# United States Patent [19]
**Ward**

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[54] **PUMP BYPASS LIQUID CONTROL**


[76] Inventor: **Elmer F. Ward,** 1041 N. LaLimona Dr., Tustin, Calif. 92705



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**Related U.S. Application Data**

[63] Continuation-in-part of Ser. No. 836,312, June 25, 1969, abandoned.

[52] **U.S. Cl.** .................................................. **417/213**
[51] **Int. Cl.** .............................................. **F04b 49/00**
[58] **Field of Search**..................... 417/222, 307, 308, 417/213; 91/506; 60/52 S, 52 VS



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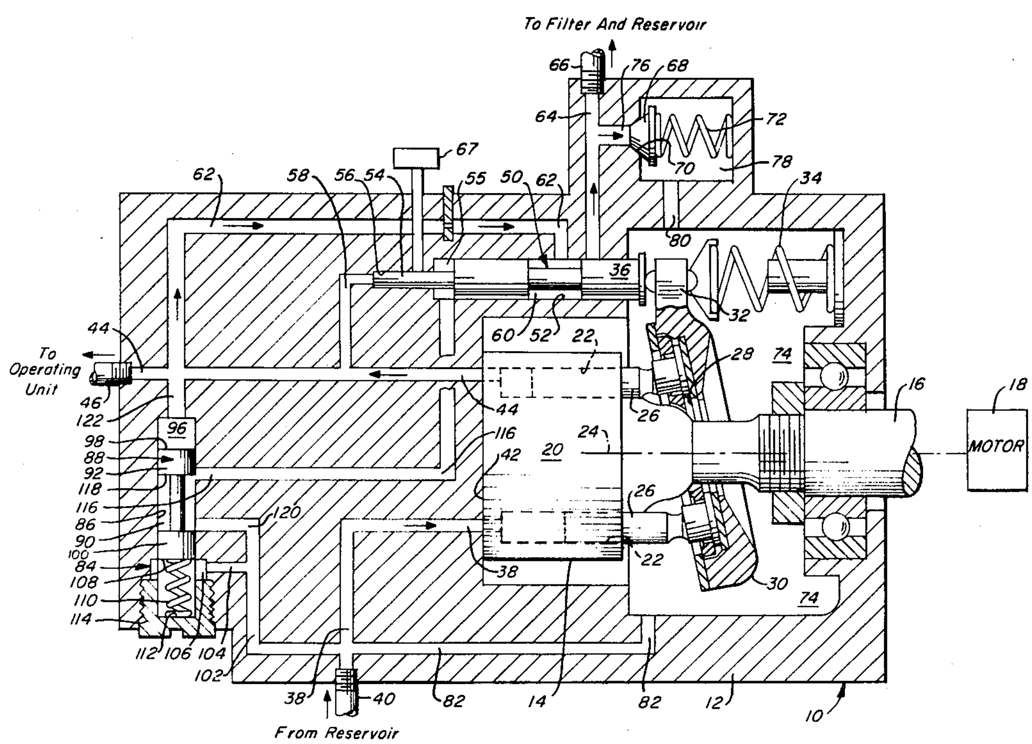
*Primary Examiner*—Charles J. Myhre
*Assistant Examiner*—Frank H. McKenzie, Jr.
*Attorney*—E. Wallace Breisch



[57] **ABSTRACT**

A fluid circulation system having a primary flow circuit for supplying fluid under pressure to an operating unit for performing a desired control function and a secondary flow circuit operative under regulated pressure conditions of said primary flow circuit for effecting a regulated control of the fluid being circulated in said secondary flow circuit. The pressure and rate of flow of fluid in the secondary flow circuit is a function of the pressure and rate of flow of fluid in the primary circuit.

