Jan. 14, 1964 F. FULLER, JR 3,117,620

TEMPERATURE EQUALIZING MEANS FOR A PLURALITY OF CONDUITS

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Fig 1.

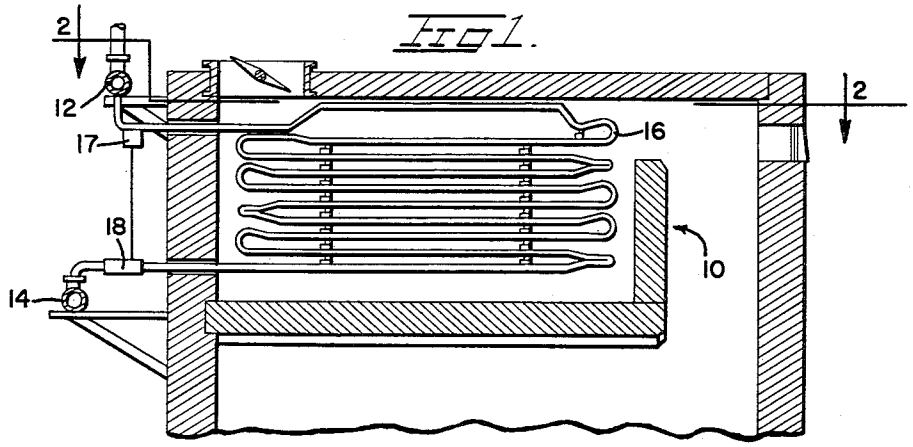
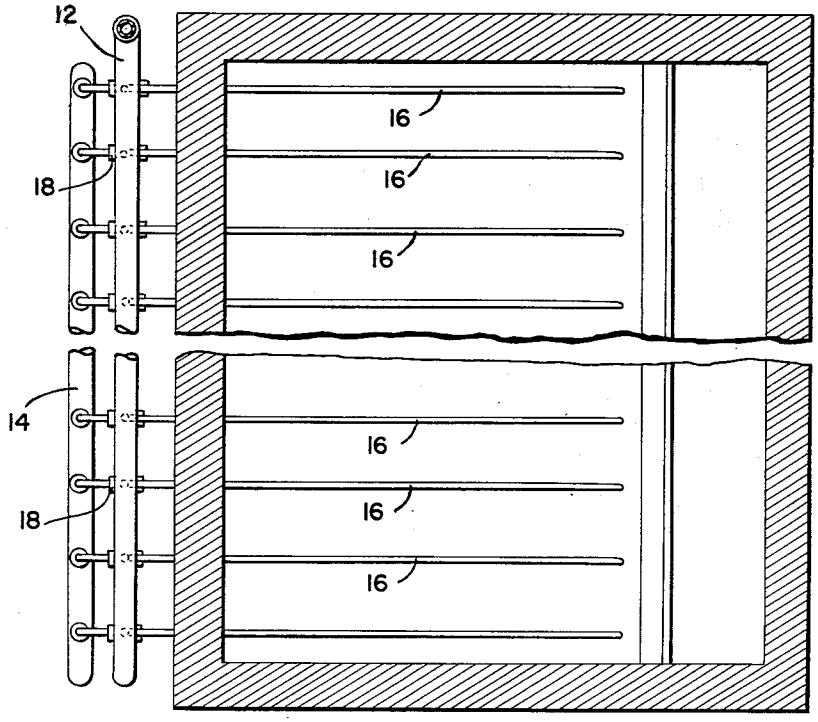


Fig 2.



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Fig. 3.

