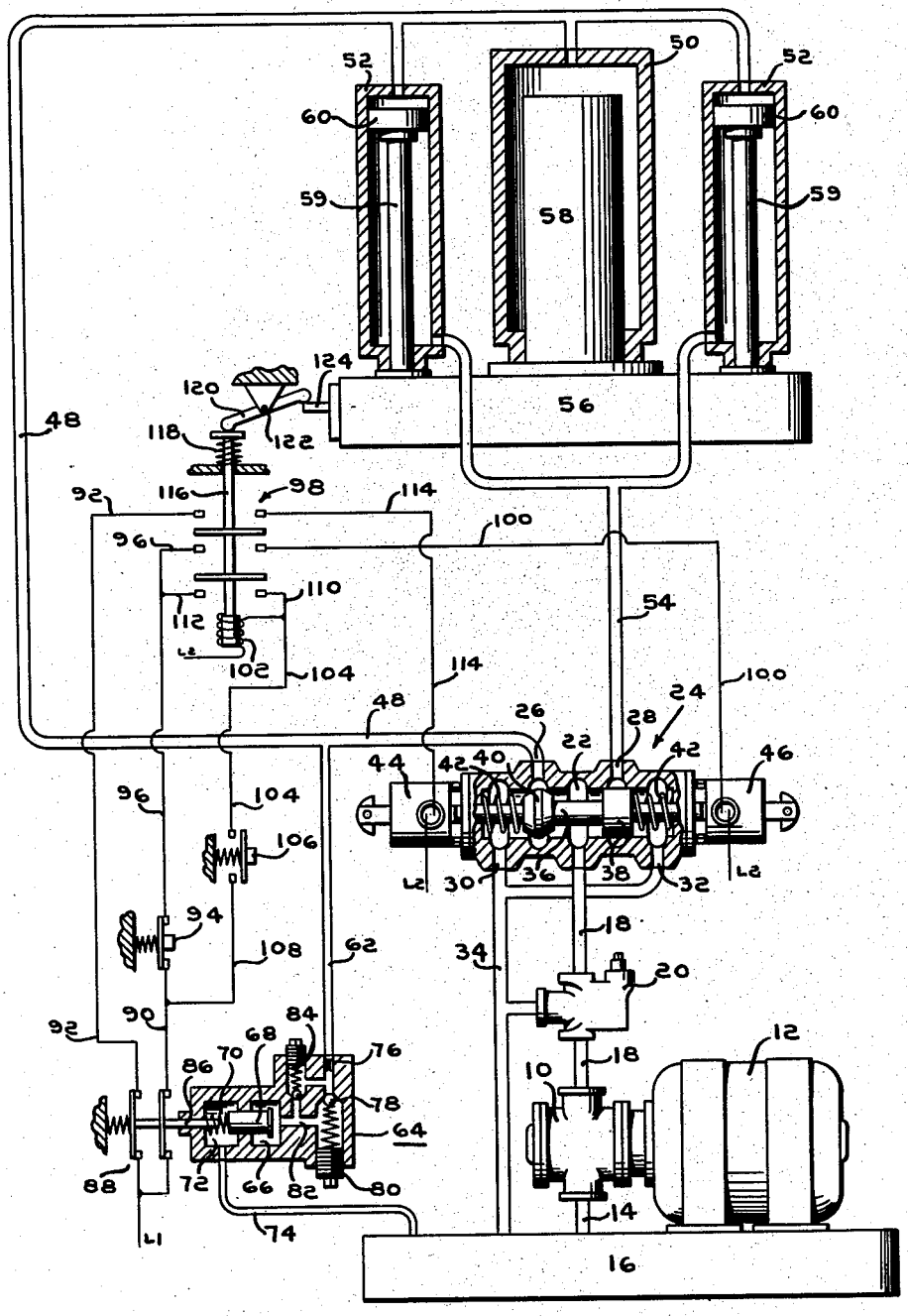
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POWER TRANSMISSION

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POWER TRANSMISSION

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This invention relates to power transmissions and particularly to those of the type comprising two or more fluid pressure energy translating devices, one of which may function as a pump and another as a motor.

The invention is more particularly concerned with a hydraulic transmission system for operating a hydraulic press or analogous device.

Presses of this character are frequently provided with a surge tank at the top of the press and with the hydraulic control mechanism and pump also mounted at the top of the press either in or adjacent to the surge tank. In very large presses the necessary manual controls must be located within reach of the operator near the bottom of the press, and it has been common practice to provide an electric circuit for operating the control mechanism at the surge tank by means of push button switches located within reach of the operator at the bottom of the press and arranged to selectively energize solenoids which are connected to operate the hydraulic controls overhead.

It is also desirable in many press installations to provide for reversing the press platen when the operating pressure in the main cylinder reaches a predetermined peak value. In presses of this character a commonly used expedient is to provide a solenoid for pulling the hydraulic control member into pressing position which solenoid is energized by a momentary-contact, normally-open, push button switch and to provide a holding relay for the solenoid, the holding circuit of which is arranged to be opened by a pressure responsive electric switch when the main ram pressure builds up to the desired peak. The control operating solenoid is thus deenergized permitting a spring or other biasing means to throw the control over to platen reversing position. Usually a mechanical or other connection between the platen and the control is provided for shifting the control member to neutral position when the platen is fully returned.

