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MOTOR CONTROL VALVE WITH FLOW RESTRICTOR MEANS

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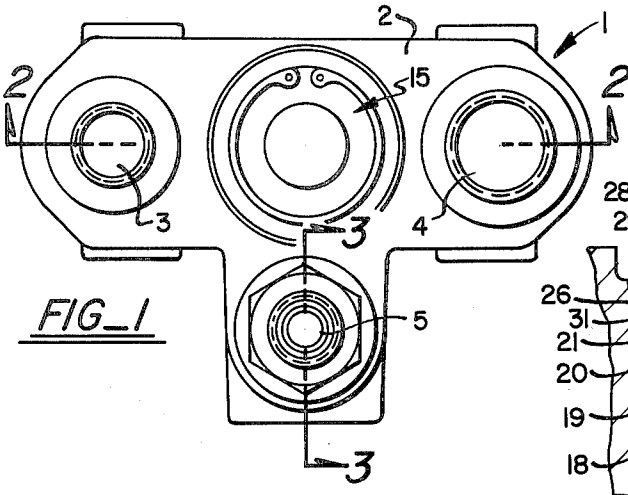


FIG_1

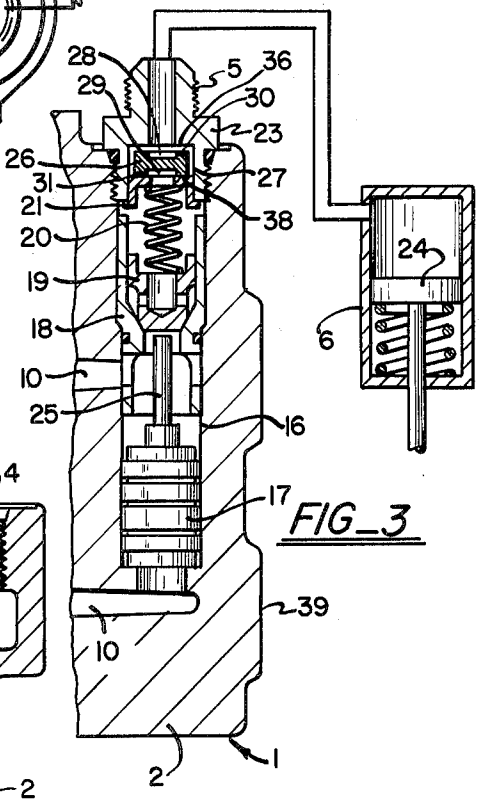


FIG_3

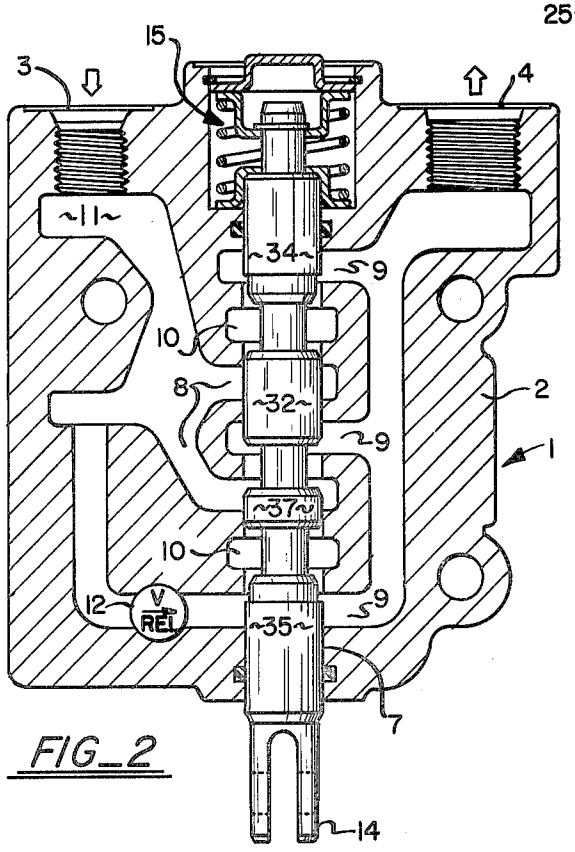


FIG_2

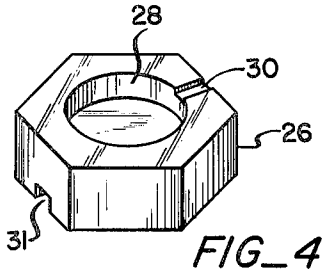


FIG_4

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MOTOR CONTROL VALVE WITH FLOW RESTRICTOR MEANS

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The present invention relates generally as indicated to a valve with flow restrictor means and more particularly to a directional control valve for a fluid motor in which the flow of fluid to and from the motor is controlled via a two-way restrictor in the housing of the directional control valve.

It is a principal object of this invention to provide a valve with flow restrictor means which provides for equal or different magnitudes of flow restriction in opposite directions.

It is another object of this invention to provide a two-way restrictor for a directional control valve which is in the form of a pressure-actuated member alternately engageable with seats on opposite sides thereof and defining with said seats flow restricting orifices which are of equal or different sizes as desired.

It is another object of this invention to provide a two-way flow restrictor of the character referred to which is disposed on the downstream side of a load check valve of a directional control valve, the check valve being arranged to be unseated in normal manner by fluid pressure on its upstream side, and to be mechanically unseated by a fluid pressure actuated plunger to permit reverse flow therethrough.

It is another object of this invention to provide a simple unitary two-way restrictor which is replaceably mounted in the motor port bushing of a directional control valve.

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 drawing 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 top plan view of one embodiment of the present invention;

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

FIG. 3 is a fragmentary cross-section view taken substantially along the line 3—3, FIG. 1; and

FIG. 4 is a perspective view, on enlarged scale, of a preferred form of flow restrictor.

As shown in the drawing, the directional control valve 1 comprises a housing 2 having a pressure inlet port 3 for connection with a fluid pressure source, such as a pump, not shown; a return port 4 for connection with a fluid reservoir, not shown; and a cylinder port 5 for connection with the port of a single acting cylinder 6. As best shown in FIG. 2, the housing 2 is cored to provide a series of passages therein that intersect the bore 7 at axially spaced intervals therealong, to wit, inlet

