

July 14, 1936.

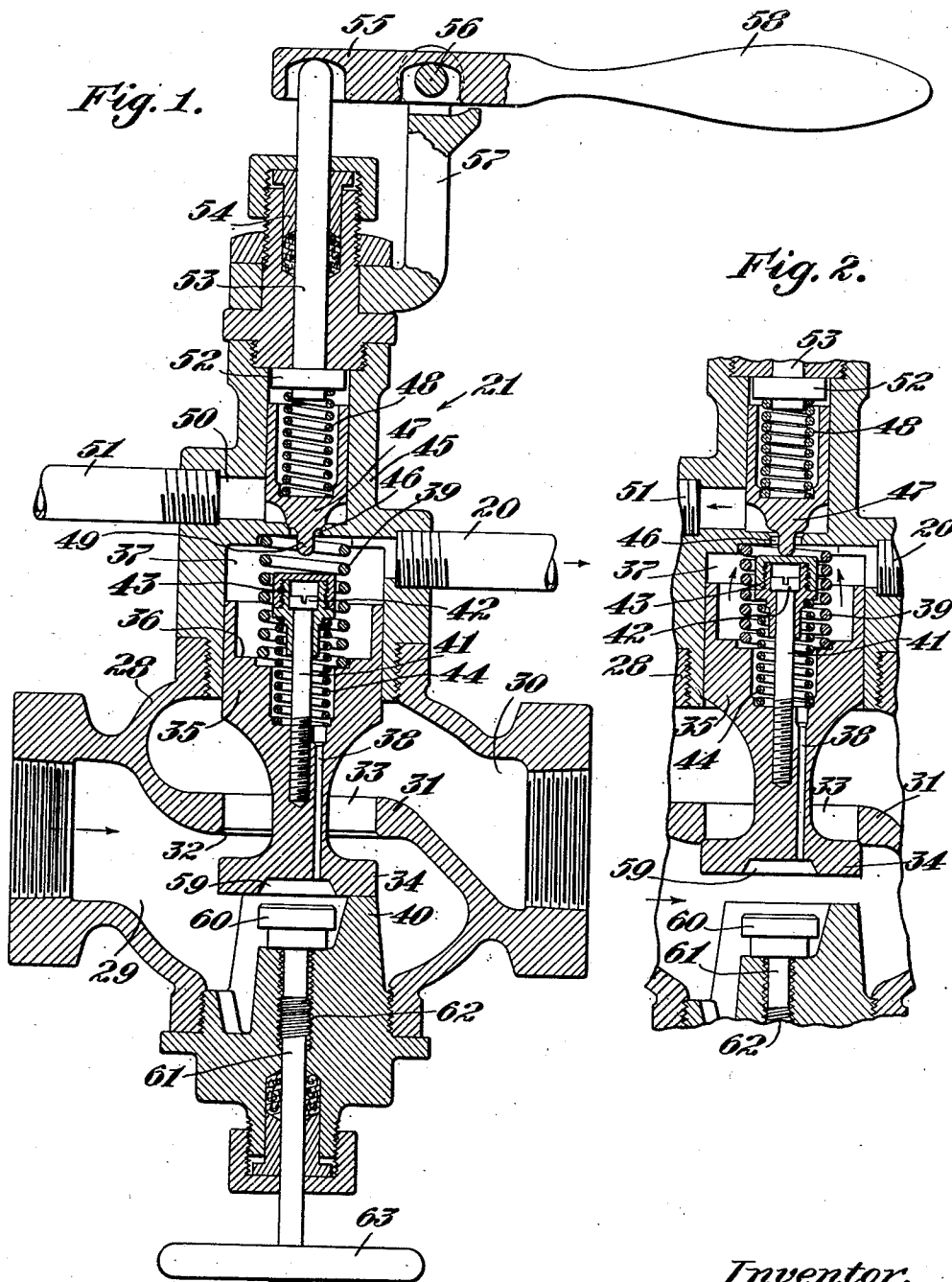
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2,047,403

