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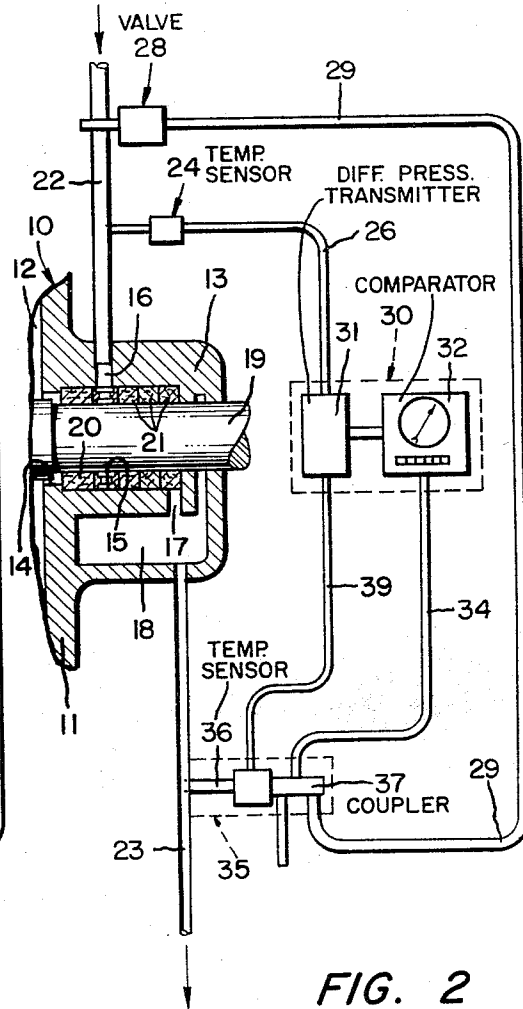
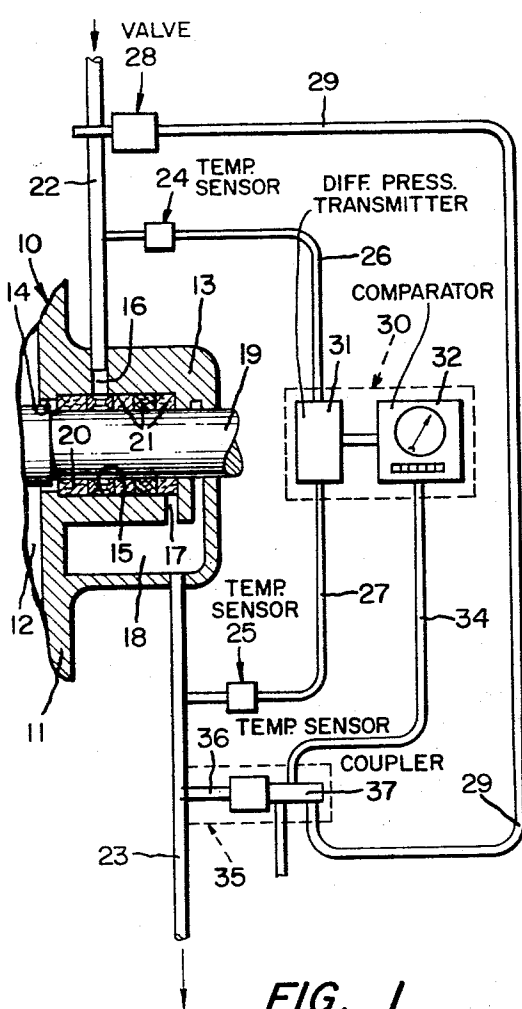
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3,297,329

