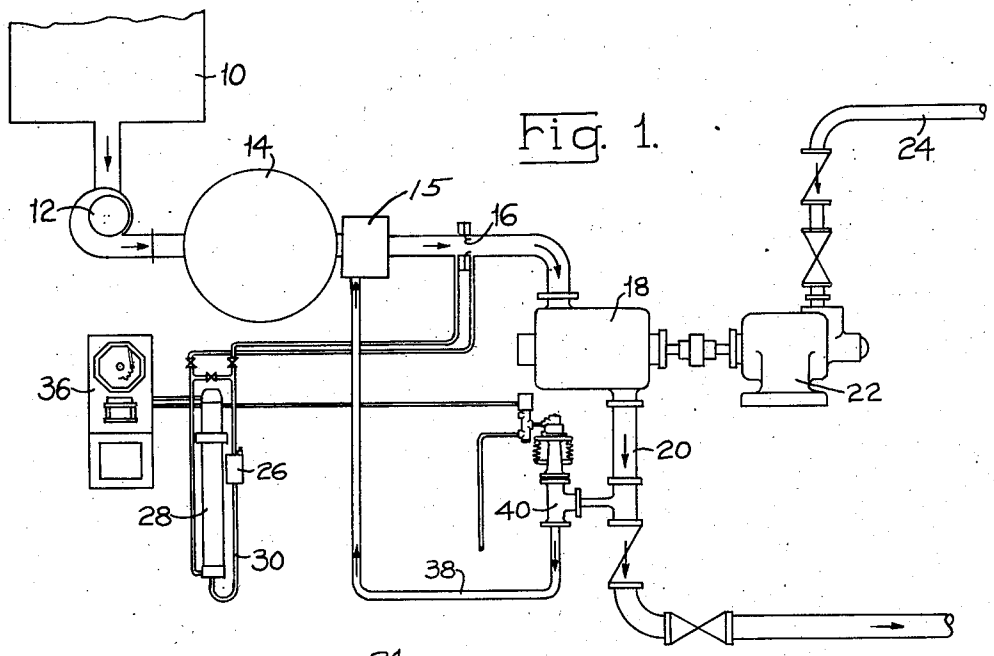
July 16, 1940. W. G. LAUFFER ET AL 2,207,809

FEED-WATER SYSTEM

Filed April 2, 1938 4 Sheets-Sheet 1

Fig. 1.



