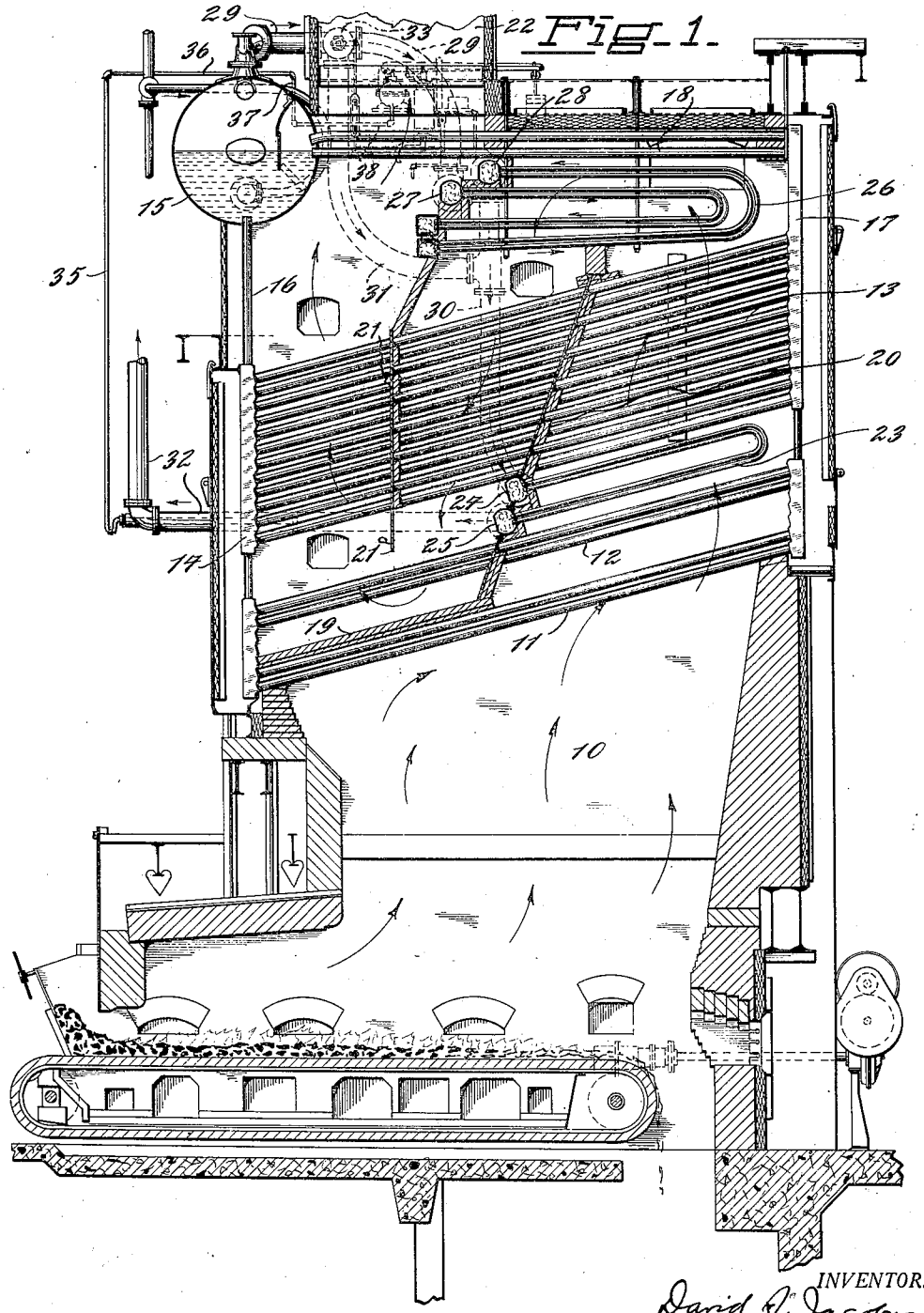
Oct. 28, 1930. D. S. JACOBUS 1,779,706

SUPERHEATER STEAM BOILER AND METHOD OF OPERATING THE SAME

Filed June 17, 1924 3 Sheets-Sheet 1

Fig. 1.



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SUPERHEATER STEAM BOILER AND METHOD OF OPERATING THE SAME

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Fig. 2.