**6 Claims, 3 Drawing Figures**

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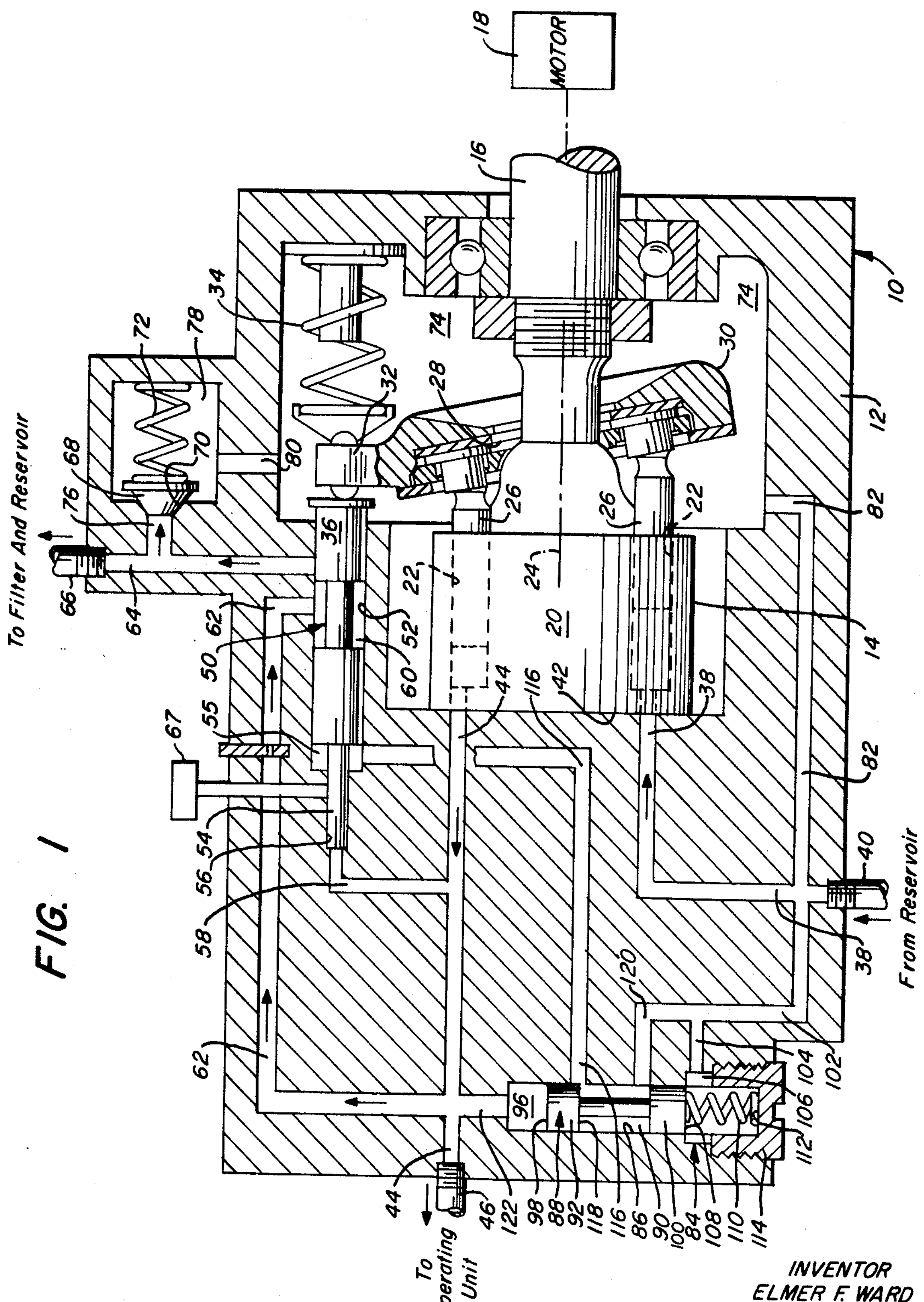