FLUID FLOW SYSTEM

Filed Oct. 1, 1934

3 Sheets-Sheet 1



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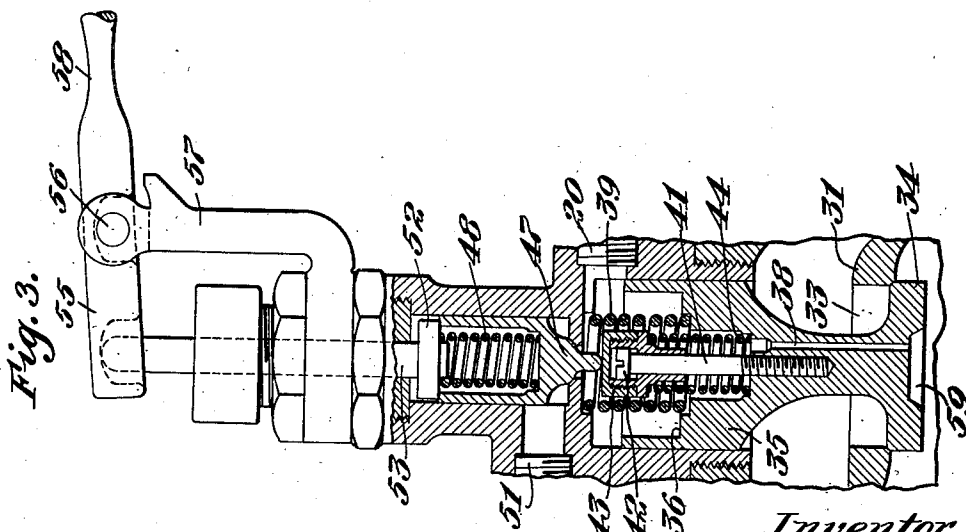
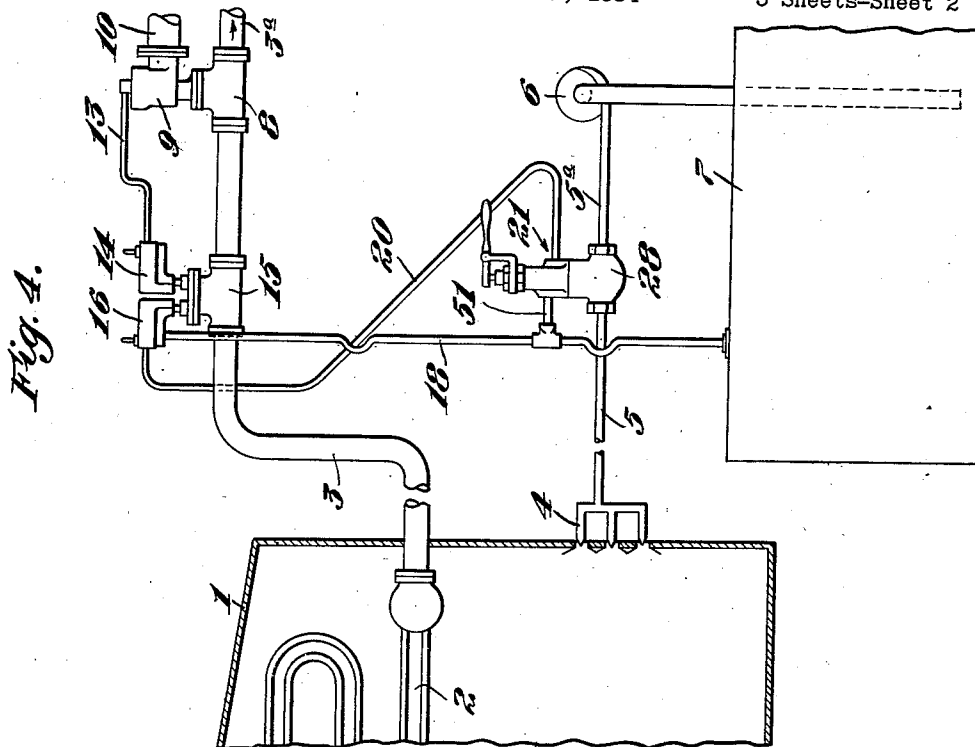
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FLUID FLOW SYSTEM

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3 Sheets-Sheet 2



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3 Sheets-Sheet 3

Fig. 5.

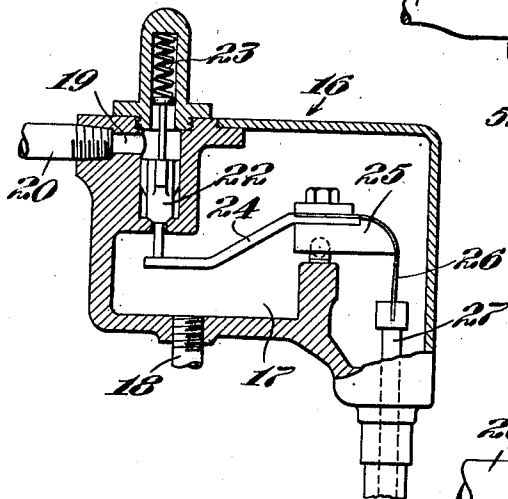


Fig. 7.

