Sept. 17, 1968 J. R. PLATE 3,401,521

HYDRAULIC CONTROL VALVE

Filed March 6, 1967

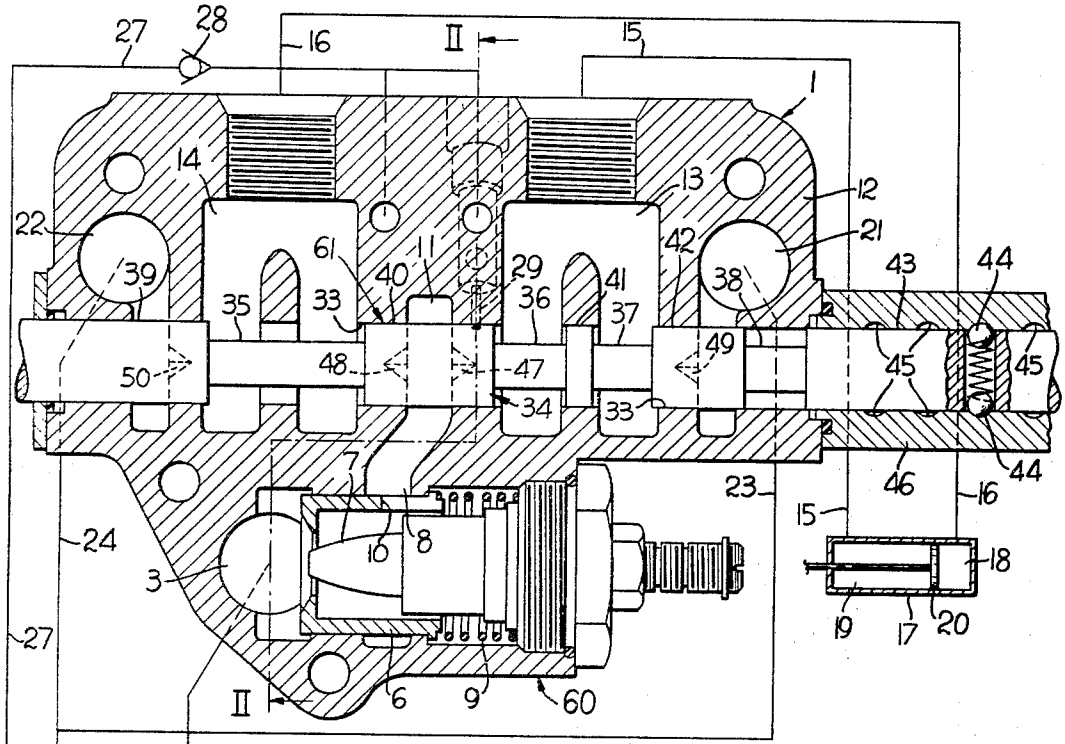



Fig.-1

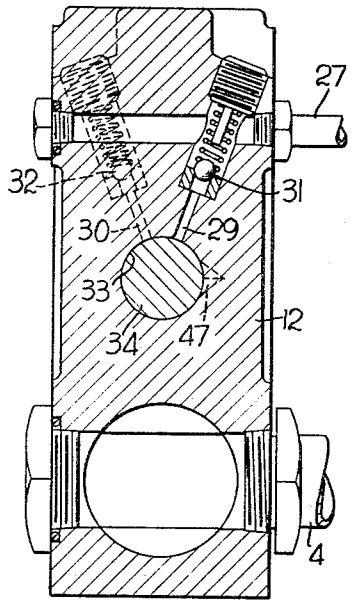



Fig.2

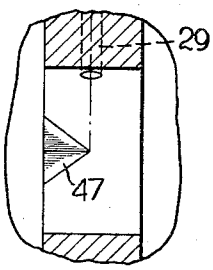
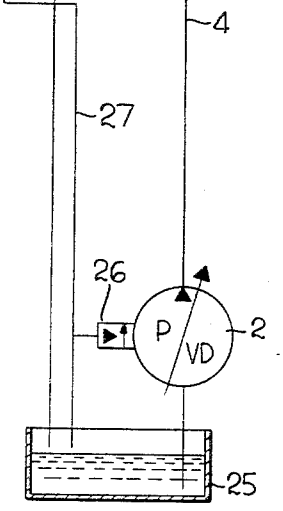



