United States Patent [19]

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[11] **3,746,040**

[45] **July 17, 1973**

[54] **DIRECTIONAL CONTROL VALVE**

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[22] Filed: **Apr. 19, 1972**

[21] Appl. No.: **245,451**

[52] **U.S. Cl.** **137/596**, 91/436

[51] **Int. Cl.** **F16k 11/07**, F16k/11/10

[58] **Field of Search** 91/420, 91/421, 436, 437; 131/596.12, 596.13, 596.2, 612.1

[56] **References Cited**

UNITED STATES PATENTS

2,965,133	12/1960	Rice et al.	137/612.1
3,482,600	12/1969	Hodgson	137/625.68 X

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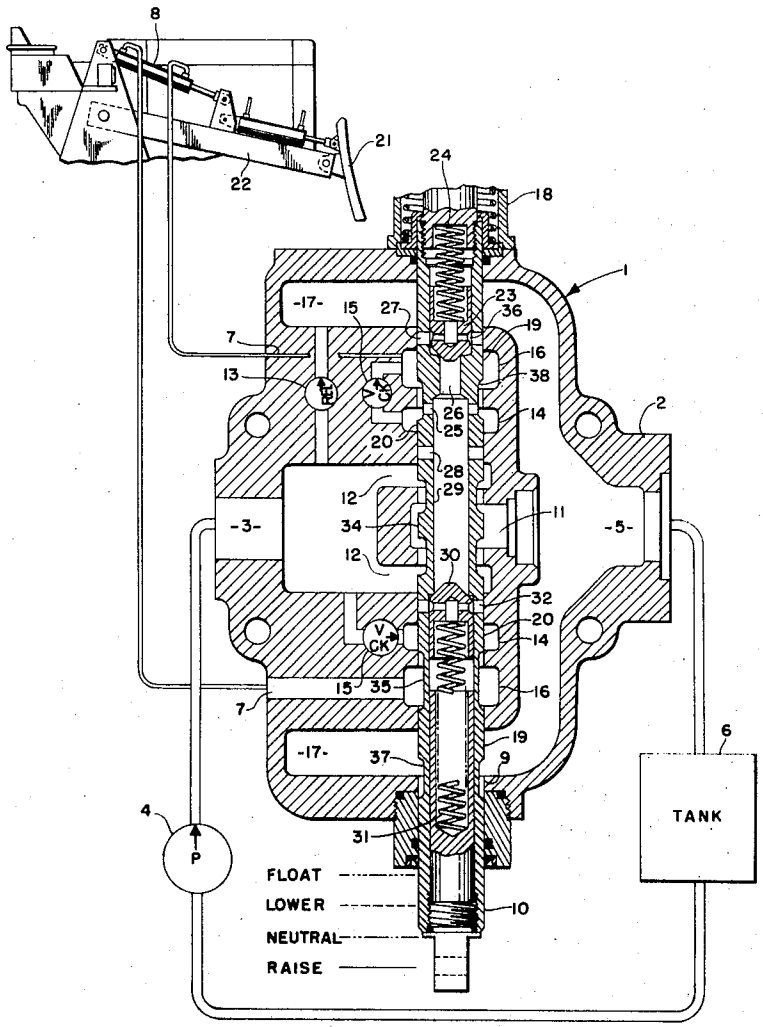
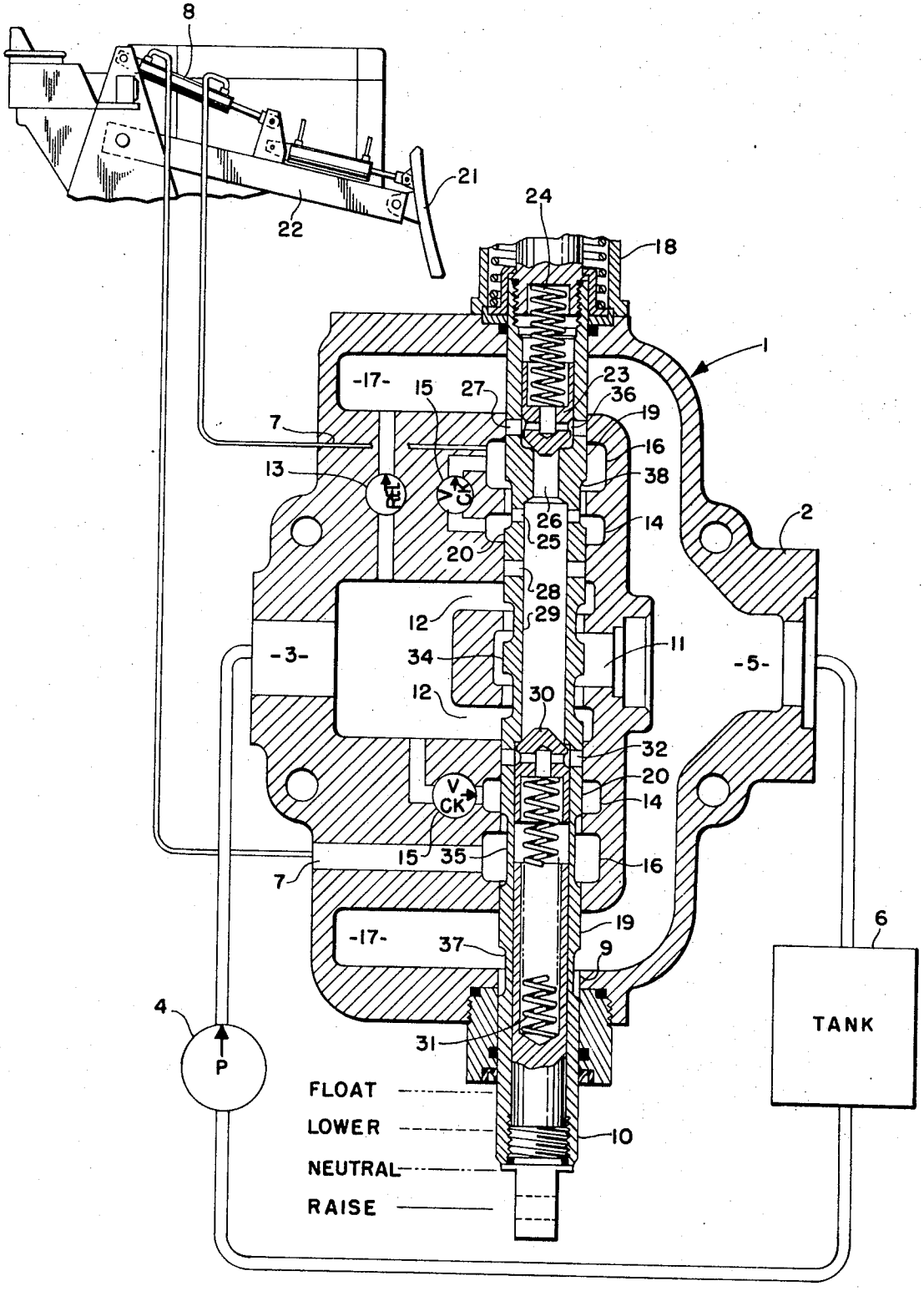
[57] **ABSTRACT**

