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HYDRAULIC COMPUTER FOR PUMP BY-PASS CONTROL

Filed June 27, 1963

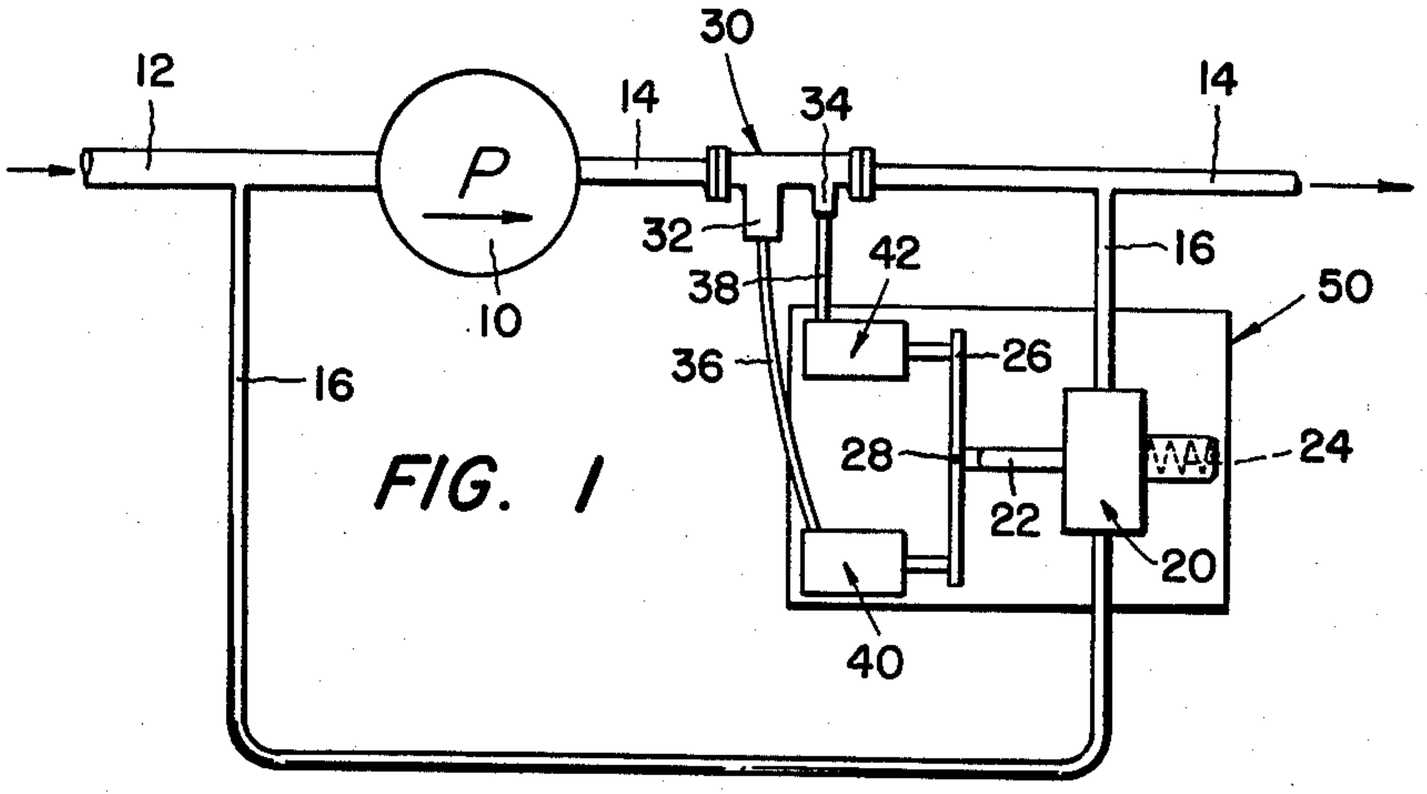

FIG. 1

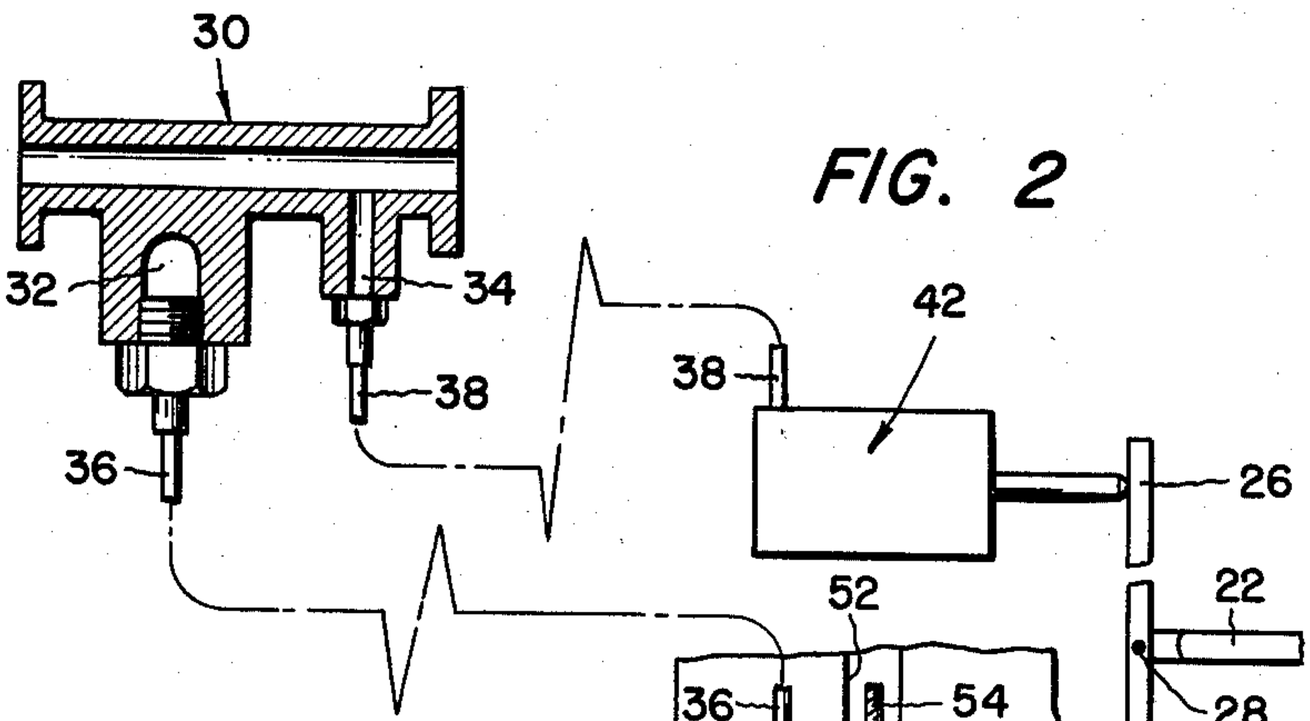

FIG. 2

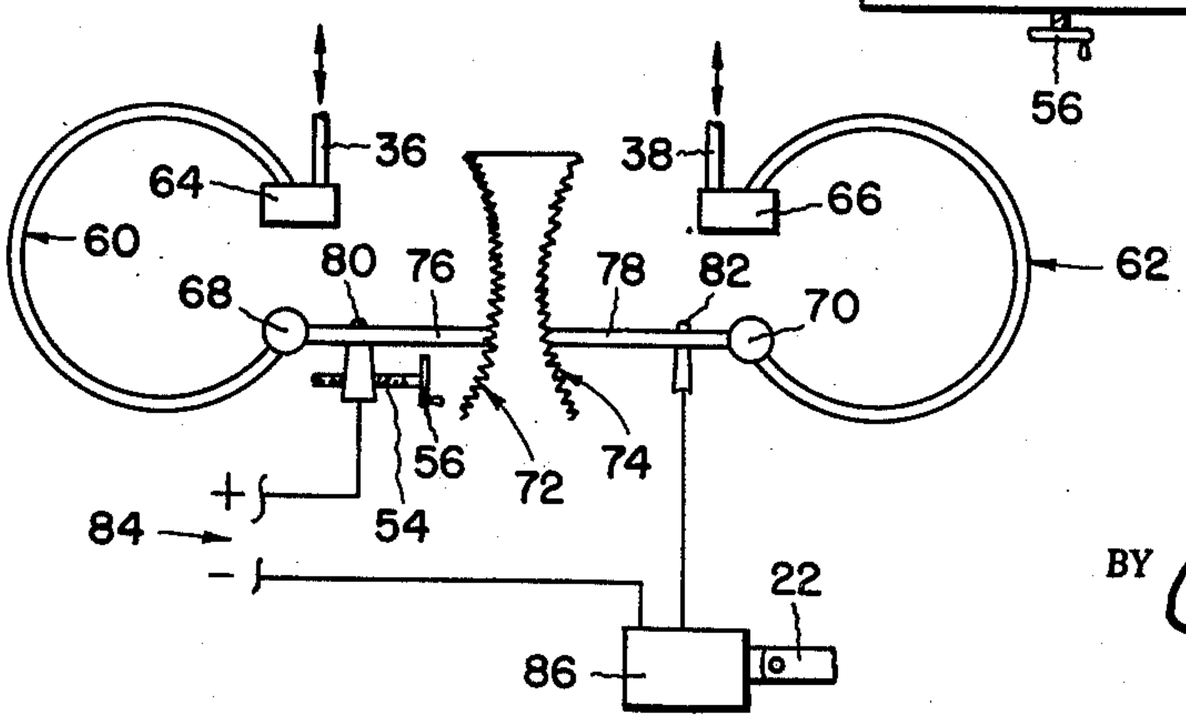

FIG. 3

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HYDRAULIC COMPUTER FOR PUMP BY-PASS CONTROL

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8 Claims. (Cl. 103—42)

This invention relates to pumps, compressors and the like and more particularly to means to control the output thereof.

The present invention is particularly adapted, but is not limited, to boiler feed pumps or similar pumps which normally operate at elevated temperatures and/or pressures. When such a pump operates at reduced flow conditions, there is a danger of pump binding and seizure because of overheating. To deter or prevent overheating present pump systems of the aforementioned type include means for maintaining