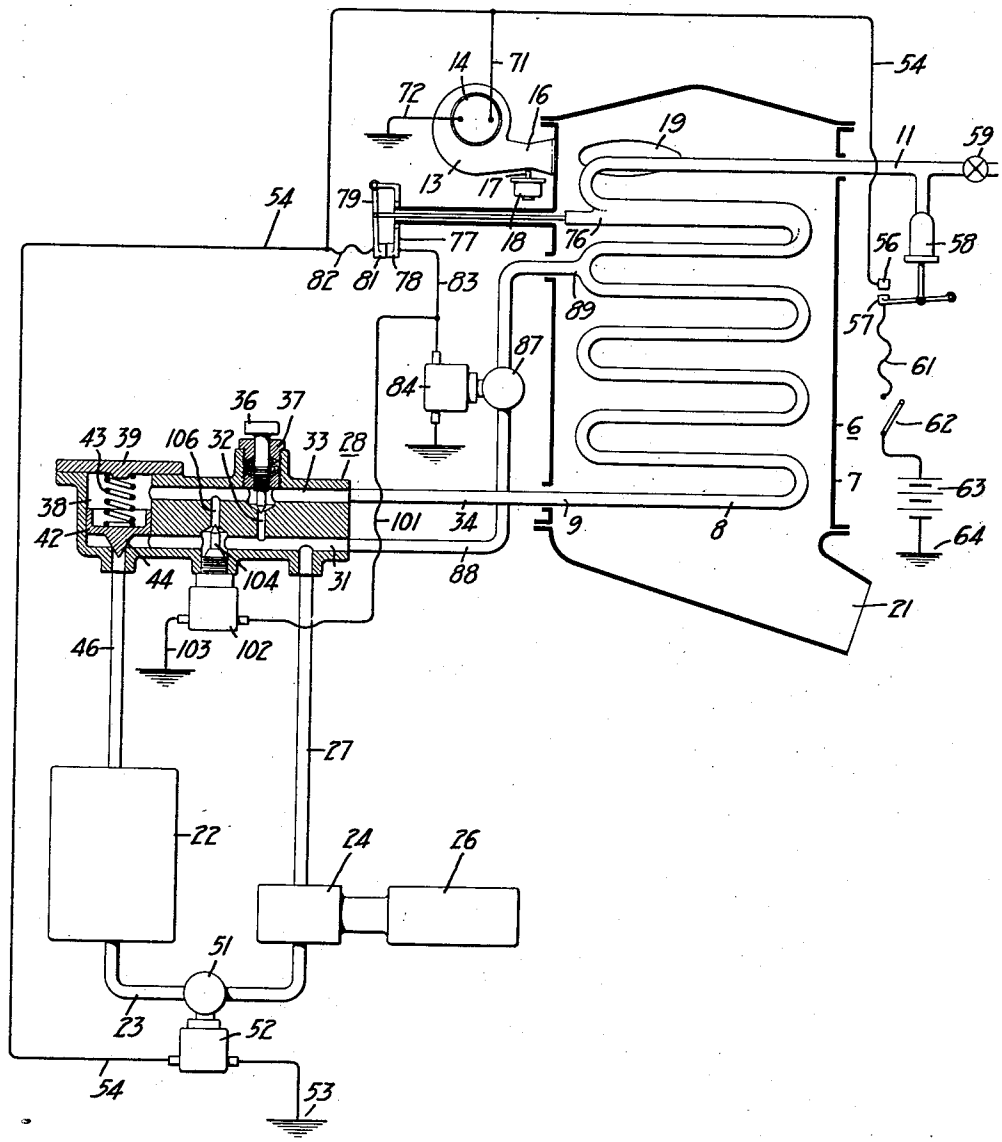
March 20, 1934. W. DOBLE 1,951,352

FEED FLUID CONTROLLER

Filed April 24, 1931



INVENTOR.
Warren Doble

BY White, Prout, Fleh & Lothrop
ATTORNEYS.

