April 9, 1968 H. J. STACEY 3,376,892

DIRECTIONAL CONTROL VALVE

Filed March 4, 1966 2 Sheets-Sheet 1

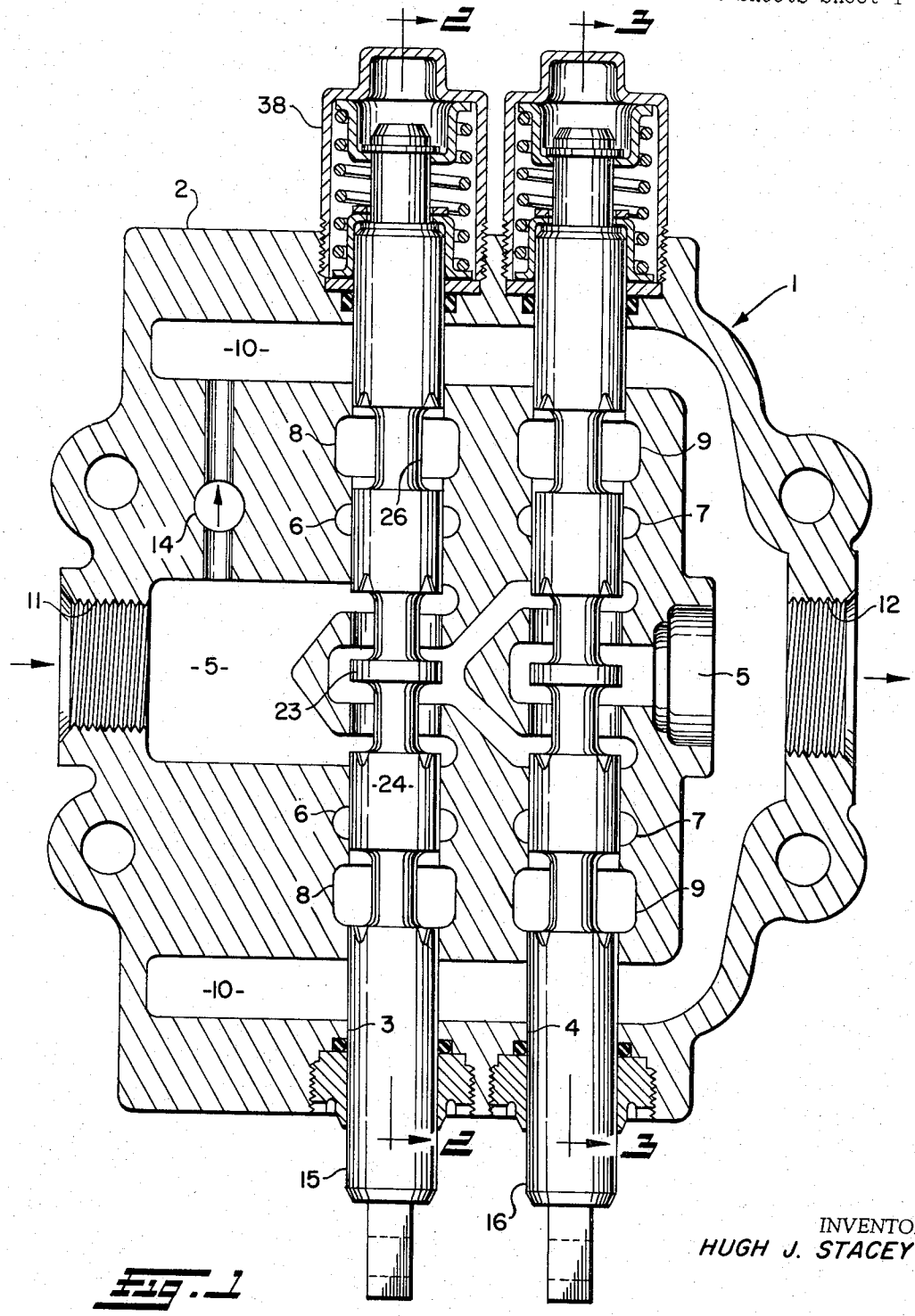


Fig. 1

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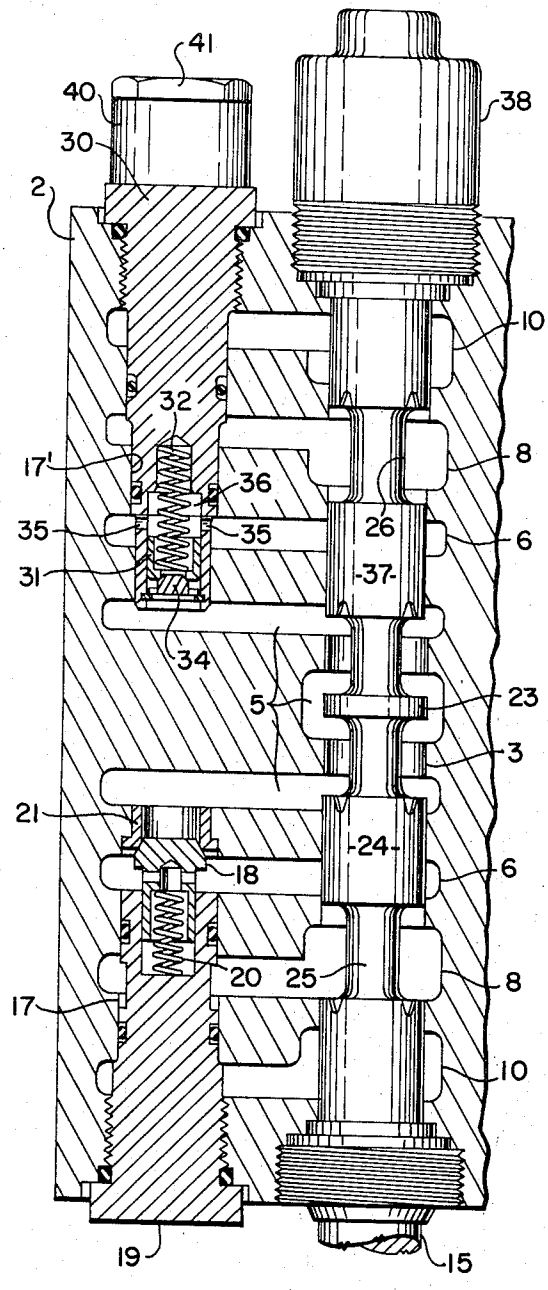


Fig. 2

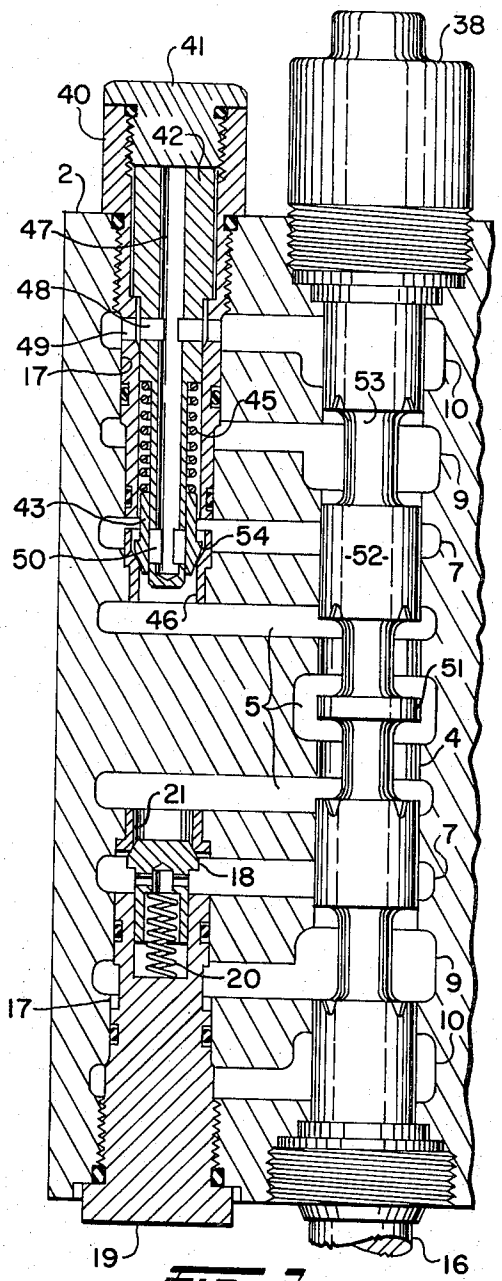


Fig. 3

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DIRECTIONAL CONTROL VALVE

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ABSTRACT OF THE DISCLOSURE

A directional control valve assembly having control or divider valves which regulate the rate of flow through the valve spool to a motor passage and also operate as load check valves to prevent flow of fluid in the opposite direction.

