

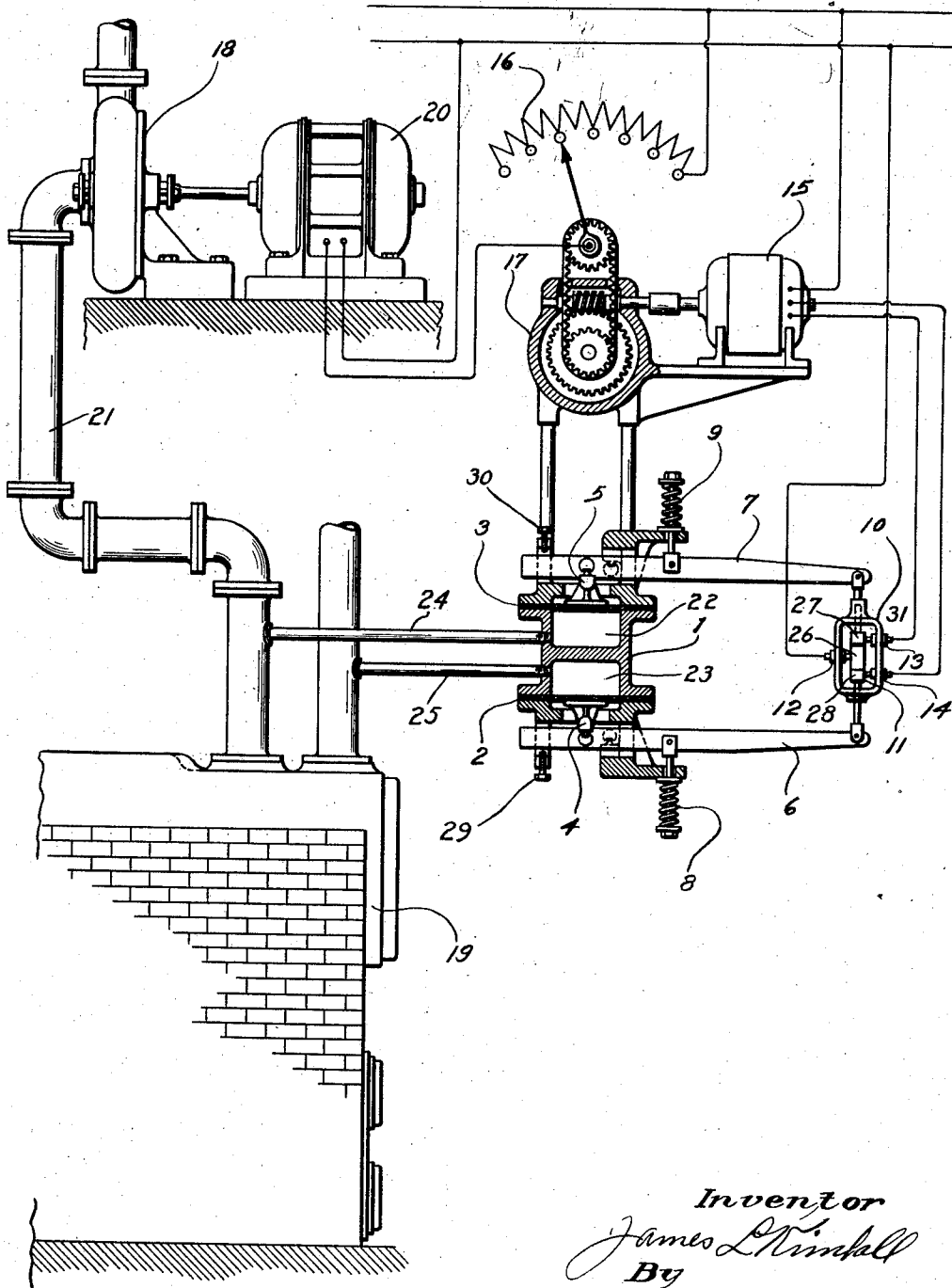
Nov. 25, 1930.