passages 8, 8 from inlet port 3 straddling the middle return passage 9 to return port 4, cylinder passages 10, 10 which straddle the aforesaid inlet passages 8, 8, and top and bottom return passages 9, 9 which, in turn, straddle the cylinder passages 10, 10. Between the inlet chamber 11 and the bottom return passage 9 is a relief valve 12 which opens communication between the inlet port 3 and the return port 4 when the pressure in the inlet chamber 11 exceeds that for which the relief valve 12 is set.

Reciprocable in the bore 7 of housing 2 is a valve spool 14 which is held in the neutral position as shown by a spring centering mechanism 15 at the upper end of the spool. The spool 14 has alternate lands and grooves cooperating with the aforementioned passages 8, 9, and 10 in a manner hereinafter explained in detail.

When the spool 7 is in the neutral or inactive position, as shown in FIG. 2, fluid flows freely from the inlet port 3 to the return port 4 via the then intercommunicating inlet passage 8 and middle return passage 9, whereby the pump connected to the inlet port 3 operates under substantially no load.

Referring now to FIG. 3, the housing has another bore 16 alongside and parallel to the spool bore 7 to which the upper and lower cylinder passages 10, 10 lead. In the lower portion of the bore 16 there is a plunger 17 which is moved upwardly by fluid pressure in the lower cylinder passage 10 and downwardly (to the position shown) by fluid pressure in the upper cylinder passage 10. In the portion of the bore 16 above plunger 17 is a tubular check valve seat and guide member 18 press-fitted or otherwise secured therein. A check valve 19 is yieldably urged into engagement with member 18 by spring 20, the upper end of spring 20 being engaged with a spring backup member 21 which is seated in the bushing or adaptor 23 screwed into the housing 2, the bushing providing the aforesaid cylinder port 5. When the spool 14 is in its neutral position, the check valve 19 constitutes a so-called load check which prevents flow of fluid from the cylinder 6 to the upper cylinder passage 10 and thus the piston 24 cannot move in upward direction as viewed in FIG. 3 so long as the check valve 19 is closed. However, when it is desired to permit upward movement of the piston 24 means must be provided for opening the check valve 19, and in the present case, that means constitutes a rod-like extension 25 of the plunger 17 which engages and moves the check valve 19 upwardly away from its seat when fluid under pressure in the lower cylinder passage 10 moves the plunger 17 upwardly.

