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Hodgson

[11] 3,707,988
[45] Jan. 2, 1973

[54] CONTROL VALVES

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[52] **U.S. Cl.** **137/596.12**
[51] **Int. Cl.** **F16k 11/10**
[58] **Field of Search**..........137/596.12, 596.13, 596.2

[56] **References Cited**

UNITED STATES PATENTS

3,160,174	12/1964	Schmiel et al.	137/596.12 X
3,482,600	12/1969	Hodgson	137/596.2
3,602,243	8/1971	Holt	137/596.12 X

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[57] **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 longitudinal bore in said control valve, a valve member movable in said bore, said valve member being hollow at each end forming spaced chambers selectively communicating with one another and through the valve member walls with the inlet ports, outlet ports and work ports and with a pair of spaced grooves surrounding the valve member, three spaced annular grooves in the valve walls communicating with the grooves in the valve member, a pressure sensing port communicating with the intermediate groove in the valve walls, 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.

5 Claims, 4 Drawing Figures

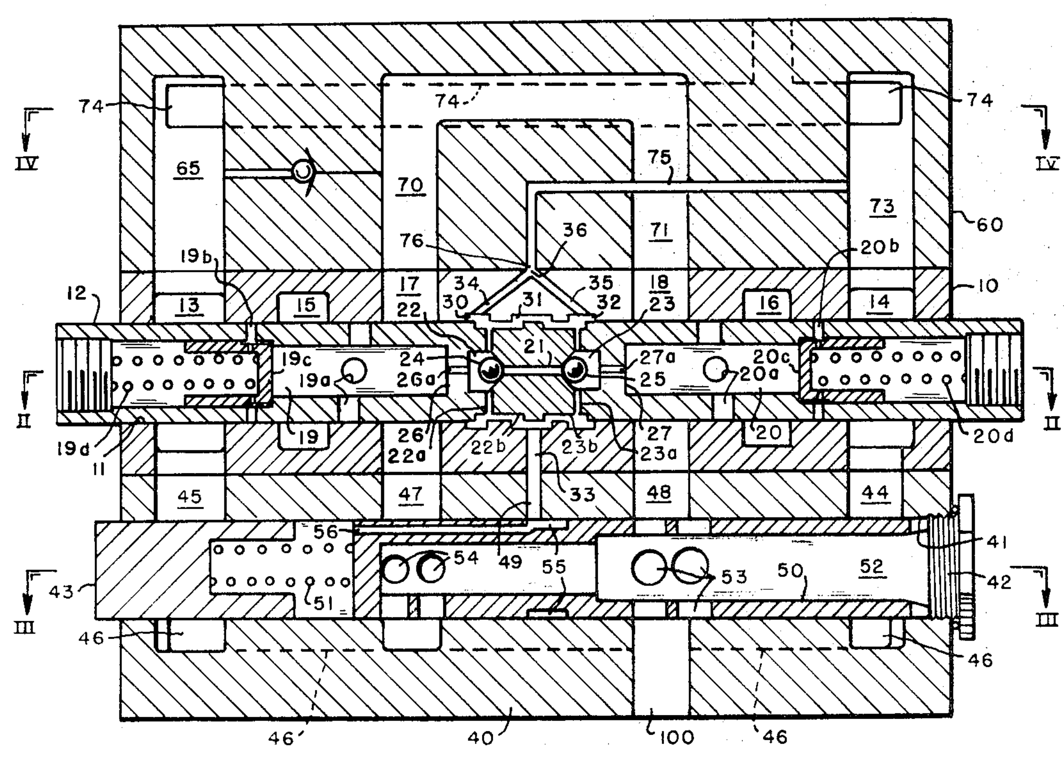

Fig. 1

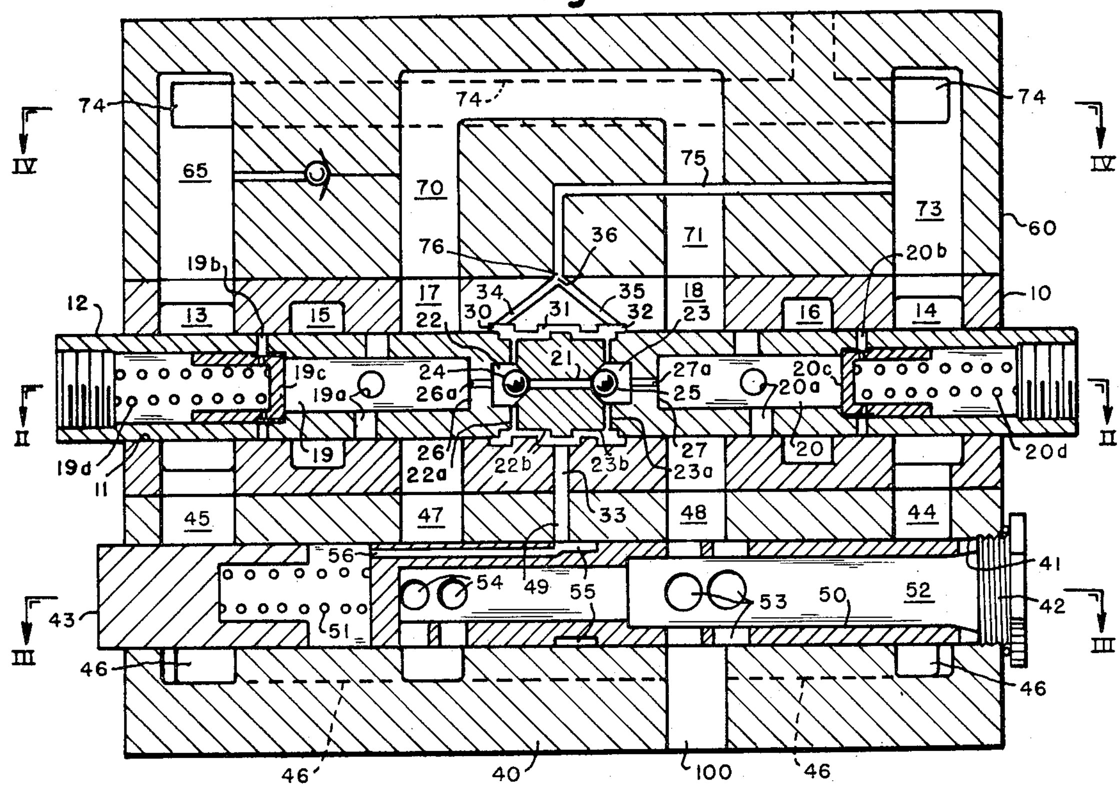

Fig. 3

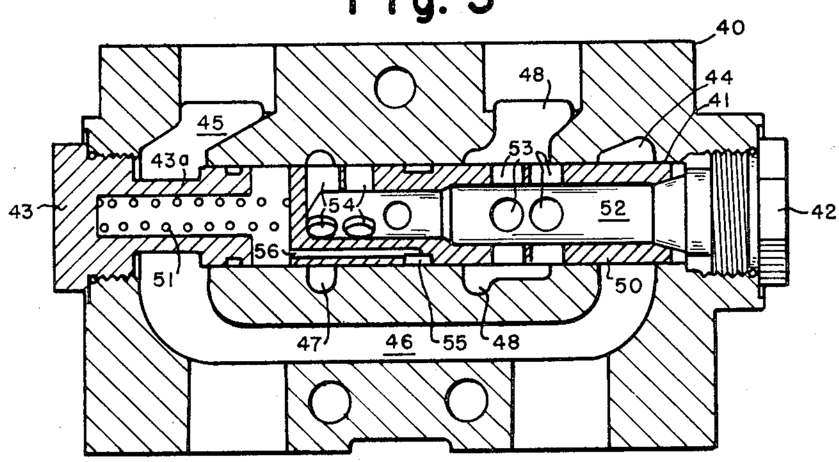

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Fig. 2

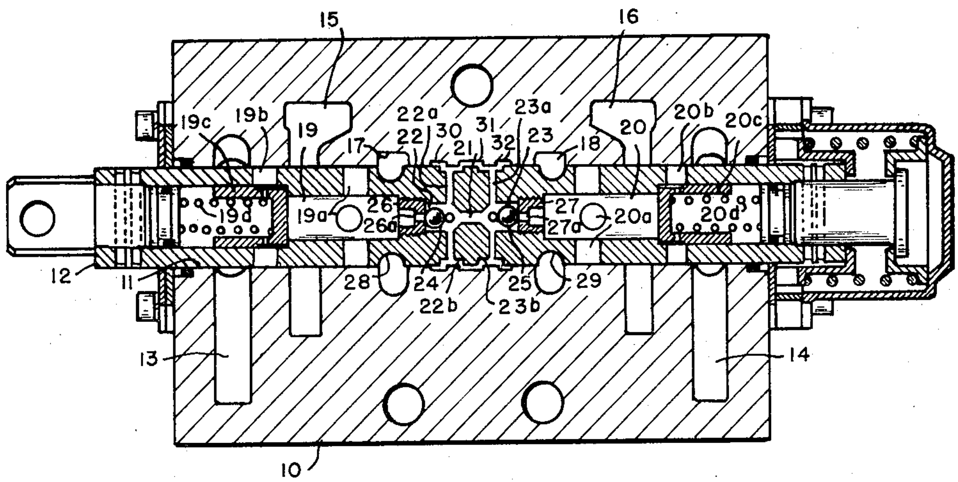
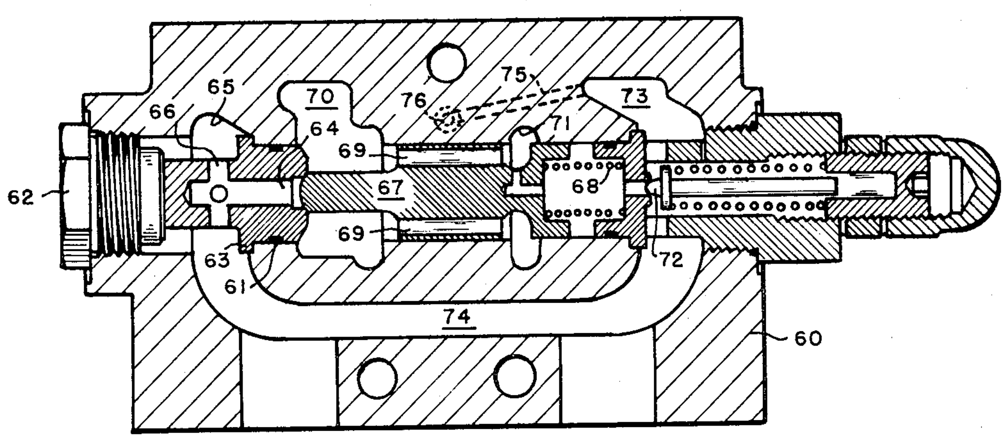