a minimal feed-back or by-pass flow. It is readily understood that maintaining a feed-back or by-pass flow during normal pump operation is a power waste.

Accordingly, an object of this invention is to provide a pump that operates at high temperature and/or pressure levels with normally closed feed-back or by-pass flow means which opens when above normal operating temperatures and/or pressures are encountered.

Another object of the present invention is to provide the foregoing pump feed-back or by-pass means that varies the rate of feed-back or by-pass flow in response to change of temperature and/or pressure above normal operating conditions.

Still another object of the present invention is to provide the foregoing pump feed-back or by-pass means in which the value of excessive heat and excessive pressure signals may be varied relative to one another.

This invention contemplates a pump with an inlet line, an outlet line, and a by-pass line connecting the inlet and outlet lines across the pump, a valve disposed in the by-pass line and has a spring for biasing the valve closed during normal operation of the pump means in the outlet line for sensing temperature and pressure of pumped fluid and for providing signals representing the sensed temperature and pressure, and motor means connected to the valve and sensing means for opening the valve in response to signals representing temperature and pressure in excess of normal pump operating ranges.

The foregoing and other objects and advantages of the invention will appear more fully hereinafter from a consideration of the detailed description which follows, taken together with the accompanying drawings wherein several embodiments of the invention are illustrated by way of example. It is to be expressly understood, however, that the drawings are for illustration purposes only and are not to be construed as defining the limits of the invention.