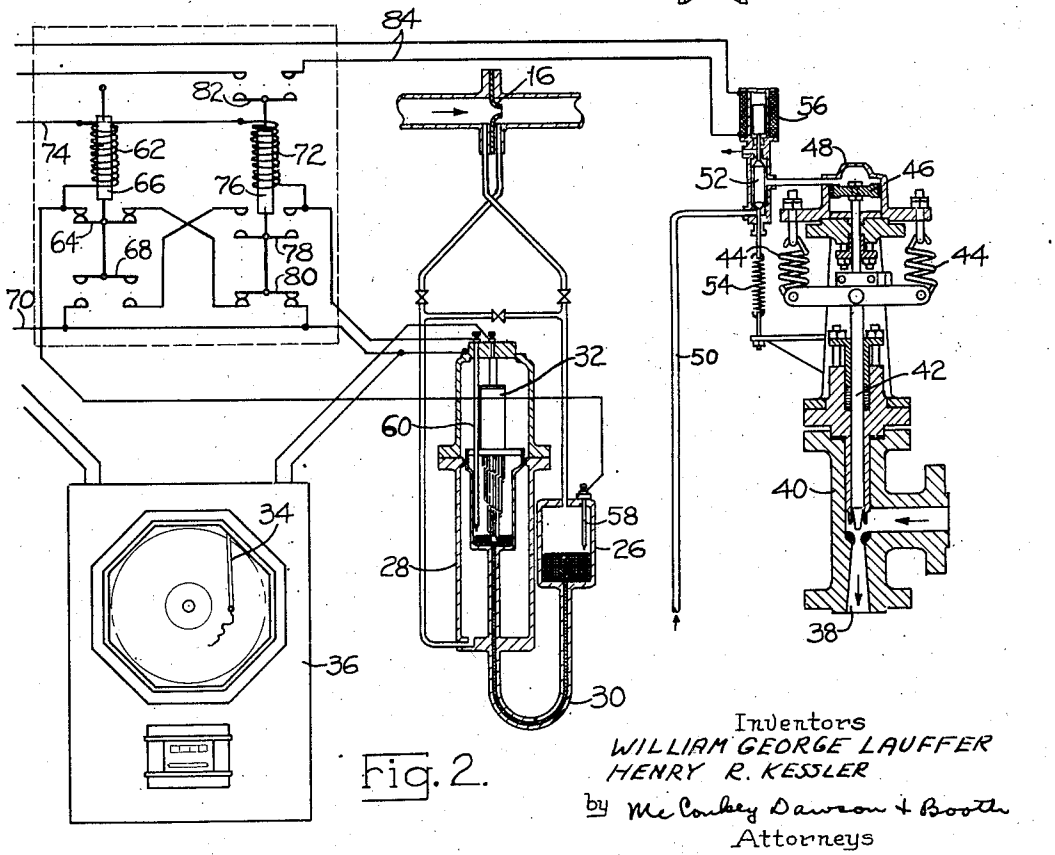


Fig. 2.

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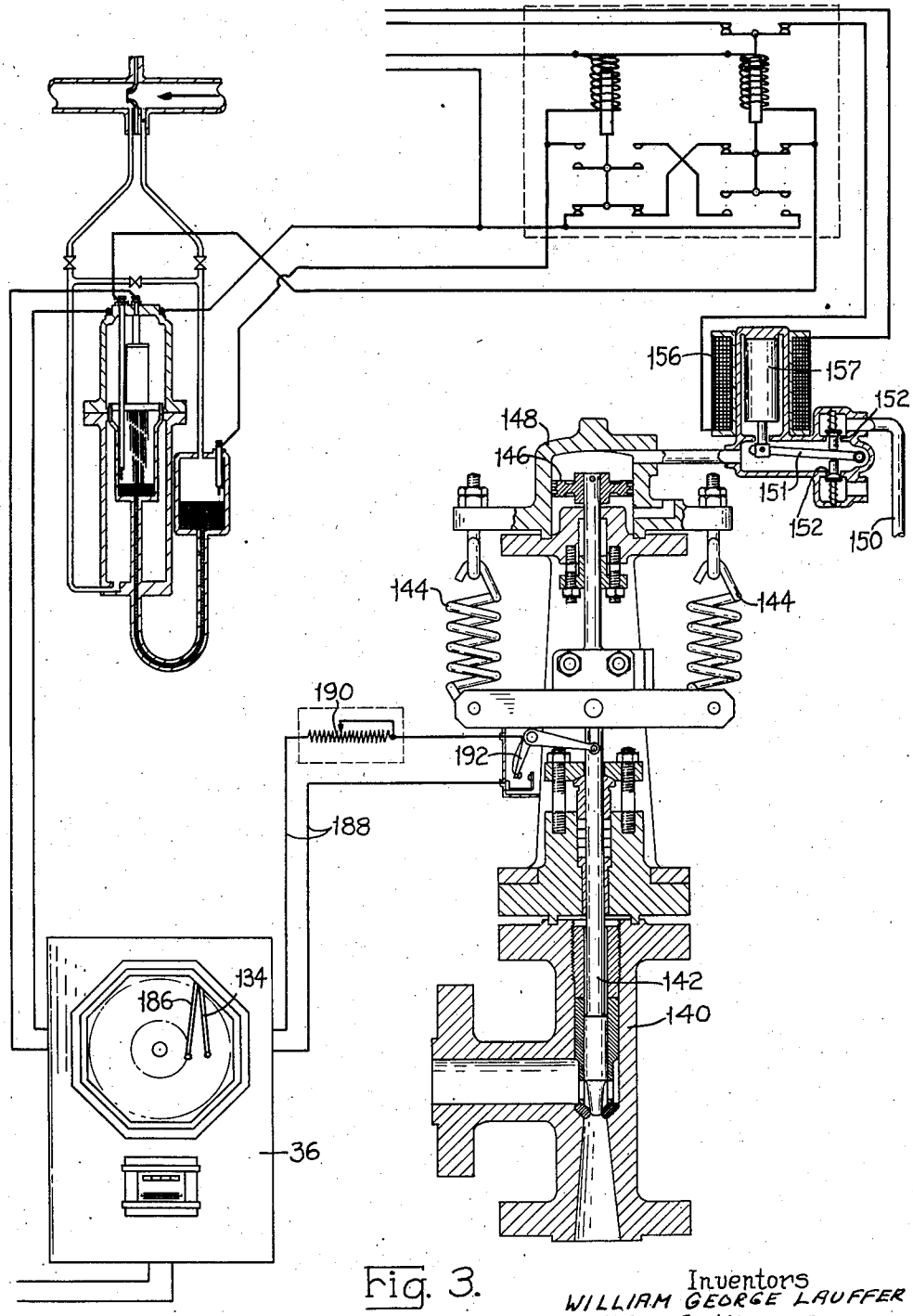

Fig. 3.

