United States Patent

Rice

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[54] DIRECTIONAL CONTROL VALVE

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[51] **Int. Cl.** **F16k 11/10**

[58] **Field of Search** 137/596, 596.12, 596.13, 625.68, 137/596.1, 596.2, 269, 270; 91/421, 437, 436

[56] **References Cited**

UNITED STATES PATENTS

3,006,372	10/1961	Ruhl	137/596.2 UX
3,255,777	6/1966	Rice et al.	97/436 X
3,391,708	7/1968	Rice	137/625.69
3,481,364	12/1969	Hodgson et al.	137/596

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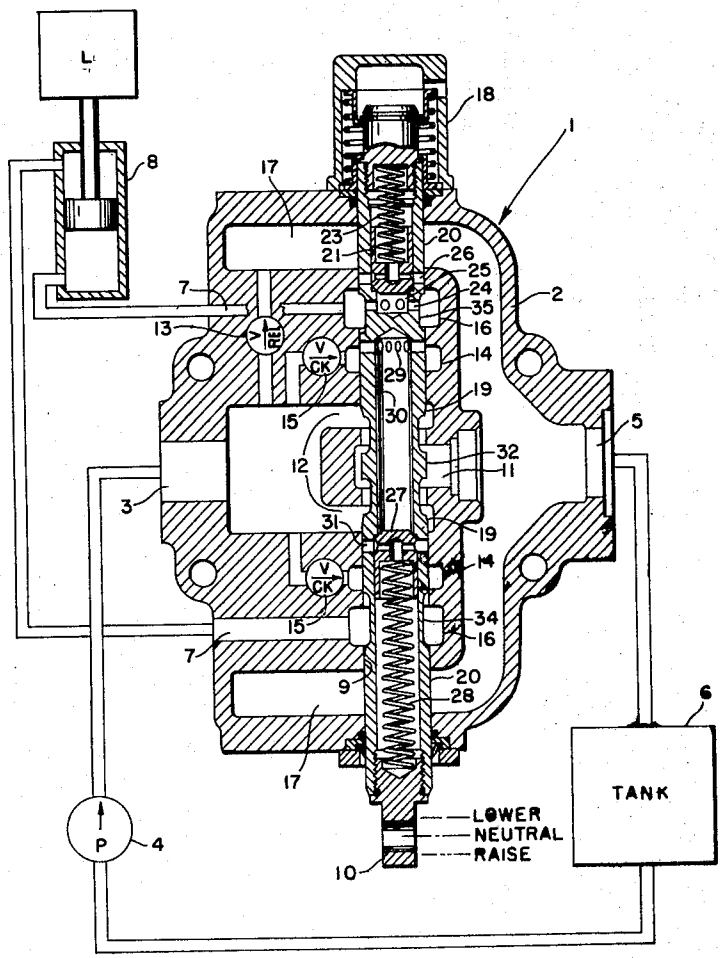
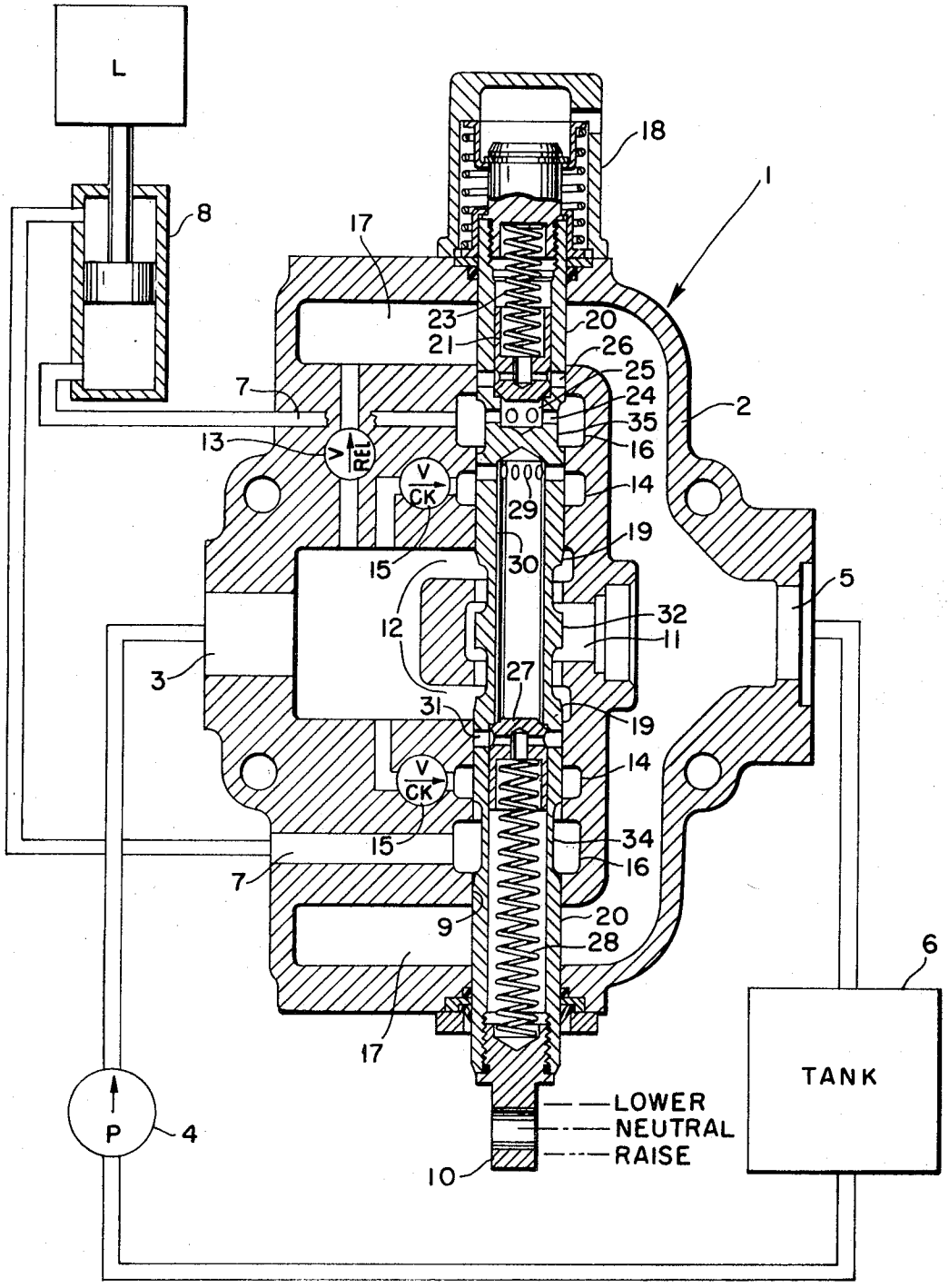
[57] **ABSTRACT**