Patented Mar. 20, 1934 1,951,352

UNITED STATES PATENT OFFICE

1,951,352

FEED FLUID CONTROLLER

Warren Doble, Berkeley, Calif.

Application April 24, 1931, Serial No. 532,513

25 Claims. (Cl. 122—448)

My invention relates to means for controlling the operation of vapor generators such as steam boilers and is more particularly concerned with the control of boilers of the forced circulation type. Such boilers usually comprise a relatively long, heated tube into one end of which feed water is introduced and from the other end of which vapor issues. Such boilers are especially useful in conjunction with vehicle propulsion, for instance, in automobiles, aircraft, rail cars and the like. In such installations the load on the boiler fluctuates very rapidly and very markedly from small output to large output and vice versa. It is a prime operating desideratum that the temperature of the steam or other vapor issuing from the boiler be maintained as close as possible to a desired value. In one practical instance such a boiler comprises a tube approximately 600 feet long operating at pressures between 1500 and 2000 pounds per square inch and furnishing steam at approximately 900 degrees Fahrenheit temperature. Since the boiler may be called upon to supply steam under full capacity or under a small capacity at periodic intervals the supply of feed fluid to the boiler is extremely difficult to regulate without affecting the temperature.

It is an object of my invention to provide a feed fluid controller for a vapor generator.

Another object of my invention is to provide a feed fluid controller which insures the maintenance of the temperature of the vapor issuing from a vapor generator substantially at a predetermined value.

The foregoing and other objects are attained in the embodiment of the invention shown in the drawing, in which

The figure is a schematic or diagrammatic showing of one embodiment of the feed fluid controller of my invention.

In its preferred form, the feed fluid controller of my invention comprises a boiler including a tube having a primary inlet at one end, an outlet at the other end and a secondary inlet between the primary inlet and outlet ends, together with means for supplying feed fluid to the primary inlet and to the secondary inlet, the control of the secondary inlet supply and all or a portion of the primary inlet supply being under the influence of a thermostat subjected to the temperature of the tube at a point between the secondary inlet and the outlet.

In the form of my invention disclosed in the drawing there is provided a boiler, generally designated 6, which includes a casing 7 enclosing a relatively long boiler tube 8. The primary inlet 9 of the boiler tube is usually situated adjacent the lower portion of the casing while the outlet 11 of the tube is usually situated at the upper end of the casing. In order to heat the tube 8 I preferably provide an air blower 13, driven by an electric motor 14 or other suitable source of power, for inducing a draft of air through a venturi 16 into which projects the nozzle 17 of a carburetor 18 of the usual aspirating type. The fuel mixture evolved within the venturi 16 is discharged through the opening 19 into the upper portion of the casing 7 in which it is ignited and burned. The products of combustion flow over the coiled tube 8 and are discharged from the casing 7 through the outlet 21. In order to supply the tube 8 with feed fluid, usually water, there is provided preferably a source of feed fluid such as a tank 22 communicating through a conduit 23 with a feed fluid pump 24. Customarily the pump is of the force variety and is driven by any suitable means 26. The discharge of the pump 24 is through a conduit 27 leading to a controller 28.

Because I desire to control the introduction of feed fluid into the boiler I provide a controller 28 as indicated. In the controller 28 there is a passage 31 with which the conduit 27 communicates and which is connected by a duct 32 to a passage 33 discharging through a conduit 34 into the primary inlet end or foot 9 of the boiler tube 8. In order to vary the effective opening of the duct 32 I provide a needle valve 36 which is sealed against leakage by a packing nut 37. Communicating with the passage 31 and the passage 33 is a cylinder 38 which is incorporated within the controller 28 and is closed by a cap 39. Adapted to reciprocate within the cylinder 38 and subjected on opposite sides to pressure from the conduits 31 and 33, respectively, is a piston 42.