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FEED-WATER SYSTEM

Filed April 2, 1938 4 Sheets-Sheet 3

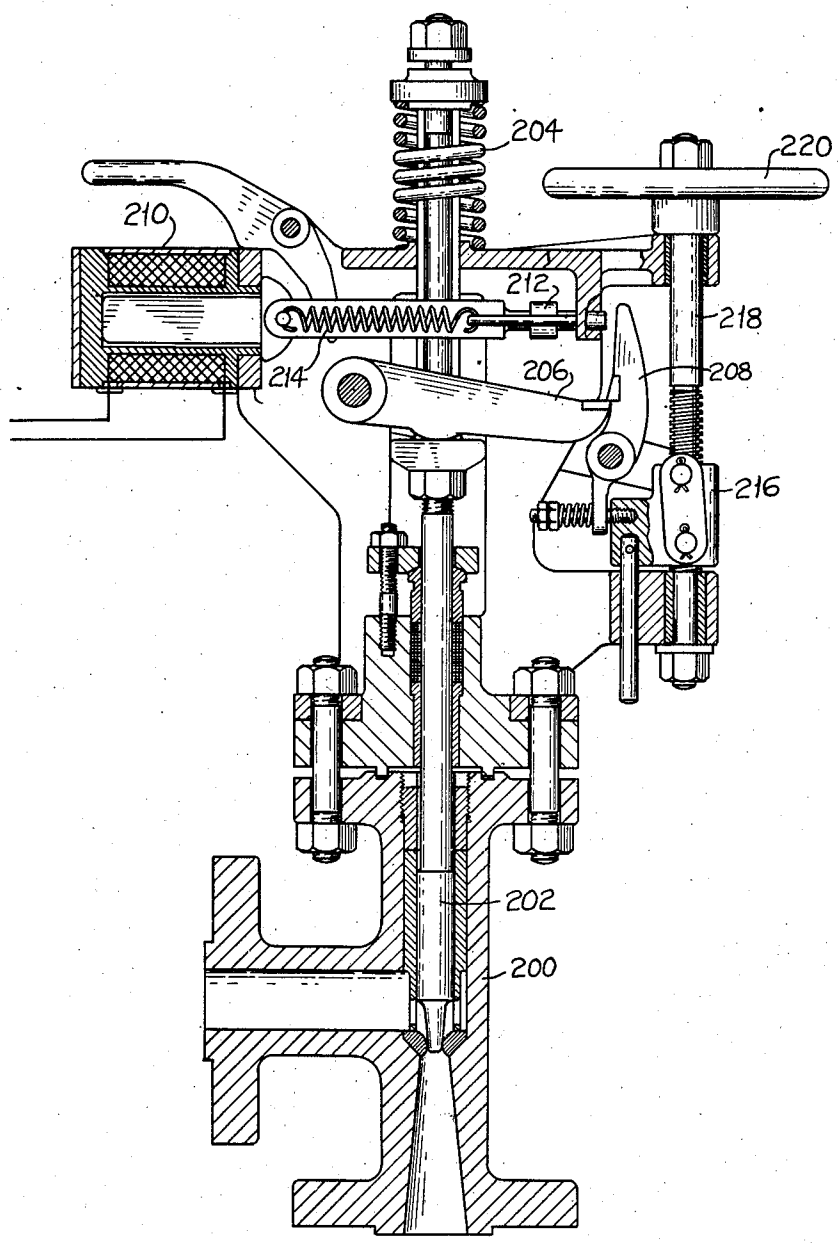

Fig. 4.