Control circuits of this character have presented certain difficulties arising at the time of reversal of the press. If the hydraulic control member happens to be a four-way valve, the sudden shifting of the same from its pressing position to its platen returning position at the time when the pressure switch opens the holding circuit causes a sudden release of the extremely large amount of energy which is stored in the main cylinder and causes deleterious shocks of great magnitude. One object of the present invention is to provide a hydraulic power transmission system for operating a hydraulic press wherein these difficulties are avoided.

These and other objects are accomplished by the provision of a four-way valve which is spring biased to neutral position in which the main cylinder is exhausted to tank along with the pump delivery line. Separate electric means are provided for shifting the valve to its pressing position and to its platen returning position together with an electric control circuit including a pressure responsive switch arranged to control initiation of both the electric valve operating means. The construction of the pressure switch and the arrangement of the circuit is such that at the time of reversal the valve is permitted to come to central position momentarily and is prevented from shifting to reverse position until the main cylinder pressure has fallen substantially to zero.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawing wherein a preferred form of the present invention is clearly shown.

In the drawing:

The single figure is a diagrammatic view of a power transmission system embodying a preferred form of the present invention.

A pump 10 may be driven by a suitable prime mover, such as an electric motor 12, and has a suction conduit 14 for withdrawing fluid from a tank 16 and a delivery conduit 18 in which is incorporated a customary relief valve 20.

The conduit 18 connects to a pressure port 22 of a spring-centered, solenoid-operated, four-way valve 24. The latter has cylinder ports 26 and 28 and tank ports 30 and 32. The latter are connected with the tank 16 by a conduit 34. The valve has a spool 36 provided with a blocking land 38 registering with the port 28 in neutral position and with a cut-away land 40 registering with the port 26 in neutral position. Suitable spring-centering means at 42 are provided for normally retaining the spool in the central position illustrated. Push-type solenoids 44 and 46 are provided for shifting the spool to the right and left respectively from the central position illustrated.

A conduit 48 connects the cylinder port 26 with the main cylinder 50 of a hydraulic press and also with the head end of booster cylinders 52. A conduit 54 connects the cylinder port 28 with the rod end of the cylinders 52 which serve as pull-backs. The press platen is indicated diagrammatically at 56 and carries the main ram 58 slidable in the cylinder 50 as well as the rods

59 of pistons 60 slidable in the cylinders 52. The parts thus far described constitute the basic elements of a typical hydraulic press-operating circuit and are intended as a diagrammatic showing only, it being understood that the circuit is capable of many variations and refinements as is well known in the art.

Connected to the main cylinder line 48 by a branch conduit 62 is a pressure responsive switch 64. The latter is provided with a switch-operating cylinder 66 in which is mounted a small ram 68 biased to the right by a spring 70 which is positioned in a seepage drain chamber 72. The latter is connected to tank by a conduit 74.

The conduit 62 leads through a restriction 76 to a spring-loaded ball valve 78 adapted to remain closed until a predetermined pressure is reached which may be made to take place at any value desired by adjustment of a spring abutment screw 80. The outlet side of valve 78 connects with the chamber 66 by a conduit 82. Arranged in parallel with the valve 78 between chamber 66 and restriction 76 is a check valve 84 arranged to permit free flow from chamber 66 to conduit 62 but to prevent flow therethrough in the opposite direction.

The ram 68 when shifted to the left abuts against an operating stem 86 of a two-circuit, normally-closed switch 88. The switch 88 normally connects conductors 90 and 92 with one side of a suitable power supply line indicated at L^1. Conductor 90 extends to a normally-closed push-button switch 94 from which a conductor 96 extends to one circuit of a holding relay 98. From the relay 98 a conductor 100 extends to the solenoid 46 and thence to the other side of the line L^2. The operating coil 102 of relay 98 is connected by a conductor 104 with a normally-open, push-button switch 106 which is connected by a conductor 108 with the conductor 90. The coil 102 also connects to the holding contacts of the relay 98 by a conductor 110, the other side of the holding contacts being connected by a conductor 112 with the conductor 96.

The conductor 92 extends to the other circuit of relay 98 from which a conductor 114 extends to the solenoid 44 which is also connected to line L^2. The relay 98 has an operating stem 116 which is normally biased upwardly by a spring 118. A lever 120 pivoted to a stationary part of the press at 122 has its left end contacting the stem 116 and its right end arranged in the path of travel of a dog 124 carried by the platen 56. Thus whenever the platen reaches its upper limit of movement, the lever 120 is swung counterclockwise to depress the stem 116 into the position illustrated in the drawing.

In operation, with the parts in the position shown and with the motor 12 driving the pump 10, oil is withdrawn from the tank through suction conduit 14 and delivered through conduit 18 to the port 22 of valve 24. The full pump delivery is by-passed to tank by passing across the cut-away land 40 to the port 30 and through conduit 34. The platen is prevented from falling by the fluid trapped in the rod ends of the cylinders 52 which cannot escape from the conduit 54 through port 28 due to the blocking land 38 of spool 36.