FIGURE 1 is a schematic view of a pump and by-pass system made in accordance with the present invention,

FIGURE 2 is an enlarged schematic view of the by-pass valve control and operating means of the system of FIGURE 1, and

FIGURE 3 is a schematic view of a modified by-pass valve control and operating means.

Referring now to the drawings, and particularly to FIGURES 1 and 2, a pump 10, such as a boiler feed pump has an inlet line 12 to receive fluid to be pumped an an outlet line 14 for the pumped fluid. A line 16 is in communication with inlet line 12 and outlet line 14 to provide a pump feed-back or a by-pass from the normal destination of the pumped fluid.

A (normally closed) valve 20 is disposed in line 16 to control the flow of fluid therethrough, and may be of the type shown, described and claimed in U.S. application

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S.N. 290,986, filed June 27, 1963, by C. J. Worth and assigned to the same assignee as this application. Valve 20 has a plunger 22 that is biased by a spring 24 to a position blocking flow of by-pass fluid under normal operating conditions of pump 10, in other words, when the temperature and pressure of the pump discharge in line 14 do not exceed operating norms.

A sensor 30 is interposed in outlet line 14 between pump 10 and by-pass line 14, and has a temperature bulb 32 and a pressure pick-off 34 to provide pilot pressure signals in accordance with or representative of the temperature and pressure, respectively, of the pump discharge in line 14. A pair of motors or actuators 40 and 42 are connected to bulb 32 and pick-off 34, respectively, by respective lines 36 and 38, and are responsive to the pilot signals. Motors 40 and 42 are operatively connected to or associated with opposite ends of a ratio bar 26 connected, by a pivot pin 28 or the like, at its mid-point to the valve plunger 22. The connections of motors 40 and 42 to bar 26 each form the pivot point for the bar 26 when the motor at the opposite end of the bar responds to a change of its pilot signal. Inasmuch as motors 40 and 42 operate in opposition to the force or bias of spring 24, they do not require positive attachment and may merely bear on bar 26 as shown in the drawings.

One form of motor construction is shown in FIGURE 2 wherein motor 40 is comprised of a cylinder 44 and a piston 46 slidable in the cylinder. Piston 46 has a rod member 48 that extends forwardly through cylinder 44 and abuts the end of bar 26. An anti-friction ball may be disposed in the front end of rod 48. Although not shown, a light rate return spring may be disposed in the cylinder 44 forward of piston 46. Valve 20 and motors 40 and 42 are mounted on a platform 50. To vary the value or effect of the pilot signals relative to one another, motors 40 and 42 are movably mounted in a slot or track 52 in platform 50 by worm or lead screws 54 that rotate by a hand wheel 56 for adjusting the distance of the motors from the pivot connection of bar 26 to plunger 22. Inasmuch as the construction mounting, and adjustment means of both motors 40 and 42 are the same as one another, such details are shown only for motor 40.

A modified valve operating system is shown in FIGURE 3 wherein Bourdon tubes 60 and 62, correspond to motors 40 and 42, have fixed ends 64 and 66, respectively, connected to the respective signal lines 36 and 38. A pair of variable resistors 72 and 74, such as industrial precision rheosats, are connected in series and have respective wiper arms 76 and 78 that pivot on trunnions 80 and 82, respectively. Wiper arms 76 and 78 are pivotally connected to free ends 68 and 70, respectively, of the respective Bourdon tubes 60 and 62. To vary the value of the pilot signals relative to one another, trunnions 80 and 82 are movably mounted relative to the respective free Bourdon tube ends 68 and 70 in a manner corresponding to the aforementioned adjustable mounting of motors 40 and 42. An electrically responsive actuator 86 is connected to plunger 22 to control valve 20 in response to D.C. signals from a source 84 as modified by the variable resistors 72 and 74 in accordance with or representative of the temperature and pressure of the pump discharge in outlet line 14.