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FEED-WATER SYSTEM

Filed April 2, 1938 4 Sheets-Sheet 4

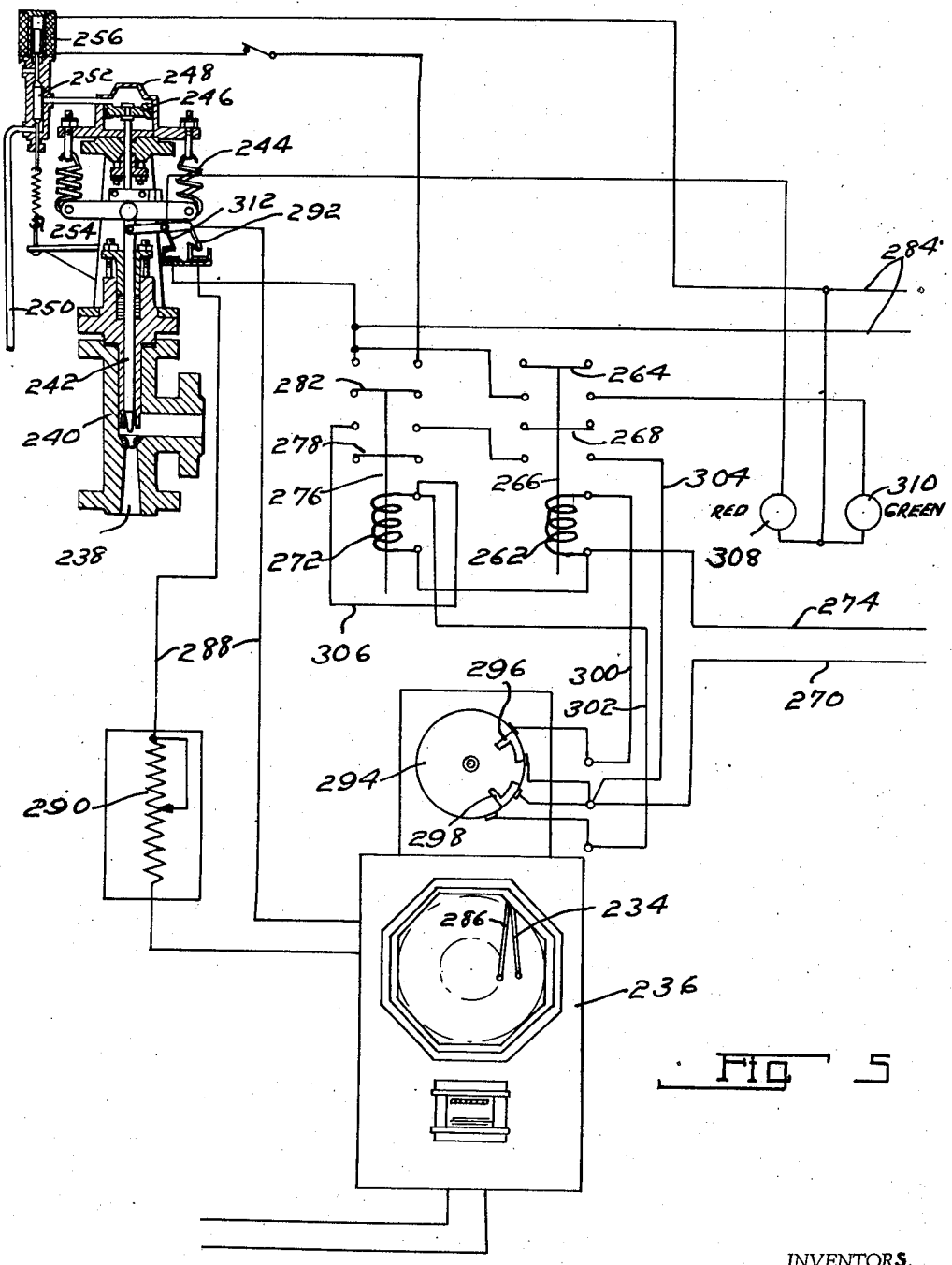

Fig. 5

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UNITED STATES PATENT OFFICE

2,207,809

FEED-WATER SYSTEM

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Application April 2, 1938, Serial No. 199,570

12 Claims. (Cl. 103—41)

This invention relates to pumping systems and more particularly to high pressure systems employing a continuously driven pump.

In high pressure pumping systems employing a continuously running pump it has been found that when the demand for liquid is very low the pump overheats and may be burned out. In other words, it is necessary, to protect the pump, that a certain minimum flow of liquid be maintained therethrough regardless of the demand for liquid.

It is accordingly one of the objects of the present invention to provide a pumping system in which flow through the pump is never allowed to fall below a predetermined minimum.