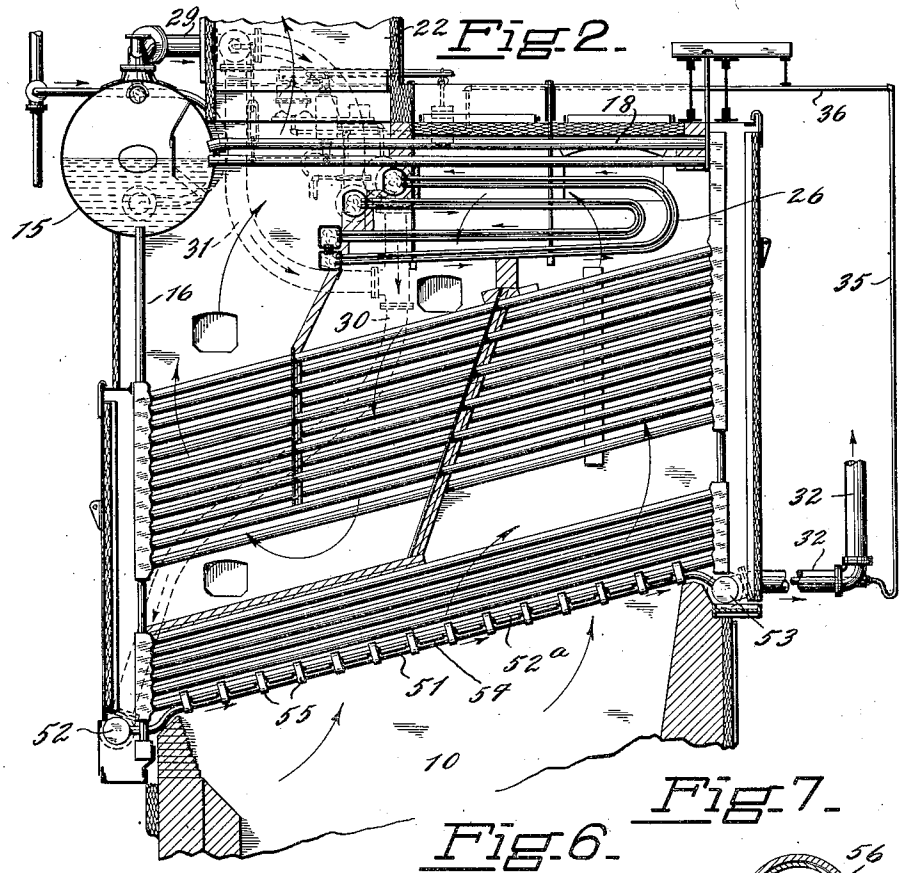


Fig. 7.

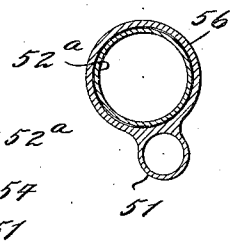


Fig. 6.

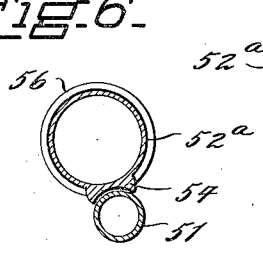


Fig. 5.

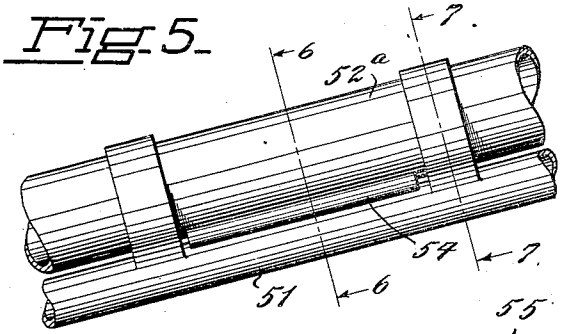


Fig. 4.

