United States Patent [19]

Lonnemo

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[54] **POWER TRANSMISSION**

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[51] **Int. Cl.** **F04b 1/00**

[58] **Field of Search** 417/213, 218, 220, 221, 417/222; 91/506; 60/450

[56] **References Cited**

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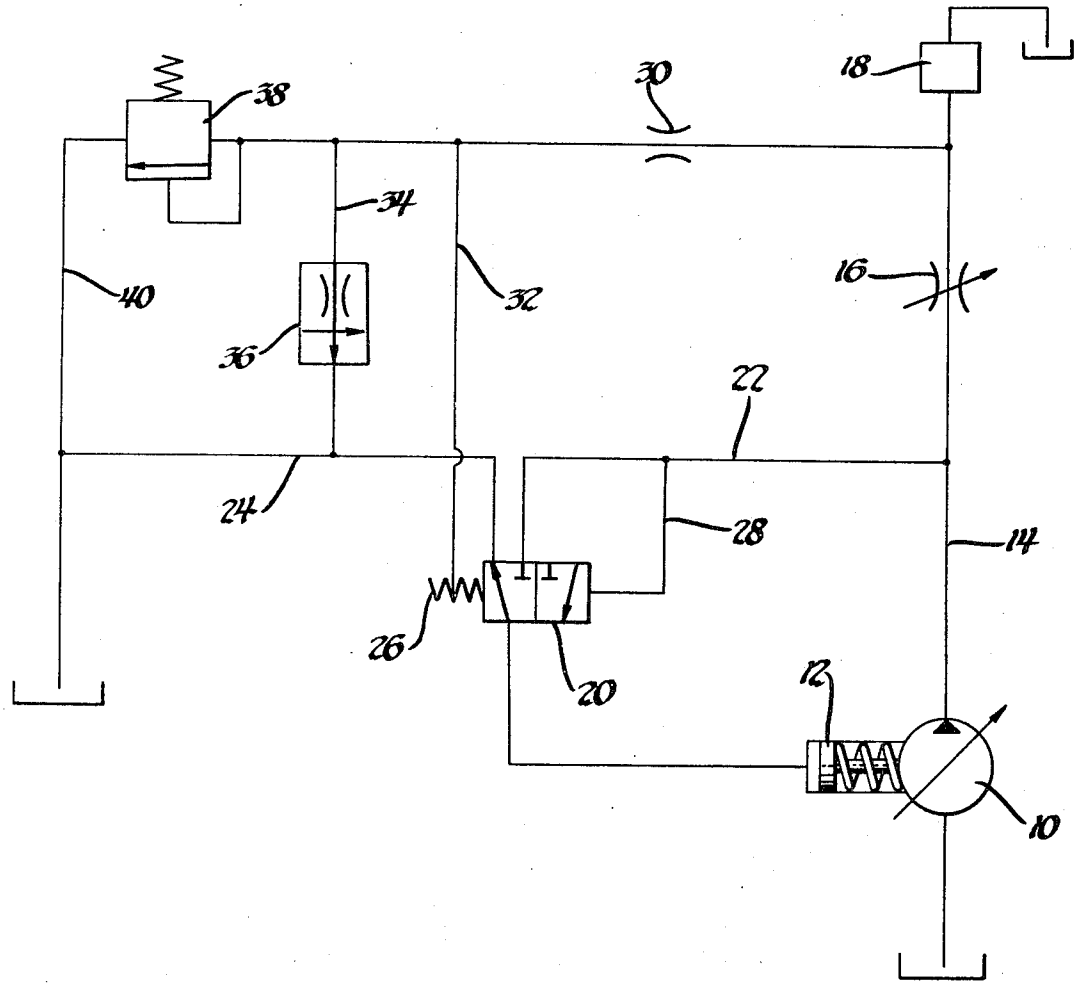
[57] **ABSTRACT**

A pilot operated load compensated variable displacement pump is controlled by a servomotor and a pilot valve to maintain a constant pressure drop across an adjustable orifice in the pump delivery line. The available pressure differential for operating the pilot valve is increased without increasing the pressure drop in the main flow through the adjustable orifice by providing a small restrictor in the operating line to the pilot valve and establishing a continuous bleed flow through that restrictor to establish a large pressure differential supplementing that at the adjustable orifice in the main pump delivery line. The bleed is established through a pressure compensated flow control valve. Maximum pressure limiting is obtained by a pilot relief valve establishing a parallel bleed. Alternatively, a special pilot relief valve establishes both the bleed flow and the maximum pressure limiting.