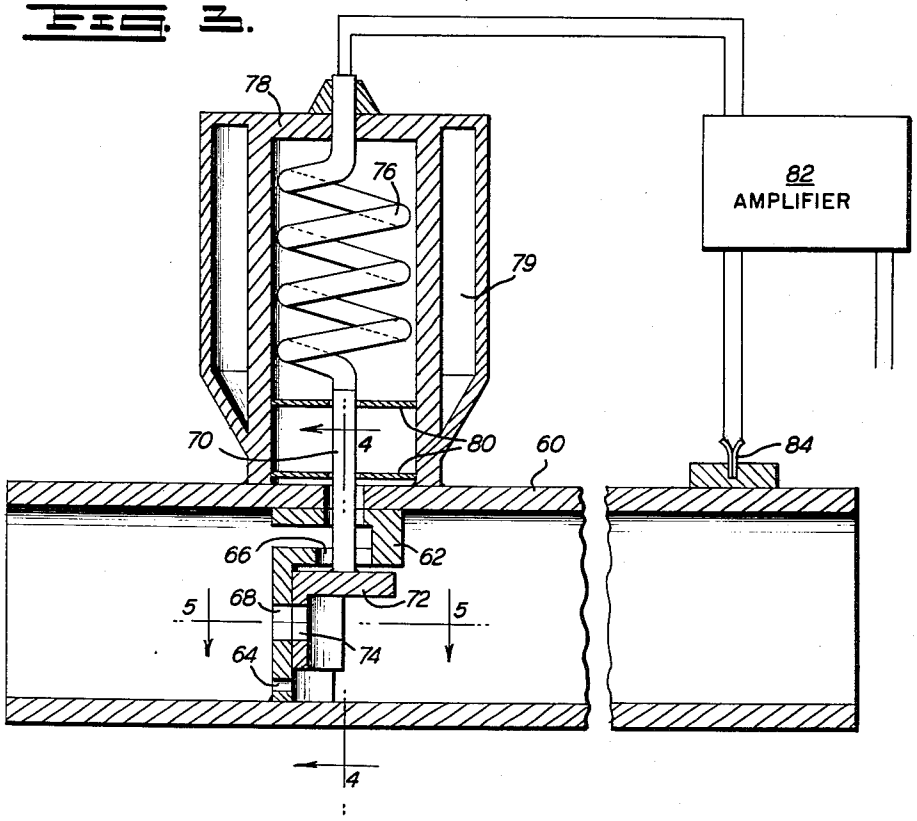


Fig. 4.

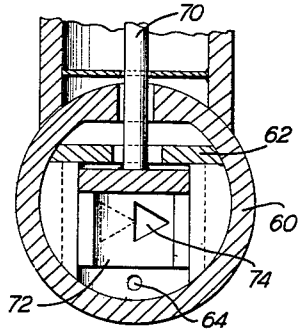
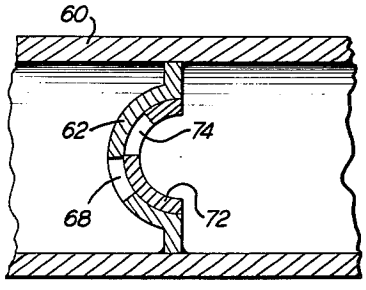


Fig. 5



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FIG. 6.

