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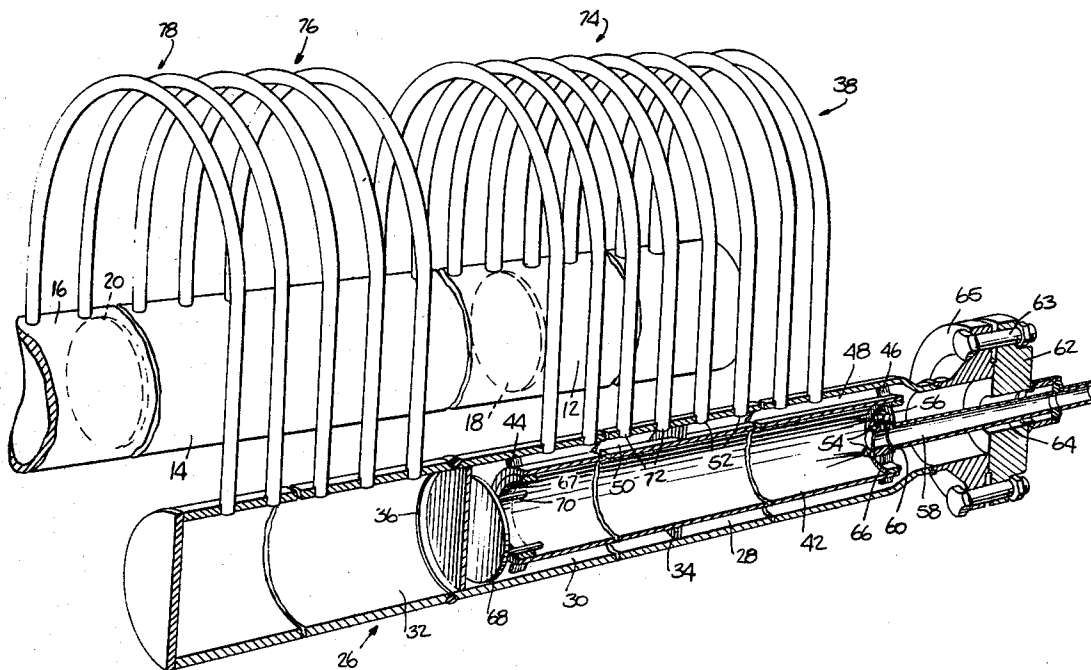
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