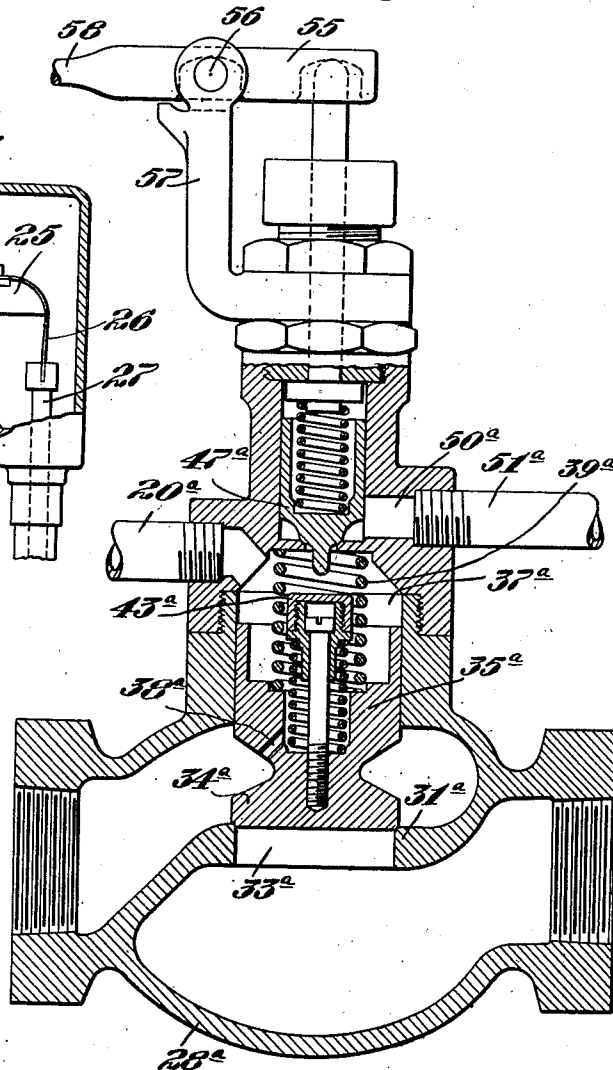
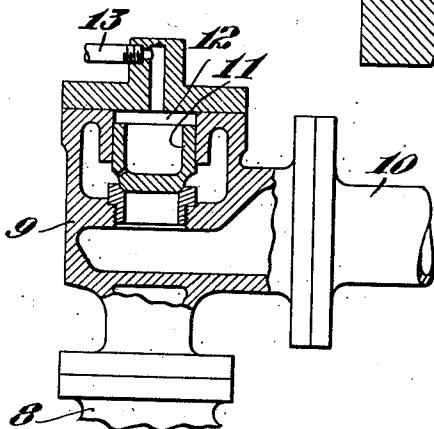


Fig. 6.



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UNITED STATES PATENT OFFICE

2,047,403

FLUID FLOW SYSTEM

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Application October 1, 1934, Serial No. 746,288

18 Claims. (Cl. 122-479)

This invention pertains to fluid flow systems and relates more particularly to automatic flow control means for such a system, such control means including a control valve of novel character. The improved flow control means may find useful application in connection with a heat exchange apparatus.

For specific instance, it may be used to control the admission of liquid fuel to the burner of a separately fired steam superheater, and when so used the temperature of the steam delivered from the superheater may be the determining factor in initiating the closure of the fuel supply valve.

Separately fired superheaters are used in some steam power plants, for example, where superheating is only required at infrequent intervals, and if, while the superheater is in operation, the normal flow of steam delivered by the superheater is materially lessened, it is desirable automatically to cut off the supply of fuel to the superheater so as to avoid overheating and destruction of the superheater tubes.

In the copending application of Beck and Briscoe, Serial No. 711,162, filed February 14, 1934, there is disclosed a thermally actuated relief valve on the superheater delivery pipe designed to open in response to undue rise in temperature of the steam, occasioned, for example, by shutting down the engine or turbine to which the steam is normally delivered. While under most conditions the arrangement disclosed in said application is adequate to ensure a sufficient flow of cool steam through the superheater, it may possibly fail to accomplish this result if the boiler pressure should be too low. The present invention may be applied to provide a further safeguard, by automatically reducing the heat supplied to the superheater whenever the temperature of the steam increases beyond a predetermined point. This improved arrangement may be in addition to or in substitution for the arrangement disclosed in the above-noted application. Obviously, the operation of the apparatus may be made dependent upon other physical characteristics than temperature, for example, pressure, if desired.

When employed for cutting off the flow of fluid fuel to the superheater, it is not desirable to restore the flow of fuel automatically when the steam temperature drops, since restoration of the fuel flow without immediately igniting the fuel would result in flooding, and possible explosion if the attempt were later made to relight the fuel. In accordance with the present invention,

while the fuel supply is automatically cut off in response to abnormal temperature rise in the steam delivery pipe, it is only restored in response to a manual operation.

Preferably the force employed for shutting off the fuel flow is the pressure of the liquid fuel itself, so that so long as the fuel is supplied under pressure, the necessary force is always available for shutting it off. Obviously if the pressure of the liquid fuel drops so low as to become ineffective as an actuating force, there is no necessity for cutting off the flow.

Since, in accordance with the present invention, it is desirable to initiate the restoration of fuel flow by manual means, and since the pressure of the liquid fuel may be considerable, for example of the order of 300 lbs. per square inch, it is desirable to relieve the operator of the necessity of directly overcoming such a pressure, and in accordance with the present invention, provision is made whereby the exertion of but a relatively small manually applied force results in so balancing the pressure of the liquid fuel as to enable the flow to be restored without undue effort on the part of the operator.

As herein illustrated by way of example, the temperature of the superheater tubes is automatically reduced when necessary by the operation of a thermostatically responsive fuel-supply valve of a novel construction and embodying desirable features hereinafter more fully described and claimed. In the accompanying drawings wherein desirable embodiments of the invention are illustrated by way of example:

Fig. 1 is a vertical section through a controlling valve structure made in accordance with the present invention, and showing the main valve feather unseated, leaving the passages for the flow of liquid fuel wide open;

Fig. 2 is a fragmentary view similar to Fig. 1, but showing the main valve feather seated so as completely to cut off the fuel flow;

Fig. 3 is a view similar to Fig. 2, but showing the parts at the completion of the manual operation necessary to initiate restoration of the fuel flow, but before the main valve feather has left its seat;

Fig. 4 is a fragmentary diagrammatic elevation illustrating a portion of a separately fired superheater, together with the fuel supply reservoir, and the fuel controlling valve, and cooperating parts, all in accordance with the present invention;

Fig. 5 is a fragmentary vertical section illustrating a thermostatic valve constituting one of

the elements of the control system illustrated in Fig. 4;

Fig. 6 is a fragmentary vertical section illustrating a relief valve also forming an element of the system illustrated in Fig. 4; and

Fig. 7 is a view similar to Fig. 1, but showing a modified form of control valve.