FIG. 1

INVENTOR
ELMER F. WARD

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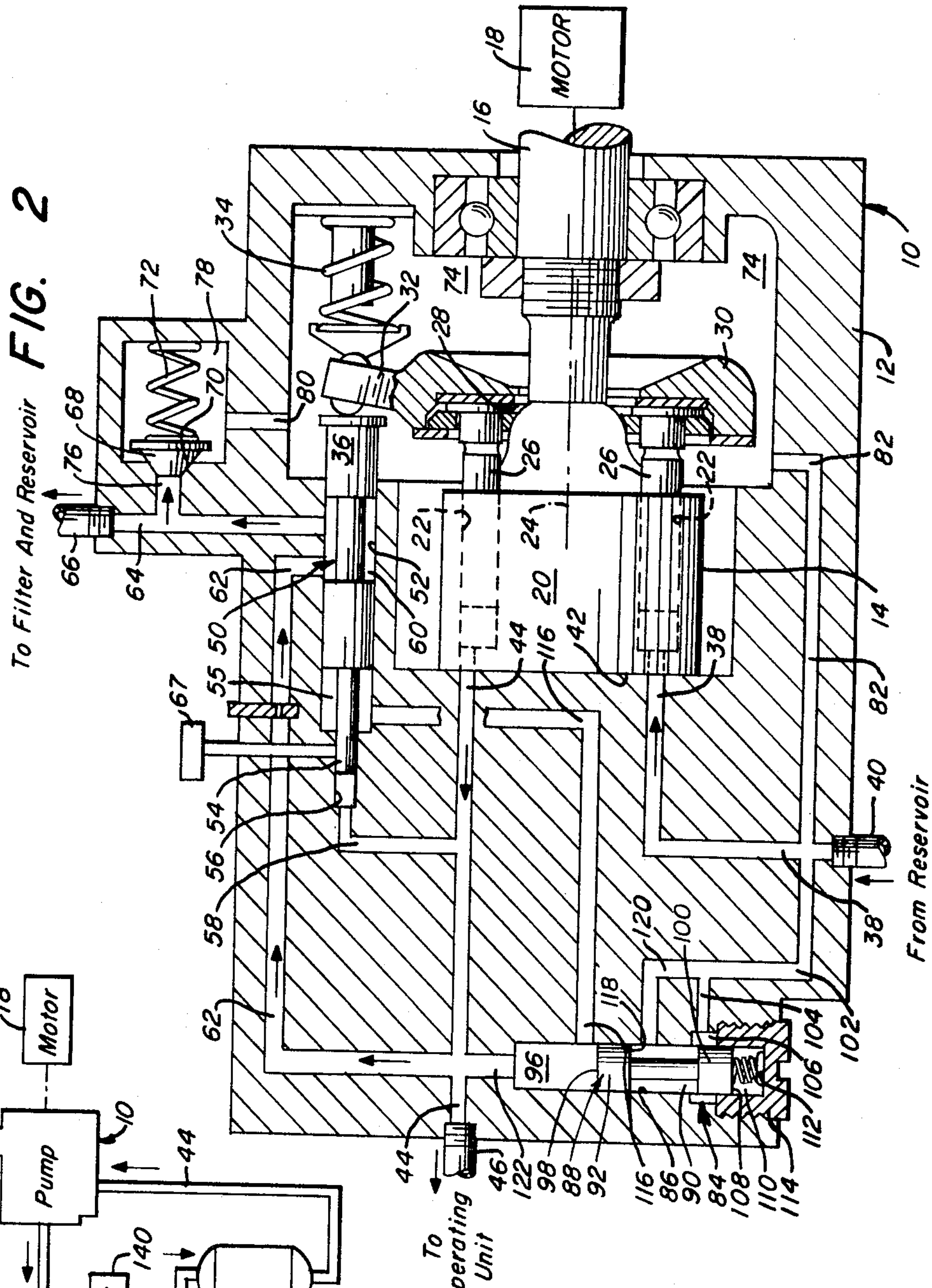


FIG. 2

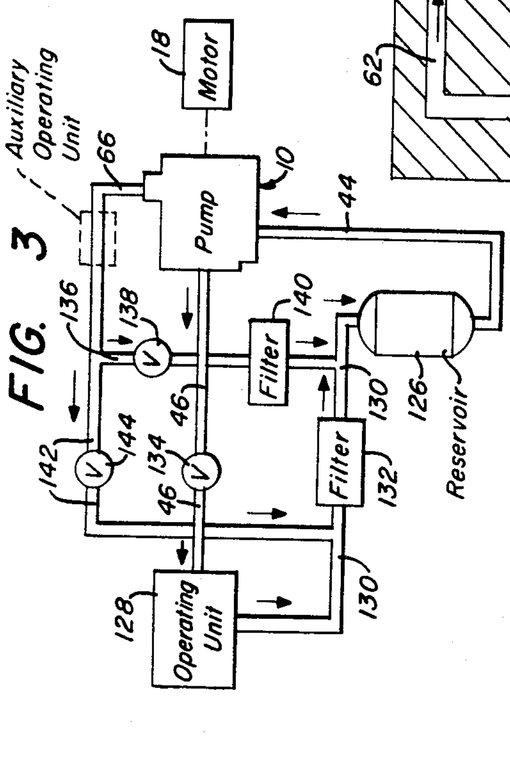


FIG. 3

INVENTOR
ELMER F. WARD

## PUMP BYPASS LIQUID CONTROL

This application is a continuation-in-part of my co-pending application Ser. No. 836,312, filed June 25, 1969 now abandoned.