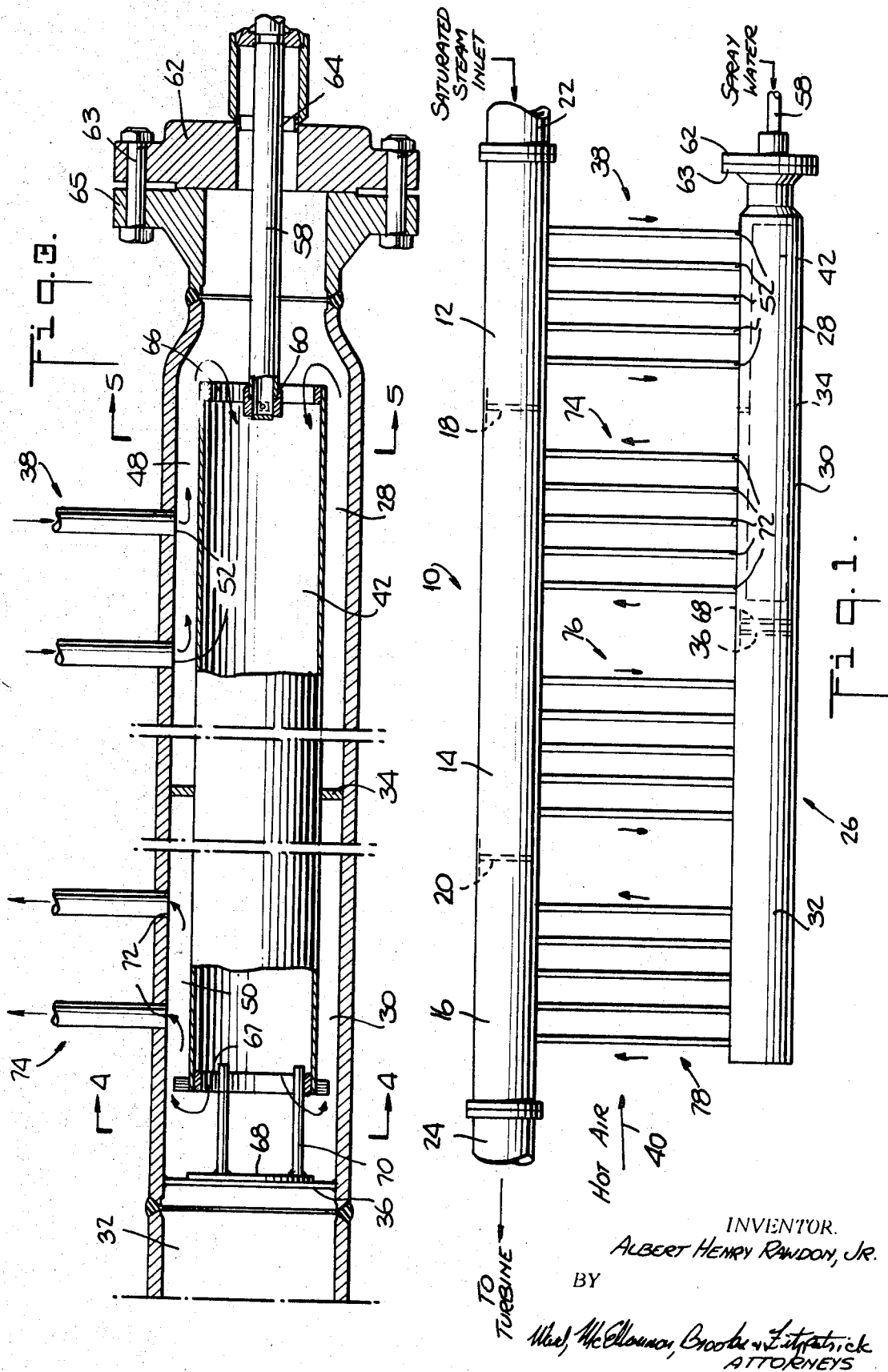
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[54] HEAT EXCHANGER 15 Claims, 6 Drawing Figs.