Referring particularly to Fig. 4, wherein the present invention is disclosed as embodied in a heat interchange system including a separately fired superheater, the numeral 1 designates the superheater casing or housing which encloses the superheater pipe coil 2 which delivers to the discharge pipe or main 3, 3^a. The coil 2 is heated by means of a fluid fuel burner 4 which is furnished with fuel by a feed pipe 5, 5^a. If liquid fuel be employed, pipe 5, 5^a may lead from a pressure pump 6 which draws a supply of fuel from the tank 7 and delivers it under pressure, for example, a pressure of from 150 to 350 lbs. per square inch.

The discharge pipe or main 3, 3^a is provided with a fitting 8 which supports a relief valve 9 having an outlet pipe or exhaust 10. This relief valve may be of the type more fully described in the application of Beck et al. above referred to, and as illustrated in Fig. 6 preferably comprises a casing 9 having therein a valve seat providing a port or passage which is normally closed by means of a pressure-loaded valve 11. This valve is exposed at its upper side within a back pressure chamber 12 in which pressure is normally built up to an extent sufficient to keep the valve closed. This back pressure chamber 12 communicates by means of a pipe 13 with a thermally responsive valve device 14 which is mounted on a fitting 15 on the pipe 3, 3^a. This fitting 15 also carries a second thermally responsive valve device 16. The valve device 14 may be similar to that disclosed in the above-named application of Beck et al. and in essential particulars is substantially like the valve device 16 herein illustrated in Fig. 5.

Referring to Fig. 5, the thermally responsive valve device comprises a casing having therein a chamber 17, which, in the case of the device 16, communicates by means of a discharge pipe 18 with the upper part of the fuel supply reservoir 7. A port 19 leading to the interior of the casing of valve 16 communicates, by means of a pipe 20, with a control valve 21 mounted in the fuel feed supply pipe 5, 5^a. Communication between the inlet port 19 and the chamber 17 of valve 16 is normally cut off by a valve 22 which is pressed toward its seat by a spring 23. For raising the valve 22 and thus permitting fuel to enter through port 19 into the chamber 17, a lever 24 is provided, one end of which engages the lower end of a stem projecting from valve 22,—such lever being mounted on a rocker 25 which is connected by means of a flexible transmission member 26 to the upper end of a bimetallic, thermally responsive member 27 whose lower end projects downwardly into the steam space in fitting 15. The construction of the parts is such that when the temperature of the steam passing through the fitting increases beyond a certain predetermined amount, the thermostatic device 27 pulls downwardly on the member 26 and thus rocks the lever 24 upwardly so as to open the valve 22, thereby permitting fuel to enter chamber 17 from which it returns through pipe 18 to the storage tank 7.

The thermally responsive valve device 14 likewise operates in response to a predetermined temperature of the fluid flow through the fitting 15

to open a relief valve similar to valve 22, thus permitting the pressure in the back pressure chamber 12 of the valve 9 to drop, whereupon the valve 11 opens and permits the heated fluid to flow outwardly through the exhaust pipe 10. The thermally responsive valve device 14 is set to operate at a somewhat lower temperature than the thermally responsive valve device 16, for a purpose hereinafter more fully described.

Referring to Figs. 1, 2 and 3, the controlling valve 21, which controls the flow of fluid fuel through the pipe 5, 5^a to the burner 4, comprises a casing 28 secured between the pipe sections 5 and 5^a and having an inlet chamber 29 and an outlet chamber 30. These chambers are separated by a septum 31 having an annular valve seat 32 defining a port or passage 33 connecting the chambers 29 and 30. A valve feather 34 is adapted to cooperate with the seat 32 in closing the port 33. This valve feather 34 is carried by a piston 35 adapted to slide in a suitable guide-way in the valve casing and has an upper surface or head 36 which is exposed within a back pressure chamber 37 in the casing. A restricted bleeder passage 38 normally permits flow of pressure fluid from the chamber 29 through the valve body into the back pressure chamber 37 so as substantially to balance the pressure at opposite sides of the piston. A spring 39 bears against the upper end of the piston and tends to hold the valve feather 34 in open position where it engages fixed stop members 40.

The piston 35 is provided with an upwardly directed fixed guide member 41 conveniently consisting of a bolt screwed into a axial bore in the piston and projecting upwardly from the upper surface of the piston, such bolt having a head 42 constituting a stop element. An abutment comprising a sleeve 43 is arranged to slide on the cylindrical bolt 41 and is normally pressed upwardly against the head of stop 42 by means of a spring 44.

