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FLUID SYSTEM AND VALVE ASSEMBLY THEREFOR

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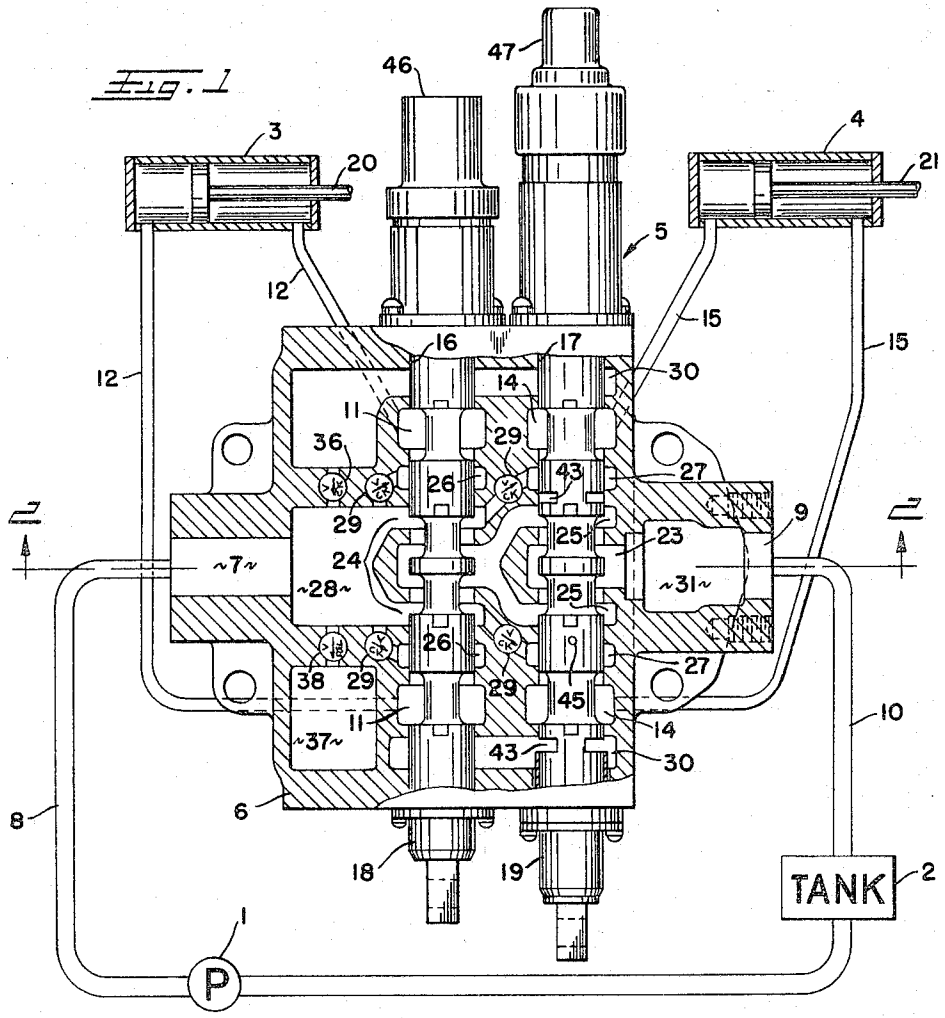
Fig. 1



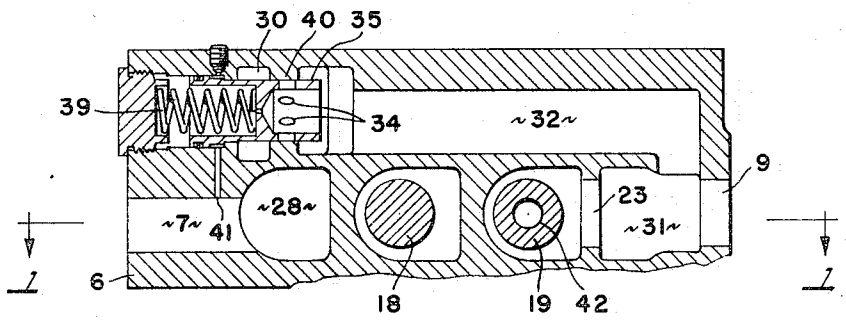


Fig. 2

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FLUID SYSTEM AND VALVE ASSEMBLY THEREFOR

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The present invention relates generally as indicated to a fluid system and valve assembly therefor and more particularly to a system having a valve therein which eliminates pump cavitation as would otherwise be caused, for example, by a fluid motor being fluid-pressure actuated in the same direction as the applied load on the motor.