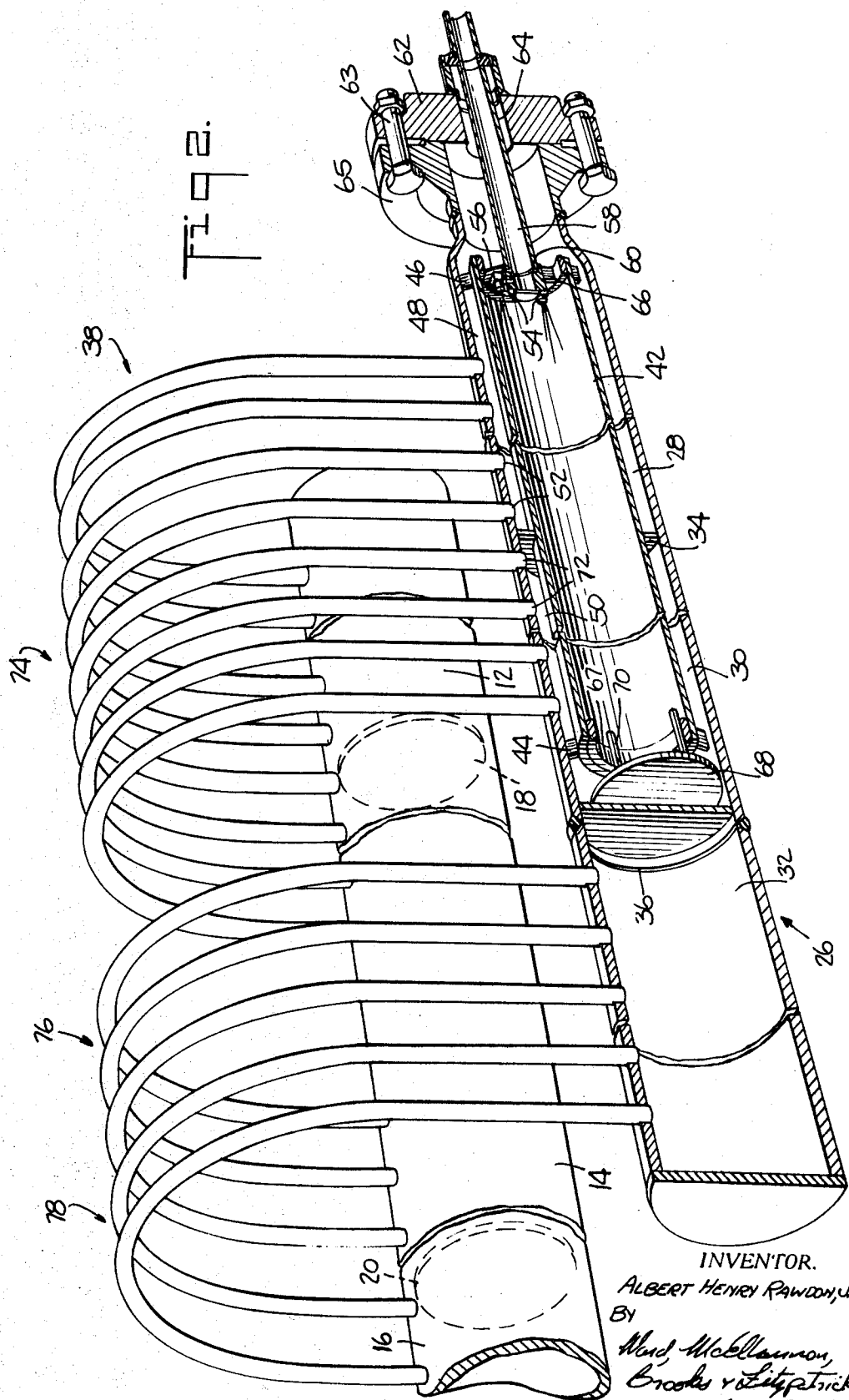
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ABSTRACT: Method and apparatus for controlling the temperature of steam in a superheater wherein steam is passed back and forth between two headers while being superheated, and spray water is mixed with the heated steam in a spray chamber mounted within one of the headers to evaporate the steam causing the mixed temperature to drop so that more heat may be absorbed in subsequent steam passes without increasing the final steam temperature.