### BACKGROUND OF INVENTION

A method of fluid control of various types of operating units is presently accomplished by utilization of fluid circulation systems wherein high pressure rotary fluid pumps deliver fluid under pressure from a reservoir means to the operating unit and thence return to the reservoir, said operating unit thereby performing a desired control function in accordance with the rate of flow and degree of pressure of said fluid provided by the fluid pump. In such fluid circulation systems in addition to the primary control function provided by the circulating fluid under pressure, the fluid is also utilized to operate ancillary apparatus and serve as a lubricant and coolant for both the pump and said ancillary apparatus. The pump normally utilized in such systems is of the type which operates at a constant or variable speed at a controlled discharge pressure, and with a variable discharge rate.

Cooling and lubrication of a typical pump is accomplished by circulation of the fluid being pumped. At full displacement there is a very generous supply of coolant flowing through the unit. At zero discharge flow, however, the passage of coolant is limited to leakage flow which accumulates in the pump case area. Although this flow is normally adequate for cooling and lubricating the pump, it is not sufficient to provide for cooling of ancillaries, such as an electric motor used to drive the pump. In addition, the pressure at which this leakage flow can be returned to the reservoir is limited to the pressure capability of the pump case housing and the pump shaft seal. As a result, this leakage flow (commonly called "case flow") is usually restricted to a very low pressure and, therefore, cannot be combined with the normal system high pressure return flow from the operating unit to the reservoir.

### SUMMARY OF THE INVENTION

It is an object of the present invention to provide a new and novel fluid control apparatus of the type supplying fluid under pressure from a reservoir to an operating unit wherein the control fluid is utilized to control ancillary equipment in the circulation system. A bypass communication means is provided in a pump means and includes a valve means in a passage whereby the valve means may be variably positioned to selectively establish communication from a discharge passage of the pump means to a reservoir in a manner to maintain circulation of the fluid within the pump and ancillaries while the requirements of the operating unit are changed. Relief valve means may be provided in association with said bypass communication to further provide a lubricating and cooling means should said bypass communication become ineffective because of excessive pressure therein for any reason such as clogging of filters therein.

Another object of the invention is to provide means for eliminating branch circuitry such as filter bypass circuitry when not required.

Still another object of the invention is to provide adequate cooling and lubricating fluid flow to ancillary equipment during periods of low discharge rate of flow from the pump.

Other provisions of this invention will become more apparent when taken in conjunction with the following detailed description and accompanying drawings wherein:

FIG. 1 is a sectionalized view of the pump shown in a high discharge opening condition;

FIG. 2 is a sectionalized view of the pumps shown in a low discharge operating condition; and

FIG. 3 is a fluid circuit diagram showing the pump and associated elements as employed to control a fluid operating unit.

### DESCRIPTION FIG. 1, FIG. 2

Referring to FIG. 1 and similarly FIG. 2 there is shown a fluid pump device **10** having a casing **12** enclosing a rotary barrel type pump **14** and hereinafter described passageways and valve means comprising the novel fluid control apparatus. The pump **14** is operatively rotated by a shaft **16** driven by any suitable motor means **18**. The pump **14** includes a barrel **20** having a plurality of bores **22** spaced therein in normally parallel relation with the axis **24** of the barrel **20**. Each bore **22** has a piston **26** slidably positioned therein and operable with a reciprocating action therein responsive to rotation of the barrel **20**. The reciprocating action of said pistons is effected by having one end of each piston secured to a swash plate **28** in a non-rotating yoke **30** which is positioned at variable angles of inclination with respect to the barrel axis **24** in a manner to thereby cause the reciprocating movement of the piston **26** within the bores **22** as the barrel **20** rotates. The length of stroke of the pistons **26** and consequently the rate of fluid discharge from the bores **22** is determined by the degree of the angle at which the yoke **30** is inclined, which in turn is determined by the positioning of a yoke flange **32** between a spring **34** and valve stem **36** as explained herein. The smaller the degree of angle of inclination of the yoke **30** with respect to the axis **24** the greater the degree of rate of discharge of fluid being pumped by the pistons **26** and similarly as the angle of inclination of the yoke **30** versus the axis **24** increases the rate of discharge of fluid by the pistons **26** is decreased. Movement of the valve stem **36** to the right (explained hereinafter) may cause the axis of yoke to pivot to approach a 90° angle of inclination with the axis **24** of the barrel **20** (FIG. **2**). If a large angle of inclination is maintained, it is of slightly lesser degree than 90° as limited by a suitable stop means and the spring **34** such that the pumping action of the pump **14** is maintained to provide a constant circulation of fluid in a manner described hereinafter.