The piston 42 is urged in one direction by a coil spring 43 interposed between the cap 39 and the piston. Formed integrally with the piston 42 is a conical valve 44 controlling flow from the passage 31 to a return conduit 46 extending to the water tank 22. Since the piston 42 is subjected on one side to pump pressure and on the other side is subjected to boiler pressure plus the bias due to the spring 43, it maintains a substantially constant pressure drop across the orifice between the duct 32 and the needle valve 36. In the event the pressure should be excessive within the passage 31 the piston 42 rises and permits communication through the return conduit 46 to discharge any surplus feed fluid.

In order to make the pump 24 responsive to a

boiler condition such as steam pressure, steam temperature, boiler tube temperature, et cetera, I preferably provide a valve 51 in the conduit 23 which is effective to interrupt communication therethrough and prevent the introduction of feed water by the pump 24. The valve 51 is preferably controlled by an electromagnet or solenoid 52 which at one side is connected to a ground 53 and at the other side is connected by a lead 54 to a contact 56. This contact cooperates with a movable contact 57 actuated, in the preferred embodiment, by a pressure cell 58. The pressure cell is subjected to pressure existing in the outlet 11 of the boiler which pressure is somewhat dependent upon the position of a throttle valve 59 for controlling the outflow of vapor from the boiler 6. In series with the contact 57, by means of a flexible lead 61 is a master switch 62 connected to a storage battery 63 or other suitable source of electromotive force which is grounded as at 64 to complete the return of the circuit. Also under control of the pressure cell 58 is the electric motor which drives the blower 13. This control is effected by connecting the motor in circuit with the contacts 56 and 57 by means of a lead 71 joined to the lead 54 and a wire 72 connected to ground.

In operation of the unit as so far described, it has been found in practice that it is desirable to introduce such a quantity of feed fluid into the inlet 9 of the boiler with relation to the amount of heat released within the casing 7 that the temperature of the outgoing vapor tends continually to rise. In order to prevent the indefinite rise of the temperature, means are provided for periodically introducing additional feed fluid into the tube 8 to reduce the temperature thereof. If such means acts solely to introduce additional feed fluid into the foot 9 of the boiler tube 8 the time involved before such additional fluid can cool the vapor issuing from the outlet of the boiler is excessive and since the introduction of additional water would necessarily continue until the temperature is reduced, an excessive amount of water is introduced subsequently causing a major temperature drop.

In order to obviate such an occurrence I preferably provide adjacent the outlet 11 of the boiler a thermostat 76 which preferably comprises two parts moving relative to each other under the influence of fluctuating temperature. The thermostat includes a frame 77 on which a stationary contact 78 is mounted and a lever 79 on which a movable contact 81 is mounted. As the temperature of the tube 8 increases, the thermostat 76 is effective to cause the contacts 78 and 81 to abut. Since the contact 81 is connected by a lead 82 to the wire 54 and since the contact 78 is connected by a wire 83 to a solenoid 84, closing of the contacts 78 and 81 is effective to energize the solenoid 84. Energization of the solenoid 84 is utilized to control the influx of additional feed water into the boiler tube. To this end the solenoid 84 controls a valve 87 interposed in a conduit 88 extending from the passage 31 to a secondary inlet 89 in the tube 8 just in advance of the thermostat 76. In other words, the thermostat 76 is in thermal relationship with the tube 8 at a point between the secondary inlet 89 and the outlet 11.

When the solenoid 84 is energized, the valve 87 is opened and an additional amount of feed fluid, that is, secondary feed fluid, is introduced into the secondary inlet 89 of the tube 8 and promptly causes the temperature of the fluid flowing by the thermostat to drop. As the thermostat is cooled, the contacts 78 and 81 are separated thereby deenergizing the solenoid 84 and interrupting the further influx of secondary feed fluid into the secondary inlet 89. After such interruption the temperature again tends to increase heating the thermostat 76 and again causing the introduction of additional feed fluid. The amount of feed fluid introduced through the secondary inlet 89 is relatively small in comparison with the amount of feed fluid introduced through the foot or primary inlet 9 of the boiler but nevertheless is capable of regulating very closely the temperature of the vapor issuing through the outlet 11 despite the fact that the temperature of the vapor arriving at the secondary inlet 89 may fluctuate considerably.

