

July 29, 1941.

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2,250,865

CONTROL VALVE FOR CENTRIFUGAL PUMPS

Filed Feb. 23, 1940

2 Sheets-Sheet 1

FIG. 1.

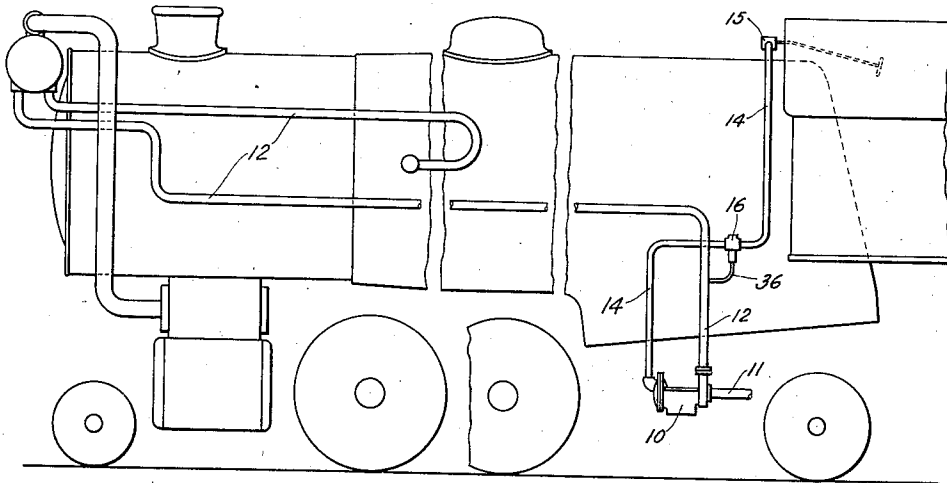
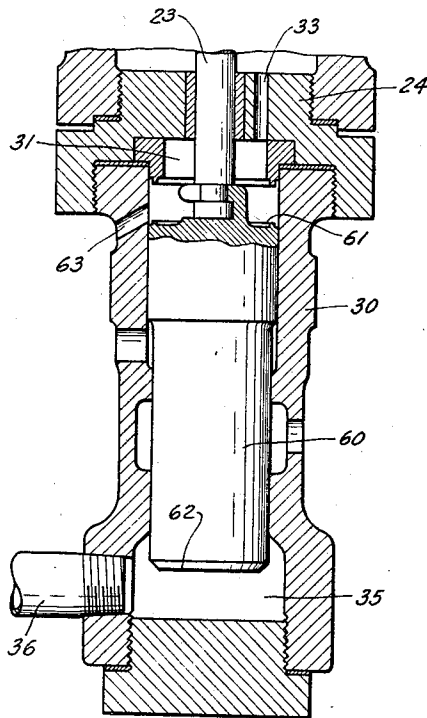


FIG. 3.