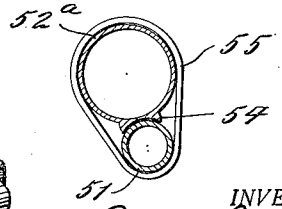
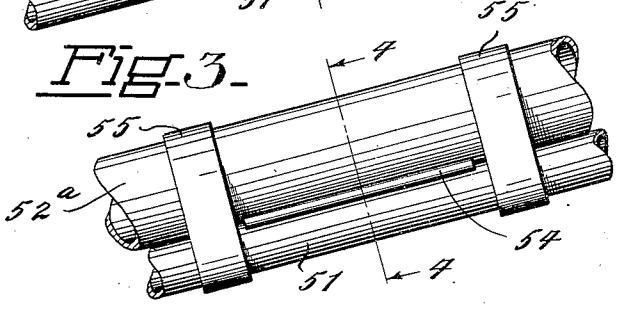


Fig. 3.



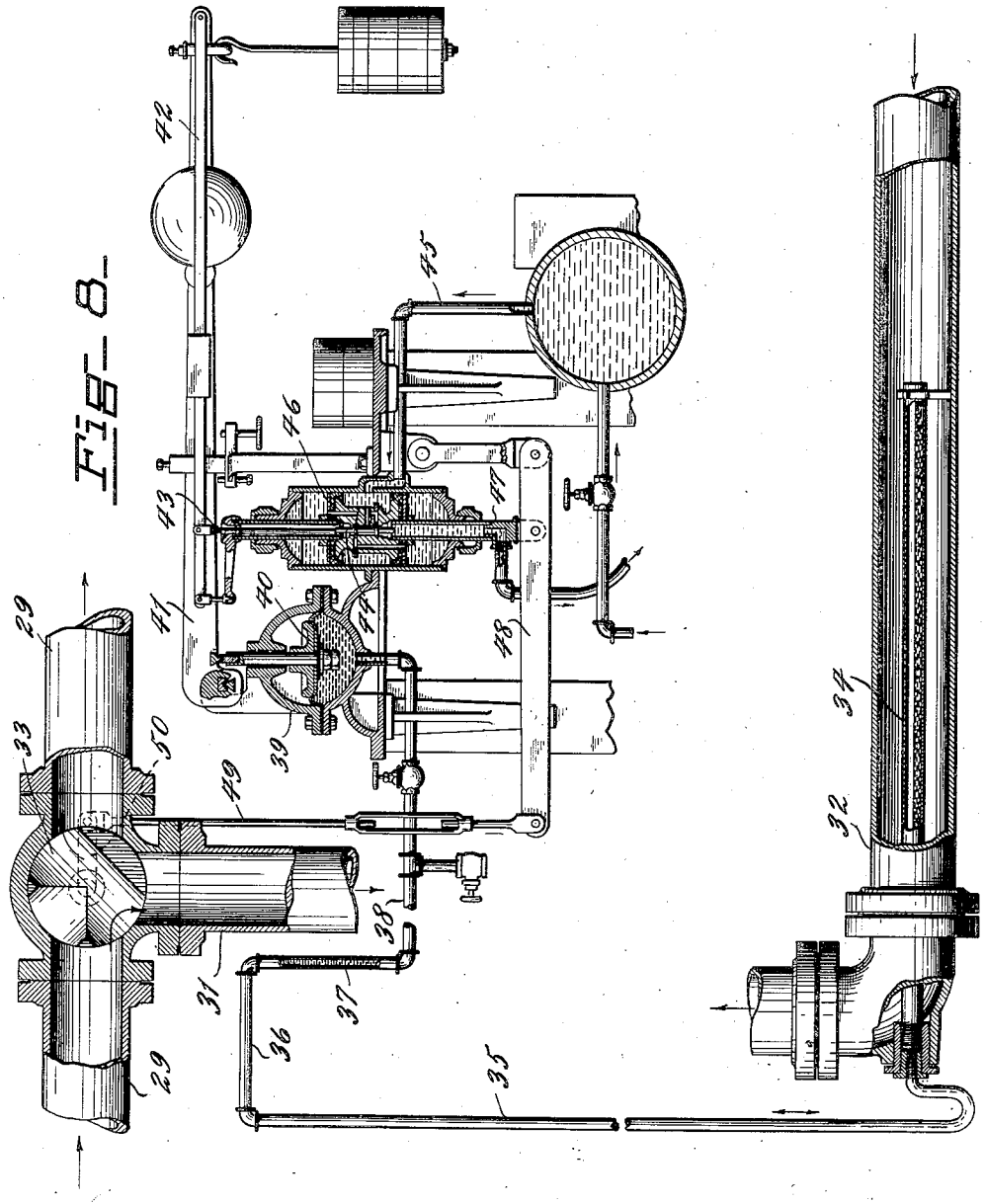
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SUPERHEATER STEAM BOILER AND METHOD OF OPERATING THE SAME

Filed June 17, 1924 3 Sheets-Sheet 3

Fig. 8.



