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[54] **CONTROL VALVES**
5 Claims, 4 Drawing Figs.

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 [51] Int. Cl. **F16k 11/10**
 [50] Field of Search 137/596.12,
 596.13, 596.14, 596.15, 596.625.28, 625.3,
 625.35, 625.68, 504

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ABSTRACT: A pressure-compensated directional control valve capable of supplying a constant volume of fluid is provided having a directional control valve with inlet and outlet ports and first and second motor ports for connection to opposite sides of a fluid motor, a pressure-compensating valve having an axial bore, an inlet port connected to the inlet port of the control valve, an outlet port connected to the outlet port of the control valve, a pressure-sensing port, a valve member movable in the bore and biased to a position normally blocking the inlet from the outlet port, said valve member having opposite surfaces thereon exposed respectively to the fluid pressure at said inlet port and to fluid pressure at said pressure-sensing port acting with the biasing means and being movable in response to a fluid pressure differential between its inlet port and pressure sensing port through the directional control valve to connect said inlet port to said outlet port for bypassing fluid from said directional control valve to thereby regulate the input flow through said directional control valve to a work port.

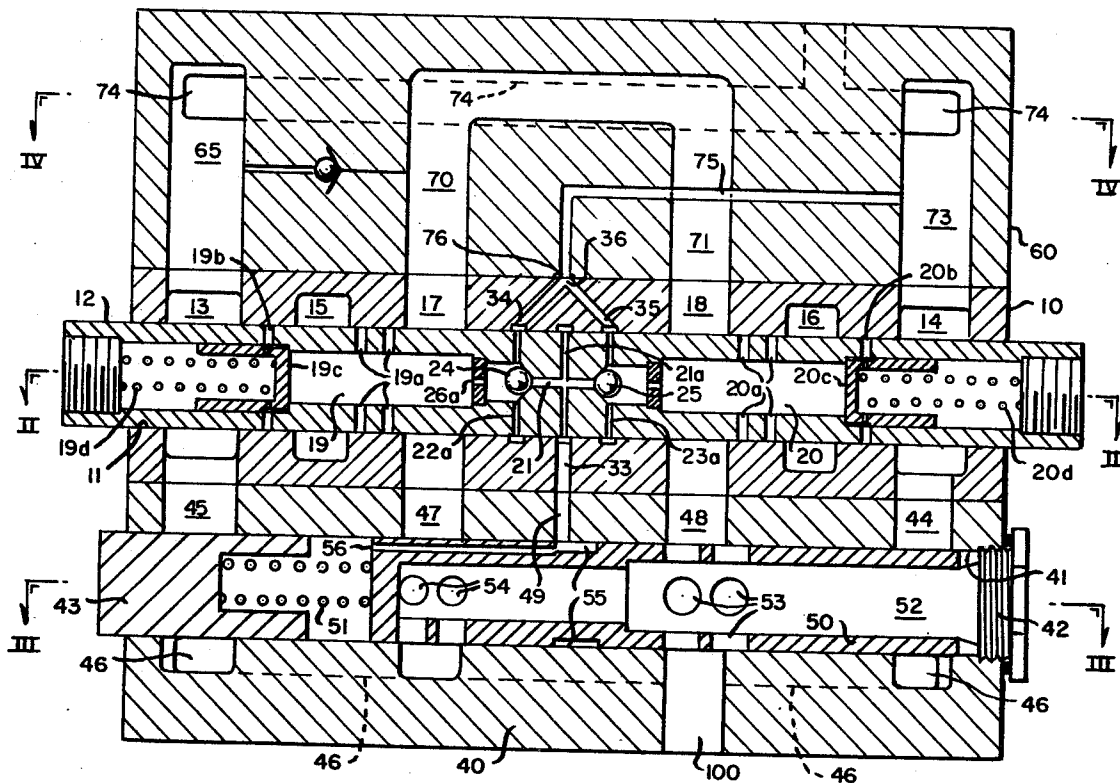


Fig. 1.