Should either or both of the lines 36 and 38 fail, the resulting actuating force on plunger 22 will become nil, and spring 24 will bias plunger 22 to a full open by-pass position.

Although several embodiments of the invention have been illustrated and described in detail, it is to be expressly understood that the invention is not limited thereto. Various changes may also be made in the design and arrangement of the parts without departing from the

spirit and scope of the invention as the same will now be understood by those skilled in the art.

I claim:

1. In combination with a pump having an inlet line to receive fluid and an outlet line for pumped fluid:

(*a*) a by-pass line connecting the inlet and outlet lines;

(*b*) a valve connected in the by-pass line having a member movable therein to control the flow therethrough and through the by-pass line, and a spring for biasing the member to a closed position for blocking such flow when the temperature and pressure of pumped fluid are within normal operating ranges;

(*c*) means connected in the outlet line to sense temperature and pressure of pumped fluid and to provide pilot signals representing such sensed temperature and pressure; and

(*d*) motor means connected to the sensing means being operatively associated with the valve to move the valve member against the bias of the spring for opening the valve to pass flow therethrough in response to pilot signals representing combined temperature and pressure each in excess of normal operating ranges.

2. In combination with a pump having an inlet line to receive fluid and an outlet line for pumped fluid:

(*a*) a by-pass line connecting the inlet and outlet lines;

(*b*) a valve connected in the by-pass line having a member movable therein to control the flow therethrough and through the by-pass line, and a spring for biasing the member to a closed position for blocking such flow when the temperature and pressure of pumped fluid are within normal operating ranges;

(*c*) means connected in the outlet line to sense temperature and pressure of pumped fluid and to provide pilot signals representing such sensed temperature and pressure;

(*d*) a pair of motors operatively associated with the valve each to move the valve member in addition to such movement by the other of the motors against the bias of the spring for opening the valve to pass flow therethrough in response to pilot signals it receives;

(*e*) one of the motors being connected to the sensing means to receive pilot signals representing pressure of the pumped fluid in excess of its normal operating range; and

(*f*) the other of the motors being connected to the sensing means to receive signals representing temperature of the pumped fluid in excess of its normal operating range.

3. In combination with a pump having an inlet line to receive fluid and an outlet line for pumped fluid:

(*a*) a by-pass line connecting the inlet and outlet lines;

(*b*) a valve connected in the by-pass line having a member movable therein to control the flow therethrough and through the by-pass line, and a spring for biasing the member to a closed position for blocking such flow when the temperature and pressure of pumped fluid are within normal operating ranges;

(*c*) a bar member pivotally connected at its midpoint to the valve member;

(*d*) means connected in the outlet line to sense temperature and pressure of pumped fluid and to provide pilot signals representing such sensed temperature and pressure;

(*e*) a pair of motors connected to the sensing means being operatively associated each with one of the ends of the bar member;

(*f*) one of the pair of motors being responsive to pilot signals representing temperature to move the valve member by the bar member and against the bias of the spring for opening the valve to pass flow therethrough when the temperature of pumped fluid exceeds its normal operating range; and

(*g*) the other of the pair of motors being responsive to pilot signals representing pressure to move the valve member by the bar member and against the bias of the spring for opening the valve to pass flow therethrough when the temperature of pumped fluid exceeds its normal operating range.

4. In combination with a pump having an inlet line to receive fluid and an outlet line for pumped fluid:

(*a*) a by-pass line connecting the inlet and outlet lines;

(*b*) a valve connected in the by-pass line having a member movable therein to control the flow therethrough and through the by-pass line, and a spring for biasing the member to a closed position for blocking such flow when the temperature and pressure of pumped fluid are within normal operating ranges, the spring urging the valve member past its closed position to a full open position in the absence of a pilot signal;

(*c*) a bar member pivotally connected at its midpoint to the valve member;

(*d*) means connected in the outlet line to sense temperature and pressure of pumped fluid and to provide pilot signals representing such sensed temperature and pressure;