The upper part 45 of the valve casing is provided with a port 46 disposed axially above the main valve seat 32, and this port is normally closed by a pilot or shunt valve 47 which is urged toward the seat by a spring 48. The pilot valve is furnished with a downwardly directed projection 49 which is adapted to be engaged at times by the upper end of the abutment 43. The port 46, when open, gives communication between the back pressure chamber 37 and a passage 50 in the valve casing which communicates, by means of the pipe 51, with the pipe 18 which leads to the upper part of the fuel reservoir 7. The pipe 20, above described, which extends from the thermally responsive valve 16, leads to the back pressure chamber 37 of the valve 21.

The spring 48 which urges the pilot valve 47 toward its seat abuts at its upper end against a head 52 carried by a vertically sliding stem 53 which passes up through a stuffing box 54 and at its upper end bears against one arm 55 of a manually actuable lever which is fulcrumed at 56 on a bracket 57 carried by the casing of the valve 21. The lever 55 is furnished with a handle 58 by means of which it may be rocked manually.

The lower face of the main valve feather 34 is preferably provided with a shallow cup-like depression 59 into which the lower end of the bleeder passage 38 opens. Immediately below the main valve feather 34 and in axial alignment with the recess or depression 59 there preferably is provided a vertically movable plug 60 carried

by a stem 61 having screw-threaded engagement at 62 with a part of the valve casing, and having a hand wheel 63 at its lower end by means of which it may be rotated. Rotation of this hand wheel 63 in the proper direction will advance the stem 61 upwardly, thus moving the plug 60 into the depression or recess 59, thereby closing the bleeder passage 38. Continued movement of the stem 61 upwardly will force the valve feather 34 against its seat 32, thus shutting off the supply of fuel to the burner. This manual closure of the main valve feather may be desirable at times, for example when it is necessary to shut down the burner for a prolonged period or when it is necessary to make repairs in the system. When thus closed manually,—leakage of fuel through the bleeder passage 38 is prevented by the plug 60 which at this time covers the lower end of the bleeder passage 38.

Since relative dimensions of parts are of importance in the construction and operation of this device, certain exemplary dimensions and characteristics of the parts above described will now be given prior to a description of the operation. The valve feather 34 may, for example, have a diameter of two inches, and the piston 35 may have an effective diameter of $1\frac{1}{8}$ inches, while the seat diameter of the pilot valve 47 may be approximately $\frac{3}{8}$ of an inch. The spring 39 may be capable of exerting substantially one hundred pounds pressure, which is sufficient to overcome friction and to restore the valve feather 34 to its fully open position against the stops 40 when the pressure at opposite sides of the piston is substantially balanced. The spring 48 which tends to hold the pilot valve closed may be capable of exerting a pressure of sixty pounds, while the spring 44 which normally holds the yielding abutment 43 against the stop 42 may be capable of exerting approximately ninety pounds pressure.

Assuming that the heat interchange system is in operation and that, for example, a steam boiler is supplying steam to the superheater coils 2 and that the burner 4 is supplied with fuel and is raising the temperature of the steam in the coils 2, certain conditions may arise which decrease the velocity of steam flow through the coils 2, thus resulting in overheating of the coils and resulting in damage of explosion. For example, if the engine or turbine to which the steam is normally delivered should be shut-down suddenly for any reason, the flow of steam through the pipe 3, 3^a should be stopped and thus the flow through the superheater coils would cease. On the other hand, the boiler pressure might suddenly drop and thus again the velocity of steam through the superheater might become too small to keep the superheater pipes properly cooled.

As described in the application of Beck et al., above referred to, if the temperature of steam in the pipe 3, 3^a becomes excessive, the thermally responsive device 14 causes a release of pressure in the back pressure chamber 12 of the relief valve 9, thus allowing the latter to open and permitting the steam to escape freely through the pipe 10, thus ordinarily maintaining the desired velocity of steam through the coils 2 to prevent overheating. However, if, under such conditions, the boiler pressure should be insufficient to deliver the proper amount of steam through the superheater coils, the present improvement provides for cutting down the heat delivered to the coils 2. Thus, for example, if the thermally responsive device 14 has operated (it being noted

that this device preferably is set to operate at a temperature slightly lower than that which causes the device 16 to act), and if the temperature of the steam flowing through the fitting 15 continue to increase, the thermally responsive device 16 acts to open the relief valve 22, thus permitting the pressure fluid in the back pressure chamber 37 of valve 21 to escape through the pipe 20 and through the chamber 17 of the valve device 16 and down through the pipe 18 back into the supply reservoir 7.

As soon as the back pressure in chamber 37 is relieved, the unbalanced pressure on piston 35 causes the latter to rise, thus seating main valve feather 34 and shutting off the fuel supply to the boiler. As the main valve feather 34 approaches its seat, the abutment 43 engages the projection 49, thus unseating pilot valve 47. This provides a second outlet from the chamber 37 through the passage 50 and pipe 51, so that if the thermally responsive device 16 should be cooled and thereby permit the valve 22 to close, it would not be possible for pressure to build up in the chamber 37 such as to cause the valve feather 34 to leave its seat. The provision of the pilot valve 47 thus shunts the thermally responsive device 16 so that the latter becomes ineffective to control the operation of valve 21. Thus the flow of fuel to the burner can not again take place without the volition of the operator.