Fig.3




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# HYDRAULIC CONTROL VALVE

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## ABSTRACT OF THE DISCLOSURE

A directional control valve providing a preload sensing of load pressure by a pressure responsive pump to eliminate delay in pump response due to inherent pressure build-up in the conventional hydraulic system as the load is applied to the pump.

This invention relates to a hydraulic system and more particularly to a directional control valve for preload application of the load pressure to a pressure responsive pump.

A pressure responsive variable displacement pump in a hydraulic system provides a means of maintaining higher pressures without delivery of a large volume of fluid. The pressure responsive pump has the added advantage of reducing the working pressure for the pump during periods when maximum pressure is not required to activate the load. The pressure responsive variable displacement pump of the conventional type operates in response to pump output. This type of operation has the disadvantage of delayed response to the load applied. Accordingly, this invention is intended to overcome this disadvantage.

A directional valve initially connects the hydraulic motor through a pilot line to the pressure sensing portion of the variable displacement pump. Sequentially pressurized fluid from the pump is metered as it is applied to the hydraulic motor to build up the pressure gradually prior to actuation of the hydraulic motor.

The objects of this invention are accomplished by providing a pilot line through the directional control valve for initially sensing the load pressure by the pressure responsive means of the pump for stroking and destroking a variable displacement pump. Subsequently to sensing of load pressure from the hydraulic motor, a metering means is provided in combination with the directional control valve to meter the pressurized fluid from the pump, which is maintained at substantially 200 pounds per square inch above the sensed load pressure, and for applying pressurized fluid through a metering means to the hydraulic motor. With further opening of the directional valve the load pressure is applied to the pump.

The preferred embodiment of this invention will be described in the following paragraphs and illustrated in the attached drawings of which:

FIG. 1 illustrates a cross section view of the directional control valve with a schematic diagram of the hydraulic system.

FIG. 2 illustrates a cross section view taken on line II—II of FIG. 1.

FIG. 3 is a fragmentary cross section view of the metering groove and a pilot passage in the directional control valve.

Referring to the drawings, the present invention is illustrated in a directional hydraulic control valve by dual check valve arrangement for transmitting the load signal to the pump pressure compensator. This disclosure is generally concerned with a closed end load sensitive hydraulic system which uses a pressure compensated, variable displacement pump and a directional control valve to control a remote hydraulic motor. A control valve is designed to sample load pressure down stream



of the control valve. This is accomplished by providing a pilot passage which transmits the load pressure signal to the pump pressure compensator. Movement of the control valve from its neutral position establishes a load pressure sensing circuit and at the same time directs fluid flow to the motor. The load sensing or pilot line connection is provided with a check valve to prevent back flow from the pressure compensator circuit.

The valve assembly **1** is illustrated in cross section. The hydraulic system is schematically illustrated and connected to the directional control valve assembly **1**. The valve assembly **1** controls the flow of fluid from the pressure compensator variable displacement pump **2**. The valve body **1** has an inlet port **3** connected to the conduit **4**. The flow control valve **60** receives pressurized fluid from the inlet port **3** which is restricted by the variable orifice in the end of spring biased sleeve **6**. The probe **7** extends into the orifice and the sleeve **6** is biased in response to a differential of pressure acting on the sleeve **6** to also close off port **10** leading to the passage **8** in response to fluid pressure acting on the sleeve which shifts axially against the biasing force of the spring **9**. The pressurized fluid is then admitted to the chamber **11** within the valve housing **12** of the directional control valve assembly **1**. The directional control valve **61** controls the flow of fluid to the outlet passages **13** and **14**. The outlet passages **13** and **14** are in communication with the conduits **15** and **16**, respectively. The conduits **15** and **16** are connected to a double acting hydraulic cylinder **17**. The chamber **18** is connected to the conduit **16** and the chamber **19** is connected to the conduit **15**. The piston **20** is moved axially in response to admission of pressurized fluid in either chambers **18** or **19** which is controlled by the directional control valve **61** as previously mentioned.

