BOILER FEED WATER CONTROL SYSTEM

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This invention relates to control means for controlling the supply of feed water to steam boilers. The supply of feed water to steam boilers is customarily regulated to maintain a constant level in the boiler. In general the supply of feed water is now automatically controlled by means utilizing a valve in the feed water supply line which is arranged to be closed or opened by motive regulation which is responsive to changes in boiler water level. The particular responsive element employed may vary, but in all events, it is found to be a water level responsive device of some sort. The responsive element may be a float actuated through leverage to control the feed water supply valve. It may be also a different type of element such as one wherein the thermal effect of changes in water level in a boiler is transmitted to a responsive element which in turn controls the position of the feed water control valve.

In any of these types of level regulations, a change in level in the boiler water is required to actuate the feed control valve and correspondingly alter the rate of feed water supply. This causes a wide variation in water level depending upon the steam demand upon the boiler because one steam demand is reflected in the amount of feed water that must be supplied. For a low rate of steam demand and a correspondingly low rate of feed water supply, a high level of water must be maintained in the boiler. For high rates of feed water supply, a low level of water becomes necessary in order to obtain a sufficient valve opening to supply the amount of water required. The use of a large valve, permitting very slight travel for a large variation in water supply would correct this condition. Such a valve, however, is impracticable because of the cost and the increasing leakage which accompanies increase in valve size.

For efficient boiler operation, it is desirable that a close regulation of water level be maintained which will be relatively independent of the rate of feed water supply. It is the object of the present invention to provide means whereby this desirable result may be accomplished.

Since the rate of feed water supply follows closely the rate of steam output, I find that an arrangement may be made whereby the feed water supply is controlled by means directly responsive to the steam demand. Such an arrangement approximates the service requirements of normal boiler operation.

Other and more specific objects and advantages of the invention will appear as the description proceeds reference being had to the accompanying drawing wherein a preferred form of the invention is shown. It is to be understood, however, that the drawing and description are illustrative only and are not to be taken as limiting the invention except in so far as it is limited by the claims.

In the drawing—

Fig. 1 is a somewhat diagrammatic view illustrating a boiler equipped with control means which embodies the present invention;

Fig. 2 is an enlarged fragmentary view of a bleed valve employed in this system.

Referring now in detail to the drawing, the numeral 5 indicates a boiler in which steam is generated by any suitable method. A steam output conduit 6 is utilized to draw steam from the boiler 5. A feed water inlet conduit 7 is adapted to supply feed water to the boiler 5 through a control valve 8, a water level responsive valve 9, and a manually operated shut off valve 10.

For purposes of illustration, I show herein a float mechanism 11 housed in a float chamber 12 for controlling the supply of feed water to the boiler 5 in response to water level variations. The float operated type of water level regulator shown at 14 is merely a conventional type which opens or closes the valve 8 in response to changes in level of water in the boiler 5 in the usual manner with a constant differential of pressure maintained across the valve 8. The rate of flow through the valve 9 is approximately proportional to the port area of this valve at any given valve position or consequently any given boiler level. It requires a considerable change in boiler water level to effect a change in port area of the valve 9. Therefore, if a greater amount of water is being withdrawn from the boiler 5 in the form of steam, it is obvious that a variation in level of water in the boiler must occur where there is a constant differential maintained across the valve 9.

The valve 8 is a differential regulator valve which is so designed as to maintain a definite but alterable difference in pressure across the water level controlled valve 9. The manner in which this is accomplished is as follows: The position of a valve head 13 in the valve 8 is controlled by a diaphragm 14 which is balanced between pressure from the down stream side of the valve 9 and a second pressure which can be altered as will be presently described. The down stream side of the valve 9 is connected by means of a conduit 15 to a chamber 16 which is in direct communication with one side of the diaphragm 14. Pressure is supplied to the other side of the diaphragm 14 through a conduit 17 that leads from the up stream side of the valve 9 through a fixed orifice 18 to a bleed valve 19. A mercury column consisting of the mercury pots 20 and 21 and a connecting conduit 22 is connected in the conduit 17 between the orifice 18 and the bleed valve 19 so that the height of the mercury column is deducted from the pressure in the conduit 17 below the aforesaid ori-
office, when this pressure is applied to the lower side of the diaphragm 14 through a conduit 23. With the bleed valve 19 closed, the pressure below
the orifice 18 becomes the upstream pressure of the valve 9 so that the height of the mercury column determines the differential pressure across the valve 9. Now, if the bleed valve 19 is opened so as to cause a drop in pressure across the orifice 18, this immediately causes a drop in the pressure on the lower side of the diaphragm 14 which causes the valve 8 to open thereby increasing the upstream pressure of the valve 9 until a balance is again restored. Thus, the position of the bleed valve 18 and its port area considered with respect to the port area of the orifice 18 governs the differential maintained across the valve 9 and thus governs the water flow through this valve for any open position thereof.