To start up the flow of fuel again, the operator raises the handle 58, thus depressing the head 52 of stem 53 and compressing the spring 48, thereby forcing the pilot valve 47 to its seat. During this time the abutment 43 yields downwardly without unseating the valve feather 34. Since the valve feather is held up against its seat by unbalanced fluid pressure which may total a thousand pounds or more, it is obvious that to unseat it by manual means, when thus unbalanced, would be a difficult if not impossible operation. However, by the provision of the yielding abutment 43 it is merely necessary for the operator to overcome the abutment spring 44 in bringing the pilot valve 47 to its seat. As soon as pilot valve 47 is seated,—assuming that the valve 22 of thermostatic device 16 has previously closed, pressure begins to build up in the chamber 37 until eventually the pressures at opposite sides of the piston 35 are substantially balanced, whereupon the spring 39 unseats the main valve feather and restores the flow of fuel to the burner.

In Fig. 7 I have illustrated a modified construction of the valve 21 which may be used in a system similar to that above described and wherein the valve 22 (Fig. 5) is normally maintained in open position and is closed by the thermostat 26 in response to abnormal temperature conditions in the line 3, 3^a. In this modified form of control valve the valve casing 28^a is furnished with a septum 31^a having the main valve port 33^a and the main valve feather 34^a carried by the piston 35^a. The upper end of this piston is exposed within a back pressure chamber 37^a to which pressure fluid is admitted through the bleeder passage 38^a. The spring 39^a normally tends to seat the valve feather 34^a. A pilot valve 47^a normally closes a port leading from the back pressure chamber 37^a to a passage 50^a which communicates by means of the pipe 51^a with the pipe 18 shown in Fig. 4. Likewise the back pressure chamber 37^a communicates by means of a pipe 20^a with the thermally responsive device 16 shown in Fig. 4. In this instance the main valve feather is urged toward its seat by the spring 39^a and is opened by

unbalanced fluid pressure. The pilot valve 47^a may be seated by a manually actuated lever in the same way as that of the device shown in Fig. 1, the piston 35^a being provided with a yielding abutment 43^a which permits such manual seating of the pilot valve in the same way as in the preceding device.

It will be noted that the opening and closing of the relief valve 9 is wholly independent of the operation of the fuel valve 21, so that the valve 9 will close automatically when the temperature of the steam in the outlet pipe drops to a predetermined point, regardless of the condition of valve 21.

While I have herein disclosed certain desirable embodiments of the invention by way of example, I wish it to be understood that in its broader aspects the invention is capable of embodiment in other constructions and that all such embodiments as well as changes in size, proportion and relative arrangement of parts and the substitution of equivalents are to be regarded as falling within the scope of the appended claims.

I claim:

1. In a heat interchange system, in combination, a heated element, a fuel burner, and means normally supplying fluid fuel under pressure to the burner, controlling means operative to determine the admission of fuel to the burner, said controlling means comprising a fluid actuated piston and a thermostatic device, the latter being operative in response to an abnormally high temperature of the heated element so to admit pressure fluid to act on said piston as to move the latter and thereby reduce the supply of fuel to the burner, means operative by such movement of the piston to shunt the thermostatic device whereby subsequent drop in temperature of the heated element is ineffective to cause reverse movement of the piston, and manual means operative to make said shunting means inoperative.
2. In a steam superheater system, in combination, a superheater coil, a fuel burner for heating said coil, means for supplying fluid fuel under pressure to the burner, controlling means including a valve operative to cut off the flow of fuel, a fluid actuated piston for closing the valve, a thermostatic device exposed to the temperature of the steam heated by passing through the superheater coil, said thermostatic device being operative in response to abnormal temperature of such steam to cause the fuel under pressure to act on the piston and thereby close the valve, a shunt device operable by said piston as the latter closes the valve to shunt the thermostatic device, whereby subsequent drop in temperature of the steam is ineffective to open the valve, and manual means for making said shunt device inoperative.
3. In a heat interchange system, in combination, a superheater tube, a fuel burner for heating said tube, and means for supplying fluid fuel under pressure to the burner, controlling means comprising a valve operative to cut off the flow of fuel, a normally balanced pressure actuated piston for closing the valve, a thermostatic device exposed to the temperature of the substance which is heated in passing through the superheater tube, said thermostatic device being operative in response to abnormal temperature of said substance to open a passage and thereby unbalance fuel pressure at opposite sides of the piston so as to permit the latter to close the valve, a shunt valve actuated by the piston, as the latter moves in closing the valve, to open said pas-

sage at a second point, whereby closure of the first-named passage by the thermostatic device is ineffective to change the pressure on the piston, and manually actuable means for restoring said shunt valve to its normal position independently of the position of the main valve.

4. In combination in a system of the class described, a fluid fuel supply valve comprising a casing having a main valve seat, a valve feather cooperable with said seat to cut off the flow of fluid fuel, a pressure actuated piston for closing the valve, said piston having a balancing head exposed within a back pressure chamber in the casing in which pressure sufficient to hold the valve open is normally maintained, a thermally responsive relief valve operative at times to release the pressure from the back pressure chamber thereby to allow the main valve feather to close, a normally closed pilot valve also operative at times to release the pressure from the back pressure chamber, and means operative to open said pilot valve as the main valve feather approaches its seat.