Axially movable in the space between the spring backup member 21 and the cylinder port bushing 23 is a two-way restrictor 26 herein shown as comprising a non-circular part guided in the counterbore 27 of the cylinder port bushing 23. Said restrictor 26 has recesses 28 and 29 in its opposite end faces, the latter each having at least one groove or channel 30 and 31 leading from the respective recesses 28 and 29 to the periphery of the restrictor 26. As a matter of convenience and economy of manufacture, the restrictor 26 herein is shown as being made of hex stock (see FIG. 4) with the channels 30 and 31 leading from the respective recesses 28 and 29 to the flat sides of the hex. As hereinafter explained, the channels 30 and 31 alternately constitute flow restricting orifices and it is to be understood that the channels 30 and 31 may be of equal or unequal size to provide

equal or different restrictions of flow in opposite directions.

Thus, when the spool **14** is moved downwardly from the position shown in FIG. 2, the land **32** thereof closes fluid communication between both inlet passages **8, 8** and the middle return passage **9**, and opens fluid communication between the upper inlet passage **8** and the upper cylinder passage **10** while the land **34** closes fluid communication between the upper cylinder passage **10** and the upper return passage **9** and the land **35** opens fluid communication between the lower cylinder passage **10** and the lower return passage **9**. Referring to FIG. 3, fluid under pressure in the upper cylinder passage **10** acts on the upper end of the plunger **17** and holds it in its down position, and forces the check valve **19** upwardly out of engagement with its seat, and as the fluid under pressure flows through the central opening in the spring backup member **21**, the flow restrictor **26** is forced upwardly into engagement with the seat **36** in the cylinder port bushing **23**. With the restrictor **26** thus seated, fluid can flow into the upper end of the cylinder **6** only through the upper groove **30**, and thus the rate of downward movement of the piston **24** is controlled by the size of the upper groove **30**. When the spool **14** is permitted to return to its neutral position by the action of the centering spring mechanism **15**, the piston **24** is locked against upward movement by the closing of the check valve **19**.

Now, when the spool **14** is shifted upwardly from its FIG. 2 neutral position, again the land **32** of the spool and, in addition, the land **37** thereof, closes communication between both inlet passages **8, 8** and the middle return passage **9**, the land **37** also being operative to open fluid communication between the lower inlet passage **8** and the lower cylinder passage **10**, and thus when fluid pressure builds up in the lower cylinder passage **10** it will act on the lower end of the plunger **17** to urge the latter upwardly until its extension **25** engages and lifts the check valve **19** away from its seat. At the same time, the land **34** opens fluid communication between the upper cylinder passage **10** and the upper return passage **9**, whereby fluid is returned through return port **4** to a reservoir from the cylinder **6** through the now open check valve **19**. However, the flow of fluid from the cylinder **6** into the cylinder port **5** forces the restrictor **26** downwardly against the seat **38** of the backup member **21** whereby all of the returning fluid must pass through the lower restrictor groove **31**, and that rate of flow may be the same as, greater than, or less than, the rate of flow through the upper groove **30** which restricts flow of fluid in the opposite direction.