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UNITED STATES PATENT OFFICE

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SUPERHEATER STEAM BOILER AND METHOD OF OPERATING THE SAME

Application filed June 17, 1924. Serial No. 720,502.

My present invention will be best understood from the following description and the annexed drawings, in which Fig. 1 is a vertical side elevation of one form of steam boiler embodying my invention and with which my method may be carried out, Fig. 2 is similar to Fig. 1, but showing a modification; Fig. 3 is an enlarged portion of Fig. 2; Fig. 4 is a section on the line 4—4 of Fig. 3; Fig. 5 is a modification of the arrangement shown in Figs. 3 and 4; Figs. 6 and 7 are sections on the lines 6—6 and 7—7, respectively, of Fig. 5; and Fig. 8 is an enlarged view of one form of regulating apparatus which may be used with my invention, with some of the parts broken away to better illustrate the construction.

Like reference characters indicate like parts in the several views.

Referring to the illustrative arrangement shown in Fig. 1, over a furnace chamber 10 is placed a water tube boiler having horizontally inclined water tubes connected by water chambers at either end, the water tubes being divided into a lower bank 11, a middle bank 12 and an upper bank 13, the downtake water chambers 14 being connected to the steam and water drum 15 by the nipples 16 and the uptake water chambers 17 being connected by the circulators 18 to the drum 15.

The lower bank 11 is separated from the middle bank 12 and the middle bank 12 is separated from the upper bank 13, as shown, and a longitudinal baffle 19 extends from the feed water chambers along the upper row of the tubes of the bank 11. A cross baffle 20, inclined to the vertical, extends across the middle and upper banks of the tubes from the inner end of the longitudinal baffle 19, and a second cross baffle 21 provides the second and third passes for the gases to the gas outlet 22. Preferably the baffle 21 has an extension 21^a extending downward partially across the space between the tubes 12 and the tubes 13, this extension preferably being made entirely of metal without tiling in front of it, as is preferably used in the upper portion of the baffle. By stopping this portion 21^a short of the tubes 12, the flow area at the bottom of the second pass is less constricted and therefore has correspondingly less draft resistance than if the baffle 21 were continued to the tubes 12.

Between the middle bank 12 and the upper bank 13 is a superheater 23 having an inlet header 24 and an outlet header 25 extending across the boiler and behind the baffle 20.

Above the upper bank 13 is a superheater 26 having, in the illustrative form, a double set of U-tubes connected serially between the inlet header 27 and the outlet header 28. A pipe 29 connects the inlet header 27 with the saturated steam outlet from the drum 15, and a pipe 30 connects the outlet header 27 with the inlet header 24.

A by-pass pipe 31 connects the pipe 29 with the pipe 30 between the connections of the latter to the headers 27 and 24. The pipe 32 is the superheated steam outlet to the point of use connected to the outlet header 25.

A valve 33, shown best on a large scale in Fig. 8, controls the connection between the pipe 31 and the pipe 29, this valve, in the form shown, being of the three-way type.

In the operation of superheater steam boilers, it is desirable to maintain the degree of superheat nearly constant, and the arrangement which I have described enables this to be done. It will be noted that the saturated steam flowing from the drum 15 may either be carried through the pipe 29 to the primary superheater 26, and from thence to the secondary superheater 23 before reaching the outlet pipe 32, or it may pass directly through the pipe 31 to the secondary superheater 23, and from thence to the outlet 32, the steam thus passing directly being by-passed around the primary superheater 26. The steam which passes through the pipe 29 and both primary and secondary superheaters will, of course, receive more heat than the steam which is passed only through the secondary superheater 23. The heat conditions surrounding the secondary superheater 23 are such as to supply more heat for a given area of superheater tube surface than will be supplied to the same area of the primary superheater 26. Therefore, if the valve 33 is set so that all of the steam flows through both superheaters, the highest degree of superheat

would be attained for a given furnace condition. If, now, the rating of the boiler were increased, the heat conditions around the superheaters would vary, and this might increase the superheat of the steam at the outlet 32. In order to correct this, the valve 33 would be opened so as to permit some of the saturated steam to pass directly to the secondary superheater 23, the remaining steam passing through both primary and secondary superheaters. The mingled steam in the outlet 32 would thus have its superheat reduced, and by increasing the amount of saturated steam supplied directly to the pipe 30 from the boiler, the degree of superheat could be correspondingly reduced.