The present invention relates generally as indicated to a directional control valve and more particularly to a spool-type directional control valve.

In such spool-type directional control valves it is known, as shown in the patent to Herbert H. Schmiel, 3,216,443, granted Nov. 9, 1965, to provide in a multiple spool valve assembly a unitary housing having parallel bores in which the respective valve spools are reciprocable, such bores being intersected by a bypass passage which has its upstream end in communication with the pressure inlet port of the housing and its downstream end in communication with the return port of the housing, by pressure feed passages intersecting the respective bores, by motor passages intersecting the respective bores, and by return passages intersecting all bores and leading to the return port of the housing. Also, as disclosed in the aforesaid Schmiel patent, the housing is provided with lateral extensions of said bypass, pressure feed, motor, and return passages which, in turn, are intersected by bores in which are provided load check valves for the respective valve spools to prevent load dropping in case of pressure drop in the system as occasioned by pump failure or, in the case of a parallel circuit valve assembly, by simultaneous operation of two or more valve spools.

With the foregoing in mind, it is one object of this invention to utilize the aforesaid load check valve bores for selective mounting of volume control valves, flow dividers, or the like.

It is another object of this invention to provide a volume control valve, a flow divider, or the like in a load check valve bore of a directional control valve which additionally functions as a load check 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 certain illustrative embodiments of the invention, these being indicative, however, of a few 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 spool-type directional control valve, such section having been taken in a plane passing through the axes of the spool bores; and

FIGS. 2 and 3 are transverse cross-section views taken substantially alongt he lines 2—2, and 3—3, respectively of FIG. 1.

Referring now more particularly to the drawing, the directional control valve 1 comprises a housing 2 having parallel bores 3 and 4 axially intersected therealong by a bypass passage 5, by pressure feed passages 6, 6 and 7, 7, by motor passages 8, 8 and 9, 9, and by return passages 10, 10. The bypass passage 5 at its upstram end communicates with the pressure inlet port 11 of the housing 2 and at its downstream end communicates with the return port 12 of the housing 2, and the return passages 10, 10 communicate also with said return port 12. The reference numeral 14 in FIG. 1 denotes schematically a relief valve which opens to relieve excess pressure in the inlet port 11 to the return port 12 via a return passage 10.

Reciprocable in the respective bores 3 and 4 are valve spools 15 and 16 which, by way of example, are herein shown as being of the four-way type for control of double acting fluid motors connected with the respective motor passages 8, 8 and 9, 9.

As best shown in FIGS. 2 and 3, said bypass, pressure feed, motor, and return passages 5, 6, 8 and 10 (FIG. 2) and 5, 7, 9, and 10 (FIG. 3) have lateral extensions which intersect stepped bores 17 in which check valves 18 are conventionally disposed, as shown in the lower portions of FIGS. 2 and 3, and as shown in the aforesaid Schmiel Patent No. 3,216,443.

As herein shown, each check valve 18 comprises a body 19 screwed into the housing 2 in which the check valve 18 is movably guided and biased by spring 20 into engagement with the seat 21. Thus, when the spool 15 of FIG. 2 is moved upwardly, the bypass is closed by the lands 23 and 24, and the lower feed passage 6 is placed in fluid communication with the lower motor passage 8 via the neck 25 of the spool, whereupon build-up of pressure in the lower lateral extension of the bypass passage 5 will open the lower check valve 18 for flow of fluid into the lower pressure feed passage 6 and thence to the fluid motor (not shown) via the lower motor passage 8, and in this upper position of the spool 15, the upper motor passage 8 is placed in fluid communication with the upper return passage 10 by way of the neck 26 whereby fluid displaced by the motor is returned to a reservoir or tank connected to the return port 12 via the upper motor and return passages 8 and 10. Similarly, when the spool 16 of FIG. 3 is shifted upwardly, the lower check valve 18 opens for conduction of fluid under pressure from the lower lateral extension of the bypass passage 5 to the lower pressure feed passage 7 and then to the lower motor passage 9, with fluid returning from the motor actuated thereby to a tank via the upper motor and return passages 9 and 10 which are then in fluid communication.