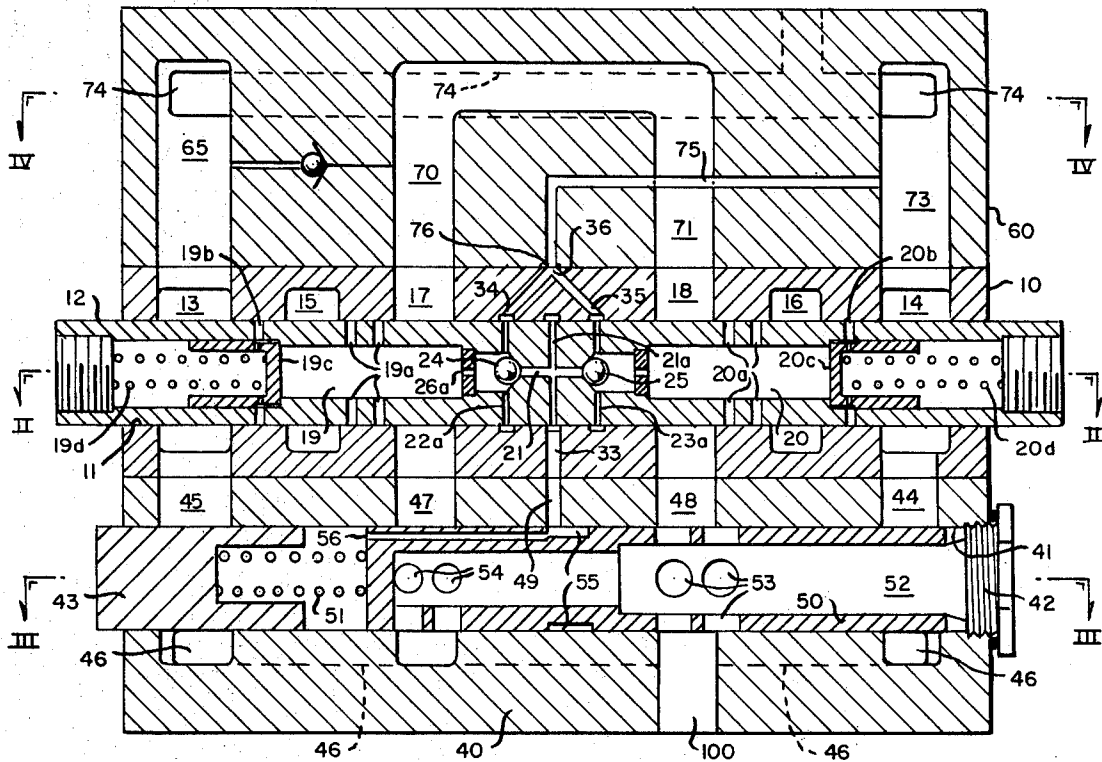


Fig. 3.

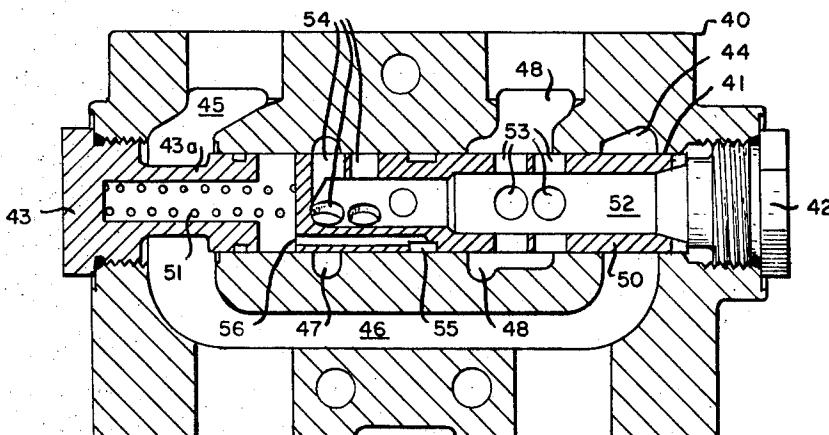


Fig. 2.