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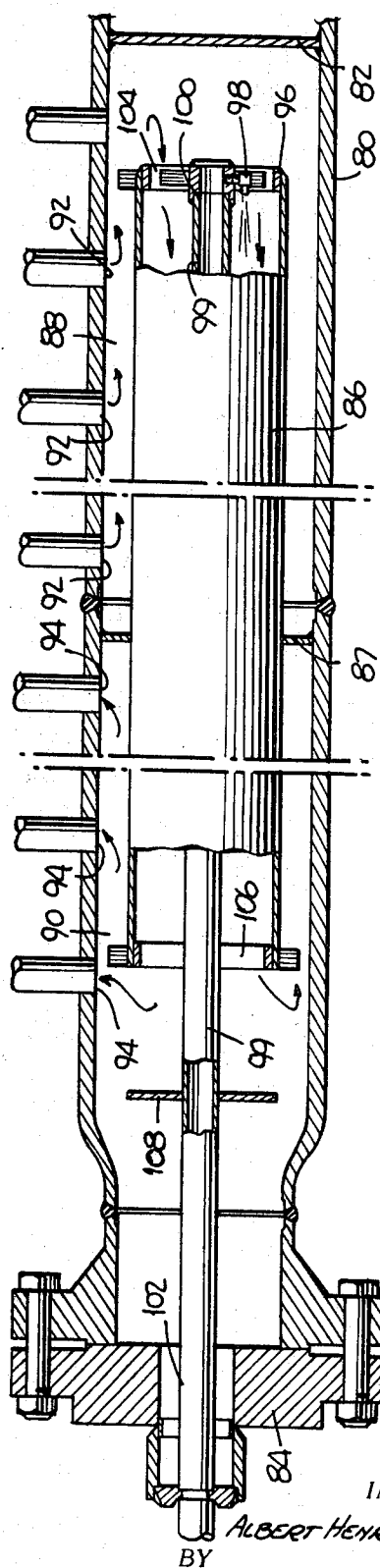
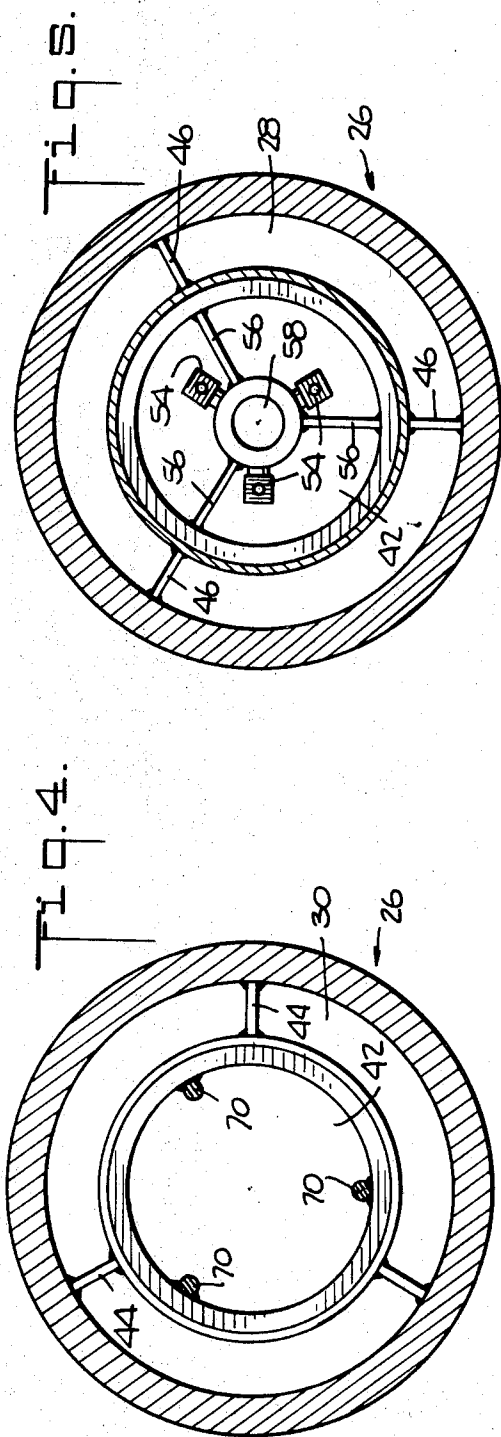