The valve 33 may be a hand-controlled valve, but I prefer to control it automatically, and to this end, I provide an apparatus which will shift the valve 33 when the temperature of the superheated steam in the steam outlet 32 exceeds a predetermined amount. As an illustrative form of apparatus suitable for this purpose, I have shown an arrangement in Fig. 8 in which a horizontal tube 34 is located in the outlet 32 to be contacted by the steam therein, this tube being connected by the vertical pipe 35, the horizontal pipe 36, the vertical pipe 37 and the horizontal pipe 38 with a pressure chamber 39 having a piston 40 exerting pressure against a lever 41 held down by a suitable amount of weights. To the end of the lever 41 is connected a lever 42, to which, in turn, is connected a rod 43, attached to a valve stem 44, controlling the flow of water under pressure from the pipe 45, so that such pressure will be applied either above or below a piston 46, which, in turn, is connected through the rod 47 with a lever 48, connected, in turn, by the connecting rod 49 with the lever 50 of the valve 33. The valve stem 44 and its piston 46 and, in fact, the entire motor arrangement is the same as shown in my prior Patent No. 1,149,265, granted August 10, 1915, at Figs. 9 and 10, and further detailed description thereof will be unnecessary, it being understood that any other form of motor mechanism controlled by a pressure fluid may be used.

Normally the weights on the lever 41 will be such as to hold the valve stem 44 in neutral position, with the valve 33 arranged to divert a given quantity of saturated steam directly to the secondary superheater 23. When the temperature of the steam at the outlet rises above the predetermined amount, however, mercury or some other vaporizable fluid in the tube 34 will be vaporized, and the pressure thereof transmitted through the pipe 35 to a fluid column in the pipes 37 and 38 and the passage 39 to raise the piston 40 and with it the levers 41 and 42 to shift the valve stem 44 to admit the motor fluid beneath the piston 46 to pull up the lever 48 and to rotate the valve 33 counterclockwise. This will divert more saturated steam to the secondary superheater 23 and, of course, correspondingly reduce the amount of saturated steam supplied to the primary superheater 26. This will decrease the amount of superheat in the steam outlet. It is obvious that this arrangement will automatically maintain the steam temperature at the steam outlet constant.

Where mercury is used in the tube 34, I preferably place the tube 34 horizontal so as to minimize the difference in pressure due to the head of the mercury in different parts of the tube, and thereby make it possible for the mercury to boil more uniformly in different parts of the tube than would be the case should a considerable difference in head of mercury exist in different parts of the tube. Placing the tube 34 horizontal also gives a maximum amount of liberating surface for the vapor produced in boiling the mercury.

The arrangement in Fig. 2 is substantially the same as that of Fig. 1, except that instead of the secondary superheater being heated by gases which have passed over one or more banks of tubes, I have shown a superheater subjected to the radiant heat of the furnace, this superheater being made up of the tubes 51 suspended beneath the lowermost tubes 52^a of the boiler directly over the furnace chamber. The header 52 is the inlet header of the superheater and the outlet header 53 is connected to the steam outlet pipe 32, as in Fig. 1. In order to prevent the superheater tubes from burning out, by reason of their direct exposure to the radiant heat of the furnace, these tubes are arranged so that there will be thermal contact between them and the water tubes. Also, because the expansion of the superheater tubes may be different from that of the water tubes on which they are suspended, I preferably arrange the connection between the two so that there may be relative longitudinal motion.

In Figs. 3 and 4, I have shown one form of connection in which the water tube 52^a is provided with separated extension portions 54 welded to the wall of the tube and each provided with a circular recess to fit the periphery of the superheater tube 51. Metallic bands 55 surround the two tubes to hold them in engagement but not so tightly as to prevent longitudinal motion of the superheater tube 51 through the loops 55.

In Figs. 5, 6 and 7, another form of connection between the superheater tube and the water tube is shown. In this case, the superheater tube will have united to it eyes 56 surrounding the water tube 52^a and arranged to slide along the tube while, at the same time, holding the superheater tube 51 in contact with the portions 54.