PUMP SEAL INJECTION CONTROL

Filed Aug. 26, 1964

2 Sheets-Sheet 1



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FIG. 3

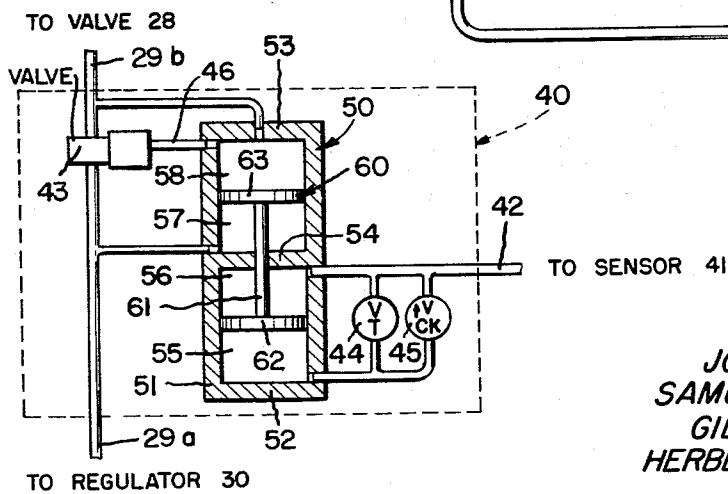
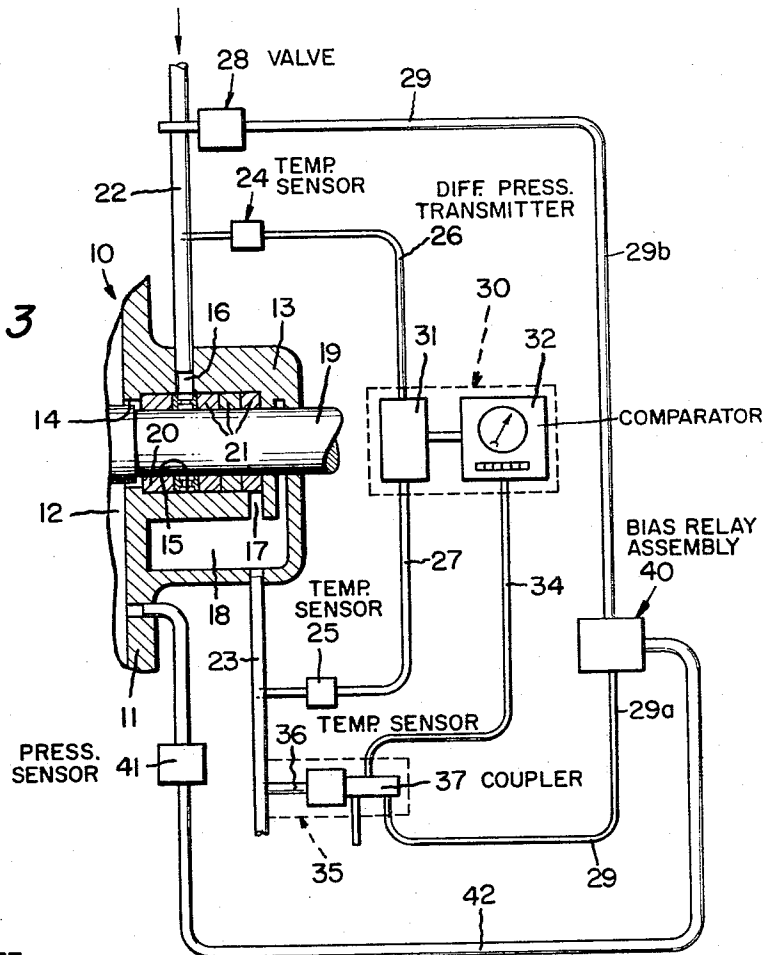


FIG. 4

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PUMP SEAL INJECTION CONTROL

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12 Claims. (Cl. 277-3)

The present invention relates generally to pumps handling high temperature fluids and more particularly to a controlled hydraulic or wet seal means for varying pump conditions.