Fig. 6.

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HEAT EXCHANGER

This invention relates to heat exchangers and more particularly to method and apparatus for controlling the temperature of steam in a superheater.

Fundamentally, steam boilers are fired to maintain a preselected output and are not designed to maintain selected steam temperatures. Accordingly, as the load increases, the steam temperature increases also, but at a lower rate. In order to control and maintain the steam at a desired constant temperature, a selected quantity of water in the form of spray is added in the superheater, thereby cooling the superheated steam, as desired. Conventionally, saturated steam is brought into the superheater and passes through a bundle of tubes disposed in parallel relationship one with respect to the others. There may be about 30 tubes, for example. Typically, the steam may be heated to about 90° degrees F. above the saturation temperature and then passed into a desuperheater. In conventional spray type desuperheaters, the steam would be collected in a header and taken to an external unit disposed in a transfer pipe on the way to the next stage of superheating. That is, water spray was added to the steam in the transfer pipe between two superheater stages. While the prior art apparatus was widely used, it nevertheless suffered from certain disadvantages including a high cost of production, high pressure connections through the sidewall of the header and a large inconvenient structure. My contribution to the art is a new and improved apparatus for controlling the temperature of steam in a superheater as will become apparent as the description proceeds.

Briefly, my invention contemplates the provision of a construction including a pair of spaced headers having inlet and outlet means for the passage of steam, and having means for passing the steam back and forth therebetween while being heated to a generally superheated condition. A spray chamber is mounted in one of the headers which is constructed and arranged to provide an annular passage between the header and the chamber. Inlet means are embodied at one end of the spray chamber for the spray water and inlet means are provided at the same end for receiving steam from the annular passage. The spray chamber is constructed and arranged to intermingle and mix the superheated steam and the spray water, thereby to evaporate the water into steam, causing the mixed temperature to drop. This allows more heat to be absorbed in subsequent steam passes without increasing the final steam temperature. After passing through the spray chamber, the cooled steam passes to the next superheating stage. It will be appreciated that the spray water may be added between any two steam passes, such as between the first and second steam passes in a four steam pass system, or between the second and third steam passes in a three steam pass system, for example.

There has thus been outlined rather broadly the more important features of the invention in order that the detailed description thereof that follows may be better understood and in order that the present contribution to the art may be better appreciated. There are, of course, additional features of the invention that will be described hereinafter which will form the subject of the claims appended hereto. Those skilled in the art will appreciate that the conception on which this disclosure is based may readily be utilized as the basis for the design of other structures for carrying out the several purposes of this invention. It is important, therefore, that this disclosure be regarded as including such equivalent constructions as do not depart from the spirit and scope of the invention.

Several embodiments of the invention have been chosen for purposes of illustration and description, and are shown in the accompanying drawings, forming a part of the specification, wherein:

FIG. 1 is a plan view of a steam superheater including means for controlling the temperature of the steam being discharged therefrom according to the concept of my invention;

FIG. 2 is an enlarged perspective view of a portion of the steam superheater of FIG. 1, partially broken away to reveal the inner structure of the water spray means for controlling the temperature of the steam;

FIG. 3 is an enlarged, medial, longitudinal sectional view of a header containing a spray chamber according to my invention;

FIG. 4 is an enlarged, transverse sectional view taken along the line indicated at 4-4 in FIG. 3;

FIG. 5 is an enlarged, transverse sectional view taken along the line indicated at 5-5 in FIG. 3; and

FIG. 6 is an enlarged, medial, longitudinal sectional view of a header containing a spray chamber according to another embodiment of my invention.

Referring to the drawings in greater detail, as shown in FIG. 1, an elongated first heater, indicated generally at 10, has a first chamber 12, a second chamber 14, and a third chamber 16 defined by blocking diaphragms or partitions 18 and 20 therebetween. The first chamber 12 is furnished with inlet means as at 22, for receiving steam to be superheated and the third chamber is furnished with outlet means as at 24, for discharging the superheated steam.

A second elongated header, indicated generally at 26, is disposed in spaced relationship with respect to the first header 10 and incorporates a first chamber 28, a second chamber 30 and a third chamber 32 defined by closure plates or partitions 34 and 36 therebetween, provided for the purpose.

A first bundle of U-shaped tubes, indicated generally at 38, is interposed between the first chamber 12 of the first header 10 and the first chamber 28 of the second header 26 for purposes of carrying steam therebetween. The tubes 38 are arranged to permit hot gases or air, as indicated by the arrow 40, to pass over their outside surfaces to heat the steam while passing between the two chambers, and hence form the first steam pass of a multipass superheater system.

As best seen in FIGS. 2 and 3, a spray chamber 42 is removably mounted in chambers 28 and 30 of the second header 26. This spray chamber is held in spaced relationship with respect to the header 26, as by means of a spider or web 44, FIG. 4, and a spider or web 46, FIG. 5, provided for the purpose. This spray chamber is provided with a loose fit with respect to the spiders and with respect to the inside of the partition 34 so that it can be longitudinally removed from the chambers 28 and 30. The spray chamber 42 is constructed and arranged to form an annular passage between its outside wall and the wall of the second header and the partition 34 serves to split this passage into a first annular passage 48 and a second annular passage 50, the first annular passage 48 having a plurality of inlet ports 52 for receiving the steam to be cooled from the tubes 38.