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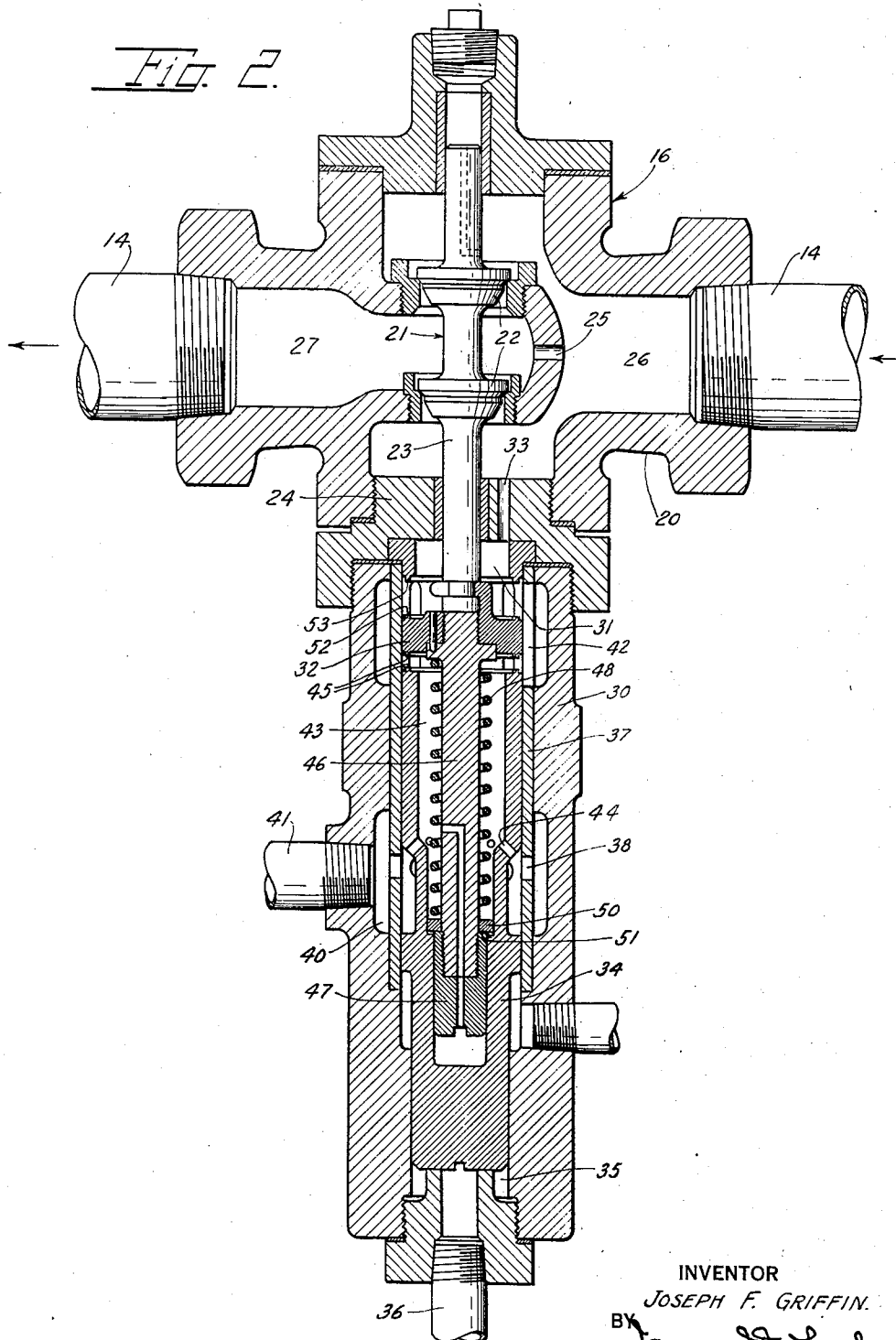
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Filed Feb. 23, 1940

2 Sheets-Sheet 2



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2,250,865

CONTROL VALVE FOR CENTRIFUGAL PUMPS

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Application February 23, 1940, Serial No. 320,329

6 Claims. (Cl. 103—16)

The present invention relates to pump control devices and particularly to a control valve for preventing overspeeding of centrifugal pumps.

Where centrifugal pumps are employed in feed water systems various failures, such as breaking of the suction line, may occur which lead to relieving the pump of its load and may cause it to overspeed dangerously unless the supply of steam is reduced or fully cut off. The invention contemplates a control valve adapted to reduce the operating speed of a pump to a safe limit when such failures occur and will be described in conjunction with the feed water system of a locomotive.

In the accompanying drawings:

Figure 1 is a diagrammatic elevational view of a locomotive having a feed water system embodying the control valve of the present invention;

Figure 2 is an enlarged vertical sectional view through the control valve of the invention; and

Figure 3 is a fragmentary enlarged sectional view of a modified form of the valve.

In Fig. 1 the numeral 10 designates a turbine driven centrifugal pump drawing water from a locomotive tender through a suction line 11 and supplying it to the boiler through the pipe 12 leading to the boiler check valve. The pump 10 is operated by steam taken from the turret of the locomotive boiler through the pipe 14 subject to the control of a starting valve 15 and the control valve of the invention, which is designated as a whole by the numeral 16.