4 Claims, 2 Drawing Figures



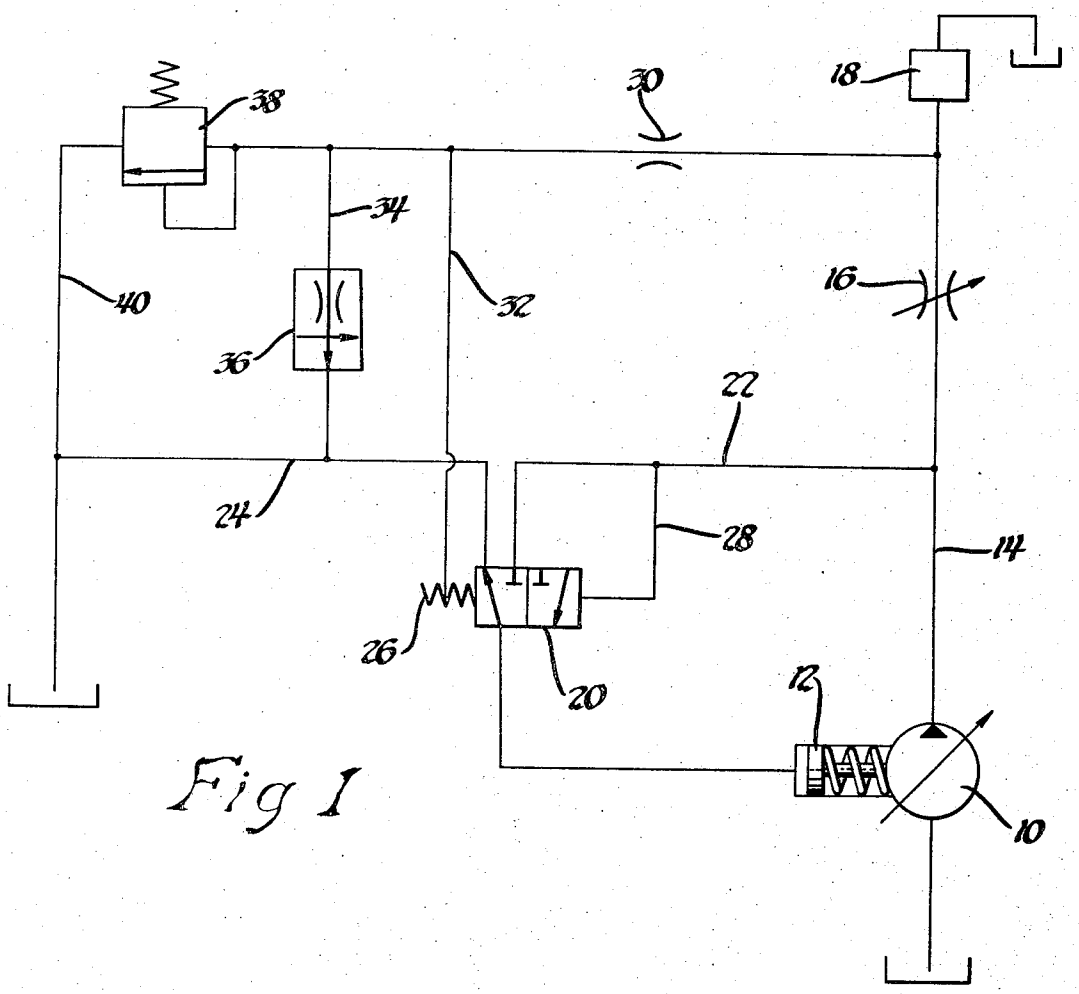

38
30
18
34
40
32
16
36
22
24
28
14
26
20
12
10

Fig 1

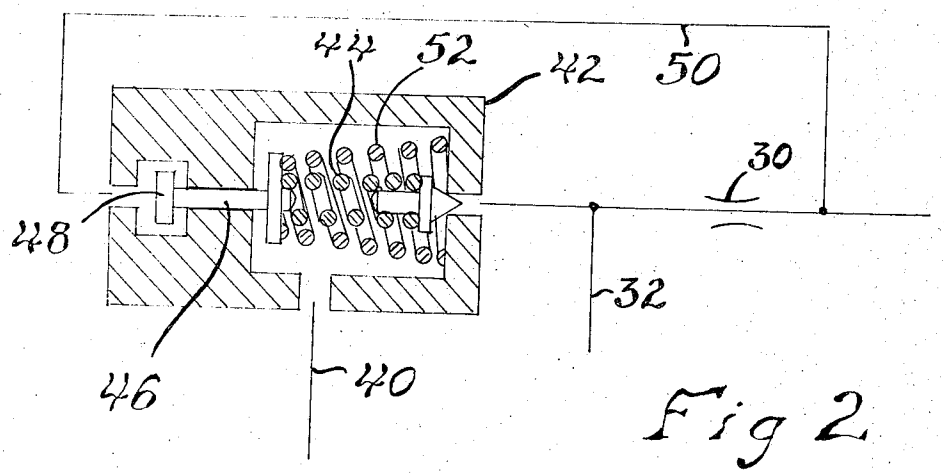

44
52
42
50
30
48
32
46
40

Fig 2

POWER TRANSMISSION

Conventional load compensated variable displacement pumps have a displacement regulator which is governed by the pressure drop across one or more adjustable orifices in the pump delivery line, thus, automatically regulating the pump delivery to the volumetric flow requirements determined by the size of the adjustable orifice, or orifices. Customarily, such an orifice is found in the variable opening of the usual main directional valve controlling flow to a fluid motor. In such systems, the regulator requires a substantial pressure available for its operation and this is determined by the amount of pressure drop across the adjustable orifice. Thus, if reasonable dynamic behavior is to be had at the regulator, a very substantial pressure drop is imposed upon all of the fluid flowing through the adjustable orifice or directional valve. In systems which transmit large amounts of power hydraulically, this represents a substantial loss through throttling.

The present invention aims to provide an improved load compensated variable displacement pump in which the available pressure for operating the regulator is high, while the pressure drop through the adjustable orifice in the main delivery line is a low one, and thus throttling losses in the main power flow are minimized.