Hydraulic type seal means are generally not new as shown in U.S. Patent 1,681,075 granted Aug. 14, 1928 to R. H. Wiegert; 2,287,205 granted June 23, 1942 to F. Stone; 2,834,619 granted May 13, 1958; 2,913,989 granted November 24, 1959 to T. J. Boardman and J. G. Williams; 2,992,618 granted July 18, 1961; and Patents 1,759,074 and 1,867,236 granted May 20, 1930 and July 12, 1932, respectively, to W. Van Rijswijk. However, none of the foregoing teach the invention as will be described and claimed hereinafter.

With a hydraulic or wet seal, sufficient flow is required for lubrication which must be held within desired limits and does not become a leakage problem.

Accordingly an object of the present invention is to provide an efficient hydraulic or wet seal for a pump handling high temperature fluids under varying conditions.

Another object of the present invention is to provide the aforementioned seal means having sensing means with controls responsive thereto for maintaining a desired limited flow for lubrication.

Still another object of the present invention is to provide the aforementioned seal means with control means responsive to rapid and excessive or emergency operating conditions.

This invention contemplates in combination with a pump for fluids at elevated temperatures having a casing defining a pump chamber, a pump shaft extending through the casing, and a plurality of rings disposed in the casing and encircling the shaft providing a wet seal with a drain at one end permitting limited flow of fluid at elevated temperature therethrough from the pump chamber to the drain, a system for controlling such flow of fluid at elevated temperature, comprising: an inlet adapted to receive cold fluid connected to the casing in communication with the seal intermediate its ends and having signal responsive means for controlling flow of cold fluid therethrough; sensing means operatively associated with the inlet and drain for sensing flow of cold fluid and drainage flow, and for providing signals representing such flows; and means connected to the sensing means to receive signals representing sensed flows and connected to the flow control means to provide signals thereto in response to the signals received to control flow of cold fluid for controlling flow of fluid from the pump chamber through the seal.

The foregoing and other objects and advantages 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.

FIG. 1 is a schematic view of a pump (shown in part) for hot fluids having a wet seal and a system for controlling flow through the seal in accordance with the present invention,

FIGS. 2 and 3 are schematic views similar to FIG. 1

each illustrating a modified system in accordance with the present invention, and

FIG. 4 is a sectional view diagrammatically illustrating the relay of the system of FIG. 3.

Referring now to FIG. 1, a pump 10 (shown in part) for handling fluid at high or elevated temperature, has a casing 11 defining a pump chamber 12 for an impeller (not shown). A shaft 19 extends through a bore 14 in an extended or seal section 13 of casing 11 for driving the pump impeller (not shown) in chamber 12. Bore 14 has an enlarged intermediate or central portion forming an annular seal chamber 15, around shaft 19, connected at its outer end, or its end remote from chamber 12, to a sump 18 by a drain 17. A plurality of inner and outer rings 20 and 21, respectively, are disposed in seal chamber 15 to provide a wet seal for shaft 19 permitting limited flow of hot fluid from pump chamber 12 to sump 18. A conduit 23 is provided for draining sump 18. At this juncture it should be understood that pump 10 is substantially a conventional pump, with a wet seal, for handling hot fluids and the like.

In a pump, such as pump 10, a wet seal is provided for a predetermined flow therethrough under normal operating conditions. To control flow of high temperature fluid from pump chamber 12 through the seal, an inlet passage 16 is provided in casing portion 13 which communicates with chamber 15 between inner and outer seal rings 20 and 21. Although but one ring 20 and a plurality of rings 21 are shown in the drawings and referred to herein, such quantities of rings are arbitrarily chosen to facilitate the description of the present invention and are not to be construed as defining limits of the invention. The single inner ring 20 is illustrative of one means of providing minimum clearance around shaft 19 which in practice, probably would be derived by machining bore 14 and shaft 19. However, for purposes of description, both such means are considered equivalents of each other with the inclusion of ring 20 providing clarity to the disclosure. Broadly stated, the wet seal in accordance with the present invention is to provide a pair of axially spaced restrictions along a flow path formed by bore 14 and shaft 19 from chamber 12 to sump drain 17. By providing a variable head to the flow path between the spaced restrictions, flow of hot fluid from chamber 12 can be controlled. Towards this end, a conduit 22 connected to a source (not shown) of cold fluid, is connected to inlet passage 16 to provide a cold flow past outer rings 21 in seal chamber 15 to sump 18. A normally open signal responsive valve 28 is provided in conduit 22 to control the flow of cold fluid to seal chamber 15 in response to signals from a regulator 30 which are received by its input line 29.