In the form illustrated in Fig. 2, the control valve 16 comprises a casing having therein a valve member 21 provided with a pair of valve discs 22 connected to a stem 23 that projects through the bottom wall 24 of its casing. The valve structure includes a small orifice or starting port 25 placing the valve inlet 26 in communication with the internal chamber of the valve and its outlet 27 for by-passing steam around the valve 21 so that the pump may be started or continue to operate at a low rate of speed whenever pump throttle valve 15 is open although the valve discs 22 may be seated.

Mounted on the underside of the valve casing 20 concentric with valve stem 23 is a piston cylinder 30 formed with a valve chamber 31 containing a piston 32 acted upon in a direction to close valve 21 by the pressure of steam reaching the chamber 31 from the valve inlet 26 through a passage 33 of relatively small area. Below piston 32 is a second piston 34 subjected on its lower end face to the delivery pressure of pump 10 conveyed to a piston chamber 35 through a pipe

36 which is connected to the water delivery line 12. The pistons 32 and 34 are guided in their respective chambers 31 and 35 by a sleeve 37 which near its lower end is formed with a number of ports 38 communicating with an annular chamber 40 surrounding the sleeve and having a vent pipe 41 connected thereto. The upper part of sleeve 37 also has ports 42 so that steam has access to the part of chamber 31 at the sides of piston 32 as well as above the latter.

The upper portion of the piston 34 has a hollow or bore 43 providing a passage placing the steam chamber 31 for the upper piston 32 in communication with the vent pipe 41 through ports 44 in the wall of the hollow part of the piston, the ports 38 in sleeve 37 and the chamber 40 with which these ports communicate. The lower face of piston 32 and the upper annular end of piston 34 lie closely adjacent each other when the valve 21 is closed and both are provided with annular seals 45 adapted to contact for closing off communication between chamber 31 and vent pipe 41, as described hereinafter. Extending downwardly from the underside of piston 32 into the hollow portion of piston 34 is a rod or stem 46 provided at its lower end with a cap 47 guiding it in the lower portion of the bore in piston 34. Embracing the stem 46 is a coil spring 48 seating at its lower end against a washer 50 adapted to be engaged on its under face by an internal shoulder 51 on the piston 34 thus providing a resilient connection between the pistons 32 and 34 so that the upward thrust of delivery pressure imparted to the latter may be transmitted through the piston 32 and valve stem 23 in a direction to open the valve 21. The upper face of the piston 32 is also provided with an annular seat 52 adapted when the valve 21 is fully opened to seat against an annular seat 53 on the casing wall 24 concentric with stem 23 so as to form a seal preventing steam escaping from the portion of chamber 31 above piston 32 between the sleeve 37 and the upper part of piston 34 and thence to the vent pipe 41.

The operation is as follows: When the pump throttle valve 15 is opened to start the pump a small amount of steam by-passes the valve 21 through the starting port 25 and the pump begins operating at a low rate of speed. Steam at the inlet side 26 of the valve also flows through the passage 33 into chamber 31 but the downward thrust on the piston 34 is not sufficient to hold the valve 21 seated. This is because the pressure is reduced by the narrow passage 33 and also due to the fact that steam is bled from the cham-

ber 31 through the space between the adjacent ends of pistons 32 and 34, and the internal passage 43 in the latter leading to the vent pipe 41. As the pump builds up the delivery pressure the latter acts on the lower end of piston 34 raising the latter and compressing the spring 48 to a slight extent because of the resistance of the downward force on piston 34 produced by steam pressure on valve 21, stem 23 and piston 32. The spring forms a direct connection between the piston 34 and piston 32. As a result, the upward thrust imparted to the piston 34 by the delivery pressure acts to open the valve 21. When the valve 21 is fully opened seat 52 of piston 32 is in contact with seat 53. The pump delivery pressure continues to increase and acts to further compress the spring 48 as the piston 34 rises until the seals 45 on the adjacent ends of pistons 32 and 34 contact, thus closing off the flow of steam from chamber 31 to the vent pipe 41.