It is a principal object of this invention to provide a fluid system which comprises a pump, a reservoir, one or more fluid motors, and a directional control valve assembly having therein one or more valve spools to control the flow of fluid to and from the respective motors, said assembly incorporating therein a novel flow control valve which prevents pump cavitation as aforesaid.

It is another object of this invention to provide a simple and compact directional control valve assembly for one or more fluid motors which has incorporated in the housing thereof a novel flow control arrangement which maintains a positive pressure in the inlet despite tendency of a motor piston to move under heavy applied load at a rate exceeding the pump capacity.

Yet another object is to provide a fluid system in which all of the return fluid from the motors is transferred to the inlet when the inlet pressure drops below a predetermined value, thereby supplementing the amount of fluid supplied to the inlet by the pump.

Still another object is to supply such return fluid to the inlet from the motors at high pressure for rapid flow.

Other objects and advantages of the present invention will become apparent as the following description proceeds.

To the accomplishment of the foregoing and related ends, the invention, then, comprises the features hereinafter fully described and particularly pointed out in the claims, the following description and the annexed drawings setting forth in detail a certain illustrative embodiment of the invention, this being indicative, however, of but one of the various ways in which the principle of the invention may be employed.

In said annexed drawing:

FIG. 1 is a cross-section view of a directional control valve assembly in association with a pump, a reservoir, and a pair of fluid motors, such section of the control valve assembly having been taken substantially along the line 1—1, FIG. 2; and

FIG. 2 is a cross-section view taken substantially along the line 2—2, FIG. 1.

As shown in FIG. 1 of the drawing, the fluid system herein shown comprises a pump 1, a fluid reservoir 2, a pair of fluid motors 3, 4, and a directional control valve assembly 5. Said assembly 5 comprises a housing 6 having an inlet port 7 connected to the pump delivery conduit 8, a return port 9 connected by conduit 10 to the reservoir 2, a pair of service ports 11, 11 connected by conduits 12, 12 with the ends of the fluid motor 3, and a pair of service ports 14, 14 connected by conduits 15, 15 with the ends of the fluid motor 4.

The housing 6 is formed with bores 16, 17 in which the respective valve spools 18, 19 are reciprocable to control the respective fluid motors 3, 4. When both spools 18 and 19 are in neutral position as shown, both

motor pistons 20 and 21 are locked against movement in either direction and the fluid discharged by the pump 1 is bypassed to the reservoir 2 via the bypass passage 23 which intersects the respective bores 16 and 17.

Straddling the bypass branches 24, 24 and 25, 25 which intersect the respective bores 16 and 17 are pressure feed passages 26, 26 and 27, 27 which communicate with the inlet chamber 28 through check valves 29 which, as well-known in the art, are so-called load check valves to prevent reverse flow of fluid from one motor circuit to another when both are operated simultaneously, as in the case where one motor is operating under greater load than the other motor. Straddling the respective pressure feed passages 26, 26 and 27, 27 are the aforesaid service ports 11, 11 and 12, 12, and straddling the respective service ports 11, 11 and 12, 12 and intersecting both bores 16 and 17 are return passages 30, 30 which, in a conventional form of control valve assembly, would communicate directly with the return chamber 31.

However, in the present case said return passages 30, 30 communicate with the return chamber 31 through return passage 32 and the openings 34 in the spring-biased flow control valve 35 as shown in FIG. 2. The return passages 30 also communicate with the inlet chamber 28 through the check valve 36 so that fluid may flow from the return passages 30 into the inlet chamber 28 whenever the pressure in the return passages 30 exceeds the pressure in the inlet chamber 28.

The return passage 32 also leads to the chamber 37 which is communicated with the inlet chamber 28 through a relief valve 38, whereby whenever the fluid pressure in the inlet chamber 28 builds up to a desired maximum as determined by the setting of the relief valve 38, the excess fluid will be returned to the reservoir 2 via the chamber 37 for return passage 32 and return chamber 31 thus to prevent build up of pressure above said predetermined maximum.