It is well known that flow of pressure fluid through a restricted orifice or passage is limited and attended by a pressure drop. In the present invention, flow of pressure fluid from chamber 12 past rings or restrictions 20 and 21 to sump 18 is attended by a two step pressure drop; the first during flow past ring or restriction 20 and the second during flow past rings or restriction 21. By providing a variable head of cold fluid to chamber 15 between rings or restrictions 20 and 21, the flow of hot fluid past ring or restriction 20 from chamber 12 can be controlled, with the resulting flow of fluid past rings or restriction 21 to sump 18 having a resultant temperature dependent upon the relative quantities of hot fluid from chamber 12 and cold fluid from conduit 22 and the temperature of each.

A pair of sensors or sensing means 24 and 25 are provided in conduits 22 and 23, respectively, for sensing the respective flows therethrough and for providing signals representing such sensed flows, sensors 24 and 25 having output or transmission lines 26 and 27, respectively, con-

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nected to the regulator 30 for transmitting the representative signals. Regulator 30 provides control signals, in response to the representative signals from sensors 24 and 25, to valve 28 through its output line 34 that is connected to valve input line 29.

The sensors 24 and 25 sense the temperature of fluid flowing through the lines 22 and 23 respectively. These sensors transmit a pneumatic signal representing the temperature of the sensed fluid through transmission lines 26 and 27 to regulator 30. Although pneumatic signals have been illustrated other signals may be used and are considered to be within the scope of this invention.

To accomplish this, regulator 30 has a resolver or differential pressure transmitter 31 which receives the representative signals from sensors 24 and 25, and provides resultant signals, in response thereto, to a comparator or differential temperature controller 32. Comparator 32 compares resultant signals to a preset standard, which can be varied or changed as desired, and derives the control signals provided to line 34 for actuating valve 28 to control flow of cold fluid in conduit 22.

A protective device 35 is provided for emergency conditions or malfunction of regulator 30. Protective device 35 has a sensor or sensing means 36 in conduit 23 for sensing flow therethrough and for providing signals representing such sensed flow, and automatic or signal responsive coupling means 37 normally connecting line 34 to line 29 for transmission of control signals from regulator 30 to valve 28. Coupling means 37 is responsive to representative signals from sensor 36 and when such signals indicate emergency conditions, coupler 37 disconnects or blocks signals from line 34 to line 29. In the absence of such signals, valve 28 opens fully to permit maximum flow in conduit 22.

As shown in FIG. 2, the signal and control arrangement of FIG. 1 is modified by eliminating sensor 25 and its output line 27, and by providing sensor 36 with an output line 39 connected to regulator 30 for transmission of signals to resolver 31 representing sensed flow in conduit 23. In this modified arrangement, sensor 36 provides signals for actuating coupler 37 and to regulator 30 for deriving signals for actuating valve 28.

In operation at start-up, pump 10 handles cold fluid, and pressure from an outside source (not shown) is available to regulator 30 to provide comparator 32 with a control signal transmitted through coupler 37, connecting lines 34 and 37, to fully close valve 28.

As pumped fluid, initially providing total allowable flow past seal rings or restrictions 20 and 21, progressively becomes heated to its normal or a desired temperature, sensors 25 and 36 in FIG. 1, or sensor 36 alone in FIG. 2, sense increasingly hot drainage in conduit 23 to provide a progressively increasing signal to resolver 31.