This is achieved by the provision of a pilot operated, load compensated, variable displacement pump for maintaining a predetermined pressure drop across an adjustable orifice which comprises a servomotor for adjusting the pump displacement, a pilot valve for controlling the servomotor, a connection from the pump output ahead of the adjustable orifice for urging the pilot valve toward a position of lesser pump displacement, a connection from the pump output beyond the adjustable orifice for urging the pilot valve toward a position of greater pump displacement, a restrictor in the second connection, and a bleed restriction from the restrictor to maintain a small continuous flow therethrough sufficient to create a pressure drop through the restrictor several times as great as the pressure drop through the adjustable orifice under steady state conditions, whereby a large pressure differential for operating the pilot valve is available without imposing a large pressure drop in the main flow through the adjustable orifice.

In the drawing:

FIG. **1** represents a hydraulic circuit diagram of a pump and control system incorporating a preferred form of the present invention.

FIG. **2** represents a modified form of the present invention.

A variable displacement pump **10** has a servomotor **12** for adjusting its displacement and feeds its output into a delivery line **14.** The delivery line **14** leads through an adjustable orifice **16** to a fluid utilization device **18.** The adjustable orifice **16** is representative of many types of valves which control the rate of flow to the fluid utilization device, such as one or more fluid motors. In many systems, of which this is typical, the adjustable orifice **16** may comprise a conventional four-way reverse valve.