The bleed valve 19 is actuated by a steam flow indicator connected at 21 to the steam line 6. A steam flow indicator 26 also controls the air pressure from an air line 25 to a control device 24. The control device 24 acts to open the bleed valve 19 as the steam flow increases in the steam line 6. The control device 24 includes a manually operable member 28 by which the degree of opening of the bleed valve 19 may be adjusted.

The degree of opening of the valve 19 is thus varied in response to steam flow in the outlet 6. The steam flow in the outlet 6 is a measure of the feed water demand. It is believed to be evident from the foregoing description that a proper design of the port areas of the orifice 18 and the valve 19 can be made to give a differential across the valve 9 which will vary in proportion to the amount of feed water necessary to supply the steam being drawn through the outlet 6. Roughly, this means that the differential pressure across the valve 9 should vary at a rate proportional to the square of the steam demand. With such a proportional arrangement, the rate of feed water supplied to the boiler by means of the valve 9 is in direct proportion to the steam outlet provided the port area of the valve 9 remains constant. Thus no change in level becomes necessary to alter the rate of feed water supply to accommodate for changes in steam demand. An extremely close regulation of water level can be maintained by this system over a wide range of steam demand. The water level regulator becomes less of a control valve and more of an auxiliary emergency protection which operates in the event of failure of the steam demand responsive device.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A boiler feed water control system comprising a feed water conduit, a valve therein, means responsive to the level of feed water in said boiler for controlling the position of said valve, and means for varying the pressure differential across said valve automatically responsive to a desired governing factor in the operating process, said means comprising a differential regulator in the feed water conduit including a valve in said feed water conduit and in series with the first named valve, a diaphragm controlling said last named valve, means for balancing said diaphragm between the pressures above and below said first named valve including conduits from said feed water conduit to the opposite sides of said dia-

2. In a system of the character described, a boiler, a liquid supply conduit therefor, and means responsive to liquid level in said boiler and rate of fluid withdrawal from said boiler for controlling the flow of liquid in said supply conduit, said means including a valve in the liquid supply conduit, means to vary the port opening of said valve in response to liquid level variations in said boiler and a differential regulator comprising a valve in said liquid supply conduit in series with said first named valve, a diaphragm controlling said last named valve, means for balancing said diaphragm between the pressures above and below said first named valve, including conduits from said supply conduit to the opposite sides of said diaphragm, means in one of said last named conduits providing a fixed pressure differential between the diaphragm and said liquid supply conduit, and a bleed orifice in the conduit from the upstream side of said first named valve to the diaphragm, said bleed orifice being adjustable in response to the rate of fluid withdrawal from the boiler.

3. In a system of the character described, a boiler, a liquid supply conduit therefor, and means responsive to liquid level in said boiler and rate of fluid withdrawal from said boiler for controlling the flow of liquid in said supply conduit, said means including a valve in the liquid supply conduit, means to vary the port opening of said valve in response to liquid level variations in said boiler and a differential regulator comprising a valve in said liquid supply conduit in series with said first named valve, a diaphragm controlling said last named valve, means for balancing said diaphragm between the pressures above and below said first named valve, including conduits from said supply conduit to the opposite sides of said diaphragm, and a bleed orifice in the conduit from one side of said first named valve to the diaphragm, said bleed orifice being adjustable in response to the rate of fluid withdrawal from the boiler.

4. A boiler feed water control system comprising a feed water conduit, a valve therein, means responsive to the level of feed water in said boiler for controlling the position of said valve, and means for varying the pressure differential across said valve automatically responsive to a desired governing factor in the operating process, said means comprising a differential regulator in the feed water conduit including a valve in said liquid supply conduit in series with the first named valve, a diaphragm controlling said last named valve, means for balancing said diaphragm between the pressures above and below said first named valve including conduits from said liquid supply conduit to the opposite sides of said diaphragm, and a bleed orifice in the conduit from the upstream side of said first named valve to a point of lower pressure, said bleed orifice being adjustable in response to the desired governing factor.

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