A four-way spool valve assembly embodying a regenerative circuit for controlling the actuation of a double acting fluid motor for a bulldozer blade or the like 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 rod end of the motor during the blade lowering operation and to permit return flow under such back pressure into the inlet port to prevent cavitation of the head end of the motor, and further characterized in that the spool has a float position in which a bypass passage in the assembly is open for flow of fluid from the inlet passage to the return passage and in which both motor ports have unrestricted communication with the return passage.

6 Claims, 1 Drawing Figure

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TANK
FLOAT
LOWER
10
NEUTRAL
RAISE

DIRECTIONAL CONTROL VALVE

BACKGROUND OF THE INVENTION

It is known to provide regenerative circuits as above-mentioned in connection with front end loaders, for example to prevent fluid motor cavitation as during the load (boom and bucket) lowering operation thereof when the load on the motor tends to run ahead of the pump. See, for example, the application of Rice Ser. No. 1715, filed Jan. 9, 1970, now U. S. Pat. No. 3,642,027 wherein the spool is hollow and has therein 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.

It is also known to provide a four-way spool type valve assembly in which the spool has a float position to permit movement of the piston of a fluid motor in a direction such that oil coming out of the head end of the cylinder is conducted to the rod end of the cylinder via a passage in the spool with excess flow passing through a spring loaded valve or an orifice leading to the low pressure side of the valve assembly. For examples of this type of four-way float spool, reference may be had to the following U.S. Pats.:

Schmiel, No. 3,000,397; Stacey, No. 3,195,559; Stacey, No. 3,106,065; Stacey, No. 3,251,277; Markovich, No. 3,120,858; Stacey, No. 3,262,467; Stacey, No. 3,132,668; Stacey, No. 3,299,903; and Schmiel et al., No. 3,160,174.

In the case of equipment such as a front end loader the downward float of the boom and bucket displaces oil from the head end of the cylinder to the rod end with excess flow being conducted to the low pressure side of the valve assembly. However, in the case of a bulldozer or the like, the bulldozer blade may be employed for back dragging while the valve assembly is in the float position and hence oil is discharged from the rod end of the cylinder to the head end. Accordingly, such orifice communication of the motor ports with the low pressure side of the valve assembly as described in the aforementioned patents cannot be used because oil would have to be drawn into the head end of the cylinder through such restricted orifice thereby causing cavitation in the head end of the motor. In such bulldozer application it is of course necessary when the blade is in operating position to press it firmly against the ground and hence oil under pressure is admitted into the head end of the cylinder for maximum ground engaging force, whereas in a front end loader or the like, oil is admitted into the head end of the cylinder to raise the boom and bucket.

SUMMARY OF THE INVENTION

In view of the foregoing, it is a primary object of the present invention to provide a four-way spool type valve assembly for bulldozer and like applications which has a regenerative circuit built into the hollow spool thereof to obtain fast power lowering of the bulldozer blade to ground-engaging position and which, in addition, has a float position permitting free flow of oil between the low pressure side of the assembly and the motor ports during the back dragging operation of the bulldozer.

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

BRIEF DESCRIPTION OF THE DRAWING

The FIGURE is a cross-section view of a preferred form of directional control valve assembly embodying the present invention and showing the same connected to the actuating cylinder for a bulldozer blade or the like.

DETAILED 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 of which the lower passage **14** communicates with the inlet port **3** via load check valve **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 "NEUTRAL" position in which it is 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 return passages **17;17** by the lands **19;19**, and are blocked from communicating with the lower feed passage **14** and with the upper inlet branch **12** by the respective spool lands **20;20**, whereby the bulldozer blade **21** and boom **22** will remain in whatever position they happen to be when the spool **10** is allowed to be shifted by the spring centering mechanism **18** to "NEUTRAL" position.

In one end of the spool **10** is a relief valve member **23** which is actuated to seated position by the spring **24** and which is operative to maintain a predetermined back pressure in the regeneration path hereinafter to be described when the spool **10** is in "LOWER" position, said relief valve member **23**, when actuated by pressure exceeding the predetermined back pressure, opening a first passage constituted by the openings **25**, the bore **26**, and the holes **27** which then register with the upper return passage **17**, to relieve excess pressure to the return passage **17**.

The upper load check valve **15** is disposed between the upper feed passage **14** and the upper motor passage **16** and hence when the spool **10** is shifted to "RAISE" position fluid under pressure will be conducted to the upper motor passage via the openings **28** in upper land **20**, bore **29**, openings **25**, upper feed passage **14**, and upper load check valve **15**.

In the other end of the spool **10** is a check valve member **30** which is urged to seated position by the spring **31** and which is operative when the spool **10** is in "LOWER" position to open a second passage in the

regeneration path which is constituted by the openings 25, the bore 29, and the openings 32 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 the spool 10 is in its power "LOWER" position. This provides for fast lowering of the blade 21 to ground engaging position.

When it is desired to lower the boom 22 with the blade 21 firmly engaging the ground as aforesaid, the spool 10 is shifted upwardly from "NEUTRAL" position to "LOWER" position, whereat the spool lands 34 and 20 close communication between the bypass portions 12 and 11 for flow of fluid under pressure delivered by the pump through the lower check valve 15 to the lower pressure feed passage 14 and thence to the lower motor passage 16 via the spool groove 35 whereby fluid under pressure is conducted into the head end of the motor 8 to move the boom 22 and blade 21 downwardly. Oil displaced from the rod end of the motor 8 flows into the upper motor passage 16 and because of the closed position of the relief valve member 23 pressure builds up in the upper motor passage 16 and effects unseating of the check valve member 30, whereby the fluid returning to the valve assembly 1 from the rod end of the motor 8 is conducted into the inlet port 3 to supplement the pump 4 output, thus to achieve rapid lowering of the boom under power control and without permitting cavitating of the head end of the motor 8.