It will be noted that any other form of radiant heat superheater may be used instead of the form which I have just described.

It will be noted that I regulate the degree

of superheat given to quantities of saturated steam delivered to a superheater by regulating the amount of saturated steam in accordance with the heat conditions surrounding the superheater, and in this way, maintaining substantially constant the temperature of the steam delivered from the superheater. Thus, in the case of the superheater 23, for instance, if the weight and temperature of the gases flowing over that superheater are increased, I increase the amount of saturated steam delivered to the superheater, so that the temperature of the steam issuing from the superheater can be held substantially constant. Similarly, if the weight and temperature of the hot gases decrease, I reduce the amount of saturated steam delivered to the superheater, this decreased amount of steam, however, being raised to the same temperature as before.

When my illustrative arrangement is used, in which the two superheaters are connected in series, with one of them by-passed, I preferably arrange them so that the secondary superheater or the one subjected to the highest temperature conditions will be the one to which steam is certainly delivered, because obviously that is the superheater which is more liable to burn out. Thus, under certain operating conditions, it might be possible for the valve 33 to be moved to a position where all of the steam to the primary superheater 26 might be cut off. Because this primary superheater is in the relatively cool gases, however, the danger of burning out the tubes would be minimized.

I claim:

1. A steam boiler, a primary superheater connected to the boiler, a secondary superheater connected to the primary superheater, each of the superheaters receiving heat from the boiler furnace and the primary superheater being located in the boiler so as to be subjected to lower temperatures than the secondary superheater, and a by-pass to conduct steam directly from the boiler to the secondary superheater.

2. A steam boiler, a primary superheater connected to the boiler, a secondary superheater connected to the primary superheater, each of the superheaters receiving heat from the boiler furnace and the primary superheater being located in the boiler so as to be subjected to lower temperatures than the secondary superheater, a by-pass to conduct steam directly from the boiler to the secondary superheater, and a valve to control the flow of steam through the by-pass.

3. A steam boiler, a primary superheater connected to the boiler, a secondary superheater connected to the primary superheater, each of the superheaters receiving heat from the boiler furnace and the primary superheater being located in the boiler so as to be subjected to lower temperatures than the secondary superheater, a by-pass to conduct steam directly from the boiler to the secondary superheater, and a valve controlled by the temperature of the steam flowing from the secondary superheater to regulate the flow of steam through the by-pass.

4. A steam boiler, a primary superheater connected to the boiler, a secondary superheater connected to the primary superheater, each of the superheaters receiving heat from the boiler furnace and the primary superheater being located in the boiler so as to be subjected to lower temperatures than the secondary superheater, a by-pass to conduct steam directly from the boiler to the secondary superheater, and a valve controlled by the temperature of the steam flowing from the secondary superheater to divert from the primary superheater some of the steam from the boiler and direct it into the by-pass.

5. A steam boiler, a primary superheater connected to the boiler, a secondary superheater connected to the primary superheater, each of the superheaters receiving heat from the boiler furnace and the primary superheater being located in the boiler so as to be subjected to lower temperatures than the secondary superheater, a by-pass to conduct steam directly from the boiler to the secondary superheater, a three-way valve at the entrance to the by-pass and means controlled by the temperature of the steam flowing from the secondary superheater, to operate the three-way valve.

6. A steam boiler, a primary superheater connected to the boiler, a secondary superheater connected to the primary superheater, each of the superheaters receiving heat from the boiler furnace and the primary superheater being located in the boiler so as to be subjected to lower temperatures than the secondary superheater, a by-pass to conduct steam directly from the boiler to the secondary superheater, a valve to regulate the flow of steam through the by-pass, a cell containing a vaporizable liquid in the outlet of the secondary superheater, a piston subjected to the pressure of the vaporizable liquid, an auxiliary motor having its power supply controlled by the position of said piston, and connections between the auxiliary motor and the valve, whereby the valve will divert steam from the primary superheater when the temperature of the steam from the secondary superheater exceeds a predetermined degree.

7. A steam boiler, a primary superheater connected to the boiler, a secondary superheater connected to the primary superheater, each of the superheaters receiving heat from the boiler furnace and the primary superheater being located in the boiler to be contacted by the gases after they have passed over a relatively large water heating surface and the secondary superheater being located to

receive radiant heat from the furnace, and a by-pass to conduct steam directly from the boiler to the secondary superheater.