It often occurs in practice upon a manifold increase in heat imparted by the fire to the tube 8 or for other causes, that the temperature of the vapor passing through the outlet 11 does not increase because the quantity of vapor passing through the outlet 11 is increased a corresponding amount. If the vapor discharge is not correspondingly increased, however, then the temperature of the vapor passing the thermostat 76 commences to rise. In accordance with my invention, therefore, I provide means for augmenting the supply of water entering the primary inlet 9 of the boiler under control of the thermostat 76 to compensate for the increase in heat. To this end I connect a lead 101 to the wire 83 and to an electromagnet or solenoid 102 which is grounded as at 103. The electromagnet 102 controls a needle valve 104 governing flow through a passage 106 affording communication between the passages 31 and 33 and acting in addition to the passage 32.

By virtue of this arrangement, each time the contacts 78 and 81 are closed due to a temperature in excess of a predetermined value, not only is feed fluid introduced through the conduit 88 into the secondary inlet 89 of the boiler but there is a corresponding additional flow through the passage 106 from the passage 31 into the outlet passage 33 and through the conduit 34 into the primary inlet 9 of the boiler tube 8. By this means the same excess in temperature, which represents an increase of heat and which causes additional feed fluid to be introduced proximate the thermostat 76 to have a prompt effect thereon, likewise causes augmentation of the primary feed fluid flow into the primary inlet 9 of the boiler to have a relatively delayed effect upon the thermostat 76 and to compensate for the increase in heat by arresting the temperature rise.

Largely in accordance with this arrangement the adjustment of the needle valve 36 can be such that a minimum quantity of feed fluid is permitted to flow through the passage 32 while an augmenting quantity can flow through the passage 106 and an additional amount can flow through the conduit 88 under influence of the valve 87 for prompt influence of the thermostat 76. Depending upon the operating conditions of the system, the needle valve 36 can be opened a maximum amount or can be closed entirely. The usual adjustment is at a position intermediate the two extreme values given.

It is assumed in the foregoing description that the capacity of the pump 24 is more than ample to supply the boiler tube 8, so that there is always available feed fluid for introduction under control of the valve 104 and under control of the valve 87 with an additional amount suitable for

by-passing through the conduit 46 back to the tank 22. While the valve 44 is sufficient to release any excess water to the tank 22 the valve 51 is shown as an additional means for interrupting operation of the pump 24, the exact arrangement of which is immaterial to the present mechanism.

It is to be understood that I do not limit myself to the form of the feed fluid controller shown and described herein, as the invention, as set forth in the following claims may be embodied in a plurality of forms.

I claim:

1. A feed fluid controller comprising a boiler tube, a source of feed fluid, means for introducing feed fluid into said tube at one end thereof, means for introducing feed fluid into said tube at a point intermediate the ends thereof, and means for controlling both said introducing means in accordance with the temperature of said boiler tube beyond said point.

2. A feed fluid controller comprising a boiler tube having an inlet and an outlet, means for heating said tube, means for introducing feed fluid into said inlet and into said tube at a point between said inlet and said outlet, and means responsive to the temperature of said tube beyond said point for controlling said introducing means.

3. A feed fluid controller comprising a boiler tube having an inlet and an outlet, a thermostat in thermal relation to said tube between said inlet and said outlet, means for heating said tube, means for introducing feed fluid into said inlet and into said tube at a point between said inlet and said thermostat, and means responsive to said thermostat for controlling said introducing means.