When resolver 31 receives signals from sensor 25 or 36 and from sensor 24 which initially merely indicates temperature within conduit 22, indicating a temperature differential between conduits 22 and 23 a resultant signal will be transmitted to comparator 32.

When comparator 32 receives a resultant signal indicating or representing an excessive temperature differential, the control signal output will reduce to open valve 28 and permit sufficient cold fluid flow to seal chamber 15 between rings or restrictions 20 and 21 to limit hot fluid flow through the seal from chamber 12. During normal operation of pump 10, the system will remain in equilibrium with partial cold injection flow through conduit 22 limiting hot fluid flow from chamber 12 combining to provide drainage at a desired temperature.

If, during pump operation, a malfunction or emergency conditions should occur wherein the drainage in conduit 23 becomes hotter than a desired maximum even though the temperature differential between injection and drainage flows in conduits 22 and 23, respectively, appears to be satisfactory, sensor 36 would provide signals, representing excessive heat, to actuate coupler 37 to vent inlet

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line 29 causing valve 28 to fully open and pass maximum cold injection flow to seal chamber 15.

While the foregoing is described as a system utilizing pressure signals, it should be understood that, in accordance with the present invention by substitution of equivalent components electrical signals can be provided.

In accordance with the present invention, a further modification of the system of FIG. 1 is derived by further control of valve 28 in accordance with pump pressure as shown in FIGS. 3 and 4 of the drawings. A bias relay assembly 40 is provided in line 29 between regulator 30 and valve 28. A sensor 41 is connected to pump 10 to sense pump operating pressure (either inlet or discharge) and to provide a signal representing sensed pressure through a transmission line 42 to relay assembly 40.

As more specifically shown, diagrammatically, in FIG. 4 a pilot operated or signal responsive proportioning valve 43 divides line 29 into two portions 29a and 29b, receiving signals from regulator 30 from line portion 29a and providing normally reduced signals to actuate valve 28 through line portion 29b. A relay 50 of the assembly 40 has a casing 51 which is closed at its ends by a pair of spaced walls 52 and 53 and has a central wall 54 therebetween. A piston 60 is movable axially in casing 51 and is comprised of a rod 61, which extends through central wall 54, connected at its ends to a pair of spaced heads 62 and 63. Head 62 divides the area between walls 52 and 54 into a pair of motor chambers 55 and 56 which vary in volume oppositely to one another when piston 60 moves axially in casing 51. Head 63 similarly divides the area between walls 53 and 54 into a pair of similar chambers 57 and 58.

Line 42, from sensor 41, communicates with chamber 56, and with chamber 55 through a throttling valve 44 and a check valve 45 connected in parallel with one another. Line portions 29a and 29b in addition to being connected to valve 43 also communicates with chambers 57 and 58, respectively. Chamber 58 is also connected to valve 43 by a pilot line 46.

Signal changes representing rapid pump pressure changes are provided by line 42 to chamber 56, and to chamber 55 through throttle valve 44, check valve 45 permitting exhaust flow only from chamber 55 to line 42. Such an increase or decrease of signal pressure in chamber 56 tends to move piston 60 axially until forces across head 62 are balanced. When piston 60 is in equilibrium forces across head 63 are balanced, chamber 57 receiving signal pressure from regulator 30 and chamber 58 receiving signal pressure provided to valve 28.

Axial movement, which is minimal of piston 60 tends to change pressures in chambers 57 and 58 seen as a change in pilot pressure from chamber 58 to valve 43 changing the relationship of the signals from regulator 30 and to valve 28 to reset valve 28 and adjust cold fluid flow in line 22 to compensate for change of the pressure head of hot fluid.

In view of the foregoing in accordance with the present invention, a novel system is provided to control flow of hot fluid through a wet seal of a pump for handling fluids at elevated temperatures, such system having emergency or malfunction controls and being adapted for control response with rapid changes of pump pressure.