8. A steam boiler, a primary superheater connected to the boiler, a secondary superheater connected to the primary superheater, each of the superheaters receiving heat from the boiler furnace and the primary superheater being located in the boiler to be contacted by the gases after they have passed over a relatively large water heating surface and the secondary superheater being located to receive radiant heat from the furnace, a by-pass to conduct steam directly from the boiler to the secondary superheater, and a valve to regulate the flow of steam through the by-pass.

9. A steam boiler, a primary superheater connected to the boiler, a secondary superheater connected to the primary superheater, each of the superheaters receiving heat from the boiler furnace and the primary superheater being located in the boiler to be contacted by the gases after they have passed over a relatively large water heating surface and the secondary superheater being located to receive radiant heat from the furnace, a by-pass to conduct steam directly from the boiler to the secondary superheater, and a valve controlled by the temperature of the steam flowing from the secondary superheater to regulate the flow of steam through the by-pass.

10. A steam boiler, a superheater located in the boiler out of the radiant heat of the furnace and in position to be contacted by the gases after they have passed over a relatively large water heating surface, a superheater located to receive radiant heat from the furnace, pipes connecting respectively each superheater to the saturated steam outlet of the boiler, a pipe to receive the steam from both superheaters, and means to regulate the proportions of the quantities of saturated steam flowing to each superheater from the saturated steam outlet.

11. A steam boiler, a superheater located in the boiler out of the radiant heat of the furnace and in position to be contacted by the gases after they have passed over a relatively large water heating surface, a superheater located to receive radiant heat from the furnace, pipes connecting respectively each superheater to the saturated steam outlet of the boiler, a pipe to receive the steam from both superheaters, and means to vary the proportions of saturated steam passed to the superheaters to maintain a constant temperature in the total superheated steam.

12. The method of maintaining substantially constant the temperature of superheated steam leaving a superheater, which consists in varying the quantity of heat supplied to the steam entering the superheater in accordance with the quantity of steam supplied to the superheater.

13. The method of maintaining substantially constant the temperature of superheated steam leaving a superheater, which consists in supplying superheated steam to said superheater, generating saturated steam in a boiler and supplying it to the superheater and varying the proportion of such saturated steam supplied to the superheater in accordance with the variation in heat supplied to the superheater.

14. In a steam boiler, a primary superheater connected to the boiler, a secondary superheater connected in series to the primary superheater, a by-pass for conducting saturated steam from the boiler to said secondary superheater, and automatic means for varying the extent of said by-pass.

15. In a steam boiler, a primary superheater connected to the boiler, a secondary superheater connected in series to the primary superheater, a by-pass for conducting saturated steam from the boiler to said secondary superheater, and means operable in accordance with the temperature of the superheated steam delivered from said secondary superheater for controlling the extent of said by-pass.

16. The method of regulating the temperature of superheated steam which consists in heating confined saturated steam by furnace gases at relatively low temperatures and then heating the steam, while confined, by furnace gases of relatively high temperatures, mingling other saturated steam therewith prior to its being heated by the gases of relatively high furnace temperatures, and delivering the mingled steam.

17. The method of regulating the temperature of superheated steam which consists in heating confined saturated steam by furnace gases of relatively low temperatures and then heating the steam, while confined, by furnace gases of relatively high temperatures, mingling other saturated steam with the first-mentioned steam prior to the heating of the latter by furnace gases of relatively high temperatures, delivering the mingled steam after being subjected to the relatively high temperatures, and regulating the amount of saturated steam which is mingled with the first-mentioned steam in accordance with the total amount of steam to be heated, and the heating conditions of the two bodies of steam to maintain the temperature of the steam delivered after being heated by the gases of relatively higher temperatures at a substantially constant temperature.

18. The method of regulating the temperature of superheated steam which consists in heating confined saturated steam by furnace gases after they have been deprived of a portion of their heat in generating steam, then subjecting the steam, while confined, to the radiant heat of the furnace, mingling other saturated steam with the first-men-

tioned steam before being subjected to the radiant heat of the furnace, and delivering the mingled steam.

