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HYDRAULIC MECHANISM

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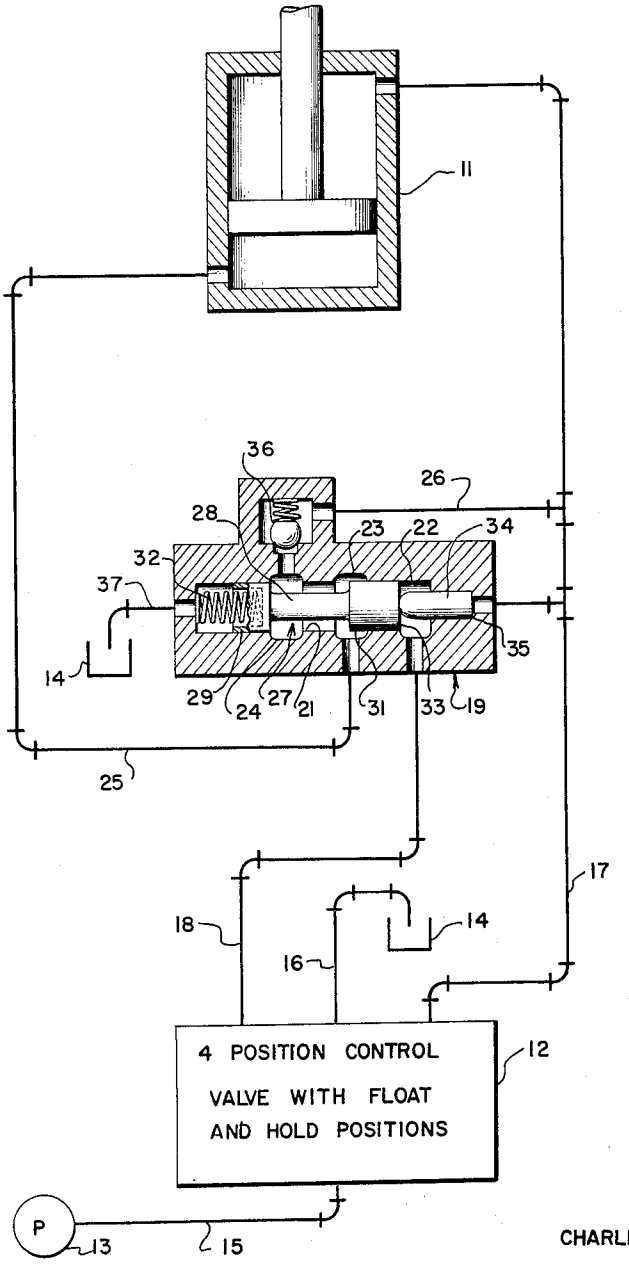

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HYDRAULIC MECHANISM

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This invention relates to hydraulic systems for controlling double-acting differential area piston motors.

In systems of this kind, the piston motor frequently is under the control of a four-position directional control valve. These valves are provided with an inlet port which is connected with a pump, an exhaust port which is connected with a reservoir or sump, and a pair of motor ports which are connected with the opposite sides of the piston motor. The control valve has a neutral or "hold" position in which each motor port is isolated from the other three ports; a "raise" position in which the inlet port is isolated from the exhaust port but is connected with one motor port, while the exhaust port is connected with the other motor port; a "lower" position in which the inlet and exhaust ports are isolated from each other and the connections between these ports and the two motor ports are reversed; and a "float" position in which all four ports are interconnected.

This type of system is used frequently in loaders for controlling the hoist motor which raises and lowers the bucket. In these installations, the "lower" position is used for digging whereas the "float" position is used to effect rapid dropping of the bucket from a raised position. It has long been a problem in this field to maintain the expanding side of the hoist motor liquid-filled during the bucket-dropping operation. An obvious means of preventing cavitation in that motor is to restrict severely the flow from the contracting side of the motor to the sump to thereby build up a back pressure adequate to force fluid into the expanding side, but this solution limits the rate of drop of the bucket.

The object of this invention is to provide means for maintaining the expanding side of a double-acting piston motor liquid-filled without unduly limiting the rate of movement of the motor. The invention is based upon the realization that one of the factors aggravating the cavitation problem is the fact that the oil expelled from one side of the motor must travel twice the distance between the motor and the control valve before reaching the other side of the motor. Since, in some cases, this path is extremely long, rather high back pressures are required to move the oil through the path at the necessary rate. This factor is minimized by the present invention through the provision of a valving device that can be mounted on or at least near the piston motor and which, in response to the pressures in the conduits extending between the control valve and the motor, automatically establishes a direct replenishing path between the opposite sides of the motor when the directional control valve is in the "float" position. This path is in parallel flow relation with, and thus provides a by-pass around, the normal replenishing path established in the directional control valve so it shortens greatly the length of the flow path travelled by the replenishing oil flowing from the contracting to the expanding side of the motor. Since the length of the path is decreased materially, a smaller back pressure is required to move the oil into the expanding side along that path. As a result, flow from the contracting side of the motor to the sump need not be severely restricted and, consequently, rate of movement of the motor is not limited.

The preferred embodiment of the invention is described herein in relation to the accompanying drawing whose

single FIGURE is a schematic diagram showing the valving device and a typical system in which it is used.

Referring to the drawing, the hydraulic system includes a double-acting differential area piston motor **11** which is under the control of a four-position directional control valve **12**. The control valve **12** affords the "hold," "raise," "lower" and "float" positions mentioned above and may take many different forms. The valve shown in U.S. Patent 2,916,050, granted December 8, 1959, is an example of a suitable directional control valve. The inlet and exhaust ports of the control valve **12** are connected with the pump **13** and sump **14** by conduits **15** and **16**, respectively, and the two motor ports are connected with the conduits **17** and **18**.