The valve 21 having been fully opened, the speed of operation of the pump 10 and its delivery pressure are regulatable by means of the throttle valve 15. At this time due to the closing off of the vent from the chamber 31 the pressure of steam therein builds up so that the force exerting a downward thrust on the piston 32 is substantially that of the steam at the inlet side 26 of the valve, valve 21 being held open by the pump delivery pressure which of course is higher than this steam pressure. If now the pump delivery pressure falls due to a broken delivery line or obstruction of the suction line 11, or some other cause acting to relieve the pump of its load so that it might overspeed, the steam pressure in chamber 31 having built up to approximately that at the inlet side 26 of the valve acts on the upper face of piston 32 to seat the valve 21. During this time the downward force exerted by steam pressure on the upper face of piston 32 and the opposing upward thrust of delivery pressure on the underface of piston 34 maintain the steam seals 45 at the adjacent ends of the two pistons in contact so that the chamber 31 remains shut off from the vent pipe 41. Thus approximately the full pressure existing at inlet 26 and in chamber 31 is available to close the valve. When the valve member 21 becomes fully seated, spring 48 acts to move the piston 34 further downwardly separating the vent seals 45 so that the chamber 31 is again placed in communication with the vent pipe 41. The control device is thus conditioned to allow the pump to again be automatically accelerated by opening valve 21 when the faulty operating condition which caused the pump to slow down has been corrected.

Although this embodiment of the invention has been described at length many changes may be made in the details of the structure without departing from the essential features which comprise a piston 32 tending to keep valve 21 closed, said piston being under the effect of steam at reduced pressure taken from the inlet side 26 of the valve, said piston located in a piston cylinder 30 which in the starting position of the apparatus is vented so that pressure is not built up in chamber 31 to an extent sufficient to interfere with opening of the valve member 21 when a second piston 34 upon being subjected to a predetermined pump delivery pressure acts to overcome the downward thrust on piston 32 to open the valve 21.

In the form shown in Fig. 3 only a single piston 60 is utilized, its upper end face 61 being subjected to steam pressure at the inlet side of the

valve 21 and its lower face to pump delivery pressure in chamber 35. In this figure a vent 63 is so located that when the valve is seated, steam is bled from the chamber 31 and does not interfere with the opening of the valve by pump delivery pressure acting on the under side of piston 60. As piston 60 ascends to fully open the valve 21 it obscures the vent port 61 so that the steam pressure is built up in the chamber at the upper face of the piston whereby when delivery pressure fails, the valve is automatically closed.

It will be seen that the two forms described are essentially the same as to the fundamentals of their operation. However, a form employing two yieldably connected pistons as illustrated in Fig. 2 is preferred because this form has been found to be more reliable to effect full closing of the valve 21 under certain operating conditions.

It should be noted that although the pressure at the inlet side of valve 21 (which is substantially boiler pressure when valve 21 is closed) is utilized as the force holding the valve closed, the latter may be opened by pump delivery pressure even where only a low steam pressure is available in starting the pump to build up delivery pressure. At low boiler pressure the force available in starting the pump to build up water delivery pressure is quite low because of the small size of the by-pass port 25. Nevertheless, this pressure is adequate to build up a delivery pressure sufficient to open valve 21 because the opposing force of steam is maintained low by the choke 33 and the venting of the steam chamber at this time.

Furthermore, when an emergency condition arises the full pressure of steam at the inlet side 26 of valve 21 is available to act on the steam piston to close the valve. This is because the final action of pump delivery pressure after opening the valve is to shut off the vent from the steam chamber so that a high pressure is built up therein to act when needs require that the pump be slowed down. In the form of Fig. 2 this pressure remains available until valve 21 is fully closed due to the fact that vent seals 45 remain in contact and are separated by spring 48 after the valve is seated.