Another object of the invention is to provide a pumping system in which a by-pass around the pump is automatically opened when the demand falls below a predetermined minimum. According to one desirable arrangement the by-pass is automatically re-closed if the demand rises to a predetermined value in excess of said minimum. In some cases where it is desired to call the operator's attention to the reduced demand, for example so that he can cut out one or more of a plurality of parallel pumps, a valve may be employed which requires manual resetting.

Another object of the invention is to provide a pumping system in which a by-pass around a continuously running pump is automatically controlled in accordance with a function of the fluid being pumped. Preferably the controlling function is rate of flow but temperature or some other function might be used

Since a flowmeter is usually employed in connection with feedwater systems, it is a further object of the invention to provide a pump by-pass which is controlled by the flowmeter.

Another object of the invention is to provide a pumping system in which suitable signals are provided to indicate the condition of the system.

The invention is applicable to a great many uses such as boiler feedwater pumps, scaling pumps in rolling mills and in fact in substantially all places where a constantly running high pressure pump is employed to supply a variable demand. Since it is particularly useful in connection with boiler feed-water systems, it has been described hereinafter in connection with such a system but it will be understood that this description is illustrative only and is not to be taken as a definition of the limits of the invention.

Other objects, advantages and novel features of the invention will be apparent from the following description when read in connection with the accompanying drawings, in which:

Figure 1 is a diagram of a feed-water system embodying the invention;

Figure 2 is a wiring diagram of the system of Figure 1 with parts in section;

Figure 3 is a view similar to Figure 2 of a slightly modified form;

Figure 4 is a section of a valve construction; and

Figure 5 is a wiring diagram of another system embodying the invention.

As shown in Figure 1, feed-water is pumped from a storage reservoir 10 by a low pressure pump 12 into a low pressure heater 14 from which it passes to a de-aerator 15 and through an orifice 16 to a high pressure feed-water pump 18 having an outlet pipe 20 connected through suitable valves to the boiler. The high pressure pump 18 is driven by a turbine 22 connected to the boiler through a steam pipe 24.

Flow of water through the high pressure pump 18 is measured by a flow meter having a high pressure chamber 26 and a low pressure chamber 28 connected by a U-tube 30 adapted to be filled with mercury or the like. As best seen in Figure 2, the low pressure chamber 28 carries a contactor 32 of the type more particularly described and claimed in the patent to Spitzglass, No. 1,325,763, which creates a variable resistance to operate a pen 34 in a recorder 36. The recorder may be of any conventional type, as illustrated for instance in the patent to Spitzglass, No. 2,076,100.

In normal operation the low pressure pump 12 draws water from the storage reservoir and forces it through the heater 14 into the high pressure pump 18. The pump 18 forces the water at high pressure into the boiler in accordance with the demands thereof, the rated delivery being controlled in any desired manner, not shown. When the rate of flow of water through the pump 18 falls below a predetermined minimum, this pump heats up very rapidly and is apt to be burned out. We have found that for proper operation of the pump it is necessary that a flow of water therethrough equal to approximately one sixth to one fifteenth of its capacity be maintained.

According to the present invention, minimum flow of water through the high pressure pump is maintained by providing a by-pass connection 38 from a high pressure point posterior to the pump outlet to a low pressure point in the sys-

tem anterior to the pump inlet and anterior to the orifice 16. Flow through the by-pass 38 is controlled by a valve 40 more particularly illustrated in Figure 2 as including a valve stem 42 urged to open position by fluid pressure thereon preferably supplemented by a pair of springs 44 and adapted to be closed by a fluid pressure piston 46 in a cylinder 48. The upper end of cylinder 48 is connected to a pipe 50 leading from a source of compressed air or the like through a double ended valve 52 urged to exhaust position by a spring 54 and adapted to be opened by a solenoid 56. In the position shown in Figure 2 the solenoid is de-energized, valve 52 is in its exhaust position, and valve stem 42 is raised by springs 44 to open the by-pass.

The solenoid 56 is controlled from the flow meter through suitable control circuits including a low contact 58 in the high pressure chamber 26 and a high contact 60 in the low pressure chamber 28. The low contact 58 is connected to a coil 62 and to one side of a switch 64 which is operated by a core 66 in the coil 62. The core 66 also operates a switch 68 controlling a holding circuit from one side of a power line 70 to a second coil 72 which is also connected to the high contact 60. Both coils 62 and 72 are connected to the other side of the power line shown at 74. The coil 72 has a movable core 76 controlling a switch 78 in series with the switch 68 and a switch 80 in series with the switch 64. A third switch 82 is connected to the core 76 and controls power lines 84 leading to the solenoid 56.