J. L. KIMBALL

1,782,926

METHOD OF AND APPARATUS FOR CONTROLLING BOILER FEED WATER

Filed May 21, 1927



Inventor
James L. Kimball
By
Attorney

UNITED STATES PATENT OFFICE

JAMES LEWIS KIMBALL, OF BEVERLY, MASSACHUSETTS, ASSIGNOR TO RUGGLES-KLINGEMANN MFG. CO., OF SALEM, MASSACHUSETTS

METHOD OF AND APPARATUS FOR CONTROLLING BOILER FEED WATER

Application filed May 21, 1927. Serial No. 193,362.

My invention relates to a method of and improved apparatus for controlling boiler feed pumps, and more specifically, to the control of motor-driven boiler feed pumps.

5 The object of my invention is to maintain a variable pressure between the steam pressure of the boiler and the feed line pressure at the pump, said pump pressure being increased on a decrease in boiler pressure and
10 likewise decreased on an increase in boiler pressure. Heretofore differential boiler feed pump governors have been so arranged that the difference in pressure between the steam
15 generated by the boiler and the water supplied by pump was either of a constant value for varying steam pressures or that the difference in pressure would be reduced on increased boiler loads and likewise increased
20 on low boiler loads.

It is readily conceivable that this is the wrong method of control, and that it is desirable to employ regulating equipment which will maintain an increased pump pressure when the boiler is generating an increased amount of steam, for the simple reason that the more steam the boiler generates, the more water must be fed to the boiler, and in order to feed an increased amount of water
25 on an increase in boiler load, it is necessary to maintain a higher pump pressure.

Where a constant pressure is maintained, or where the pressure tends to decrease on increased boiler load, it becomes necessary to either continuously adjust a feed valve,
30 or adjust the regulator.

It will be understood that the pressure of a steam boiler varies with the demand or boiler load, usually termed the pressure operating range, and that such variation is a reliable indicator of the requirements for more or less fuel and more or less air to support combustion. Also, a reliable indicator of the requirements for more or less feed water to maintain the required water level in
35 the boiler.

My invention provides novel means whereby on a drop in steam pressure due to an increase in boiler load, the feed line pressure is increased, and likewise, on a rise in pressure
40 due to a falling load, the feed line pressure

is decreased. This increase and decrease in pressure is of a predetermined value, it being such as may be required to feed an amount of water corresponding to the amount of water being evaporated by the boiler. It will
55 be understood that in pumping feed water through the feed line pipe with the various valves, also through the feed water heater, that there will be a considerable drop in pressure, and the pressure drop will be increased on increased volume demand; it is, therefore, the purpose of my invention to so vary the pressure at the pump as to compensate for these losses, thereby, always insuring a sufficient supply of water at the required pressure to feed the boilers under
60 varying load demands.

Referring to the drawing,—19 represents a steam boiler, 18 is a pump for supplying the boiler with water, 20 is a motor for driving the pump, 21 is the feed line to the boiler it being understood that in this line there will be installed the ordinary boiler stop valve (not shown in the drawing) and usually a feed water heater for raising the temperature of the feed water, 16 represents a rheostat for controlling the speed of the motor 20; 15 is a pilot motor for operating the rheostat 16, and 31 is a switch for controlling the operation of the pilot motor 15.
65

Thus far I have enumerated apparatus which is old in the art, and I will now describe the novel features of my invention.

A pressure head 1 has upper and lower pressure chambers 22 and 23; these chambers have flexible diaphragms 2 and 3. To the upper chamber is pressure connection 24 whereby the feed line pressure is allowed to exert a force on the under side of diaphragm 3. To the lower chamber is a pressure-connection 25 which permits the steam pressure of the boiler to exert a force on the upper side of diaphragm 2. The feed line pressure in the chamber 22 is counteracted by means of coil spring 9 acting through lever 7 and pressure cap 5, and likewise the steam pressure in chamber 23 is counteracted by means of spring 8 acting through lever 6 and pressure cap 4. The spring 8 being adjusted for a predetermined boiler pressure, and likewise
70
75
80
85
90
95
100

the spring 9 being adjusted at predetermined feed line pressure, in excess of the boiler pressure, it will be seen that the levers 6 and 7 will float up and down in accordance with variations in the feed line and boiler pressure, the lever 6 being responsive to variations in steam pressure, and lever 7 responsive to variations in feed line or pump pressure.