As the blade 21 contacts the ground, pressure starts to build up in the inlet port 3 sufficient to close the check valve member 30 and the increased pressure in the upper motor passage 16 acting on the area of the relief valve member 23 moves the same to open position and when opened the pressure drop across the annular orifice 36 acting on the larger diameter of the relief valve member 23 opens the relief valve member 23 further and maintains it open for prompt reduction of pressure in the return circuit to a value less than initially required to unseat the relief valve member 23. Thus, the increased pressure acts on the head end of the motor 8 to firmly press the blade 21 into the ground.

When it is desired to raise the boom 22 and blade 21, the spool 10 is shifted downwardly from "NEUTRAL" position to "RAISE" position whereat the spool lands 34 and 20 block communication between the bypass portions 12 and 11 with fluid under pressure in the inlet port 3 being conducted through openings 28, bore 29, openings 25, upper feed passage 14, and upper check valve 15 into the upper motor passage 16 for flow into the rod end of the motor 8. Fluid displaced from the head end of the motor 8 is conducted to the lower motor passage 16 and to the lower return passage 17 via the spool groove 35. When the force on the spool 10 is released, the spring centering mechanism 18 will return the spool 10 from the "RAISE" position back to "NEUTRAL" position.

When the spool 10 is in "FLOAT" position, the boom 22 and blade 21 may float up or down, the lower motor passage 16 being communicated with the lower return passage 17 by way of the spool groove 37, and the upper motor passage 16 being communicated with the upper return passage 17 by way of the spool groove 38. In "FLOAT" position the bypass passage 12-11 is open as shown.

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

1. In a spool valve assembly having a housing including a pressure inlet port, a return port, and a pair of motor ports; 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; said valve spool, in addition to said grooves, having 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; the improvement which comprises a valve spool in which said first and second passages, upstream of said relief valve and check valve, both open in said second groove and in a land adjacent to said second groove to respectively communicate with a passage in said housing leading to said other motor port and with said inlet port when said spool is in a position communicating said one motor port with said return port.

2. The valve assembly of claim 1 wherein said housing passage has another check valve therein to prevent reverse flow of fluid therethrough.

3. The valve assembly of claim 1 wherein said valve spool has a float position whereat both motor ports are communicated with said return port via said second groove and via a third groove in said spool adjacent to said first groove.

4. The valve assembly of claim 3 wherein said first and second passages, downstream of said relief and said check valve, terminate in openings through other spool lands adjacent to said second groove and said first groove to communicate respectively with said return port and inlet port when said spool is in a position communicating said inlet port with said one motor port.

5. In a spool valve assembly having a hosuing including a pressure inlet port, a return port, and a pair of motor ports; and a valve spool movable in said housing to two operating positions to control actuation of a double acting fluid motor adapted to be connected to said motor ports and having first and second grooves selectively communicating said motor ports with said inlet and return ports; the improvement which comprises a valve spool having a third groove adjacent to said first groove operative in conjunction with said first groove to communicate each motor port with said return port upon movement of said valve spool to a third operating position whereby the movable component of the fluid motor may float in opposite directions; said spool being hollow and having openings thereinto through a land adjacent to said second groove to communicate with said inlet port and through said second groove; and said housing having a passage communicating said second groove with said other motor port when said spool is in a position communicating said one

motor port with said return port via said first groove.

6. In a 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 two operating positions whereat first and second grooves therein selectively communicate said motor ports with said inlet and return ports; the improvement which comprises a valve spool having a third operating position whereat one motor port is freely communicated with said return port via said second groove and the other motor port is freely communicated with said return port via a third groove in said spool which is adjacent to said first groove thus to permit free floating of the movable component of the fluid motor in opposite directions; said spool having a passage therein which opens to said inlet port and to said second groove when said spool is in a position communicating said other motor port with said return port via said first groove; said housing having a passage communicating with said second groove and said one motor port when said spool is in the last-mentioned position.

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