As best seen in FIG. 2, a radially disposed spray nozzle cluster 54 of nonclogging type nozzles is mounted at one end of the spray chamber 42, as by means of a web or spider 56, FIG. 5. Spray water is supplied to said spray nozzle as by means of a spray tube 58 having one end thereof connected to said spray nozzle in fluid flow communication as at 60, and the other end thereof passing through a closure plate or flange 62, as at 64. The flange 62 is bolted, as by bolts 63, to a mating flange 65 on the second header 26 to permit removal of the spray chamber 42.

As best seen in FIG. 3, the steam flows from the first annular passage 48 through an inlet aperture 66 disposed at one end of the spray chamber 42. The spray chamber is constructed and arranged to intermingle and mix the spray water and the steam, thereby to lower the temperature of the steam.

Referring in particular to FIGS. 2 and 3, the steam flows out through an outlet aperture 67 disposed at the other end of the spray chamber 42. A splash plate 68 is mounted adjacent the outlet aperture 67 for deflecting the low temperature steam through the second annular passage 50, the splash plate being structurally connected to the end of the spray chamber by rods 70 provided for the purpose. The spray plate may frictionally bear against the partition 36. The second annular passage 50 has a plurality of outlet ports 72 through which the steam passes to a second bundle of tubes, indicated generally at 74. It will be appreciated that a great deal of spray water is likely to be on the inside walls of the spray chamber, re-

ardless of the efficiency of the spray nozzles. However, according to my concept, hot steam is in contact with the outside surface of the spray chamber, thereby assisting to evaporate the water on the inside of the spray chamber wall. It will also be appreciated that the water spray must travel a maximum linear distance before entering the U-tubes by reason of the fact that the spray chamber 42 extends through the two chambers 28 and 30, and then the spray must double back through the second annular passage 50, thereby providing maximum opportunity for vaporizing of the water spray outside of the U-tubes. Particular attention is directed to the fact that the steam flows in one direction on the outside of the spray chamber 42 and in the opposite direction on the inside thereof. This serves to reduce the thrust on the spray chamber supports by reason of balancing the friction drag. This is a feature of some importance as many spray chambers have broken loose of their fastenings and blocked the flow of steam into the turbine. This prevents the U-tubes from being subjected to the high erosive effect accompanying moisture in the steam. Actually, the spray chamber and the splash plate are the main elements which are subjected to the erosive effect of the water, and these elements are readily replaceable, as will be pointed out hereinafter.

Referring to FIG. 1, the bundle of tubes, indicated generally at 74, allows the steam to pass from the second chamber 30 of the second header 26 to the second chamber 14 of the first header 10, forming a second steam pass. The steam turns around in the second chamber 14 of the first header 10 and passes through a bundle of tubes, indicated generally at 76, to the third chamber 32 of the header 26, forming a third steam pass. From the third chamber 32, the steam passes through another bundle of tubes, indicated generally at 78, to the third chamber 16 of the first header 10 forming the fourth steam pass. It will be appreciated that the hot gas or air 40 passes over the outside of the tubes 38, 74, 76 and 78, thereby heating the steam passing through the tubes. From the chamber 16, the steam passes through the outlet means 24.

While for purposes of explanation a four pass superheater system has been described, my concept is applicable to any multipass superheater. The spray chamber is illustrated as being disposed between the second and third steam passes. However, this chamber can also be positioned between any two steam passes such as the first or second, or the third and fourth, for in some installations, it may be desirable to employ a plurality of spray chambers between several steam passes.

Referring next to FIG. 6, it may be desirable to connect the spray water supply pipe to the end of the apparatus opposite the spray nozzle. Such an embodiment is illustrated in FIG. 6. An elongated header 80 is provided embodying end partitions or walls 82 and 84. A spray chamber 86 is mounted therein in spaced relationship with respect thereto to form an annular passage between the header and the spray chamber for the passage of steam. This passage has a partition 87 forming a first annular passage 88 and a second annular passage 90. The first annular passage has a plurality of inlet ports 92 for receiving steam to be cooled, and the second annular passage has a plurality of outlet ports 94 for discharging steam after it has been cooled. Spider means 96 serve to mount a cluster of spray nozzles 98 adjacent an end of the spray chamber. A spray tube 99 is furnished having one end connected to the spray nozzle, as at 100, in fluid flow communication therewith. The spray tube 99 extends through the spray chamber 88 and the other end thereof passes through the end plate or partition 84, as at 102. The spray chamber 86 embodies inlet means 104 for receiving steam from the first annular passage 88, and the spray chamber is constructed and arranged to intermingle and mix the spray water and the steam to lower the temperature of the steam. The spray chamber 86 embodies outlet means 106 at the other end thereof for discharging the low temperature steam. The outlet means includes a splash plate 108 mounted adjacent the end of the spray chamber for deflecting the steam to the second annular passage 90, from which it is discharged through the outlet means 94.