When the flow through the orifice 16 is relatively high, the mercury will be forced down in chamber 26 and up in chamber 28 to engage the high contact 60. This will complete a circuit through the coil 72, raising the core 76 to close switches 78 and 82. At this time the solenoid 56 will be energized, the valve 52 will be raised to its open position, and fluid under pressure will be admitted to the upper end of cylinder 48 to move the valve stem 42 down, thereby closing the by-pass. This is the normal operating condition in which the boiler demand for feedwater is sufficient to maintain a flow above the desired minimum through the high pressure pump.

As the flow decreases, the mercury will move away from the high contact 60, but the coil 72 will still be energized due to the holding circuit from line 70 through switches 68 and 78 to the coil. As the flow drops further to the minimum allowable value, mercury will rise in the chamber 26 to engage the contact 58, thereby completing a circuit through the coil 62 to raise core 66 to the position shown in Figure 2. This interrupts the holding circuit for coil 72 by opening switch 68, and the core 76 falls to the position shown, opening switches 78 and 82 and closing switch 80. At this time solenoid 56 is de-energized and valve 52 moves down under the influence of spring 54 to exhaust pressure from the cylinder 48 and to permit valve stem 42 to rise under the influence of springs 44. The by-pass 38 is then opened and water is recirculated from the pump outlet pipe 20 back to the pump inlet to maintain the desired minimum flow through the pump regardless of boiler demand.

This operation will immediately effect an increase in flow through the orifice 16, causing mercury in the chamber 26 to move away from the contact 58. Coil 62, however, will remain energized due to the holding circuit from line 70 through switches 80 and 64, so that the by-pass valve 40 will remain open. The valve will be held open until the flow increases in response to increasing demand to a point sufficient to close the above described circuit through high contact 60. This will raise core 76, opening switch 80 and interrupting the holding circuit through the coil 62. It will be noted from the above that a substantial increase in flow is necessary before the valve 40 closes after once being opened. This insures that minimum flow will be maintained through the pump and eliminates possibility of fluttering of the valve due to small variations in demand. It will be apparent that, if desired, the valve could be regulated to intermediate positions to control the flow through the by-pass.

Figure 3 illustrates a slightly modified control, parts therein corresponding to like parts in Figures 1 and 2 being indicated by the same reference numbers plus 100. In this construction the control circuits are substantially identical, but a somewhat different valve arrangement is provided to control flow of operating fluid to the cylinder 148. As shown, the solenoid 156 has a movable core 157 connected to one end of a lever 151 which is pivoted at its opposite end to the valve casing. The valve 52 is replaced by a pair of poppet valves 152, one of which controls the supply of fluid from the pipe 150 and the other of which controls the exhaust. Both poppet valves are engaged by the lever 151 so that when one valve is open the other will be closed, as will be apparent.

Since the flow meter will measure the total flow passing through the high pressure pump, it is desirable to provide a measurement of flow through the by-pass so that the total amount of water actually supplied to the boiler will be indicated. For this purpose the flow meter may be provided with a second pen 186 controlled by a circuit 188 including a variable resistance 190 and a switch 192 which is operated by the valve stem 142. Since the by-pass is either fully opened or fully closed, the flow therethrough will either be zero or some predetermined quantity depending upon the size of the by-pass connection or of a suitable throttling orifice therein. The variable resistor 190 may therefore be set to a value which will cause the pen 186 to indicate flow through the by-pass so that whenever switch 192 is closed, pen 186 will record a substantially constant value, and whenever switch 192 is opened, it will record zero. Thus the flow through the by-pass is indicated and the amount of feedwater supplied to the boiler may be computed by deducting this flow from the total flow indicated by pen 134. It will be understood that if desired, this deduction could be made automatically so that the pen 134 would indicate at all times the amount of feed water actually being supplied to the boiler.