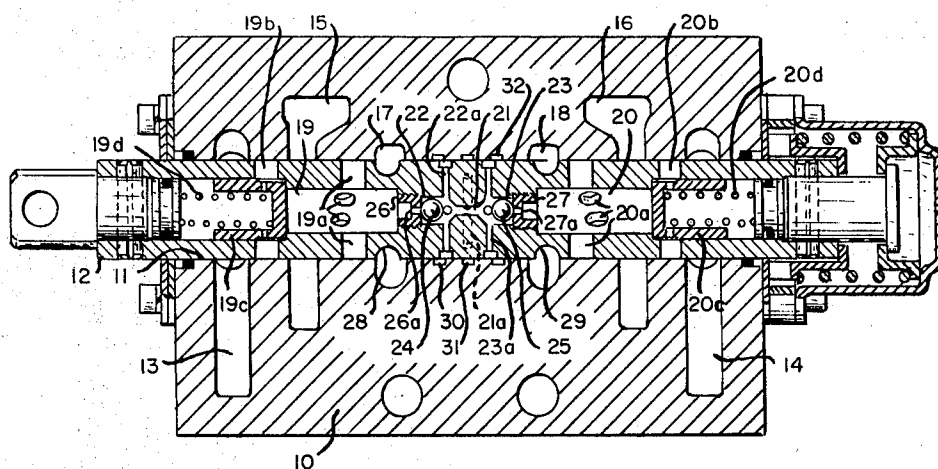
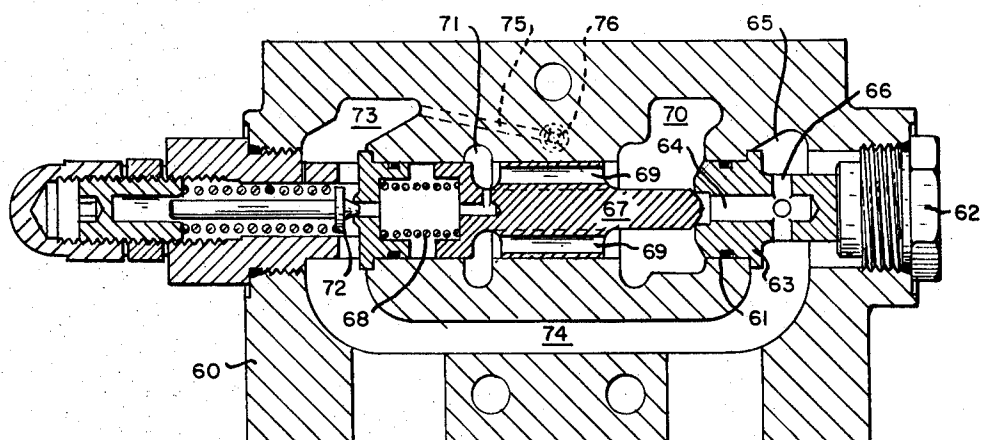


Fig. 4.



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CONTROL VALVES

This invention relates to control valves and particularly to pressure-compensated control valves for fluid-actuated systems.

It has long been recognized that it is desirable for the rate of movement of a load-moving mechanism be the same regardless of the amount of the load. In fluid-actuated systems, this means that the volume of fluid flowing in the system must be the same regardless of load size. This can, of course, be regulated manually to some degree by moving the valve manually to adapt it to varying conditions of load. The manual control is, however, quite difficult and requires a highly skilled operator and constant attention by him.

The present invention provides a valve structure which automatically regulates the position of the valve depending upon the load so as to maintain a constant volume flow of fluid.