4. A feed fluid controller comprising a relatively long boiler tube having a primary inlet, an outlet, and a secondary inlet between said primary inlet and said outlet, means for heating said tube, a thermostat in thermal relation to said tube between said secondary inlet and said outlet, means for introducing feed fluid into said primary inlet, means for introducing feed fluid into said secondary inlet, and means for controlling both of said introducing means in response to said thermostat.

5. A feed fluid controller comprising a boiler tube having an inlet end, an outlet end and a secondary inlet between said inlet end and said outlet end, means for heating said tube, means for introducing feed fluid into said inlet end, means for introducing feed fluid into said secondary inlet, a thermostat influenced by said heating means and by feed fluid introduced into said inlet end and into said secondary inlet, and means for simultaneously controlling both said introducing means in response to said thermostat.

6. A feed fluid controller comprising a boiler tube having a primary inlet at one end thereof and a secondary inlet between the ends thereof, means for introducing feed fluid into said primary inlet and into said secondary inlet, and means for controlling said introducing means in accordance with a boiler thermal condition beyond said secondary inlet.

7. A feed fluid controller comprising a boiler tube having a primary inlet at one end thereof and a secondary inlet between the ends thereof, means for introducing feed fluid into said primary inlet, means for introducing feed fluid into said secondary inlet, and means for simultaneously controlling both said introducing means in accordance with temperature in said tube adjacent the outlet thereof.

8. A feed fluid controller comprising a relatively long boiler tube having a primary inlet at one end thereof, and a secondary inlet between the ends thereof, means for introducing feed fluid into said primary inlet, means for introducing feed fluid into said secondary inlet, means for heating said tube, a thermostat responsive to the temperature of said tube beyond said secondary inlet, and means for simultaneously controlling both said introducing means in response to said thermostat.

9. A feed fluid controller comprising a boiler tube, means for heating said tube, means for introducing a regulated supply of feed fluid into the inlet end of said tube, a thermostat responsive to the temperature of said tube, means controlled by said thermostat for introducing feed fluid into said tube between the inlet end thereof and said thermostat, and means for augmenting the supply of feed fluid into the inlet end of said tube in response to said thermostat.

10. A feed fluid controller comprising a relatively long tube having a primary inlet, a secondary inlet and an outlet, means for heating said tube, a thermostat responsive to the temperature of said tube between said secondary inlet and said outlet, means for introducing a regulated supply of feed fluid into said primary inlet, and means for introducing additional feed fluid into said primary inlet and said secondary inlet when a predetermined temperature is exceeded by said thermostat.

11. A feed fluid controller comprising a boiler tube, a source of feed fluid, means for introducing feed fluid into said tube at one end thereof, means for introducing additional feed fluid into said tube at a point between said one end thereof and the other end thereof, and means responsive to the temperature of said tube beyond said point for controlling both said introducing means.

12. A feed fluid controller comprising a relatively long boiler tube, a conduit communicating with said tube between the ends thereof, means for supplying feed fluid to the inlet of said tube and to said conduit, and means for controlling the flow of feed fluid through said conduit and to the inlet of said tube in accordance with a boiler thermal condition at a point of said tube between the junction of said conduit therewith and the outlet of said tube.

13. A feed fluid controller comprising a relatively long tube, a thermostat responsive to temperature of said tube, means controlled by said thermostat for introducing feed fluid into said tube to have a delayed influence on said thermostat, and means simultaneously controlled by said thermostat for introducing feed fluid into said tube to have a prompt influence on said thermostat.

14. A feed fluid controller comprising a relatively long tube having in sequence a primary feed fluid inlet, a secondary feed fluid inlet, and a thermostat for simultaneously controlling flow through said primary inlet and said secondary inlet.

15. A feed fluid controller comprising a relatively long tube having a primary feed fluid inlet and a secondary feed fluid inlet spaced from said primary inlet, and a thermostat influenced by feed fluid entering said tube through said primary inlet and said secondary inlet for controlling flow through said primary inlet and said secondary inlet.