At the right hand end of the levers 6 and 7 is connected the pilot motor controlling switch, the lever 6 being connected to the barrel 11 of the switch and lever 7 being connected to the frame 10 of the switch.

I will now describe the operation of the pilot switch: the frame of this switch has insulated contactors and terminal connections 12—13 and 14, while the barrel of the switch is made up of a cylindrical contacting portion 26 and two portions of insulating material 27 and 28. The switch as shown is in a neutral or open circuit position, but if the barrel should be moved upward, or the frame downward, then terminal 13 would make contact with cylindrical portion 26 and current would flow from one side of the line and from 12 to 13 operating the pilot motor in one direction, and if either the barrel was lowered or the switch frame raised, current would flow from the line and from 12 to 14, thereby operating the motor in the opposite direction. It will be noted that one side of the line is direct to the pilot motor, so all that is necessary to reverse the motor, it being of the split field type, is to alternate the flow in the other two lines.

The operation of the system is as follows:—assuming a normal steam pressure in chamber 23 of 100 pounds and a feed line pressure in chamber 22 of 130 pounds, and these pressures represent a pressure differential required to feed the boiler under a mean average load condition; and assume that the steam pressure rises, due to a falling load of 101 pounds,—then diaphragm 2 will be forced downward compressing counteracting spring 8 and raising the right hand end of the lever 6, which in turn raises contact barrel 11, and the conducting portion 26 will complete a circuit from terminal 12 to terminal 13 on switch frame, thereby operating the pilot motor to install additional resistance in the motor circuit of motor 20 and slow down the pump 18. This slowing down of the pump would reduce the feed line pressure and diaphragm 3 would therefore be compressed by the counteracting spring 9 and the frame 10 of the switch would be raised thereby returning the switch to its neutral or open circuit position and preventing the further operation of the pilot motor. The feed line pressure has now been reduced due to the increase of the boiler pressure.

Now assume that the steam pressure decreases from 100 lbs. to 99 lbs. due to an in-

crease in boiler load; the counteracting spring 8 will now depress the diaphragm 2 which will operate lever 6 to complete a circuit from terminal 12 to 14 which will operate the pilot motor in the opposite direction to cut out resistance and speed up pump motor 20; this in turn will increase the feed line pressure which will force diaphragm 3 upward thereby lowering the switch frame and again returning the switch to a neutral or open circuit position and preventing further operation of the pilot motor. We now have an increase feed line pressure due to a decrease in steam pressure caused by a rising boiler load, and assuming the steam pressure continued to further drop to say 98 lbs. then the operation would be repeated and the feed line pressure proportionally increased. This increase in feed line pressure would continue with the drop in steam pressure until the steam pressure device had operated over its entire pressure-operating range which would be when the left-hand end of the lever 6 engaged the stop screw 29 and no further movement was possible. This pressure-operating range of the steam pressure device would be adjustable by increasing or decreasing the travel of the diaphragm 2.

Now assuming the steam pressure device should be adjusted for a 10 lb. operating range, that is to say, 5 lbs. above and below the mean average steam pressure,—and assuming the water-pressure device should be adjusted for a like pressure-operating range: now if the boiler load should increase to an amount which would cause the pressure to drop from 100 to 95 lbs., then the feed line pressure would be increased from 130 to 135, and the differential would now be 40 lbs. instead of 30, as was the case when the steam pressure was at its mean average value of 100 lbs.

Assuming the boiler load should fall off to an extent which would cause the steam pressure to rise to 105 lbs.,—now the feed line pressure would be reduced to 125 lbs. and the pressure differential would be 20 lbs. instead of 30, as was the case when the steam pressure was at its mean average.