It is sometimes desirable to provide a system in which the by-pass valve must be manually reset to call the operator's attention forcibly to the reduced demand for feed water. This is particularly desirable where a plurality of feed water pumps operating in parallel are provided, so that the operator may cut out one or more pumps when they are not necessary to supply the demand. For this purpose a valve, as illustrated in Figure 4, may be employed, the illustrated valve including a body 200 and a sliding stem 202 moved upwardly to open the by-pass by a spring 204. The valve is normally held closed by a latch mechanism including a pivoted lever 206 engaging an abutment on the valve stem 202 and

held down in the position shown by a pivoted latch 208. A solenoid 210 operates a plunger 212 urged in one direction by springs 214 so that when the solenoid is energized the plunger 212 will strike the latch 208 and disengage it from the lever 206 to permit the valve to open under the influence of spring 204. It will be understood that any suitable signal can be operated in parallel with the solenoid 210 to indicate to the operator when the by-pass is opened.

In order to reset the valve, the latch 208 is mounted on a carriage 216 which can be moved by a fixed screw 218 having a hand wheel 220. When the valve is open, the hand wheel may be turned to raise the carriage 216 far enough to permit engagement of latch 208 with the lever 206. Thereafter the carriage may be screwed down to the position shown with the valve closed.

In Figure 5 there is shown a modified circuit arrangement, parts therein corresponding to like parts in Figures 1 and 2 being indicated by the same reference numerals plus 200. As shown in this arrangement the contacts in the meter body are replaced by a rotating member 294 driven by or in synchronism with the meter mechanism and carrying a pair of contactors 296 and 298. The contactor 296 serves to connect the power lead 270 with a wire 300 leading to one side of the coil 262 and the contactor 298 connects lead 270 with a wire 302 leading to one side of the coil 272. The other sides of both coils are connected to the power lead 274. The contactors 296 and 298 are so spaced with relation to their corresponding contacts that only one of the coils can be energized at any one time.

The coil 262 operates a core 266 carrying a switch member 268 connecting a wire 304 which is connected to the lead 270 to a fixed contact at one side of switch member 278 carried by the core 276. A fixed contact at the other side of switch 278 is connected by a wire 306 to the wire 302 and the coil 272. The core 276 carries a second switch member 282 adapted to open and close a circuit in the power leads 284 through the solenoid 256.

In order to indicate the operation of the device a red signal light 308 and a green signal light 310 are provided. Both lights are connected on one side to one of the leads 284 and the other side of the green light 310 is connected to a fixed contact on one side of the switch 264 carried by core 266 and having a contact on its other side connected to the other lead 284. The other side of the red light is connected to the other lead 284 through a switch 312 which is operated by the valve 240 to be closed when the valve is open and open when the valve is closed.

The parts are shown in the position they will occupy when the flow is at or below the minimum permissible value with the contactor 296 closed to energize the coil 262 to open both switches 264 and 268. At this time the coil 272 is de-energized to open switches 278 and 282 thereby interrupting the circuit to solenoid 256. The valve 252 is therefore in its exhaust position and the valve 240 is open, closing the switches 292 and 312. Thus the red light 308 is lighted indicating that the by-pass is open.

After the by-pass has opened and flow through the pump and meter is again above the minimum the contact 296 will open de-energizing the coil 262 so that core 266 will drop down to close switches 264 and 268. Switch 264 will close a circuit through the green light so that both lights will be burning, indicating that the by-pass is open and the demand is less than the minimum pump capacity.

As the demand increases to a predetermined point above the minimum pump capacity, the contactor 298 will close, energizing the coil 272. This will close switches 278 and 282, the latter completing a circuit through the solenoid 256 so that the by-pass valve 240 will be closed, incidentally opening switches 292 and 312 so that the red light will be extinguished. Thus only the green light is burning, indicating that the demand is greater than the minimum pump capacity.

If the demand should drop sufficiently to cause contactor 298 to open the coil 272 will remain energized due to the holding circuit through switches 268 and 278. This condition will continue until the demand drops below the minimum and closes contactor 296 to energize the coil 262 and raise core 266 at which time switch 268 will be opened to interrupt the holding circuit.

While several embodiments of the invention have been shown and described in detail, it will be understood that various changes might be made therein, and it is not intended to limit the scope of the invention to the forms shown nor otherwise than by the terms of the appended claims.

What is claimed is:

1. A safety control system for a boiler feedwater pump having its inlet connected to a source of liquid supply and having a by-pass connection from its outlet to the source of supply comprising, a normally closed valve in the by-pass, and means responsive to the flow of liquid through the pump to open the valve when the flow falls below a predetermined minimum, and to close the valve when the flow reaches a value a predetermined amount greater than said minimum.