The return passages **21** and **22** are in communication with conduits **23** and **24** which are connected to the reservoir **25**. The return passages receive fluid exhausting from the low pressure side of the piston **20** in the cylinder **17**. The fluid is returned to the reservoir simultaneously with admission of pressurized fluid on the opposite side of the piston **20**. In this manner the load is actuated in one of two axial directions in response to the position of the directional control valve **61**. The pressure sensitive variable volume pump **2** has a pressure sensing means **26** which is connected to a pilot line **27**. The pilot line **27** is connected through a check valve **28** to the unidirectional passages **29** and **30** which also include the check valves **31** and **32**, respectively.

The passages **29** and **30** intersect the bore **33** in the housing **12**. The bore **33** in the valve housing **12** has an axially movable spool **34** slidable in the bore in response to manual actuating means not shown. The valve spool **34** is formed with four annular grooves **35**, **36**, **37** and **38** and five lands **39**, **40**, **41**, **42**, **43**. The valve passages **29** and **30** are formed by intersecting cross passages in which are located the pressure opened directional valves in the form of check valve assemblies **31**, **32**. The valve bore **33** is provided with metering grooves in the valve housing **12** to initially throttle the movement of pressurized fluid from the pump to the hydraulic motor.

One end of the valve spool **34** is provided with detents **44** which are received in the plurality of recesses **45** on the inner periphery of the sleeve **46**.

The metering orifices **47** and **48** are formed in the valve housing **12** within the bore **33**. The metering orifices **47**, **48** are formed by triangular shaped cross sectional grooves formed in the housing which place the communication between the chamber **11** which is connected to the pump and to either of the chambers **13** or **14** which are in communication with the fluid motor **17**.

The orifices provide metering of pressurized fluid from the pump subsequent to sensing of the motor pressure through the pilot line **27**, to the pressure responsive means **26** on the variable displacement pump **2**. Similar metering grooves **49** and **50** provide metering of the fluid from the chambers **13** and **14** to the return passages **21** and **22**, respectively.

The description refers to stroking or destroking of the pump. Effectively this means changing the volume of displacement of the pump for each cycle of operation. If the pump is a reciprocating piston type pump, the length of the stroke can be varied to change the volume of displacement and therefore provide a variable displacement in response to pressure signal from the motor line.

Referring to FIG. 3, the sequence of operation is more clearly illustrated. The passage **29** is in communication with the chamber **13** prior to metering through the orifice **47** of pressurized fluid from the chamber **11** to the chamber **13** during operation of the valve **61**. The spool **34** moves axially to the left in housing **12** to provide this operation of pressure sensing and metering.

The operation of the control valve spool will be described in the following paragraphs. When the control valve spool **34** is shifted to the left from its shown neutral position, the passage **29** and the pilot line **27** are placed in communication with the load pressure in the motor outlet passage **13**, thereby transmitting a load signal to the pump compensator **26** just prior to transmitting pressurized fluid from the inlet passage in the chamber **11**. Since the compensator **26** maintains pump pressure at approximately 200 pounds per square inch above load pressure, the initial opening of the pressure sensing line to the pump compensator establishes the pump pressure 200 pounds per square inch above load pressure at the time the throttling grooves **47** are opened to emit pressurized fluid to the chamber **13**. As the spool **34** continues to move the metering groove **47** and passage **11** are opened to the chamber **13** to allow pressurized fluid to flow through the passage **11** and conduit **15** to actuate the piston **20** in the cylinder **17**. Whether the pressurized fluid is metered or the valve is completely open the compensator senses the load pressure and strokes the pump to maintain the 200 pounds per square inch pressure over load pressure. This eliminates the need for the pump to operate at full pressure during metering of the pressurized fluid and overcomes the problem of heat or horsepower loss. With the present valve design, load checks are not required because the pump is stroked to accept the load pressure prior to being exposed to the load pressure.