A four-way spool-type valve assembly for controlling the actuation of a double-acting fluid motor characterized in that the spool has therewithin a relief valve and a check valve respectively operative to build up back pressure in the return line from the motor during the load lowering operation and to permit return flow under such back pressure into the inlet port to prevent cavitation of the fluid motor. The spool herein is further characterized in that in the load raising position thereof both the relief valve and the check valve are bypassed so as to offer minimum restriction to fluid flow into and from the fluid motor.

4 Claims, 1 Drawing Figure





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DIRECTIONAL CONTROL VALVE

BACKGROUND OF THE INVENTION

It is known to provide regenerative circuits as above mentioned to prevent fluid motor cavitation as during the load lowering operation thereof when the load on the motor tends to run ahead of the pump. However, in known valves having a regeneration path to the spool thereof, as for example, as disclosed in the U.S. Pat. Nos. 3,255,777 and 3,391,708, the relief valve to build up back pressure in the regeneration path constitutes in whole or in part a load check valve in the spool between the return fluid motor passage and the return passage. Therefore, as in U.S. Pat. No. 3,255,777, when the spool is actuated to reverse the fluid motor, i.e., to raise the load, the aforesaid relief valve must be opened thus constituting restriction of flow to the motor and in addition, a load check valve at the other end of the spool restricts return flow of fluid from the motor. The latter also applies in the case of the U.S. Pat. No. 3,391,708. Moreover, the check valves in the regeneration path in the aforementioned patents constitute restrictions in the bypass flow path when the spool is in its neutral position.

Another disadvantage of known valves having a regeneration path through the spool thereof is that the motor passage from whence the regeneration path commences must be axially enlarged i.e., provided with an extension, and this renders the housing of special form with special coring, and, furthermore, the valve spool is not capable of being reversely mounted in the housing. Furthermore, in U.S. Pat. No. 3,255,777, the check valve in the regeneration path is of complex expensive construction because it is in the form of a ring fitted on a neck of the spool, thus necessitating making of the check valve in multiple parts and further requiring expansion of the check valve spring to snap it over the neck of the spool.

In the case of U.S. Pat. No. 3,391,708, the relief valve comprises two valve members with one spring therebetween and another spring bearing on the outer and larger valve member, both parts having to move together against the heavier spring before communication is established between the motor passage in the regeneration path and the return passage to build up the desired back pressure in the regeneration path. In said U.S. Pat. No. 3,391,708 the smaller valve member urged against its seat by the lighter spring constitutes the load check valve when the spool is actuated to a position to raise the motor load.