(*e*) a pair of motors connected to the sensing means being operatively associated each with one of the ends of the bar member;

(*f*) one of the pair of motors being responsive to pilot signals representing temperature to move the valve member by the bar member and against the bias of the spring for opening the valve to pass flow therethrough when the temperature of pumped fluid exceeds its normal operating range;

(*g*) the other of the pair of motors being responsive to pilot signals representing pressure to move the valve member by the bar member and against the bias of the spring for opening the valve to pass flow therethrough when the temperature of pumped fluid exceeds its normal operating range; and

(*h*) means for changing the distance of each of the pair of motors from the connection of the bar and valve members.

5. In combination with a pump having an inlet line to receive fluid and an outlet line for pumped fluid:

(*a*) a by-pass line connecting the inlet and outlet lines;

(*b*) a valve connected in the by-pass line having a member movable therein to control the flow therethrough and through the by-pass line, and a spring for biasing the member to a closed position for blocking such flow when the temperature and pressure of pumped fluid are within normal operating ranges;

(*c*) means connected in the outlet line to sense temperature and pressure of pumped fluid and to provide pilot signals representing such sensed temperature and pressure;

(*d*) motor means connected to the sensing means being operatively associated with the valve to move the valve member against the bias of the spring for opening the valve to pass flow therethrough in response to pilot signals representing combined temperature and pressure each in excess of normal operating ranges; and

(*e*) said motor means including an actuator connected to the valve member responsive to D.C. signals for opening and closing the valve, and means connecting the actuator to a D.C. signal source and varying the D.C. signal in response to the pressure signals.

6. In combination with a pump having an inlet line to receive fluid and an outlet line for pumped fluid:

(*a*) a by-pass line connecting the inlet and outlet lines;

(*b*) a valve connected in the by-pass line having a member movable therein to control the flow therethrough and through the by-pass line, and a spring for biasing

the member to a closed position for blocking such flow when the temperature and pressure of pumped fluid are within normal operating ranges;

(*c*) means connected in the outlet line to sense temperature and pressure of pumped fluid and to provide pilot signals representing such sensed temperature and pressure;

(*d*) a pair of motors connected to the sensing means, one being responsive to pilot signals representing temperature and the other being responsive to pilot signals representing pressure;

(*e*) an actuator connected to the valve member being responsive to D.C. signal for opening the valve to pass flow therethrough when the D.C. signal represents temperature and pressure in excess of normal operating ranges; and

(*f*) means connecting the actuator to a D.C. signal source being connected to the motors and actuated thereby to vary the D.C. signal in response to changes of the pilot signals.

7. In combination with a pump having an inlet line to receive fluid and an outlet line for pumped fluid:

(*a*) a by-pass line connecting the inlet and outlet lines;

(*b*) a valve connected in the by-pass line having a member movable therein to control the flow therethrough and through the by-pass line, and a spring for biasing the member to a closed position for blocking such flow when the temperature and pressure of pumped fluid are within normal operating ranges, the spring urging the valve member past its closed position to a full open position in the absence of a pilot signal;

(*c*) means connected in the outlet line to sense temperature and pressure of pumped fluid and to provide pilot signals representing such sensed temperature and pressure;

(*d*) a pair of motors connected to the sensing means, one being responsive to pilot signals representing temerature and the other being responsive to pilot signals representing presure;

(*e*) an actuator connected to the valve member being responsive to D.C. signal for opening the valve to pass flow therethrough when the D.C. signal represents temperature and pressure in excess of normal operating ranges; and

(*f*) a pair of series connected variable resistors connecting the actuator to a D.C. signal source each being connected to one of the motors and actuated thereby, one varying the D.C. signal in response to change of the pilot signal representing temperature and the other varying the D.C. signal in response to change of the pilot signal representing pressure.

8. The combination in accordance with claim 7, and means for varying the rate of response of each of the variable resistors.

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