Referring in detail to the flow control valve 35, it comprises a tubular valve member which is biased by the spring 39 to the position shown in FIG. 2, in which communication is blocked thereby between the return passages 30 and the return chamber passage 32 because the openings 34 through the valve member 35 are blocked by the land 40 between said passages.

The valve spool 18 is of conventional four-way open center type and when it is moved downwardly from the position shown in FIG. 1, the upper feed passage 26 is communicated with the upper service port 11, whereby fluid under pressure in the inlet chamber 28 will flow into the rod end of the motor 3. In this position of the spool 18, the lower service port 11 is communicated with the lower return passage 30, whereby fluid displaced from the head end of the motor 3 will flow into said lower return passage 30. Since normally there is sufficient fluid pressure in the inlet chamber 28 to actuate the motor 3 as aforesaid, such fluid pressure through the passage 41 will act on the annular area of the flow control valve member 35 to urge it toward the left to bring the openings 34 therethrough in register with the return passage 30, and thus the displaced fluid will flow the return passage 30 through the openings 34 and into the return passage 32 and chamber 31 to the reservoir 2.

Now, in the event of a heavy load acting on the piston 20 tending to move it rapidly toward the left to require more fluid than is available from the pump 1, there will be a drop in pressure in the inlet 7 to the point where the pressure acting on the valve member 35 is insufficient to maintain the valve member in its aforesaid left open position. In that case the spring 39 biases the valve

member 35 to the position shown in FIG. 2 to cause a build up in pressure in the return passage 30 which then will open the check valve 36 to assist in maintaining pressure and supplying additional fluid into the inlet chamber 28. As is readily apparent, so long as the valve member 35 remains in the closed position, all of the return fluid from the fluid motor 3 will be directed to the inlet chamber 28 via the check valve 36 for recirculation through the directional control valve 5. Moreover, since the pressure of the return fluid in the return passages 30 does not act on the valve member 35 tending to move the same to the open position, the pressure at which the return fluid is transferred from the return passages 30 to the inlet chamber 28 can be quite high for rapid flow, the amount of pressure depending, among other things, upon the weight of the load tending to move the piston 20 in the same direction in which it is being fluid acuated. Only when the inlet pressure again reaches a value sufficient to cause actuation of the valve member 35 to the open position, will the pressure in the return passages 30 be relieved through the return chamber 31.

When the pressure in the inlet chamber 28 again builds up to the point where the valve member 35 is shifted to the left, the piston 20 will be acuated by fluid pressure to the left without causing pump cavitation.

The flow control valve 35 operates in the same manner as above-described when the spool 18 is shifted upwardly from its neutral position to cause actuation of the fluid motor 3 in the opposite direction, and if the load on the piston 20 acts to tend to move it rapidly toward the right, the flow control valve 35 will prevent cavitation in the pressure circuit leading to the head end of the fluid motor 3.

The other valve spool 19 is also of the four-way open center type but has an additional operating position, namely, a float position, in which the service ports 27, 27 are communicated with each other through the bore 42 and slots 43 of the spool 19 and with the bypass 23 through the orifice 45 which extends radially into bore 42. Thus, in the float position when a load is acting to move the piston 21 toward the left such movement is permitted at a controlled rate of speed with the excess fluid from the head end being conducted to the reservoir 2 via the orifice 45. When piston 21 floats toward the right, fluid flows into the head end of motor 4 through orifice 45.

Within the cap assemblies 46 and 47 secured to the valve housing 6 are the usual forms of spool centering spring mechanisms, and suitable detent mechanisms for yieldably retaining said spools 18 and 19 in one or more operating positions.

When the spool 19 is actuated to its operating positions to move the piston 21 in opposite directions, the flow control valve 35 will operate in the manner already described to prevent cavitation of the pressure circuit, and return fluid from the motor 4 will be conducted via the check valve 36 into the inlet chamber 28 to help maintain higher pressure therein should the rate of movement of piston 21 tend to exceed the pump capacity.