From the foregoing, it will be seen that I have devised control apparatus which will increase the pressure differential on increased boiler loads and will likewise decrease the pressure differential on decreased boiler loads.

So far I have described my invention in connection with a single boiler, and we will now consider a condition in which there are several boilers, all being fed by the same pump and operated at the same mean average pressure of 100 lbs. It will be readily conceived that variations in steam pressure of all the boilers, assuming the pressure pipe 25 to be connected to a steam line common to all boilers, will cause corresponding increase and

decrease in the differential pressure as before, but assuming an extra boiler should be cut into the line, which would mean that additional feed-water must be pumped to supply this extra boiler; or that a boiler should be cut out of the line, which would mean that less feed-water would be required; we now have a condition where a variation in feed line pressure may take place without any change in steam pressure, and under such conditions, the control is from the feed line pressure only. Assuming an extra boiler should be cut into the line, the feed line pressure would drop, which would decrease the pressure in chamber 22 causing the spring 9 to depress the diaphragm 3 and thereby raise the right-hand end of the lever 7 and also the switch frame 10, this would complete a circuit from terminal 12 to terminal 14 which would operate the pilot motor to cut out resistance 16 and speed up motor 20. This would cause the pump to discharge more water and consequently increase the pressure in the feed line 21 and in the chamber 22 to its original value, at which time the switch frame 10 would be lowered to its neutral or open circuit position and the further operation of the pilot motor stopped.

Likewise, if a boiler should be cut out of the line, then the feed line pressure would increase raising diaphragm 3 and lowering switch frame 10 which would complete a circuit from terminal 12 to terminal 13, which would operate the pilot motor 15 to cut in resistance, thereby reducing the feed line pressure and returning the switch to neutral.

It will be seen that my invention provides an independent control of the feed line pressure and also provides steam-pressure-operated means to correct this control, whereby the feed line pressure is changed in the opposite direction to the change in steam pressure.

While I have described my invention in connection with electric motor-driven pumps, it will be readily conceived that the same method of control is equally applicable to steam-driven pumps, as the controlling device can just as well be a pilot valve in which the body of the valve is operated from one pressure device and the valve stem from the other. In this way, a fluid pressure motor would be substituted for the pilot motor and this would operate a throttling valve in place of the rheostat, which in turn would control the operation of a steam-driven pump.

Various other modifications might be made in the structure and arrangement of parts of my improved method of controlling boiler feed-water without departing from the scope of the invention; therefore, without limiting myself to the precise embodiment herein shown and described, I claim:

1. The method of controlling boiler feed-water which consists in automatically maintaining the feed line pressure a predeter-

mined value in excess of the steam pressure in the boiler for a mean average boiler pressure, and automatically increasing the feed line pressure on a decrease in boiler pressure, and automatically decreasing the feed line pressure on an increase in boiler pressure.

2. The method of controlling boiler feed-water which consists in automatically maintaining the feed line pressure a predetermined value in excess of the steam pressure in the boiler for varying demands, so long as the steam pressure remains constant, and automatically increasing the feed line pressure when the boiler pressure falls below its mean average value, and likewise decreasing the feed line pressure when the boiler pressure exceeds its mean average value.

3. In a regulating system for maintaining a boiler feed line pressure differential for feeding the boiler with water, governing means for maintaining a predetermined feed line pressure in excess of the steam pressure in the boiler for a mean average boiler pressure, and governing means for increasing the feed line pressure on a decrease in steam pressure, said governing means likewise decreasing the feed line pressure on an increase in steam pressure.

4. In a differential pressure regulator, means for controlling the pressure at the high pressure source, a motor for controlling the pressure-controlling means, a governing device for the control of said motor, means controlled by the pressure at the high and low pressure source for jointly controlling said governing device for maintaining a predetermined pressure differential for a mean average pressure value at the low pressure source, and means for increasing the pressure at the high pressure source on a decrease in pressure at the low pressure source, and means for decreasing the pressure at the high pressure source on an increase in pressure at the low pressure source.