In the present invention, there is provided a directional control valve for selectively operating a fluid motor at a controlled speed, said valve having inlet and outlet ports and first and second motor ports for connection to opposite sides of said fluid motor, a pressure-compensating valve having an axial bore, an inlet port connected to the inlet port of said control valve, an outlet port, a pressure-sensing port, a valve member movable in said axial bore, means biasing said valve member to a position normally blocking said outlet port from said inlet port and partially blocking said inlet port from the inlet port of the control valve, said valve member having opposite surfaces thereon exposed to respectively the fluid pressure at said inlet port and to fluid pressure at said pressure sensing port acting with said biasing means, said valve member in the pressure-compensating valve being movable in response to a fluid pressure differential between its inlet port and pressure-sensing port through the directional control valve to connect said inlet port to said return port for bypassing input pressure fluid from said directional control valve to thereby regulate the input flow through said directional control valve means to one of said work ports. Preferably the directional control valve is provided with a valve member movable in a bore therein, said valve member being hollow at each end to form chambers therein adapted selectively to communicate through the valve member walls with the inlet port, work ports and outlet port and the pressure-sensing port of the pressure-compensating valve.

In the foregoing general description, I have set out certain objects, purposes and advantages of my invention. Other objects, purposes and advantages will be apparent from a consideration of the following description and the accompanying drawings in which:

FIG. 1 is a schematic section through a directional control valve and pressure-compensating valve according to my invention;

FIG. 2 is a section on the line II-II of FIG. 1;

FIG. 3 is a section on the line III-III of FIG. 1; and

FIG. 4 is a section on the line IV-IV of FIG. 1.

Referring to the drawings, I have illustrated a directional control valve housing 10 having an axial bore 11 carrying a valve member 12. The housing is provided with spaced exhaust chambers 13 and 14 adjacent each end and intersecting bore 11, a pair of work chambers 15 and 16, one adjacent each exhaust chamber and each adapted to be connected to the opposite sides of a fluid motor. Between the two work chambers are spaced inlet chambers 17 and 18. The valve member 12 is hollow at each end to provide a pair of spaced internal chambers 19 and 20 extending axially of the valve member and connected by an axial passage 21 and ball chambers 22 and 23 at each end of said passage. The ball chambers are provided with freely movable balls 24 and 25 held in place by plugs 26 and 27 threaded into the ends of chambers 22 and 23 and each provided with a passage 26a and 27a respectively. Each of chambers 22 and 23 is provided with passages 22a and 23a extending radially to the periphery of the valve member. The chamber 20 is provided with two sets of radial openings 20a and 20b and chamber 19 is provided with a corresponding

set of radial openings 19a and 19b. The openings 19a and 20a lie on a helical line so that their center lines are not on the same circumferential line. Openings 19b and 20b are separated from openings 19a and 20a respectively by check valves 19c and 20c within the chamber operated by springs 19d and 20d. A pair of spaced annular grooves 28 and 29 surround the valve member in alignment with inlet chambers 17 and 18 when the valve is in neutral position. When the valve is shifted to the right viewing FIG. 2 the openings 20a are one after another opened to work chamber 16 while openings 20b are open to outlet or exhaust chambers 14. At the same time, openings 19a are opened to inlet chamber 17 and openings 19b are opened to work chamber 15. As the valve is moved the openings 19a and 20a are opened to the appropriate chamber one after another to provide slowly increased flow of fluid into the corresponding chamber in a throttling manner. This fluid then opens the corresponding check valve 19c and 19d permitting fluid in chamber 19 to flow to work chamber 15 and thence to one side of a fluid motor (not shown). In turn, the fluid in the opposite side of the fluid motor is discharged to work chamber 16 thence through openings 20a, check valve 20c and into outlet chamber 14. At the same time, the pressure in chamber 19 passes through passages 26a forcing ball 24 to close passage 21 and its corresponding radial passages 21a. Passage 23a is isolated at this point. Moving the valve in the opposite direction from neutral reverses the flow of fluid. The valve housing is provided with annular grooves 30, 31 and 32 which when the valve is in neutral are open to radial passages 22a, 21a and 23a respectively. The groove 31 is connected to a radial passage 33 which extends to the outside of housing 10. Grooves 30 and 32 are connected respectively to passages 34 and 35 which extend angularly to the outside of housing 10 and connect at the outside of the housing to a common port 36.