Included in the pump casing **12** is an intake passage **38** leading from an intake pipe **40** to the face of barrel **20** which is positioned abutting the casing wall **42** in a manner such that the bores **22** sequentially come into alignment with the intake passage **38** to receive fluid therein on the intake stroke of the pistons **26**. A discharge passage **44** similarly leads from the casing wall **42** at a position where it will come into alignment with the bores **22** sequentially to receive fluid under pressure discharged from the bores **22** on the compression stroke of the pistons **26** to thereby supply fluid under pressure to the discharge pipe **46** and thence to an operating unit (labeled as such in FIG. **3**).

A spool valve **50** is slidably positioned in a bore **52** within the pump casing **12** in a manner such that the right hand extremity or valve stem **36** abuts the yoke flange 32 in opposition to biasing forces of spring 34. The spring 34 tends to maintain the yoke flange 32 in constant engagement with the valve stem 36 and biased in a leftward direction as viewed in the drawings. The left hand extremity or valve stem 54 of the spool valve 50 is of suitable diameter shown herein as a reduced diameter for guide means, and slidably extends through a chamber 55 into a bore 56 which in turn is connected by a passage 58 to the discharge passage 44. Intermediate the extremities of the spool valve 50 is an annular groove 60 which is in constant communication with a bypass passage 62 connected to the discharge passage 44. When spool valve 50 is positioned in its right hand position (FIG. 2), the annular groove 60 establishes communication between bypass passage 62 and return passage 64 leading to a return pipe 66. Such urging may be effected by fluid pressure means in chamber 55 or by a manual or other control shown at 67 as having schematic connection with the plunger extension 54.

A normally seated relief valve 68 may be provided to limit pressure in bypass passage 64. This valve is biased toward its seat 70 by a spring 72 and is positioned in the pump casing 12 such that when unseated or open, communication is established between the return passage 64 and a yoke housing chamber 74 in the pump casing 12 by way of a passage 76, a spring chamber 78 and a passage 80. The chamber 74 is provided with a return drain passage 82 leading to the intake passage 38 for recycling the fluid in the chamber 74.

A compensating device 84 is provided within a bore 86 in the pump casing 12 to control the upper limit of the pressure of fluid discharge from the pump 14. The compensator device 84 comprises spool valve 88 having an annular groove 90 located between opposite piston ends thereof. The upper piston end 92 is subject to the fluid discharge pressure from passage 44 and chamber 96 acting on the piston face 98 to tend to move the spool valve 88 downward. The lower piston end 100 is subject to the fluid intake pressure from the intake passage 38, passage 102, passage 104 and chamber 106 acting on the piston face 108 in cooperation with biasing forces of a spring 110 to tend to move the spool valve upward to a normal position shown in FIG. 1. The spring 110 is positioned between the piston face 108 and a bore 112 by an adjustable cap screw 114 in a manner that the spring biasing force acting on the piston face 108 can be pre-regulated.

According to the positioning of the spool valve 88 (explained hereinafter) two fluid pressure communications may be selectively established: a first communication shown in FIG. 1 includes chamber 55 in the bore 52 adjacent the face of the spool valve 50, a passage 116 to a control opening below the lower face 118 of the upper piston end 92, the annular groove 90, a passage 120, and passage 102 to the intake passage 38 such that the pressure throughout said communication is maintained at the low level of intake fluid pressure. A second communication shown in FIG. 2 includes the aforementioned chamber 55, passage 116 to a control opening above the upper face 98 of the upper piston end 92 and passage 122 to the discharge passage 44 such that the pressure throughout said communication when established is at the level of pump discharge fluid pressure when such pressure is high.

For simplicity of description it should be understood that all reference numerals applied to FIG. 1 similarly can be applied to FIG. 2 and also FIG. 3 where applicable.