What I claim is:

1. In pump control mechanism having a valve in a conduit for supplying actuating fluid to the pump, and a by-pass for passing a relatively small amount of said fluid to the pump when said valve is closed; means forming a chamber in communication with the inlet side of said valve; pressure responsive means in said chamber so connected to said valve that fluid pressure at the inlet side of said valve tends to close it; a vent for relieving said chamber of pressure; and means responsive to a predetermined pump delivery pressure of the pump connected to said valve so as to open it and acting to close said vent for subjecting said first pressure responsive means to the pressure of fluid at the inlet side of said valve.

2. In pump control mechanism having a valve in a conduit for supplying actuating fluid to the pump, and a by-pass for passing a relatively small amount of said fluid to the pump when said valve is closed; means forming a chamber in communication with the inlet side of said valve; pressure responsive means in said chamber connected to said valve so that fluid pressure at the inlet side of said valve tends to close it; a vent for relieving said chamber of pressure;

and means responsive to a predetermined pump delivery pressure operatively connected to said valve for opening it and for subsequently closing said vent to subject said first pressure responsive means to pressure at the inlet side of said valve upon falling of pump delivery pressure below said predetermined value.

3. In pump control mechanism having a valve in a conduit for supplying actuating fluid to the pump, and a by-pass for passing a relatively small amount of said fluid to the pump when said valve is closed; means forming a chamber in communication with the inlet side of said valve; a piston in said chamber; means subjecting said piston to the pressure of fluid at the inlet side of said valve; means connecting said piston to said valve so as to close said valve; a vent port for said chamber; a second piston having its upper end located in said chamber and formed with a passage leading from its upper end face to said vent port; means for subjecting the lower end of said second piston to pump delivery pressure for moving it in a direction to open said valve and into engagement with the under side of said first piston to close said vent so that inlet steam pressure acts on said first piston to close said valve when pump delivery pressure falls below a predetermined value; and a spring mounted between said pistons for transmitting the motion of said second piston to said first piston to open said valve and maintaining said pistons separated to keep said vent open until said valve is fully open.

4. In pump control mechanism having a valve in a conduit for supplying actuating fluid to the pump, and a by-pass for passing a relatively small amount of said fluid to the pump when said valve is closed; means forming a chamber in communication with the inlet side of said valve; pressure responsive means in said chamber so connected to said valve that fluid pressure at the inlet side of said valve tends to close it; a choke restricting the flow of steam from the inlet side of said valve to said chamber; a vent for relieving said chamber of pressure; and means responsive to a predetermined pump delivery pressure of the pump connected to said valve so as to open it and acting to close said vent for subjecting said first pressure responsive means to the pressure of fluid at the inlet side of said valve.

5. In pump control mechanism having a valve in a conduit for supplying actuating fluid to the pump, and a by-pass for passing a relatively small amount of said fluid to the pump when said valve is closed; means forming a chamber in communication with the inlet side of said valve; a piston in said chamber so connected to said valve that pressure at the inlet side of the latter acts on said piston to tend to close said valve; a vent for said chamber; a second piston responsive to pump delivery pressure operatively connected to said valve for opening the latter and closing said vent to enable pressure at the inlet side of said valve to act on said first piston to close said valve when pump delivery pressure falls below a predetermined value; and means for reopening said vent when said valve is closed.

6. In pump control mechanism having a valve in a conduit for supplying actuating fluid to the pump, and a by-pass for passing a relatively small amount of said fluid to the pump when said valve is closed; means forming a chamber in communication with the inlet side of said valve; a piston in said chamber; means subjecting said piston to the pressure of fluid at the inlet side of said valve; means connecting said piston to said valve so as to close said valve; a vent port for said chamber; a second piston having its upper end located in said chamber and formed with a passage leading from its upper end face to said vent port; means for subjecting the lower end of said second piston to pump delivery pressure for moving it in a direction to open said valve and into engagement with the under side of said first piston to close said vent so that inlet steam pressure acts on said first piston to close said valve when pump delivery pressure falls below a predetermined value; and a spring forming a yieldable connection between said pistons for transmitting the movement of one piston to the other and acting, on movement of said second piston in a direction to open said valve, to maintain said vent open until said valve opens and acting, upon movement of said second piston, in a direction to close said valve, to reopen said vent when said valve is fully closed.

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