The same operation as described above will also be accomplished if the spool valve is moved to the right instead of the left except the hydraulic motor will move in the opposite direction. Simultaneously with the actuation of the fluid motor by the admission of pressurized hydraulic fluid into the chamber **18** the chamber **19** decrease in volume causing a reverse flow of fluid into conduit **15** and chamber **13** around the spool into the return passage **21** and through the return conduit **23** to the reservoir **25**. The system as illustrated is the basic system used in its simplest form. It is understood that a number of motors may be used and more than one directional valve in combination with the flow control valve **6**. The circuit must be designed to provide a pump having adequate displacement to accommodate the amount of fluid which may be used in operating more than one fluid motor.

The preferred embodiments of this invention have been illustrated and described and it is understood that other embodiments might be devised which would fall within the scope of this invention which is defined by the attached claims.



The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

**1.** A directional control valve in a hydraulic system for connection with a variable displacement pressure compensating hydraulic pump having pressure compensating means and a fluid motor, said directional control valve comprising, means defining inlet passage means for receiving pressurized fluid from the pump, means defining outlet passage means for communication with the hydraulic motor, means defining pilot passage means in communication with the pressure compensating means of said variable displacement pump, means defining orifice means communicating with said inlet passage means, a valve element movably mounted in said directional control valve initially connecting said pilot passage means to said outlet passage means for sensing load pressure by said pressure compensating means of said variable displacement pump and sequentially connecting said inlet passage means through said orifice means to said outlet passage means to thereby provide a load responsible variable displacement pump for maintaining a predetermined output pressure responsive to load pressure required by said hydraulic motor.

**2.** A directional control valve as set forth in claim **1** wherein said valve includes a valve housing defining a central bore communicating with said inlet passage means and said outlet passage means and said pilot passage means, a valve spool reciprocally mounted in said bore to control communication between said outlet passage means and said pilot passage means initially and subsequently provide communication between said inlet means and said outlet passage means.

**3.** A directional control valve as set forth in claim **1** wherein a pressure response flow control valve is positioned to communicate with said inlet passage means and the variable displacement pump to regulate the rate of flow of pressurized fluid to said inlet passage means.

**4.** A directional control valve as set forth in claim **1** wherein said valve includes a valve housing defining a central bore, means defining at least two outlet passages in spaced relation to each other communicating with said central bore, means defining an inlet passage means positioned intermediate said two outlet passages communicating with said bore, a valve spool received in said bore adapted for reciprocal movement to initially provide communication between one of said outlet passages and said pilot passage means and subsequently provide communication between one of said passages and said inlet passage means through said orifice means.

**5.** A directional control valve as set forth in claim **1** wherein said valve includes a valve housing defining a central bore, means defining two outlet passages communicating with said central bore in spaced relation to each other, means defining an inlet passage intermediate said two outlet passages communicating with said central bore, a pilot passage communicating with said central bore positioned intermediate each of said outlet passages and said inlet passage, orifice means defining a groove in said bore positioned intermediate said inlet passage and each of said pilot passage means, a spool reciprocally mounted in said bore to initially provide communication between one of said outlet passages and one of said pilot passages to transmit load pressure to the pressure responsible compensating means of said pump, and subsequently provide metering of hydraulic fluid from said inlet passage to said outlet passage for actuation of the hydraulic motor.

No references cited

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## Disclaimer

3,401,521.—*John R. Plate,* Milwaukee, Wis. HYDRAULIC CONTROL VALVE. Patent dated Sept. 17, 1968. Disclaimer filed Apr. 1, 1981, by the assignee, *Allis-Chalmers Corp.*

Hereby enters this disclaimer to claims 1 and 2 of said patent.

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