Referring to FIG. 3 there is shown a fluid circuit diagram including the fluid pump device 10 driven by the motor 18 for drawing fluid from a reservoir 126 via a pipe 44 to the pump device 10 wherein said fluid is pressurized and delivered via a pipe 46 to any desired operating unit 128 to perform a desired function and is returned via a main filter pipe 130 including a large main filter 132 and thence to the reservoir 126. A regulating valve 134 is provided in the pipe 46 to regulate the flow of fluid therethrough as desired. In the event of reduced rate of flow in the pipe 46 a bypass filter circuit is provided from the pump device 10, said circuit including pipe 66, and a pipe 136 to the reservoir 126. Said bypass filter circuit includes a cut-off valve 138 and a relatively small filter 140 in the pipe 136.

An alternate and preferred by-pass circuit is incorporated in FIG. 3 by closing of valve 138 wherein the bypass flow from pump device 10 is directed from pipe 66 via pipe 142 and open cut-off valve 144 into pipe 130 thus eliminating the need for separate filter 140.

The flow path of the various pipes in the diagrams of FIG. 3 is indicated by arrows at various positions along the pipes. It should be noted that the terminology "pipes" is utilized, wherein, "tubing" or similar conduit means may be included under the definition of pipes.

## OPERATION

Under normal operating conditions the pump 14 of the pump device 10 is rotated by the motor 18 such that low pressure fluid is circulated from the reservoir 126 through the pump 14, and delivered as fluid under pressure to the operating unit 128 to perform a control function and thence returned to the reservoir 126. The reciprocating action of the pistons 26 within pump 14 causes the low pressure fluid to be drawn from the intake passage 38 into the bores 22 and pumped out at the discharge passage 44 as each bore passes said passages 38 and 44. The pistons 26 and bores 22 are manufactured with tolerances therebetween that during the reciprocating action of the piston 26 permits the leakage flow or a limited access flow of fluid between the walls of the bores 22 and the pistons 26 into a fluid filled yoke housing chamber 74 such that the fluid in said chamber is being circulated from said chamber 74 via drain passage 82 to the low pressure intake passage 38 and thence either out the discharge 44 or recirculated through the limited access flow between the piston 26 and bores 22 back to the yoke chamber 74. This circulation of leakage flow in addition to normal circulation of incoming fluid from the low pressure reservoir to the operating unit serves for both cooling and lubricating purposes for the moving parts of the pump and associated ancillaries as long as there is a relatively large amount of discharge of fluid from the pump. When the fluid pressure requirements of the operating unit 128 have been attained, or should the regulating valve 134 be operated to a reduced flow condition while the pump is still running at its operating rate of speed, the pressure to the operating unit 128 and in the discharge passage 44 continues to increase slightly while the rate of flow therethrough decreases. Under these conditions, the cooling and lubricating of the pump 14 and associated ancillaries becomes critical due to the reduced discharge rate effecting reduced recirculation of fluid. Also when the fluid pressure requirements of the operating unit 128 have been attained, it is very often desirable to operate the associated ancillaries such as driving motors, flowmeter or auxiliary operating units.

In the present invention there is provided by-pass flow control for supplying fluid under pressure to a separate flow circuit for operating, lubricating or cooling associated ancillary equipment. The control of fluid under pressure to this may be effected by manual operation of the aforementioned control device 67 to reposition the spool valve 50, or such repositioning can be accomplished automatically as now explained. When the discharge flow through pipe 46 is reduced by the decreasing demands of operating unit 128, the flow of fluid through bypass 66 is automatically increased. As the flow through pipe 46 is decreased, the pressure in passage 44 is increased. This increase in pressure is shown to be utilized to move spool valve 50 to the right in opposition to the biasing force of spring 34 to uncover return passage 64. Movement of spool valve 50 is affected by the build-up of pressure in discharge passage 44 acting on the face of valve stem 54 in addition to the action of compensating device 84 as now explained. Increase in pressure in the discharge passage 44 and discharge pipe 46 transmitted via passage 122 to chamber 96, acts on the piston face 98 of the spool valve 88 in opposition to the biasing force of the spring 110 to thereby reposition the spool valve 88 downward as shown in FIG. 2. The spool valve 88 in its down position permits flow of the high pressure fluid from chamber 96 past the upper piston end 92 to passage 116 and chamber 55 formed by the bore 52 associated with spool valve 50. The high pressure fluid in chamber 55 causes the spool valve 50 to move toward its right hand position wherein the return passage 64 is completely uncovered to permit full flow of fluid under pressure from the bypass passage 62 to return passage 64 and return pipe 66 to thereby further increase the intake of low pressure fluid from the reservoir 126 through the pump 14 to the bypass passage 62 and thence to return passage 64 to be supplied to ancillary equipment and back to reservoir 126. Simultaneously the valve stem 36 has positioned the yoke 30 to a position (shown in FIG. 2) with an angle of inclination approaching 90 degrees wherein the pump 14 is operating with a pumping action sufficient only to maintain this increased bypass fluid circulation or operate ancillary equipment.