By way of example, the directional control valve assembly 1 is of the multiple spool type arranged so that either or both spools may be operated independently or simultaneously. However, it is to be understood that the check valves 29 for the downstream spool 19 may have their inlets in the bypass portions 25 between the spools 18 and 19, substantially as shown in the patent to Herbert H. Schmiel, U.S. Patent No. 3,000,397, granted September 19, 1961, in which case only one spool at a time may be actuated to control its respective motor. Although the housing for the flow control valve 35 is herein shown as being an integral part of the spool valve housing 6, it is to be understood that said flow control housing may be separately formed and bolted or otherwise secured, to a mating face of the spool valve housing 6.

It is to be noted that if the pressure in inlet port 7 decreases gradually, the return flow through openings 34 will likewise gradually decrease to effect a gradual build up of pressure in the return passages 30. Such build up of pressure in the return passages 30 opposes movement of the piston 20 and 21 under load and when the pressure in return passages 30 exceeds that in the inlet chamber 28, the check valve 36 will be opened to supplement the fluid supplied by pump 1.

Other modes of applying the principle of the invention may be employed, change being made as regards the details described, provided the features stated in any of the following claims, or the equivalent of such, be employed.

I therefore particularly point out and distinctly claim as my invention:

1. In combination, a directional control valve and a flow control valve, said directional control valve comprising a housing having an inlet port for communication with a fluid pressure source, a return port, a pair of bores, and a pair of motor ports associated with each bore, said bores being intersected axially therealong by passages communicating with said inlet, return, and motor ports, a valve spool in each bore movable to operating positions whereat communication is established selectively between said inlet passage and one of its associated motor ports while the other associated motor port is communicated with said return passage, and mean including a check valve operative to permit flow of fluid from said return passage to said inlet port when the pressure in said inlet port is lower than the pressure in said return passage to supplement the fluid in said inlet port which is already being supplied by said fluid pressure source; said flow control valve comprising a valve means located in said return passage downstream of both of said valve spools operative to block return flow from said motor ports through said return passage to said return port when the pressure in said inlet port drops below a predetermined value to cause a buildup of the pressure in said return passage, whereby the discharge from all of said motor ports will be directed to said inlet port to provide makeup flow for said directional control valve when the pressure in said inlet passage drops below such predetermined value.

2. The directional control valve of claim 1 wherein said housing has a bypass passage communicating said inlet port with said return port when said valve spools are in a neutral position, and the inlet passages for the downstream valve spool communicate with said bypass passage between said valve spools, whereby only one valve spool at a time may be moved to an operating position as aforesaid.

3. The combination of claim 1 wherein the inlet passages for the downstream valve spool communicate with said inlet port upstream of the other valve spool, whereby either or both valve spools may be operated independently or simultaneously.

4. In combination, a directional control valve and a flow control valve, said directional control valve comprising a housing having an inlet port for communication with a fluid pressure source, a return port, and a pair of motor ports, said housing having a bore intersected axially therealong by passages communicating with said inlet, return, and motor ports, a valve spool movable in said bore to operating positions whereat communication is established selectively between said inlet passage and one motor port while the other motor port is communicated with said return passage, and means including a check valve operative to permit flow of fluid from said return passage to said inlet port when the pressure in said inlet port is lower than the pressure in said return passage to supplement the fluid in said inlet port which is already being supplied by said fluid pressure source; said flow control valve comprising a valve means operative to block return flow from said motor ports through said return passage to said return port when the pressure in said inlet port drops below a predetermined value to cause a buildup of the pressure

in said return passage, said valve means being disposed in said return passage and defining with the housing of said directional control valve a fluid chamber, a passage leading from said inlet port to said fluid chamber, said valve means having a plurality of openings through one end and an annular shoulder adjacent the other end exposed to fluid pressure in said chamber tending to move said valve means to a position whereat return fluid is permitted to flow through said return passage via said openings in said valve means to said return port, and spring means in said housing biasing said valve means to a position whereat said openings in said valve means are blocked by a land in said return passage when the pressure in said inlet port and thus in said chamber is below such predetermined value.

References Cited by the Examiner

UNITED STATES PATENTS

2,648,346	8/1953	Deardorff et al.	91—420
2,980,135	4/1961	Tennis	91—436 X
3,000,397	9/1961	Schmiel	137—596.13
3,006,323	10/1961	Tilney	91—420
3,060,688	10/1962	Gondek	91—420
3,169,453	2/1965	Westveer	91—420
3,194,265	7/1965	Tennis	137—596.2 X

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