The servomotor **12** is controlled by a three-way pilot valve **20** which can supply fluid to the servomotor **12** from the supply line **15** through a branch **22** or can exhaust fluid from the servomotor through an exhaust line **24.** The pilot valve **20** is urged to the left against a spring **26** by delivery line pressure directed through a brnach **28.** Also acting on the pilot valve **20** in opposition to delivery line pressure is a lower pressure derived from the delivery line after passing through the adjustable orifice **16** and a fixed orifice **30.** This pressure is transmitted through a branch **32.** A continuous bleed flow through the restrictor **30** is established by a branch **34** containing a pressure compensated flow control valve **36** feeding into the exhaust line **24.** For the purpose of establishing a maximum pressure limit in the system, a pilot relief valve **38** is connected as an additional possible bleed from the orifice **30** through a branch **40.**

In operation, with the pump **10** running and with the servomotor **12** stationary because of the pilot valve **20** being in the neutral position, the pump outlet pressure in lines **14, 22** and **28,** transmitted to the right end of pilot valve **20,** is exactly balanced by the force of spring **26** and the pressure maintained in line **32** on the left end of pilot valve **20.** This pressure is determined by the sum of the pressure drops through the adjustable orifice **16** and the restrictor **30.** The pressure drop at restrictor **30** is determined by the setting of the flow control valve **36** which determines the fixed and continuous bleed flow through the restrictor **30.**

When the adjustable orifice **16** is changed to a more restricted position, for example, this causes a temporary pressure rise in conduits **14, 22** and **28** which shifts the pilot valve **20** to the left admitting pressure fluid to the servomotor **12** and reducing the pump displacement. Motion of the valve **20** to the left pumps a small quantity of fluid upwardly through line **32** into the bleed circuit thus reducing the flow rate through restrictor **30** and consequently reducing the pressure at its outlet. When the pump displacement has been reduced to the value necessary to maintain the previous pressure drop through the adjustable orifice **16,** the valve **20** will return to its neutral position. A similar but opposite action occurs upon an opening adjustment of orifice **16.** Whenever the system pressure rises above a predetermined limit, the pilot relief valve **38** will open, causing a further bleed flow through the orifice **30,** thus dropping the pressure in conduit **32** and allowing pilot valve **20** to shift to the left and reduce the pump displacement until the pressure overload has ceased.

The pressure available for operating pilot valve **20** is theoretically the sum of the pressure drops through adjustable orifice **16** and restrictor **30.** By making the latter pressure drop relatively high, say five times as high as the former pressure drop, it will be seen that effective control of the pilot valve **20** is maintained without imposing a large pressure drop through the adjustable orifice **16.** In this way, substantial power losses in the main flow line are avoided.

In the modification illustrated in FIG. **2,** a special pilot relief valve **42** is provided to take the place of the flow control valve **36** and the pilot relief valve **38** together. Thus the inner spring **44** of the relief valve poppet is adjusted automatically by means of a piston **46** having a diameter equal to the seat diameter of the poppet. A head **48** limits the stroke of piston **46** and a branch line **50** connects the piston **46** to a point ahead of the restrictor **30.** An auxiliary spring **52** aids in biasing the piston **46** against this pressure.

Thus, depending upon the pressure drop across the restrictor **30,** the piston **46** will take up a certain posi-

tion balancing this pressure drop against the force of springs **44** and **52** and will vary the pressure setting of the pilot relief valve **42** correspondingly. A continuous quiescent flow is accordingly maintained through restrictor **30** which is at a substantially constant rate because of the constant pressure drop across restrictor **30.**

I claim:

1. A pilot operated load compensated variable displacement pump for maintaining a predetermined pressure drop across an adjustable orifice comprising a servomotor for adjusting the pump displacement, a pilot valve for controlling the servomotor, a connection from the pump output ahead of the adjustable orifice for urging the pilot valve toward a position of lesser pump displacement, a second connection from the pump output beyond the adjustable orifice for urging the pilot valve toward a position of greater displacement, a restrictor in the second connection and a bleed restriction comprising a pressure responsive flow regulator from the restrictor to maintain a small and fixed continuous flow therethrough independent of system pressure and sufficient to create a pressure drop through the restrictor several times as great as the pressure drop through the adjustable orifice under steady state conditions, whereby a large pressure differential for operating the pilot valve is available without imposing a large pressure drop in the main flow through the adjustable orifice.

2. A pump as defined in claim **1** wherein the flow regulator comprises an additional restrictor and a compensator for maintaining a constant pressure drop across the additional restrictor.

3. A pump as defined in claim **1** which includes a pilot relief valve connected to the restrictor to limit the maximum pump output pressure.

4. A pump as defined in claim **2** having a pilot relief valve connected to the first restrictor to limit the maximum pump output pressure.

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