2. A safety control system for a boiler feedwater pump having its inlet connected to a source of liquid supply and having a by-pass connection from its outlet to the source of supply comprising, a flowmeter responsive to the flow of liquid through the pump, a normally closed valve in the by-pass, electrically controlled means to open the valve, and electric control circuits for said means including switch means operated by the flowmeter to open the valve when the flow falls below a predetermined minimum, said circuits including a holding circuit to hold the valve open until the flow reaches a value a predetermined amount in excess of said minimum.

3. A safety control system for a boiler feedwater pump having its inlet connected to a source of liquid supply and having a by-pass connection from its outlet to the source of supply comprising, a normally closed valve in said by-pass, fluid pressure means to operate said valve, and electric control means responsive to the flow of liquid through the pump to control said fluid pressure means to open the valve when the flow falls below a predetermined minimum and to close the valve when the flow reaches a value a predetermined amount in excess of said minimum.

4. A safety control system for a boiler feedwater pump having its inlet connected to a source of liquid supply and having a by-pass connection from its outlet to the source of supply comprising, a normally closed valve in said by-pass, fluid pressure means to operate said valve, and electric control means responsive to the flow of liquid through the pump to exhaust fluid from said fluid pressure means to open the valve when the flow falls below a predetermined minimum and

to supply fluid to the fluid pressure means to close the valve when the flow reaches a value a predetermined amount in excess of said minimum.

5. A pumping system comprising a pump having its inlet connected to a source of liquid supply, a by-pass connection from the pump outlet to the pump inlet, a valve in said by-pass, resilient means urging the valve to open position, a latch normally holding the valve closed, and means responsive to the flow of liquid through the pump to release the latch when the flow falls below a predetermined minimum.

6. A pumping system comprising a pump having its inlet connected to a source of liquid supply, a by-pass connection from the pump outlet to the pump inlet, a valve in said by-pass, resilient means urging the valve to open position, a latch normally holding the valve closed, a flowmeter responsive to the flow of liquid through the pump, and means controlled by the flowmeter to release the latch when the flow falls below a predetermined minimum.

7. A pumping system comprising a pump having its inlet connected to a source of liquid supply, a by-pass connection from the pump outlet to the pump inlet, a valve in said by-pass, resilient means urging the valve to open position, a latch normally holding the valve closed, a flowmeter responsive to the flow of liquid through the pump, a solenoid operably associated with the latch, and a control circuit operated by the flowmeter to energize the solenoid to release the latch when the flow falls below a predetermined minimum.

8. In a pumping system including a pump, safety control means comprising a by-pass connection from the pump inlet to the pump outlet, a valve in said by-pass, a flowmeter having means for indicating the flow through the pump, means operated by the flowmeter to open said valve when the flow falls below a predetermined minimum, and supplemental means on the flowmeter to indicate the rate of flow through the by-pass when the valve is open.

9. In a pumping system including a pump, safety control means comprising a by-pass connection from the pump inlet to the pump outlet, a valve in said by-pass, a flowmeter having means for indicating the flow through the pump, means operated by the flowmeter to open said valve when the flow falls below a predetermined minimum, and supplemental means on the flowmeter operated by the valve to indicate the normal rate of flow through the by-pass when the valve is open.

10. In a pumping system including a pump, safety control means comprising a by-pass connection from the pump inlet to the pump outlet, a valve in said by-pass, means responsive to the rate of flow through the pump, electrical means for operating said valve and including electrically operated switches controlled by said last named means, said means operating to open the valve when the flow falls below a predetermined minimum, and signal means operated by one of said switches and by opening and closing of the valve to indicate the condition of the system.

11. In a pumping system having a pump with a by-pass between its discharge line and its intake line and a valve in the by-pass, control means for the valve comprising a flowmeter responsive to the flow of fluid passing through the pump, means to operate the valve, and means controlled by the flowmeter for controlling said last named means to open the valve fully when the flow falls below a predetermined minimum and to close the valve when the flow reaches a value a predetermined amount above said minimum.

12. In a pumping system having a pump with a by-pass between its discharge line and its intake line and a valve in the by-pass, control means for the valve comprising a flowmeter responsive to the flow of fluid passing through the pump, means to operate the valve, means controlled by the flowmeter for controlling said last named means to open the valve fully when the flow falls below a predetermined minimum and means to hold said valve open until the flow reaches a value a predetermined amount above said minimum.

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