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 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.

We claim:

1. In combination with a pump for fluids at elevated temperatures having a casing defining a pump chamber, a pump shaft extending through the casing from the casing, and a wet seal in the casing encircling the shaft providing a pair of spaced restrictions and being subject to a head

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of hot fluid at one end with a drain at its other end for limited flow of fluid therethrough from the pump chamber; a system for controlling flow of fluids at elevated temperature through the seal, comprising:

- (a) an inlet adapted to receive cold fluid connected to the casing in communication with the seal intermediate its restrictions and having signal responsive means for controlling flow of cold fluid therethrough,
 - (b) means operatively associated with the inlet and drain for sensing flows of cold fluid and seal drainage and for providing signals representing the second flows, and
 - (c) regulator means connected to the sensing means to receive signals representing sensed flows and connected to the flow control means to provide actuating signals thereto in response to signals representing sensed flows to control flow of cold fluid to the seal for controlling flow of fluid therethrough from the pump chamber.
2. The system, in combination, in accordance with claim 1, and
- (a) signal responsive coupling means connected to the regulator and flow control means normally passing signals therethrough, and being connected to the sensing means for receiving signals representing sensed drainage flow and for blocking signals between the regulator and flow control means when the signals representing sensed drainage flow exceed a predetermined maximum.
3. The system, in combination, in accordance with claim 1, and
- (a) means connected to the casing in communication with the pump chamber for sensing pressure therein and for providing signals representing the sensed pressure, and
 - (b) relay means connected to the regulator means for receiving signals therefrom, the flow control means for providing actuating signals thereto in response to signals from the regulator means, and the pressure sensing means for varying the relationship between signals received from the regulator means and provided to the flow control means to compensate for sudden changes in pressure in response to signals representing such sensed pressure.
4. The system in combination, in accordance with claim 1, and
- (a) means connected to the casing in communication with the pump chamber for sensing pressure therein and for providing signals representing the sensed pressure,
 - (b) signal responsive coupling means and relay means connected in series with one another to the regulator and flow control means,
 - (c) the coupling means normally passing signals between the regulator and flow control means being connected to the flow sensing means to receive signals therefrom representing drainage flow, and blocking normally passed signals when the signals representing drainage flow exceed a predetermined maximum, and
 - (d) the relay means receiving signals from the regulator means and providing actuating signals to the flow control means in response to signals from the regulator means, and being connected to the pressure sensing means and responsive to the signals therefrom for varying the relationship between signals received from the regulator means and provided to the flow control means to compensate for sudden changes in pressure in response to signals representing such sensed pressure.
5. In combination with a pump for fluids at elevated temperatures having a casing defining a pump chamber, a pump shaft extending through the casing from the casing, and a wet seal in the casing encircling the shaft providing a pair of spaced restrictions and being subject to a head

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of hot fluid at one end with a drain at its other end for limited flow of fluid therethrough from the pump chamber, a system for controlling flow of fluids at elevated temperature through the seal, comprising:

- (a) an inlet conduit adapted to receive cold fluid connected to the casing in communication with the seal intermediate its restrictions and having normally open signal responsive means for controlling flow of cold fluid therethrough,
 - (b) means operatively associated with the inlet conduit for sensing temperature of cold fluid flowing therethrough and for providing signals representing the sensed temperature,
 - (c) a drain conduit connected to the casing in communication with the seal through the drain,
 - (d) means operatively associated with the drain conduit for sensing temperature of seal drainage flow therethrough and for providing signals representing the sensed temperature,
 - (e) regulator means connected to both temperature sensing means to receive signals representing temperatures of cold fluid and seal drainage flows and connected to the flow control means to provide actuating signals thereto in response to signals representing sensed temperatures to control flow of cold fluid to the seal for controlling flow of fluid therethrough from the pump chamber.
6. The system, in combination, in accordance with claim 5, and
- (a) signal responsive coupling means connected to the regulator and flow control means normally passing signals therethrough, and being connected to the sensing means operatively associated with the drain conduit for receiving signals representing temperature sensed thereby and for blocking signals between the regulator and flow control means when the drainage temperature representing signal represents a temperature in excess of a predetermined maximum.
7. The system, in combination, in accordance with claim 5, and
- (a) means connected to the casing in communication with the pump chamber for sensing pressure therein and for providing signals representing the sensed pressure, and
 - (b) relay means connected to the regulator means for receiving signals therefrom, the flow control means for providing actuating signals thereto in response to signals from the regulator means, and the pressure sensing means for varying the relationship between signals received from the regulator means and provided to the flow control means to compensate for sudden changes in pressure in response to signals representing such sensed pressure.
8. The system, in combination, in accordance with claim 5, and
- (a) means connected to the casing in communication with the pump chamber for sensing pressure therein and for providing signals representing the sensed pressure,
 - (b) signal responsive coupling means and relay means connected in series with one another to the regulator and flow control means,
 - (c) the coupling means normally passing signals between the regulator and flow control means being connected to the sensing means operatively associated with the drain conduit for receiving signals representing temperature sensed thereby and for blocking signals between the regulator and flow control means when the temperature representing signal represents a temperature in excess of a predetermined maximum; and
 - (d) the relay means receiving signals from the regulator means and providing actuating signals to the flow control means in response to signals from the regulator means, and being connected to the pres-

sure sensing means and responsive to the signals therefrom for varying the relationship between signals received from the regulator means and provided to the flow control means to compensate for sudden changes in pressure in response to signals representing such sensed pressure.

9. The system, in combination, in accordance with claim 5, wherein the regulator means comprises:

- (a) resolver and comparator means connected in series with one another,
- (b) the resolver means providing the regulator means input connected to both temperature sensing means to provide a resultant signal in response to both temperature representing signals, and
- (c) the comparator means receiving resultant signals from the resolver means and providing the regulator means output connected to the flow control means for providing a signal thereto when the resultant signal exceeds a predetermined minimum.

10. The system, in combination, in accordance with claim 9, and

- (a) signal responsive coupling means connected to the regular means output and flow control means normally passing signals therethrough, and being connected to the sensing means operatively associated with the drain conduit for receiving signals representing temperature sensed thereby and for blocking signals between the regulator means output and flow control means when the drainage temperature representing signal represents a temperature in excess of a predetermined maximum.

11. The system, in combination, in accordance with claim 9, and

- (a) means connected to the casing in communication with the pump chamber for sensing pressure therein and for providing signals representing the sensed pressure, and
- (b) relay means connected to the regulator means output for receiving signals therefrom, the flow control means for providing actuating signals thereto in response to signals from the regulator means, and the pressure sensing means for varying the relationship between signals received from the regulator

means output and provided to the flow control means to compensate for sudden changes in pressure in response to signals representing such sensed pressure.

12. The system, in combination, in accordance with claim 9, and

- (a) means connected to the casing in communication with the pump chamber for sensing pressure therein and for providing signals representing the sensed pressure,
- (b) signal responsive coupling means and relay means connected in series with one another to the regulator means output and flow control means,
- (c) the coupling means normally passing signals between the regulator means output and flow control means being connected to the sensing means operatively associated with the drain conduit for receiving signals representing temperature sensed thereby and for blocking signals between the regulator means output and flow control means when the drainage temperature representing signal represents a temperature in excess of a predetermined maximum,
- (d) the relay means receiving signals from the regulator means output and providing actuating signals to the flow control means in response to signals from the regulator means output, and being connected to the pressure sensing means and responsive to the signals therefrom for varying the relationship between signals received from the regulator means output and provided to the flow control means to compensate for sudden changes in pressure in response to signals representing such sensed pressure.

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