SUMMARY OF THE INVENTION

In the present invention the valve housing is of conventional form in every respect including the main relief valve and load check valves disposed upstream of of the spool bore. In order to provide a directional control valve assembly which has a regeneration path therein for preventing motor cavitation during lowering of a heavy load on the motor, the present invention requires only the provision of a hollow spool embodying therein a relief valve and a check valve which are bypassed when the motor load is being raised, thereby avoiding restrictions of flow by said relief valve and check valve either on the pressure side or the return side.

Another feature of the present invention is that because the valve housing is of conventional form the spool assembly containing the relief valve and the check valve in the regeneration path may readily be reversed for convenient actuation, depending on the available space at either end of the valve housing.

Another feature of the present invention is that the check valve in the regeneration path does not in any way restrict bypass flow when the spool is in neutral position, its location being adjacent that branch of the pressure inlet which is most closely located to the pressure feed passage which is then being used to lower the load of the fluid motor.

Other objects and advantages of the present invention will appear hereinafter.

BRIEF DESCRIPTION OF THE DRAWING

The single FIGURE of the drawing is a central cross section view of a directional control valve embodying the present invention.

DESCRIPTION OF THE INVENTION

The directional control valve assembly **1** herein shown comprises a housing **2** having a pressure inlet port **3** adapted for connection with a pump **4**, a return port **5** adapted for connection with a tank **6**, and a pair of motor ports **7;7** adapted for connection with a double-acting fluid motor **8**.

The housing **2** is of conventional form having a bore **9** therethrough for a spool **10**, said bore **9** being intersected axially therealong starting from the middle by a bypass passage portion **11** which leads to the return port **5**, said bypass portion **11** being straddled by bypass portions **12;12** leading to the inlet port **3**, a pair of pressure feed passages **14;14** which straddle the aforesaid bypass portions **12;12** and which communicate with the inlet port **3** via load check valves **15;15**, a pair of motor passages **16;16** which straddle the pressure feed passages **14;14** and which lead to the respective motor ports **7;7**, and a pair of return passages **17;17** which straddle the motor passages **16;16** and which lead to the return port **5**. Between the inlet port **3** and one return passage **17** is the main relief valve **13**.

When the spool **10** is in its neutral position as shown in the drawing in which position it is yieldably held by the spring centering mechanism **18**, fluid delivered by the pump **4** to the inlet port **3** freely circulates through the bypass passages **12;12** and **11** back to the tank **6** through the return port **5**, and the motor passages **16;16** are blocked from communicating with the pressure feed passages **14;14** and the return passages **17;17** by the respective spool lands **19;19** and **20;20**.

In one end of the spool is a relief valve member **21** which is actuated to seated position by the spring **23** and which is operative to maintain a predetermined back pressure in the regeneration path hereinafter to be described, said relief valve member **21**, when actuated by pressure exceeding the predetermined back pressure, opening a first passage constituted by the holes **24**, bore **25**, and holes **26** in the spool **10** to relieve excess pressure to the return passage **17**.

In the other end of the spool **10** is a check valve member **27** which is urged to seated position by the spring **28** and which is operative to open a second passage in the regeneration path which is constituted by the holes **29**, bore **30**, and holes **31** in the spool **10** for flow of fluid into the lower bypass passage portion **12** to supplement the fluid delivered by the pump **4** thus to prevent cavitation.

When it is desired to lower the load L on the motor **8**, the spool **10** is shifted upwardly to "Lower" position whereat the land **32** and lower land **19** close the bypass passage **12;12** and **11** and the groove **34** opens communication between the lower pressure feed passage **14** and the lower motor passage **16** whereby fluid under pressure is conducted through the lower check valve **15** to the upper end of the motor **8**. In this "Lower" position of the spool **10**, the holes **24** and **26** are now in the upper motor passage **16** and upper return passage **17** respectively whereby the pressure of the returning fluid under the influence of the load L may act on the relief valve member **21** to open the same. In this "Lower" position, the holes **29** at the upper end of the bore **30** are also disposed in the upper motor passage **16** and the holes **31** at the lower end of the bore **30** are in register with the lower upstream bypass passage portion **12** downstream of the check valve member **27**, whereupon fluid may flow through the aforesaid second passage unseating the check valve member **27** thus to supply fluid to the inlet port **3** so that the upper end of the motor **8** will not cavitate despite the influence of a heavy load L tending to actuate the motor **8** at a speed which may exceed the capacity of the pump **4**.

In the case of a front end loader, scraper, bulldozer, etc., as soon as the bucket, scraper bowl, or blade strikes the ground, return flow stops whereby the relief valve member **21** and check valve member **27** immediately close to effect rapid build-up of pressure in the motor circuit.