It will be particularly appreciated that in each embodiment of this invention, the spray chamber assembly may be unbolted as at the flange 62 in the embodiment of FIGS. 1-5 and at flange 84 in the embodiment of FIG. 6, and readily removed as a module from its header for purposes of repair and/or replacement. This is of particular practical importance as it reduces the time during which the entire apparatus is inoperative. In addition, the structure according to this invention does not require a high pressure connection through the side wall of the header.

It will thus be seen that the present invention does indeed provide an improved control means for superheaters which is superior in simplicity, economy and efficiency as compared to prior art such devices.

Although certain particular embodiments of the invention are herein disclosed for purposes of explanation, various modifications thereof, after study of this specification, will be apparent to those skilled in the art to which the invention pertains.

I claim:

1. Apparatus for controlling the steam temperature in a superheater comprising a first header and a spaced second header, said headers having inlet and outlet means for said steam, means for passing said steam back and forth between said headers while being heated, a spray chamber, means mounting said spray chamber in one of said headers, said spray chamber being constructed and arranged to provide an annular passage between the header and the spray chamber for the passage of steam, inlet means for spraying water disposed at one end of said spray chamber and inlet means for receiving steam from said annular passage disposed at said one end of said spray chamber, said spray chamber being constructed and arranged to intermingle and mix said spray water and said steam to lower the temperature of said steam, and outlet means for discharging the low temperature steam disposed at the other end of said spray chamber.

2. Apparatus for controlling the steam temperature in a superheater according to claim 1 wherein said means for passing said steam back and forth between said headers comprises a plurality of bundles of U-shaped tubes, said tubes being arranged to permit heating fluid to pass over the outside surface thereof to heat said steam.

3. Apparatus for controlling the steam temperature in a superheater according to claim 1 wherein said annular passage is arranged to direct the flow of said steam in one direction, and said spray chamber being arranged to direct the flow of steam in an opposite direction, thereby reducing the thrust on the spray chamber mounting means by reason of the friction drag of the steam.

4. Apparatus for controlling the steam temperature in a superheater according to claim 1 wherein said spray chamber is characterized by the passage of heat from said annular passage to the inside of said spray chamber, thereby assisting to evaporate the water on the inside of the spray chamber wall.

5. Apparatus for controlling the steam temperature in a superheater according to claim 1 wherein said inlet means for the spray water comprises a radially disposed cluster of non-clogging nozzles.

6. Apparatus for controlling the steam temperature in a superheater according to claim 1 wherein said outlet means for the spray chamber includes a splash plate for deflecting the low temperature steam to a next succeeding superheater stage.

7. Apparatus for controlling the steam temperature in a superheater according to claim 1 wherein said annular passage has a partition therein forming a first annular passage and a second annular passage, and wherein said inlet means for the spray chamber receives steam from said first annular passage, and said outlet means at the other end of the spray chamber discharges the low temperature steam into the second annular passage.

8. Apparatus for controlling the steam temperature in a superheater according to claim 7 wherein said means mounting said spray chamber in one of said headers comprises a pair of

spaced spider members interposed between the spray chamber and said one header, and flange means interconnecting one end of said spray chamber with one end of said one header, said flange means disengageable and said spray chamber having a loose fit with respect to said spider members and said partition in the annular passage to permit removal of the spray chamber from said one header.