5. In combination in a system of the class described, a valve comprising a casing having therein a main valve seat, a valve feather cooperable with the seat, a pressure actuated piston for moving the valve toward its seat, a spring tending to move the valve feather away from its seat, the piston having a balancing head exposed within a back pressure chamber in the casing, a conduit leading from the back pressure chamber, a relief valve operative at times to permit pressure fluid in said back pressure chamber to escape through said conduit, a normally closed pilot valve also operative at times to permit pressure fluid to escape from the back pressure chamber, means operative, as the main valve feather approaches its seat, to open said pilot valve, and manually actuable means for closing the pilot valve.

6. In combination in a system of the class described, a valve structure comprising a casing and a main valve feather therein, a pressure actuated element for moving the feather in one direction at least, said casing having a back pressure chamber in which pressure fluid under pressure sufficient to hold the valve feather at one limit of its movement is normally maintained, a pair of independent relief valves, controlling ports leading from the back pressure chamber, automatic means responsive to a predetermined physical condition to open one of said relief valves thereby to permit unbalanced pressure on the pressure actuated element to move the main valve feather toward the other limit of its movement, automatic means operative to open the second relief valve during such movement of the main valve feather, and means operative to close said second relief valve without correspondingly moving the main valve feather.

7. A valve of the class described comprising a casing having therein a main valve seat and a main valve feather cooperable with the seat, a spring tending to move the main valve feather in one direction, a pressure actuated element for moving the valve feather in the opposite direction, said element having a balancing surface exposed in a back pressure chamber in the casing, a pilot valve normally closing a port leading from said back pressure chamber, means operative as the main valve feather nears one limit of its movement to open said pilot valve, and manually actuable means operative to close said pilot valve without imparting a corresponding movement to the main valve feather.

8. A valve of the class described comprising a casing having therein a main valve seat and a main valve feather cooperable with the seat, a spring tending to move the main valve feather in one direction, a pressure actuated element for moving the valve feather in the opposite direction, said element having a balancing surface exposed in a back pressure chamber in the casing, a pilot valve normally closing a port leading from said back pressure chamber, a yieldable abutment moving with the main valve feather and operative as the latter approaches one limit of its movement to open the pilot valve, and manually operable means for closing the pilot valve.

9. A valve of the class described comprising a casing having therein a main valve seat and a main valve feather cooperable with the seat, a spring tending to move the main valve feather in one direction, a pressure actuated element for moving the valve feather in the opposite direction, said element having a balancing surface exposed in a back pressure chamber in the casing, a pilot valve normally closing a port leading from said back pressure chamber, a spring normally keeping the pilot valve closed, an abutment carried by the main valve feather and normally moving with the latter, said abutment being movable relatively to the main valve feather, a spring tending to hold said abutment at one limit of its movement relative to the valve feather, said spring being stronger than the pilot valve spring, the abutment being arranged to engage the pilot valve and open the latter as the main valve feather approaches one limit of its movement, and manually actuable means operative to force the pilot valve back to closed position while moving the abutment relatively to the main valve feather.

10. A valve of the class described comprising a casing having a main valve seat and a main valve feather cooperable therewith, a spring tending to unseat the valve feather, a pressure actuated element for moving the valve feather toward its seat, said element having a balancing surface exposed in a back pressure chamber within the casing, a pilot valve for closing a port leading from the back pressure chamber, means normally keeping the pilot valve closed, a yielding abutment normally moving with the main valve feather and operative as the latter approaches its seat to open the pilot valve in opposition to its closing spring, and manually operable means for closing the pilot valve in opposition to the force exerted by said yieldable abutment.

11. In a system of the class described, in combination, a valve comprising a casing having an annular valve seat defining a passage for fluid under pressure, a valve feather for closing said passage, a spring tending to hold the valve feather away from the seat, a pressure actuated element for moving the valve feather toward its seat, said element having a balancing surface exposed in a back pressure chamber in the casing,—there being a restricted passage permitting pressure fluid to enter the back pressure chamber, means remote from the valve casing operative at times to release the pressure from said back pressure chamber thereby to unbalance the main valve feather, and to move it against its seat in opposition to its spring, a pilot valve for closing the port leading from the back pressure chamber, a spring normally holding said pilot valve closed, an abutment carried by the main valve feather and operative as the latter approaches its seat to open the pilot valve, said abutment being

yieldable in response to a force greater than that necessary to overcome the pilot valve spring but less than that necessary to open the main valve feather in opposition to fluid pressure acting thereon, and manually actuable means for closing the pilot valve.

12. In combination with a heating device, means for supplying fluid fuel under pressure to said device, said supply means comprising a pipe and a valve for controlling the flow of fluid through said pipe, said valve including a casing having therein a main valve feather, a spring normally holding said feather open, a pressure actuated element for moving the feather to closed position, said element having a balancing surface exposed in a back pressure chamber in the casing, there being a restricted bleeder passage permitting pressure fluid to enter said back pressure chamber, a relief valve normally closing a port leading from the back pressure chamber, thermally responsive means exposed to the heat generated by the heater and operative at a predetermined temperature to open the relief valve thereby to permit the pressure fluid to close the main valve feather, a pilot valve normally closing a second port leading from the back pressure chamber, means actuable by the main valve feather as the latter moves toward its seat to open the pilot valve, and manually actuable means for closing the pilot valve.