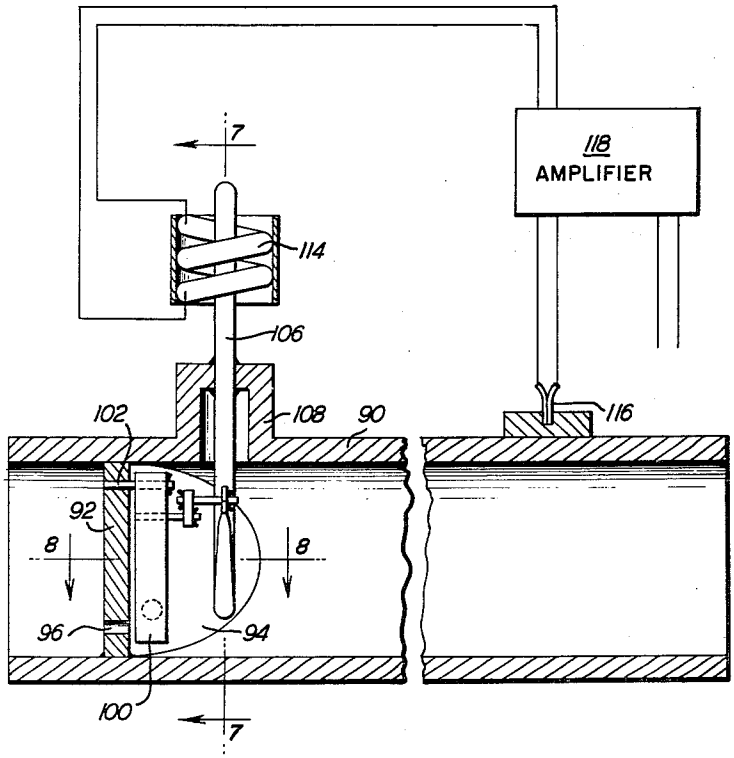
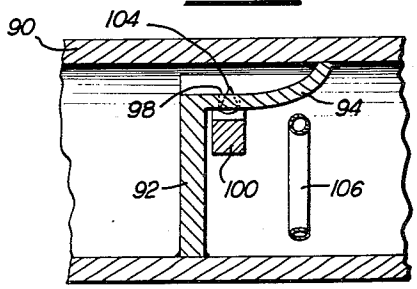


FIG. 8.



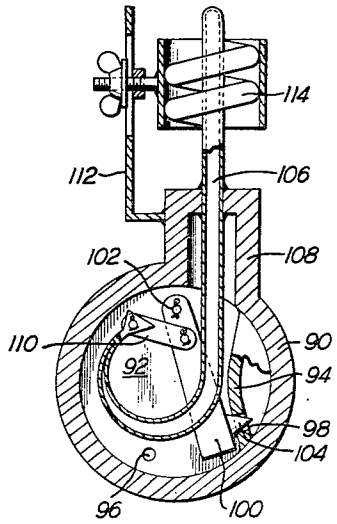


FIG. 7.

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3,117,620
TEMPERATURE EQUALIZING MEANS FOR A PLURALITY OF CONDUITS

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3 Claims. (Cl. 165—40)

This invention relates to steam heaters of the type known in the power art as superheaters and reheaters. Superheaters and reheaters are heat transfer devices through which steam passes to absorb heat and thus raise the steam to a desired temperature. A superheater heats saturated steam after it leaves the evaporating section of a boiler for admission to a turbine. A reheater heats steam which has been bled from one section of a steam turbine for reintroduction to the turbine at another section thereof. The invention concerns an improvement to both superheaters and reheaters and hence the following description will treat these two devices as synonyms.

More specifically, the invention relates to a scheme for equalizing the temperatures in each of a plurality of conduits which connect the inlet and outlet headers in a stream heater. By equalizing these temperatures, each conduit will conduct the steam to be heated which passes therethrough at the maximum temperature which the metal from which the conduits are fashioned may withstand without failure. As well known to workers in the power art, the higher the temperature of the steam passing through a prime mover, the greater the latter's efficiency.

In steam heaters there are several factors which give rise to unequal temperatures in the various conduits. The temperature of the heater varies with burner design, air flow to the burners, fuel flow to the burners and furnace arrangement. Varying gas flow patterns across the heater exist due to furnace design and heat absorbing arrangement in the furnace, heater and boiler. Non-uniform ash and slag accumulations on the heater conduits cause non-uniform heat absorbing surfaces thereon. The internal design of steam drums and steam headers causes different steam flow patterns through the conduits. Conduit design sometimes dictates different conduit configurations, thus causing different steam paths through the heating gas. Non-uniform operation of soot blowers results in non-uniform heat transfer to the conduits.

According to the invention an orifice of variable area is placed in each heater conduit. A temperature sensing element, which may be located near the orifice or at a point in the conduit remote therefrom, controls the flow through the orifice in accordance with the temperature sensed. Varying the steam flow through the conduit varies the temperature thereof. By such an arrangement, the operating temperature of each conduit in the steam heater may be made to be the maximum for the metal from which it is fashioned, thereby effecting optimum heat transfer.