16. A feed fluid controller comprising a relatively long tube, means for introducing feed fluid into said tube, means farther along said tube for introducing additional feed fluid into said tube, and a thermally responsive device still farther along the tube for controlling said feed fluid introducing means and said additional feed fluid introducing means in conjunction.

17. A feed fluid controller comprising a relatively long tube, means for introducing feed fluid into said tube, a valve for controlling flow through said means, means farther along said tube for introducing additional feed fluid into said tube, a second valve for controlling flow through said last named means, and a thermally responsive device still farther along the tube for controlling said valve and said second valve.

18. A feed fluid controller comprising a relatively long tube, means for heating said tube, means for introducing feed fluid into said tube at points spaced apart in the direction of flow through said tube, a thermostat responsive to temperature of said tube beyond the second of said points, and means responsive to said thermostat for augmenting the introduction of feed fluid into said tube at temperatures above a predetermined temperature.

19. A feed fluid controller comprising a relatively long tube having in sequence a primary feed fluid inlet, a secondary feed fluid inlet and a thermostat for simultaneously controlling flow through said primary inlet and said secondary inlet; means for heating said tube; and means responsive to pressure in said tube for interrupting the operation of said heating means and flow through said primary inlet and said secondary inlet.

20. A feed fluid controller comprising a relatively long tube, a primary inlet to said tube, a secondary inlet to said tube, a thermostat, said primary inlet, said secondary inlet and said thermostat being arranged in sequence in the direction of flow through said tube, means for heating said tube, means for supplying feed fluid to said primary inlet and said secondary inlet, means responsive to said thermostat for controlling flow through said primary inlet and said secondary inlet, and means responsive to pressure within said tube for interrupting the operation of said heating means and said supplying means.

21. A feed fluid controller comprising a relatively long tube, means for heating said tube, a primary inlet to said tube, a secondary inlet to said tube, a thermostat, said primary inlet, said secondary inlet and said thermostat being arranged in sequence in the direction of flow through said tube, means controlled by pressure within said tube for controlling the operation of said heating means and introduction of feed fluid to said tube through said primary inlet, and means controlled by said thermostat for controlling introduction of feed fluid to said tube through said secondary inlet and augmenting of said introduction through said primary inlet.

22. A feed fluid controller comprising a relatively long surface, means for heating said surface, a primary feed fluid discharge onto said surface, a secondary feed fluid discharge onto said surface, a thermostat thermally united to said surface, said primary discharge, said secondary discharge and said thermostat being arranged in sequence in the direction of flow along said surface, and means responsive to said thermostat for simultaneously augmenting the flow of feed fluid at said primary discharge and controlling the flow of feed fluid at said secondary discharge.

23. A feed fluid controller for a heated tube adapted to discharge a fluid having pressure and temperature characteristics comprising means effective below a predetermined pressure of said fluid for supplying feed fluid to a primary point in said tube, and means effective above a predetermined temperature at a tertiary point in said tube to augment the supply of feed fluid to said primary point and to supply feed fluid to a secondary point in said tube, said primary, secondary and tertiary points being in sequence in the direction of fluid flow in said tube.

24. A feed fluid controller for a heated tube adapted to discharge a fluid having a temperature characteristic comprising means for supplying feed fluid to a primary point in said tube, and means effective at a predetermined temperature at a tertiary point in said tube for augmenting the supply of feed fluid to said primary point and to supply feed fluid to a secondary point in said tube, said primary, secondary and tertiary points being in sequence in the direction of fluid flow in said tube.

25. In apparatus of the character described, a relatively long tube adapted to discharge a fluid having pressure and temperature characteristics comprising means for heating said tube, means for introducing a relatively constant amount of feed fluid into a primary inlet of said tube, means responsive to pressure in said tube for controlling said heating means and said introducing means, means for forcing additional feed fluid into said primary inlet, means for forcing feed fluid into a secondary inlet of said tube, and means responsive to temperature at a tertiary point in said tube for controlling said two forcing means.

WARREN DOBLE.