Fig. 4



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CONTROL VALVES

This invention relates to control valves and particularly to pressure compensated control valves for fluid actuated systems and is an improvement on the control valve structure disclosed and claimed in my U.S. Pat. 3,565,110 issued Feb. 23, 1971.

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, just as was the case in the structure of U.S. Pat. No. 3,565,110. In the structure of U.S. Pat. No. 3,565,110, there are situations where the compensator receives a false signal because of the movement of the balls in the ball chambers of the directional valve.

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 by-passing 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 through cooperating grooves in the directional control valve bore and the directional control valve member 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 **24** held in place by plugs **26** and **27** threaded into the ends of chambers **22** and **23** and each provided with a passage **26*a*** and **27*a*** respectively. Each of chambers **22** and **23** is provided with passages **22*a*** and **23*a*** extending radially to the periphery of the valve member. The chamber **20** is provided with two sets of radial openings **20*a*** and **20*b*** and chamber **19** is provided with a corresponding set of radial openings **19*a*** and **19*b***. The openings **19*a*** and **20*a*** lie on a helical line so that their center lines are not on the same circumferential line. Openings **19*b*** and **20*b*** are separated from openings **19*a*** and **20*a*** respectively by check valves **19*c*** and **20*c*** within the chamber operated by springs **19*d*** and **20*d***. A pair of annular grooves **22*b*** and **23*b*** surround the valve member in communication with passages **22*a*** and **23*a*** of the directional control valve member. When the valve is shifted to the right viewing FIG. **2** the openings **20*a*** are one after another opened to work chamber **16** while openings **20*b*** are open to outlet or exhaust chambers **14**. At the same time, openings **19*a*** are opened to inlet chamber **17** and openings **19*b*** are opened to work chamber **15**. As the valve is moved the openings **19*a*** and **20*a*** 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 **19*c*** and **19*d*** 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 **20*a***, check valve **20*c*** and into outlet chamber **14**. At the same time, the pressure in chamber **19** passes through passages **26*a*** forcing ball **24** to close passage **21**. Passage **23*a*** 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 **22*a*** and **23*a*** with fluid moving freely between them and grooves **22*b*** and **23*b*** in the valve member. 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**. In short, the position of the pool and openings **19a** establish an equivalent orifice whether there is flow or not. This establishes substantially the same stable pressure in **19** and at the spring end of valve **50** as exists at **100** and in **52**. Valve **50** is therefore biased to the right by spring **51** to begin shutting off the flow to **44**. 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 100 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. 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 **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 his 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 longitudinal bore in said control valve, a valve member movable in said bore, said valve member being hollow at each end forming spaced chambers selectively communicating with one another and through the valve member walls with the inlet ports, outlet ports and work ports and with a pair of spaced grooves surrounding the valve member, three spaced annular grooves in the valve walls communicating with the grooves in the valve member, a pressure sensing port communicating with the intermediate groove in the valve walls, 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 communicating with the pressure sensing port of the directional control valve, 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 pressure sensing port of 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 with the pressure sensing port of the pressure compensating valve through one of the annular grooves in the valve member and the pressure sensing port of the directional control valve.

3. A control valve as claimed in claim **2** wherein said directional control valve member communicates with the pressure sensing port through the annular grooves in the valve member and walls and 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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