In the drawings:

FIG. 1 is a partial cross-section of a conventional separately-fired steam heater showing the provision of one conduit with a variable orifice and temperature sensing element.

FIG. 2 is a view taken along line 2—2 of FIG. 1 showing the plurality of stream conduits within the steam heater.

FIG. 3 is a cross section of a steam conduit showing an embodiment of a variable orifice and temperatures sensing element.

FIG. 4 is a view taken along section 4—4 of FIG. 3.

FIG. 5 is a view taken along section 5—5 of FIG. 3.

FIG. 6 is a cross-section of a steam conduit, similar to that of FIG. 3, showing a second embodiment of a variable orifice and temperature sensing element.

FIG. 7 is a view along section 7—7 of FIG. 6.

FIG. 8 is a view along section 8—8 of FIG. 6.

Referring now to FIGS. 1 and 2 of the drawings, the numeral 10 denotes a separately fired steam heater which houses a plurality of parallel steam conduits extending between and joining an inlet header 12 and an outlet header 14. The shown steam conduit (similar to the others) is denoted by the numeral 16 and is provided at its interior with an orifice of variable opening shown at point 17 therealong (disclosed in more detail hereinafter) and temperature sensing means for its control at point 18 therealong. Suitable circuitry is provided between the sensing element and the orifice of variable opening.

In operation, steam at a given temperature from inlet header 12 passes through the conduit 16, is heated during this passage by hot gases in the heater 10, and exits through outlet header 14. In the event that the steam temperature at point 18 is greater than that permissible for the metal of the conduit, the flow passage opening of the orifice at point 17 increases allowing a greater flow rate through the conduit. A greater flow rate causes the conduit temperature to diminish since the inlet steam is at a lower temperature than that of the gases within the heater 10.

In the event that the temperature of the steam at point 18 is less than the allowable maximum for the particular conduit metal employed, the temperature sensing element causes the flow passage opening of the orifice at point 17 to diminish, causing a lesser flow rate through the conduit. A lesser flow rate results in an increase of conduit temperature, since the inlet steam dwells within the conduit for a longer time, thereby absorbing more heat from the gases within the heater 10.

By suitable relation (to be given later in detail) of the orifice 17 and temperature element sensing at 18, a given steady state or operating temperature for each conduit 16 may be realized in spite of the above enumerated factors which usually act to cause their variance.

The remaining description will dwell upon the two embodiments of FIGS. 3 to 8.

Referring now to FIGS. 3 to 5 of the drawings, the numeral 60 denotes a steam conduit provided internally with a curved stationary member 62 having apertures 64, 66, and 68. A stem 70 extends through segment 60 and carries a curved element 72 at its lower end. Element 72 is provided with an aperture 74. A spiral Monel or other suitable metal tube 76 is connected at its lower end to stem 70 and at its upper end to a housing 78 provided with a coolant chamber 79. Guides 80 surround stem 70. A resistance heating coil, not shown, is located within coil 76 and is connected to an electrical amplifier 82. A thermocouple element 84, for sensing temperature, is located along the conduit 60 and is connected to the amplifier.

During normal or steady state operation, steam passes through apertures 64 and 66. In the event the conduit temperature increases beyond a desired level, thermocouple 84 senses the increase and, by suitable circuitry in 82, the resistance coil within tube 76 is energized, causing the tube to expand and rotate. Such rotation is transmitted through stem 70 and aperture 74 moves into at least partial coincidence with aperture 68. Also downward motion of coil 76 increases the flow through aperture 66 just above element 72. These two motions allow a greater rate of steam flow with consequent lessening of steam temperature.

In the event of a decrease in desired conduit temperature, tube coil 76 contracts due to the effect of coolant in chamber 79 and the flow through aperture 66 is diminished due to the upward travel of element 72. Contraction of coil 76 is also accompanied by rotation of element 72,

but in the opposite direction and hence apertures 68 and 74 do not come into coincidence. With a diminished flow rate through aperture 66 the steam temperature rises.

