through said minimum load portion to generate superheated vapor therein during the start-up of the unit; and second combustion means arranged to fire only said minimum load portion during start-up; said minimum load portion having at least a part of its vapor superheating section arranged to form radiant heat receiving walls.

3. A vapor generating and superheating unit comprising wall means forming a gas flow chamber; economizer, vapor generating and vapor superheating sections disposed in said chamber; a start-up minimum load portion including said economizer section and parts of the vapor generating section and of the vapor superheating section; said economizer section and said parts of the vapor generating section and of the vapor superheating section being connected for serial flow of fluid therethrough; means connecting said minimum load portion in parallel flow relation with the remaining parts of said vapor generating section and said vapor superheating section; first combustion means supplying high temperature gases to said chamber to normally heat said sections; said minimum load portion being of a size to provide the minimum load vapor requirements for said unit; means for flowing all of the vaporizable fluid supplied for start-up through said minimum load portion to generate superheated vapor therein during the start-up of the unit; and second combustion means arranged to fire only said minimum load portion during start-up; said minimum load portion having at least a part of its vapor superheating section arranged to form radiant heat receiving walls and comprising two laterally spaced panels of tubes with combustion of fuel from said second combustion means occurring therebetween.

References Cited in the file of this patent

UNITED STATES PATENTS

1,770,987	Lundgren	July 22, 1930
1,890,468	Noack	Dec. 13, 1932
1,927,649	Noack	Sept. 19, 1933
1,973,365	Wood	Sept. 11, 1934
2,334,187	Frisch	Nov. 16, 1943
2,366,717	Frisch	Jan. 9, 1945

FOREIGN PATENTS

566,817	Great Britain	Jan. 16, 1945