The pressure compensating valve housing 40 has a bore 41 closed at one end by a cap 42 threaded into the bore at one end and by a cap 43 threaded into the bore at the opposite end. The bore 41 is intersected by outlet or exhaust chambers 44 and 45 at each end connected together by a U-shaped passage 46. Inlet or high-pressure chambers 47 and 48 intersect the bore intermediate the outlet chambers. A pressure sensing passage 49 intersects the bore 41 between the inlet chambers 47 and 48. The cap 43 extends through the exhaust or outlet chamber 45 and is provided with a groove 43a which permits free movement of fluid around it in chamber 45. A valve member 50 is freely movable in bore 41 and is biased toward cap 42 by spring 51 which bears on cap 43 at one end and on the valve member 50 with the other. The valve member is hollow from the end adjacent cap 42 to a point spaced from its opposite end to form an inner axial chamber 52. Radial openings 53 spaced axially along and through the wall of the valve member 50 connect the chamber 52 with inlet chamber 48. Similar radial openings 54 spaced axially along and through the wall of valve member 50 connect the chamber 52 with inlet chamber 47. An annular groove 55 surrounds the valve member 50 in communication with passage 49. Groove 55 is connected to the area between cap 43 and valve member 50 by an axially extending passage 56 which parallels the chamber 52.

Outlet section 60 has a bore 61 closed at one end by threaded cap 62 which holds relief valve base member 63 in place. This base member 63 has an axial bore 64 which communicates with outlet chamber 65 through radial passage 66. Relief valve 67 in bore 61 is biased to base member 63 by spring 68. The body of relief valve 67 is provided with parallel bores 69 which provide communication between inlet chambers 70 and 71. The relief valve 67 is pilot operated and controlled by pilot valve 72 which opens into outlet chamber 73. Outlet chambers 65 and 73 are connected by U-shaped passage 74. An angular passage 75 extends from port 76 to outlet passage 73. The port 76 is designed to communicate with port 36 of the directional control valve.

The operation of the valve structure of this invention is as follows. Referring to FIG. 1, I have shown the assembly of directional control valve 10, inlet pressure compensating valve 40 and outlet section 60 in their position with no fluid pressure applied. When fluid pressure is applied to input port 100 from a pump (not shown) the chambers 48, 18, 71, 70, 17 and 47 are pressurized along with the interior chamber 52 of valve element 50. The pressure with chamber 52 causes the valve 50 to shift to the left viewing FIG. 1 to discharge out of the open end of chamber 52 into chamber 44 and thence through chambers 14 and 73 to the outlet and back to tank (not shown). When the control valve is shifted, as for example to the right viewing FIG. 1, the input fluid passes through openings 19a into chamber 19, past check valve 19c, through openings 19b into work chamber 15 and thence to one side of a fluid motor to be operated. The position of valve member 12 in bore 11 controls the amount of volume initially by the amount and number of openings 19a opened to chamber 17. Return fluid from the work chamber 16 enters openings 20a, past check valve 20c and exhausts through openings 20b to exhaust or outlet chamber 14. At the same time passage 22a comes into communication with passage 49 as the valve member is moved to the right so that the area behind valve 50 in which spring 51 operates is pressurized at the same pressure as chamber 19 in valve 12. If the pressure increases then valve member 50 moves to the right cutting off the amount of fluid dumping through the valve end to chamber 44 increasing the pressure of input fluid in chamber 17 to maintain a constant flow through work chamber 15. If, on the other hand, the pressure drops in chamber 19 then the pressure behind valve 50 drops and the valve moves leftward increasing the amount being bypassed to chamber 44. In short, once the control valve 12 is set for a given volume, the change in pressure drop controls the amount of fluid being dumped in valve 40 so that the amount of fluid going to the work port is constant. When the control valve 12 is completely opened, that is, at its left or right extreme one hundred percent of the oil goes to the work port and the valve 50 is in its extreme right position with no oil being bypassed. When so pressurized, both ball checks 24 and 25 close the passage 21 from chamber 19 to chamber 20.