The pump continues to operate under this just described condition until the operating unit 128 begins to function, thereby creating a demand for fluid under pressure from discharge pipe 46. As the pressure in the discharge pipe 46 and discharge passage 44 is reduced, the pressure in chamber 96 on top of the spool valve 88 of the compensating device 84 is simultaneously reduced. Reduction of pressure in chamber 96 permits the spring 110 to restore the spool valve 88 to its upper position (shown in FIG. 1) wherein the fluid under pressure in chamber 55 adjacent spool valve 50 is vented via passage 116, annular groove 90 and passage 120 to the intake passage 38. With reduction of pressure in chamber 55, the spring 34 acts on the yoke flange 32 to tend to restore the yoke 30 and the spool valve 50 to the position shown in FIG. 1 with normal pumping operation defined.

As described, the flow of fluid from return pipe 66 may be directed to either the bypass filter circuit of pipe 136 or the bypass circuit of pipe 142 as desired by



proper operation of the cut-off valves 138 and 144. If for any reason during operation, one or both of these circuits become ineffective by filter clogging or undesired valve closing, the resultant pressure build-up in return pipe 66 and return passage 64 would automatically open the relief valve 68 to permit continued fluid circulation through the pump 14. It should be noted herein that if so desired the bypass filter circuit of pipe 136 may be completely eliminated to prevent difficulties resultant from the use of filter 140.

Although the flow control shown herein is shown and described as functioning with rotary barrel type pumps, it may readily be adapted with fluid circulation of other type pumps, without inventive modification.

It should be noted herein that all directional references made herein such as "leftward", "left hand", "upward", etcetera, have been made relative to the present drawings associated herewith and should not be construed as limiting requirements in actual applications.

Summarizing, there is disclosed herein a "Pump Bypass Liquid Flow Control" wherein a pump operating with a high discharge flow rate may function with low or zero bypass flow rate, yet at low discharge flow rate will modify its bypass flow rate in inverse relationship to the reduction in discharge flow rate. In addition, the pressure availability at the bypass discharge may be any required value from zero to full system pressure.

What is claimed is:

1. A pump assembly comprising: a pump casing; pump means operable within said casing to pump fluid for flow between inlet and discharge sides of said pump means; said pump means having a movable member which controls the quantity of fluid being discharged therefrom; a main discharge passageway means communicable with the pump means discharge; a bypass discharge passageway means selectively communicable with said pump means discharge; movable means to selectively control flow through said bypass discharge passageway means and operable to establish such bypass flow when a predetermined pressure has been reached in said main discharge passageway means; and said movable means additionally being operable to engage and move said movable member to decrease the quantity of fluid being discharged from said pump means when said predetermined pressure has been reached.

2. A pump assembly as specified in claim 1 wherein said movable means maintains at least a cooling flow of fluid through said pump means.

3. A pump assembly as specified in claim 1 additionally including another movable means operable to establish communication between a portion of the flow through said main discharge passageway means and said first mentioned movable means when a predetermined pressure has been reached in said main discharge passageway means.

4. A pump assembly as specified in claim 3 wherein such portion of such flow through said main discharge passageway means aids said first mentioned movable means in establishing such bypass flow.

5. A pump assembly as specified in claim 3 wherein said first and second mentioned movable means are spring biased into a first position and establishment of such a bypass flow requires overcoming such spring bias by the portion of the flow through said main discharge passageway means.

6. A pump assembly as specified in claim 1 wherein said movable means is spring biased into a first position and establishment of such a bypass flow requires overcoming such a spring bias.

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