9. A desuperheater comprising an elongated header, closure plates disposed at each end of said header, a spray chamber, spider means mounting said spray chamber in said header, said spray chamber being constructed and arranged to provide an annular passage between the header and the spray chamber for the passage of steam, said annular passage having a partition therein forming a first annular passage, and a second annular passage, said first annular passage having a plurality of inlet ports for receiving steam to be cooled, and said second annular passage having a plurality of outlet ports for discharging steam after it has been cooled, a cluster of spray nozzles, spider means for mounting said spray nozzles adjacent one end of said spray chamber, a spray tube having one end connected to said spray nozzles in fluid flow communication and having the other end extending through one of said closure plates, inlet means for receiving steam from said first annular passage disposed at one end of said spray chamber, said spray chamber being constructed and arranged to intermingle and mix said spray water and said steam to lower the temperature of said steam, and outlet means for discharging the low temperature steam disposed at the other end of said spray chamber, said last named outlet means including a splash plate mounted adjacent the end of the spray chamber for deflecting said low temperature steam to said second annular passage.

10. A desuperheater according to claim 9 wherein the other end of said spray tube passes through the closure plate adjacent the spray nozzle.

11. A desuperheater according to claim 9 wherein said spray tube passes through said spray chamber and the other end of the spray tube passes through the closure plate adjacent the outlet means of the spray chamber.

12. Apparatus for controlling the steam temperature in a superheater comprising an elongated first header having first, second and third chambers defined by partitions therebetween, said first chamber having inlet means for receiving steam to be superheated, a second elongated header disposed in spaced relationship with respect to said first header, said second having first, second and third chambers defined by partitions therebetween, a first bundle of tubes for receiving steam from the first chamber of the first header, and carrying it to the second chamber of the second header, an elongated spray chamber extending through the first and second chambers of the second header, inlet means for spray water disposed at one end of said spray chamber, said last named inlet means including a spray nozzle cluster for injecting a fine spray of water into said spray chamber, spider means for mounting said spray nozzle cluster on said spray chamber, said spray chamber having inlet means disposed adjacent said spray nozzle cluster for receiving steam from the first chamber of the second header, said spray chamber being constructed

and arranged to intermingle and mix said spray water and steam to lower the temperature of said steam, said spray chamber having outlet means disposed adjacent the opposite end of said spray chamber for discharging the steam at a lower temperature into the second chamber of the second header, a second bundle of tubes for receiving steam from the second chamber of the second header and carrying it to the second chamber of the first header, a third bundle of tubes for carrying steam from the second chamber of the first header to the third chamber of the second header, a fourth bundle of tubes carrying the steam from the third chamber of the second header to the third chamber of the first header, the third chamber of the first header having outlet means for discharging said steam, said tubes being arranged to permit heating fluid to pass over the outside surfaces thereof to heat said steam.

13. A method of controlling the steam temperature in a superheater comprising the steps of passing said steam into a first chamber of a first header, then passing said steam through a bundle of tubes extending from said first chamber of said first header to a first chamber of a second header while subjecting said tubes to hot gas for heating said steam, then passing said steam through said first chamber which is in the form of an annular passage formed between said second header and an elongated spray chamber mounted inside said second header, then passing said steam through said spray chamber while simultaneously spraying water into the spray chamber to intermingle and mix the steam and the water to lower the temperature of the steam, and then passing the steam to a next succeeding superheating stage.

14. A method of controlling the steam temperature in a superheater according to claim 13 wherein the steam after passing through said spray chamber is passed through a second annular passage formed between the second header and the spray chamber, and then the steam is passed through a second bundle of tubes to a second chamber in said first header.

15. A method of controlling the steam temperature in a superheater comprising the steps of passing said steam into a first chamber of a first header, then passing said steam through a bundle of tubes extending from said first chamber of said first header to a first chamber of a second header while subjecting said tubes to hot fluid for heating said steam, then passing said steam through said first chamber which is in the form of an annular passage formed between said second header and an elongated spray chamber mounted inside said second header, then reversing the flow direction of said steam and passing it through said spray chamber while simultaneously spraying water into the spray chamber to intermingle and mix the steam and the water to lower the temperature of the steam, and then reversing the flow direction of said steam and passing it through a second annular passage formed between the second header and the spray chamber, and then the steam is passed through a second bundle of tubes to a second chamber in said first header while subjecting said second bundle of tubes to hot fluid for heating said steam.