If a second control valve is incorporated into the system as it can be with the present invention, then the valve demanding the highest pressure will be compensated. The valve of the present invention is the first which can be used in conjunction with more than one directional control valve. Assuming two identical control valves corresponding to valve 10 and assuming 50 gallons of available hydraulic at a pressure of 3,000 p.s.i. and that 20 gallons at 1,000 p.s.i. is being used at work chamber 15 of the first valve from inlet 100, then assuming that the next succeeding valve is operated and it requires 2,000 p.s.i. on work chamber 16 of this second valve, this will cause fluid in chamber 20 to pass through passage 23a to port 36 of the previous valve. This will in turn pass down through passage 35 to passage 21a and into passage 21 which will cause the ball checks 24 and 25 to move over to close passages 26a and 27a. The pressure then passes through passage 22a, passage 49, groove 55, passage 56 to the area containing spring 51 behind valve 50 causing valve 50 to move to the right closing off the bypass to passage 44 until the pressure in

passages 48, 18 and 71 reaches 2,000 p.s.i. and then valve 50 remains under the control of the pressure drop in the second control valve. At this point the first valve must be manually throttled to control volume.

If conditions change so that the first valve requires the higher pressure, then it takes over control of valve 50 and valve 50 maintains a constant volume through it while the second valve is manually operated. In short, the control valve operating at highest pressure automatically becomes pressure compensated and the other valve or valves in the system are manually operated.

While I have illustrated and described a presently preferred embodiment of my invention in the foregoing specification, it will be obvious that this invention may be otherwise embodied within the scope of the following claims.

I claim:

1. A pressure-compensated directional control valve comprising a directional control valve for selectively operating a fluid motor at controlled speed, said valve having inlet and outlet ports and first and second motor ports for connection to opposite sides of a fluid motor, a pressure compensating valve having an axial bore, an inlet port connected to the inlet port of said control valve, an outlet port connected to the outlet port of said control valve, a pressure sensing port, a valve member movable in said axial bore, means biasing said valve member to a position normally blocking said outlet from said inlet port, said valve member having opposite surfaces thereon exposed respectively to fluid pressure from said inlet port and to fluid pressure at said pressure-sensing port acting with said biasing means, said valve member being movable in response to fluid pressure differential between its inlet port and pressure-sensing port through the directional control valve to connect said inlet and outlet ports for bypassing input pressure fluid to thereby regulate the input flow through said directional control valve to one of said work ports.

2. A control valve as claimed in claim 1 wherein the directional control valve is provided with a valve member movable in a bore therein, said valve member being hollow at each end to form chambers therein adapted selectively to communicate through the valve member walls with the inlet port, work ports and outlet port and the pressure-sensing port of the pressure compensating valve.

3. A control valve as claimed in claim 2 wherein said directional control valve member communicates with the pressure-sensing port through a passageway between the two chambers in the neutral position and through a passageway in each chamber in each work position.

4. A control valve as claimed in claim 3 wherein the passageways in each chamber communicate with the outlet port when the valve is in neutral position.

5. A control valve as claimed in claim 1 wherein the pressure-compensating valve member is hollow and open at one end, said hollow portion communicating with the inlet port of both the directional control valve and the pressure compensating valve through openings in the sidewalls and discharging through its open end to the outlet port when the pressure in the chamber exceeds the biasing means and pressure-sensing pressures.

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