19. The method of regulating the temperature of superheated steam which consists in heating confined saturated steam by furnace gases after they have been deprived of a portion of their heat in generating steam, subjecting other saturated steam, while confined, to the radiant heat of the furnace, delivering the mingled steam, and regulating the respective amounts of saturated steam in accordance with the heat conditions of the respective bodies of steam to maintain the temperature of the total superheated steam substantially constant.

20. The method of superheating steam and regulating the temperature thereof which consists in supplying steam to a fuel-fired superheater and raising its temperature therein, leading the superheated steam from the superheater to the point of use at substantially the exit temperature from the superheater, and regulating the exit temperature of the superheated steam from the superheater by adding varying amounts of heat to the steam entering the superheater.

21. The method of supplying superheated steam, comprising feeding steam in a successive manner from a source of supply through two stages of superheating, heating the second stage of superheating from the combustion of fuel to a higher temperature than it is in the first stage, supplying heat to the first stage other than that of steam passing from the second stage, and varying the amount of preheating of the steam before it is delivered to the second stage.

22. The method of supplying superheated steam comprising feeding steam in a successive manner from a source of supply through two stages of superheating, the first superheating stage being located in a position where it is subjected to relatively low temperature and the second superheating stage being located in a position where it is heated from the combustion of fuel to a higher temperature than it is in the first stage, supplying heat to the first stage other than that of steam passing from the second stage, and varying the amount of preheating of the steam before it is delivered to the second stage.

23. The method of supplying superheated steam, comprising feeding steam in a successive manner from a source of supply through two stages of superheating, heating the second stage of superheating from the combustion of fuel to a higher temperature than it is in the first stage, supplying heat to the first stage other than that of steam passing from the second stage, and varying the amount of preheating of the steam before it is delivered to the second stage in accordance with the exit temperature of the steam from the second stage of the superheater.

24. The method of supplying superheated steam, comprising feeding steam in a successive manner from a source of supply through two stages of superheating, heating the second stage of superheating from the combustion of fuel to a higher temperature than it is in the first stage, supplying heat to the first stage other than that of steam passing from the second stage, and maintaining the exit temperature of the steam from the second stage substantially constant by varying the temperature of the superheated steam entering the second stage.

25. In a device for superheating steam and regulating the temperature thereof, a fuel-fired superheater in which the temperature of the steam is raised, means for leading the superheated steam from said superheater to the point of use at substantially the exit temperature from the superheater, and means for regulating the exit temperature of the superheated steam from the superheater by adding varying amounts of heat to the steam entering the superheater.

26. In a device for supplying superheated steam, a first and a second stage of superheating, means for feeding steam in a successive manner from a source of supply through the two stages of superheating, means for heating the second stage of superheating from the combustion of fuel to a higher temperature than it is in the first stage, means for supplying heat to the first stage other than that of steam passing from the second stage, and means for varying the amounts of preheating of the steam before it is delivered to the second stage.

27. In a device for supplying superheated steam, a first and a second stage of superheating, means for feeding steam in a successive manner from a source of supply through the two stages of superheating, means for heating the second stage of superheating from the combustion of fuel to a higher temperature than it is in the first stage, means for supplying heat to the first stage other than that of steam passing from the second stage, and means for varying the amount of preheating of the steam before it is delivered to the second stage in accordance with the temperature of the steam leaving the second stage.

28. In a device for supplying superheated steam, a first and a second stage of superheating, means for feeding steam in a successive manner from a source of supply through the two stages of superheating, means for heating the second stage of superheating from the combustion of fuel to a higher temperature than it is in the first stage, means for supplying heat to the first stage other than that of steam passing from the second stage, and means for maintaining the exit

temperature of the steam from the second stage substantially constant by varying the amount of preheating of the steam before it is delivered to the second stage.

29. The method of maintaining substantially constant the temperature of superheated steam leaving a superheater, which consists in supplying the superheater with superheated steam at a temperature which varies inversely as the temperature of steam leaving said superheater.

30. The method of superheating steam and regulating the temperature thereof, which consists in supplying steam to a fuel-fired superheater and raising its temperature therein, leading the superheated steam from the superheater to the point of use at substantially the exit temperature from the superheater, and regulating the exit temperature of the superheated steam from the superheater by supplying it with superheated steam at a temperature which varies inversely as the temperature of steam leaving said superheater.

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