Although by way of illustrative example only, the two-way restrictor **26** herein is shown in a spool valve **1** for controlling the actuation of a single acting fluid motor **6**, it is to be understood that the present invention has equal applicability in connection with double acting fluid motors simply by forming a second cylinder port in the boss **39** of the housing **2** communicating with the lower cylinder passage **10** so that when the lower cylinder passage **10** is communicated with the lower inlet passage **8**, the piston **24** in the cylinder will be moved by fluid pressure in the opposite direction from that in which it is moved by fluid under pressure in the upper cylinder passage **10** when communicated with the cylinder port **5**. It is also obvious that in such double acting arrangement, the bore **16** may be extended downwardly for installation of another load check valve **19**, and another cylinder port bushing **23**. In such case, a second restrictor **26** would not be required, since flow in both directions is already restricted by the upper restrictor **26**, but the plunger **17** will have a downwardly extending rod-like extension **25** for opening of the lower check valve **19** upon downward movement of said plunger **17**.

Grooves **30, 31** provide for a self-cleaning action. Thus, if the operator moves spool **14** downwardly to connect upper cylinder passage **10** with inlet passage **8** for causing pressure fluid to flow past restrictor **26** into cylinder **6** for extending piston **24** and a dirt particle enters grooves **30** in the restrictor to block such flow, the operator will be aware of this fact when piston **24** fails to move to extended position. The operator may then momentarily move spool **14** upwardly to connect upper cylinder passage **10** with the upper branch of exhaust passage **9** to permit reverse flow of fluid from cylinder **6** past restrictor **26** and to exhaust port **4**. This reversal of fluid flow causes restrictor **26** to move downwardly away from seat **36** and give the fluid a chance to wash the dirt particle out of groove **30**. The operator may then reposition spool **14** for extending piston **24**.

Recesses **28, 29** are formed to a standard preselected depth in restrictor **26** and grooves **30, 31** are thereafter formed of selected widths and depths to provide the desired flow rate in the particular valve in which the restrictor **26** is to be assembled. Such preselected depth for recesses **28, 29** is the same or greater than the maximum depth of the respective grooves **30, 31** so that any semi-finished restrictor **26** may be taken from the shelf and have grooves **30, 31** formed therein of a size to suit the particular requirement. Because the recesses **28, 29** are deeper than, or at least as deep as, the respective grooves **30, 31**, the latter are of constant length so that the flow rates therethrough are controlled solely by width and depth.

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 a valve assembly for controlling actuation of a fluid motor, the combination of a housing having an inlet port for connection with a fluid pressure source, a return port for connection with a fluid reservoir, and at least one motor port for connection with a fluid motor; a valve member movable in said housing from an inactive position to either of two operating positions whereat said motor port is selectively communicated with said inlet port and said return port via a passage in said housing extending from said valve member to said motor port; a check valve in said passage opened by flow of fluid under pressure in said passage from said valve member to said motor port; a fluid pressure actuated member in said housing moved by fluid under pressure acting thereon to open said check valve to permit flow of fluid in said passage in the opposite direction from said motor port to said valve member; and two-way flow restrictor means in said passage defining therewith first and second restricted passages which respectively restrict flow of fluid in opposite directions only according to the relative flow capacities of said first and second passages, said restrictor means comprising a plate-like means movable in said passage with its opposite end faces alternately engaging spaced apart seats in said passage, said end faces having grooves therein constituting the respective first and second passages when engaged with the respective seats.

2. In combination, a valve housing having a passage through which fluid flows in opposite directions; said passage being laterally enlarged to provide spaced apart seats; a restrictor means movable in said passage having opposite end faces alternately engaging said seats; said respective seats and end faces, when engaged, defining first and second restricted passage means which respectively restrict flow of fluid in opposite directions only according to the relative flow capacities of said first and second passage means; a spring seated check valve means disposed in said passage having a spring back up means constituting one of said seats, said seated check valve

means being adapted to be moved by fluid pressure to an open position permitting flow of fluid in one direction, and means adapted to be moved into engagement with said check valve means to move it to such open position permitting flow of fluid in the opposite direction.

3. The combination of claim 2 wherein a port means detachably connected to said housing contains the other one of said seats whereby, upon detachment of said port means, said restrictor means, back up means, and check valve means may be removed from said housing.

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