In FIG. 2 the upper stepped bore 17′ has screwed therein a body 30 for a volume control valve 31 which is biased by spring 32 against a seat 34 in said body 30. As evident, when the valve 31 is moved upwardly away from seat 34 under the influence of fluid pressure in the upper lateral extension of the bypass passage 5 fluid will flow through flow orifices 35 in body 30 into the upper feed passage 6. However, as the pressure drop between the upper bypass passage 5 and the chamber 36 increases, the valve 31 will progressively close said orifices 35 thus to regulate the rate of flow of fluid to upper feed passage 6. Thus, when the spool 15 in FIG. 2 is moved downwardly from the position shown, the bypass passage 5 will be closed by the lands 23 and 37 and the neck 26 will open communication between the upper pressure feed passage 6 and the upper motor passage 8 whereby fluid under pressure in the upper bypass passage 6 will urge the volume control valve 31 upwardly out of engagement with the seat 34 for flow of fluid through the openings 25 into the upper pressure feed passage 6 and into the upper motor passage 8 for actuating the associated fluid motor (not shown). However, as the fluid flow tends to increase through the valve 31, it will progressively block the openings 35 thus to control or limit the rate of flow of fluid to the upper motor passage 6 thus to obtain precision control of the rate of actuation of the

associated fluid motor. When the spool **15** is released, the spring return mechanism **38** will return it to the neutral position shown in FIG. 2 to open the bypass passage **5**. The valve **31** will then be urged by spring **32** against seat **34**. In the event that there is a drop in pressure in the system while the spool **15** is in its down position, the valve **31** will engage the seat **34** to prevent reverse flow from the upper pressure feed passage **6** into the upper bypass passage **5**. The valve **31** thus operates as a load check valve, the same as check valve **18**.

Referring now to FIG. 3, the upper stepped bore **17** has screwed therein a flow divider body **40** in which is secured by the screw plug **41** a valve guide **42** on which the flow divider valve **43** is slidable and biased by spring **45** against the seat **46**. The valve guide **42** has a passage **47** therein which is slotted at **48** to register with openings **49** in the body **40** and with the upper return passage **10**, and which is slotted at **50** within the valve **43** when the latter is in seated position as shown. When the spool **16** in FIG. 3 is shifted downwardly from the neutral position shown, the bypass passage **5** will be closed by the lands **51** and **52**, and the upper pressure feed passage **7** will be in fluid communication with the upper motor passage **9** via the spool neck **53**, and build up of fluid pressure in the upper bypass passage **5** will urge the valve **43** away from its seat **46** for flow of fluid into the upper pressure feed passage **7** to the upper motor passage **9** to actuate the associated fluid motor (not shown). As the valve **43** thus moves upwardly as viewed in FIG. 3, it defines with the seat **46** an annular orifice **54** through which the fluid flows at increasing rate as the pressure drop across said orifice **54** increases. However, at a desired maximum flow as determined by the spring **45**, the lower end of the valve **43** commences to uncover the lower slots **50** in the valve guide **42**, whereby excess flow of fluid passes through the lower slots **50** and the passage **47** in the valve guide **42** to the upper return passage **10** via the upper slots **48** and openings **49**.

The spool **16** like spool **15** has associated therewith a spring return mechanism **38** to return said spool **16** to neutral position when axial force thereon in either direction is released. In the event of reduction of fluid pressure in the upper bypass passage **5** to a value less than that in the upper pressure feed passage and the upper motor passage when the spool **16** is in its downwardly shifted position, the spring **45** will urge the valve **43** into engagement with seat **46** thereby preventing load dropping. Thus, the valve **43** operates as a load check valve the same as the check valve **18** which is disposed in the lower stepped bore **17**.

From the foregoing, it can be seen that a conventional spool-type directional control valve can be readily converted to include flow control, flow divider, and like functions by substituting such units for the conventional load check valves employed in such directional control valves. Furthermore, in the present case, the volume control valve **31** and the flow divider valve **43** yet retains the load check valve function to prevent load dropping in the event of pressure drop in the supply circuit to a value less than that in the motor circuit.