5. In a differential pressure control system for boiler feed pumps, a motor for driving said pump, a speed-controlling device for said motor, a reversible motor for controlling the operation of the speed-controlling device, a governing device for the control of the reversible motor, a pressure-responsive device controlled from the pump pressure for actuating the governing device to maintain a mean average pressure differential for a mean average steam pressure, and means whereby the pump pressure is increased on a decrease in steam pressure below the mean average value and likewise decreased when the steam pressure increases above its mean average value.

6. In a differential pressure regulator, a motor and means controlled by said motor for regulating the pressure at the high pressure source, a governing device for controlling the operation of said motor, said govern-

ing device comprising two independently operated co-operating elements, means whereby the operation of either element will affect the operation of said motor, means to control the operation of one of said elements from variations in pressure at the high pressure source, and means to control the operation of the other element from variations in pressure at the low pressure source, all as specified and for the purpose set forth.

7. In a differential pressure regulator, a reversible motor and means controlled by said motor for regulating the pressure at the high pressure source, a governing device for said motor, said governing device comprising two co-operating elements, means whereby the operation of either element will control the starting, stopping and reversal of operation of said motor, means to control the operation of one of said elements from variations in pressure at the high pressure source, and means to control the operation of the other element from variations in pressure at the low pressure source, all as specified and for the purpose set forth.

8. In a differential pressure-control system for boiler feed pumps, a motor for driving said pump, a speed-controlling device for said motor, a pilot motor for controlling the operation of the speed-controlling device, a governing device for the control of the pilot motor, means whereby said governing device is jointly controlled by the pump pressure and by the pressure of the steam in the boiler, and means whereby an increase in steam pressure would cause a decrease in pump pressure, and likewise a decrease in steam pressure would cause an increase in pump pressure.

9. In a differential pressure control system for boiler feed pumps, a motor for driving said pump, a speed-controlling device for said motor, a reversible pilot motor for controlling the operation of the speed-controlling device, a governing device for controlling the operation of the reversible motor, said governing device being arranged to start, stop and reverse the operation of the pilot motor, means whereby said governing device is jointly controlled by the pump pressure and by the steam pressure of the boiler, and means whereby an increase in steam pressure will operate the governing device to decrease the pump pressure and likewise a decrease in steam pressure will operate the governing device to increase the pump pressure.

10. In a boiler feed-water regulator comprising means for supplying the boiler with water, a governing device for regulating the water-supplying means, said governing device having two co-operating elements, said elements having a relative neutral position and two relative effective positions for regulating the water-supplying means, a pressure device operated from the steam pressure

of the boiler for actuating one of said elements to either of its effective positions, and a pressure device operated by the feed line pressure for actuating the other element to a relative neutral position, all as specified and for the purpose set forth.

11. In a boiler feed regulator, a motor and means controlled by said motor for regulating the feed line pressure, a governing device comprising two independently operated co-operating elements, means to control one of said elements from variations in the feed line pressure, and means to control the other element from variation in the boiler steam pressure, and means, whereby, the combined operation of the said two elements controls the operation of the motor to maintain an increased feed line pressure on an increase in steam demand.

12. In a boiler feed regulator a reversible motor and means controlled by said motor for regulating the feed line pressure, a governing device comprising two independently operated co-operating elements, said elements having a relatively neutral position at which the operation of the motor is not effective, and two relatively effective positions in which the motor is operated in either of two directions, means to control one of said elements from variations in the feed line pressure, and means to control the other element from variations in boiler steam pressure, and means, whereby, the combined operation of the said two elements controls the operation of the motor to maintain an increased feed line pressure on an increase in steam demand.

13. In a boiler feed regulator, a pump for supplying the boiler with water, a motor for controlling the speed of the pump, a governing device for operating the motor, said governing device comprising two independently operated co-operating elements, means to control one of said elements from variations in feed line pressure, and means to control the other element from variations in boiler steam pressure, and means, whereby, the combined operation of the said two elements controls the operation of the motor to maintain an increased feed line pressure on an increase in steam demand.

JAMES LEWIS KIMBALL.