13. In combination with a heating device, means for supplying fluid fuel under pressure to said device, said supply means comprising a pipe and a valve for controlling the flow of fluid through said pipe, said valve including a casing having therein a main valve feather, a spring normally holding said feather open, a pressure actuated element for moving the feather to closed position, said element having a balancing surface exposed in a back pressure chamber in the casing, there being a restricted bleeder passage permitting pressure fluid to enter said back pressure chamber, a relief valve normally closing a port leading from the back pressure chamber, thermally responsive means exposed to the heat generated by the heater and operative at a predetermined temperature to open the relief valve thereby to permit the pressure fluid to close the main valve feather, a pilot valve normally closing a second port leading from the back pressure chamber, means actuable by the main valve feather as the latter moves toward its seat to open the pilot valve, manually actuable means for closing the pilot valve, and manually actuable means for closing the main valve feather.

14. In combination with a heating device, means for supplying fluid fuel under pressure to said device, said supply means comprising a pipe and a valve for controlling the flow of fluid through said pipe, said valve including a casing having therein a main valve feather, a spring normally holding said feather open, a pressure actuated element for moving the feather to closed position, said element having a balancing surface exposed in a back pressure chamber in the casing, there being a restricted bleeder passage permitting pressure fluid to enter said back pressure chamber, a relief valve normally closing a port leading from the back pressure chamber, thermally responsive means exposed to the heat generated by the heater and operative at a predetermined temperature to open the relief valve thereby to permit the pressure fluid to close the main valve feather, a pilot valve normally closing a second port leading from the back pres-

sure chamber, means actuable by the main valve feather, as the latter moves toward its seat, to open the pilot valve, manually actuable means for closing the pilot valve, and manually actuable means for closing the main valve feather and for simultaneously closing said restricted bleeder passage.

15. In combination with a superheater having a fluid fuel burner, a pressure actuated relief valve for the superheater, a thermally responsive device operative to cause the relief valve to open at a predetermined temperature, a fuel supply pipe, means for delivering fuel under pressure to the supply pipe, a control valve for the supply pipe, said control valve comprising a casing having therein a valve seat and a valve feather and a pressure actuated normally balanced element for moving the valve feather toward its seat, and a second thermally responsive device operative at a predetermined temperature to unbalance said element and thereby cause the valve feather to approach its seat, said second thermally responsive device acting at a temperature higher than that which causes the relief valve to open.

16. In combination with a superheater having a fluid fuel burner, a pressure actuated relief valve for the superheater, a thermally responsive device operative to cause the relief valve to open at a predetermined temperature, a fuel supply pipe, means for delivering fuel under pressure to the supply pipe, a control valve for the supply pipe, said control valve comprising a casing having therein a valve seat and a valve feather, and a pressure actuated normally balanced element for moving the valve feather toward its seat, a second thermally responsive device operative at a predetermined temperature to unbalance said element and thereby cause the valve feather to close, a pilot valve actuated by the movement of said valve feather as the latter closes to prevent rebalancing of the pressure on the pressure actuated element and the consequent opening of the main valve feather, and manually actuable means for closing the main valve feather,

17. In combination with a superheater having a fluid fuel burner, a pressure actuated relief valve for the superheater, a thermally responsive

device operative to cause the relief valve to open at a predetermined temperature, a fuel supply pipe, means for delivering fuel under pressure to the supply pipe, a control valve for the supply pipe, said control valve comprising a casing having therein a valve seat and a valve feather, and a pressure actuated normally balanced piston for moving the valve feather toward its seat, a second thermally responsive device operative at a predetermined temperature to bring about an unbalancing of the pressure on the piston thereby to cause the valve feather to approach its seat, a pilot valve actuated by the main valve feather as the latter approaches its seat to prevent rebalancing of the pressures on the piston, manually actuable means for seating the main valve feather, and manually actuable means for restoring the pilot valve to normal position.

18. In combination in a system of the class described, a control valve comprising a casing having a valve seat, a valve feather cooperable therewith, a spring normally tending to move the valve feather away from its seat, a pressure actuated element for moving the valve feather toward its seat, said element having a surface exposed in a back pressure chamber in the casing, there being a restricted bleeder passage permitting pressure fluid to enter the back pressure chamber, a pair of ports leading from the back pressure chamber, a remotely located relief valve operative at times to permit pressure fluid to discharge through one of said ports, a pilot valve normally closing the second port, a spring tending to hold the pilot valve closed, a guide carried by the main valve feather; an abutment slidable along said guide, a spring normally holding said abutment at one limit of its movement, said spring being capable of exerting a force greater than the maximum force which the pilot valve spring can exert, a part carried by the pilot valve engageable by the abutment as the main valve approaches its seat thereby to open the pilot valve, and manually actuable means for forcing the pilot valve against its seat while moving the abutment along said guide.

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