Interposed between the conduits **17** and **18** is the valving device **19** provided by this invention. This device comprises a housing containing a valve bore **21** encircled by three spaced annular chambers **22, 23** and **24** that communicate, respectively, with the conduits **18, 25** and **26**. Mounted in bore **21** is a shuttle valve plunger **27** formed with an annular groove **28** that defines the two lands **29** and **31**. Valve plunger **27** is biased to the position shown in the drawing by coil compression spring **32** and is shifted in the opposite direction by the fluid pressure in annular chamber **22** acting on the end face **33** of the plunger and by the fluid pressure in conduit **17** acting on the reciprocable pin **34** mounted in a reduced diameter extension of bore **21**. A shoulder **35** in the extension of bore **21** acts as a stop to limit rightward movement of the plunger **27** and pin **34**. Positioned between annular chamber **24** and conduit **26** is a spring-biased check valve **36** arranged to permit flow to conduit **17** through conduit **26** and to prevent flow in the opposite direction. The left end of bore **21** is vented to sump **14** through conduit **37**.

During operation, the device actuated by motor **11**, for example the bucket of a loader, is connected to it in such a manner that the load imposed on the motor tends to contract the piston side. If the directional control valve **12** is in its "raise" position, it establishes one flow path between conduits **15** and **18** and another such path between conduits **16** and **17**, with the result that the rod end of motor **11** is vented to sump **14** and the pressure fluid delivered by pump **13** is transmitted to the annular chamber **22** of valving device **19**. The pressure force developed on end face **33** by this fluid shifts valve plunger **27** to the left against the bias of spring **32** from the illustrated position to a second position in which land **31** interrupts communication between annular chambers **23** and **24** and opens communication between annular chambers **22** and **23**. As a result, high pressure oil is delivered to the piston end of motor **11** through conduit **25** where it is effective to move the piston upward against the load.

When the control valve **12** is shifted to its "hold" position, conduits **17** and **18** are blocked so that no oil flows to or from either one. The load carried by motor **11** maintains the oil in conduits **25** and **18** under a positive pressure and, therefore, plunger **27** is held in the second position to which it previously had been shifted. Under these conditions, the motor **11** is hydraulically locked.

If the control valve **12** is now shifted to its "float" position to interconnect conduits **15, 16, 17** and **18**, the pressure in conduits **18** and **25** and in annular chambers **22** and **23** decreases below that value required to hold valve plunger **27** in its second position, and spring **32** shifts it to the position shown in the drawing. Groove **28** now interconnects annular chambers **23** and **24** and thus allows the oil expelled from the piston end of motor **11**, under the action of the load acting on the motor, to flow to the rod end through a replenishing path comprising conduit **25**, annular chambers **23** and **24**, check

valve 36 and conduits 26 and 17. This path is in parallel with and by-passes the replenishing path defined by the interconnection between conduits 17 and 18 in control valve 12. Since the motor 11 employs a differential area piston, the quantity of fluid displaced from the piston end is more than that required to fill the rod end. The excess fluid is delivered to the sump 14 through conduits 16 and 17 and the connection between them provided by valve 12. Since it is contemplated that the valving device 19 will be mounted on or very near motor 11, the resistance to flow through conduit 17 from its junction with conduit 26 to sump 14 will be more than sufficient to provide a back pressure at the junction adequate to maintain the rod end of motor 11 liquid-filled.

If the control valve 12 is now shifted to the "lower" position, conduit 17 will be connected with conduit 15 so that pressure fluid is delivered to the rod end of motor 11. Simultaneously conduits 16 and 18 are interconnected. The pressure in conduit 17 acts upon the right end of pin 34 and develops a force that causes the pin to shift plunger 27 to the left to the second position. This action causes land 31 to interrupt communication between annular chambers 23 and 24 and to open communication between chambers 22 and 23, and thereby establish a return path to the sump for the fluid expelled from the piston end of motor 11. Therefore, the piston of the motor moves downward.

If the valve 12 is now shifted back to its "hold" position, the pin 34 and shuttle valve plunger 27 will be locked in their second positions in the same manner as when the control valve 12 was returned to "hold" position from the "raise" position.

As stated previously, the drawing and description relate only to the preferred embodiment of the invention. Since many changes can be made in the structure of this embodiment without departing from the inventive concept, the following claim should provide the sole measure of the scope of the invention.

What is claimed is:

In combination, a double-acting differential area piston motor; a four-position control valve having "float" and "hold" positions and first and second motor ports; a first conduit connecting the first motor port with the rod end of the piston motor; a second conduit connected with the piston end of the motor; a third conduit connected with the second motor port of the control valve; a fourth conduit connected with the first conduit; a shuttle valve connected with the second, third and fourth conduits and shiftable between a first position in which it connects the second conduit with the fourth conduit and isolates the second conduit from the third conduit, and a second position in which it connects the second conduit with the third conduit and isolates the second conduit from the fourth conduit; a check valve located in the fourth conduit and arranged to permit flow toward but not away from the junction of this conduit and the first conduit; resilient biasing means urging the shuttle valve toward its first position; first pressure-responsive means connected with the shuttle valve and responsive to the pressure in the third conduit for shifting that valve toward its second position; and second pressure-responsive means connected with the shuttle valve and responsive to the pressure in the first conduit for shifting that valve toward its second position.

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