When the load L is to be raised the spool is moved downwardly from the "Neutral" position to the "Raise" position and in that position fluid under pressure will flow from the inlet port **3** into the upper pressure feed passage **14** via the check valve **15** and thence through the spool groove **35** into the upper motor passage **16** and motor port **7** which leads to the lower end of the motor **8**. In said "Raise" position, the lower motor passage **16** is communicated with the lower return passage **17** by the spool groove **34** whereby fluid displaced from the upper end of the motor **8** is returned with minimum restriction to the return port **5**. In the aforesaid "Raise" position land **32** and upper land **19** are effective to close the bypass passage **12;12** and **11**.

In the event that the valve housing **2** is so installed that there is no room for a spool actuator at the lower end thereof, it is a simple matter to remove the spring-centering mechanism **18** and to remove the spool from the housing and to reverse it so that the actuating end thereof will be disposed at the top and the spring-centering mechanism **18** will be disposed at the bottom. The housing **2** is as aforesaid of standard symmetrical construction and the embodiment of the regeneration path does not require any modifications in the passage coring in the housing **2**.

I claim:

1. In a four-way spool valve assembly having a housing including a pressure inlet port, a return port, and a pair of motor ports, and a valve spool movable in said housing to control actuation of a double-acting fluid motor adapted to be connected to said motor ports and having first and second grooves respectively communicating one motor port selectively with said inlet port and said return port and the other motor port with said inlet port when said one motor port is communicated with said return port via said first groove; the improvement which comprises a valve spool having, in addition to said grooves, first and second passages therein respectively communicating said other motor port with said return port and with said inlet port when said one motor port is communicated with said inlet port; a relief valve in said first passage to build up back pressure in returning fluid in said other motor port; and a check valve in said second passage permitting returning fluid flow into said inlet port in the event of decrease of fluid pressure in said inlet port to a value less than the back pressure in said other motor port when said spool is in a position communicating said inlet port with said one motor port.

2. In a directional control valve assembly comprising a housing having an inlet port for connection with a fluid pressure source and a return port for connection with a fluid reservoir, said housing further having a bore intersected axially therealong by a bypass passage communicating at its upstream and downstream portions with said inlet and return ports, a pressure feed passage communicating with said inlet port, a pair of motor passages for connection to a double-acting fluid motor, and a return passage communicating with said return port; and a valve member movable in said bore from a neutral position whereat said inlet and return ports are in fluid communication via said bypass passage and communication of said motor passages with said pressure feed and return passages is blocked to an operating position whereat said bypass passage is blocked, one motor passage is communicated with said pressure feed passage, and the other motor passage is communicated with said return passage; the improvement which comprises first and second passages in said valve member which, in said operating position, respectively communicate said other motor passage with said return passage and with the upstream portion of said bypass passage; a relief valve in said first passage to build up a back pressure in said other motor passage; and a check valve in said second passage to permit flow of fluid from said other motor passage to said bypass passage and thence to the pressure feed passage in the event of reduction of fluid pressure in said inlet port and in said one motor passage to a value less than the back pressure in said other motor passage; said valve member being movable to another operating position whereat said other motor passage is communicated with said pressure feed passage and said one motor passage is communicated with said return passage without passage of fluid through said first and second passages and said relief and check valves.

3. In a directional control valve assembly comprising a housing having an inlet port for connection with a fluid pressure source and a return port for connection with a fluid reservoir, said housing further having a bore intersected axially therealong by a bypass passage communicating at its upstream and downstream portions with said inlet and return ports, a pair of pressure feed passages straddling said bypass passage and communicating with said inlet port, a pair of motor passages straddling said pressure feed passages and adapted for connection to a double-acting fluid motor, and a pair of return passages straddling said motor passages and communicating with said return port; and a spool valve member movable in said bore from a neutral position whereat said inlet and return ports are in fluid communication via said bypass passage and communication of said motor passages with the adjacent pressure feed and return passages is blocked to an operating position whereat said bypass passage is blocked, one motor passage is communicated with the adjacent pressure feed passage, and the other motor passage is communicated with the adjacent return passage; the improvement which comprises first and second passages in said spool valve member which, in said operating position, respectively communicate said other motor passage with said adjacent return passage and with the upstream portion of said bypass passage; a relief valve in said first passage to build up a back pressure in said other motor passage; and a check valve in said second passage to permit flow of fluid from said other motor passage to said bypass passage and thence to the pressure feed passage adjacent to said one motor passage in the event of reduction of fluid pressure in said inlet port and in said one motor passage to a value less than the back pressure in said other motor passage; said spool valve member having peripheral grooves which in another operating position respectively communicate said other motor passage with the adjacent pressure feed passage and said one motor passage with the adjacent return passage without passage of fluid through said first and second passages and said relief and check valves.

4. The valve assembly of claim **3** wherein said bypass, pressure feed, motor, and return passages are symmetrically disposed whereby said spool valve member may be turned end for end for actuation from either end of said bore.

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