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. A directional control valve assembly comprising a housing having a first bore intersected axially therealong by a pressure feed passage for connection with a fluid pressure source, by a motor passage for connection with a fluid motor, and by a return passage for connection with a reservoir; a valve spool movable in said first bore to at least one operating position whereat said pressure feed passage is communicated with said motor passage; a second bore communicating said pressure feed passage with such fluid pressure source; and a flow control valve in said second bore comprising a valve body having a flow orifice therein for flow of fluid between said second bore and pressure feed passage, a valve seat, control valve means movable in said valve body away from said seat under the influence of higher fluid pressure supplied by such fluid pressure source than in said pressure feed passage for flow of fluid from such fluid pressure source through said orifice into said pressure feed passage and thence into said motor passage when said spool is in said one operating position, said flow orifice being progessively closed by continued movement of said control valve means away from said seat for regulating the rate of flow through said flow orifice to said pressure feed passage; and spring means biasing said control valve means toward said seat for preventing flow of fluid in the opposite direction in said pressure feed passage.

2. The assembly of claim **1** wherein there are a plurality of flow orifices in said valve body which are progressively closed by such movement of said control valve means away from said seat.

3. The assembly of claim **1** wherein said second bore is intersected axially therealong by said pressure feed passage, said motor passage, and said return passage, and said valve body isolates said motor passage from said pressure feed passage and said return passage.

4. The assembly of claim **1** further comprising a bypass passage in said housing intersecting said first bore for connection with such fluid pressure source and reservoir at its respective upstream and downstream ends, said second bore communicating said pressure feed passage with said bypass passage, said valve spool being movable in said first bore from a neutral position whereat said bypass passage is open for flow of fluid therethrough from its upstream end to its downstream end and whereat communication between said motor passage and said pressure feed and return passages is blocked thereby to two operating positions whereat said bypass passage is blocked thereby and whereat said motor passage is selectively communicated with said pressure feed passage or with said return passage, respectively.

5. A directional control valve assembly comprising a housing having a first bore intersected axially therealong by a pressure feed passage for connection with a fluid pressure source, by a motor passage for connection with a fluid motor, and by a return passage for connection with a reservoir; a valve spool movable in said first bore to at least one operating position whereat said pressure feed passage is communicated with said motor passage; a second bore communicating said pressure feed passage with such fluid pressure source; and a flow divider valve in said second bore comprising a valve guide having a passage which at one end is in fluid communication with said return passage and at the other end is in fluid communication with said second bore, a valve seat, flow divider means slidable on said valve guide for movement away from said seat under the influence of higher fluid pressure supplied by such fluid pressure source than in said pressure feed passage to permit flow of fluid from such fluid pressure source into said pressure feed passage and thence into said motor passage when said spool is in said one operating position, said flow divider means when adjacent said seat blocking such fluid communication between said second bore and said other end of said valve guide passage, and establishing such fluid communication which progressively increases as said flow divider means moves away from said seat to divert excess flow through said valve guide passage to said return passage.

6. The assembly of claim **5** further comprising spring means for biasing said flow divider means against said seat to close said other end of said valve guide passage and to prevent flow of fluid in the opposite direction in said pressure feed passage.

7. The assembly of claim **5** where in said flow divider means and a surrounding portion of said seat define an

annular orifice for establishing such fluid communication between such fluid pressure source and said pressure feed passage.

8. The assembly of claim 5 wherein said second bore is intersected axially therealong by said pressure feed passage, said motor passage, and said return passage, and said flow divider valve further comprises a valve body surrounding said valve guide which isolates said motor passage from said pressure feed passage and said return passage.

9. The assembly of claim 8 wherein there are aligned openings in one end of said valve guide and body for establishing fluid communication between said passage in said valve guide and said return passage, and slots in the other end of said valve guide which are progressively uncovered by movement of said flow divider means away from said seat for establishing progressively increasing fluid communication between such fluid pressure source and said passage in said valve guide.

10. The assembly of claim 5 further comprising a bypass passage in said housing intersecting said first bore for

connection with such fluid pressure source and reservoir at its respective upstream and downstream ends, said second bore communicating said pressure feed passage with said bypass passage, said valve spool being movable in said first bore from a neutral position whereat said bypass passage is open for flow of fluid therethrough from its upstream end to its downstream end and whereat communication between said motor passage and said pressure feed and return passages is blocked thereby to two operating positions whereat said bypass passage is blocked thereby and whereat said motor passage is selectively communicated with said pressure feed passage or with said return passage, respectively.

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HENRY T. KLINKSIEK, *Primary Examiner.*