Preferably, thermocouple 84 is placed near an outlet header while the other elements are placed near an inlet header, to subject them to lower steam temperatures.

Referring now to the embodiment shown in FIGS. 6 to 10, the numeral 90 denotes a steam conduit provided internally with a disc 92 having an integral tongue portion 94. The disc has an aperture 96 and an aperture 98 on its tongue portion. An arm 100 is pivoted on pin 102 carried by disc 92 and carries a conical plug 104 which extends partially into aperture 98. Bourdon tube 106 filled with water or other suitable liquid is mounted on and passes through a housing 108. The lower end of the Bourdon tube is pivotally secured to a link 110 which in turn is pivotally secured to arm 100. A bracket 112, secured to housing 108, adjustably supports an electrical resistance heater element 114. A thermocouple temperature sensing element 116 is secured to the conduit 90 at a point therealong. An electrical amplifier 118 connects the coil 114 to the thermocouple.

In normal or steady state operation steam passes apertures 96 and 98. In the event the conduit temperature rises above a desired level, the increase is sensed by thermocouple 116 and by suitable circuitry in amplifier 118 and resistance coil 114 heats the Bourdon tube. Upon heating, the Bourdon tube end moves leftward as viewed in FIG. 7. Through the link 110 and 100 also moves leftward, moving plug 104 away from aperture 98 thus allowing greater steam flow and causing a lessening of conduit temperature.

In the event the conduit temperature falls below a desired level, the sensing thermocouple and amplifier act to diminish the current to resistance heater 114 and the Bourdon tube end consequently moves to the right, as viewed in FIG. 7, and diminishes the flow opening, plug 104 moving into the aperture 98. The conduit temperature then rises occasioned by a lesser flow rate of steam therethrough.

Preferably, the temperature sensing element 116 is placed near an outlet header while the other elements are located near an inlet header, to subject them to lower steam temperatures.

Apertures 64 and 96 in the embodiments insure the passage of a minimum quantity of steam through the conduit at all times.

I claim:

1. A fluid heater for heating steam and the like including an inlet header and an outlet header, a plurality of conduits extending between and communicating with said headers, fluid flow regulating means disposed within each of said conduits at a point therealong near said inlet header for constantly maintaining the operating temperature of said conduit at an allowable maximum comprising an orifice, means for varying the size of said orifice including

means located externally of said conduit, means sensitive to variances of temperature located on the outer surface of said conduit and near said outlet header, said temperature sensitive means controlling said fluid flow regulating means, said regulating means adapted to increase fluid flow with increase in temperature.

2. A fluid heater as claimed in claim 1 wherein each of said plurality of conduits comprises an element across the conduit passage having two apertures therein, a second element having an aperture therein, a rotatable stem extending through the steam conduit and also through one aperture of the first element and secured to the second element, a tubular coil secured at its bottom end to the other end of the said stem, an electrical resistance element within said coil, a thermocouple temperature sensing element secured to the conduit downstream from said elements and coil, means coupled to the said resistance element and the said thermocouple for energizing the resistance element in response to temperatures sensed by the thermocouple, whereby the aperture in the second element becomes aligned with the other aperture in the first element and the second element moves away from the aperture in the first element through which the steam passes, all upon expansion of the coil and whereby increased steam flow results with increasing temperatures.

3. A steam conduit adapted to carry steam in a steam heater, an element in said conduit having an aperture therein, a Bourdon tube whose lower end extends into the conduit, a linkage secured to the lower end of the Bourdon tube and connected to a plug which is adjacent the said aperture, heating means for heating the Bourdon tube exteriorly of the said conduit, a temperature sensing element disposed on the conduit downstream from said Bourdon tube, means coupling the heating means to the said temperature sensing element, whereby the sensing of increased temperature results in the heating of the Bourdon tube and movement of the lower end of the Bourdon tube to move the plug away from the aperture and thereby increase flow of steam through said conduit.

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