When it is desired to initiate a single cycle of press operation, the switch 106 is depressed permitting current to flow from line L^1 through switch 88, conductor 90, conductor 108, switch 106, and conductor 104 to the operating coil 102. The stem 116 is accordingly pulled downwardly establishing the holding circuit which extends through switch 88, conductor 90, switch 94, conductors 96 and 112, and conductor 110 to the coil 102. The relay 98 accordingly remains down without requiring further holding of the switch 106 closed.

With the relay 98 down, the solenoid 46 is energized through switch 88, conductor 90, switch 94, conductor 96, relay 98, and conductor 100. Spool 36 is accordingly shifted to the left against its spring bias and remains in this position so long as solenoid 46 remains energized. In this position the pump delivery is directed from port 22 to port 26 and through conduit 48 to the main cylinder 50 and to the head end of booster cylinders 52. The platen accordingly descends, forcing oil from the rod ends of cylinders 52 through conduit 54 and port 28 which is now connected to port 32 from which the discharge continues to tank through conduit 34.

As the platen meets the work and completes the pressing stroke, the pressure in line 48 builds up until it reaches a value such that the spring-loaded valve 78 will open admitting oil to chamber 66 through conduit 82. At this point the small ram 68 is pushed fully to the left opening both circuits of switch 88 and thereby deenergizing solenoid 46 and the operating coil 102 of relay 98.

Since the platen is now in its down position, the lever 120 does not interfere with upward movement of the stem 116 which is shifted upwardly by spring 118 to close the circuit between conductors 92 and 114. At this moment, however, this circuit is incomplete at the switch 88. Accordingly both solenoids 44 and 46 are deenergized momentarily permitting the spool 36 to come to center position under the action of springs 42, thus connecting the main cylinder line 48 to tank across the cut-away land 40.

The potential energy stored in the compressed oil and in the highly stressed tension rods of the press is thus permitted to escape. Until this energy does escape and the pressure in line 48 falls substantially to zero, the oil in chamber 66 is trapped and the ram 68 remains in its left-hand position. As soon as this pressure is relieved, however, the spring 70 is able to force the ram 68 back to the right, discharging oil from chamber 66 through check valve 84, conduits 62 and 48, ports 26 and 30, and conduit 34 to tank. The switch 88 accordingly again closes at this point completing the circuit to solenoid 44 through line L^1, switch 88, conductor 92, relay 98, and conductor 114. The spool 36 is accordingly shifted to the right connecting the pump delivery through ports 22 and 28 and conduit 54 to the rod ends of cylinders 52. The platen is accordingly moved upwardly, discharging oil from the head ends of cylinders 52 and from the main cylinder 50 through conduit 48, ports 26 and 30, and conduit 34 to tank.

As soon as the platen approaches the upper limit of its stroke, the dog 124 shifts the lever 120 counterclockwise, depressing the stem 116 of relay 98 to open the circuit 92—114, thus deenergizing solenoid 44. The spool 36 accordingly shifts to center position under the action of springs 42 thus restoring the parts to the position from which they started.

If at any time during pressing stroke it should be necessary to reverse the press manually, this may be done by depressing the switch 94 which deenergizes the solenoid 46 and also the operating coil 102 of relay 98. Since the switch 88 remains

closed at this time, the solenoid 44 will be immediately energized causing the platen to return in the manner previously described. In thus reversing the press in an emergency the valve spool 36 is shifted substantially instantaneously without hesitation into reversing position, which is permissible since the main ram pressure is not high, and there is accordingly no appreciable potential energy stored in the compressed oil and the stressed rods of the press.

It will be understood that the advantages of the present invention may be derived from many various circuit arrangements including those wherein reversal of the press is made to take place in response to the platen reaching a predetermined position. Thus the conductor 90 may be controlled by a limit switch operated by the platen instead of by the pressure switch 64 which, however, may be utilized for control of the circuit 92 in the manner described.

While the form of embodiment of the invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. In a hydraulic power transmission system for operating a press or the like the combination with a source of pressure fluid and a reversible fluid motor of a valve shiftable to forward and reverse positions to direct fluid to the motor in either direction and having a neutral position in which fluid is exhausted from one side of the motor, an electric operator for shifting said valve to forward position, an electric operator for shifting the valve to reverse position, means normally biasing the valve to neutral position, means for initially energizing the first electric operator, and means responsive to a predetermined rise in motor pressure for deenergizing the first operator to permit the valve to shift to neutral position under its bias for exhausting pressure fluid from the motor and thereafter responsive to a predetermined fall in motor pressure for energizing the second operator.

2. In a hydraulic power transmission system for operating a press or the like the combination with a source of pressure fluid and a reversible fluid motor of a valve shiftable to forward and reverse positions to direct fluid to the motor in either direction and having a neutral position in which fluid is exhausted from one side of the motor, electric operating means for shifting the valve, and a control circuit including switch means responsive to a predetermined pressure rise at said one side of the motor for causing shifting of the valve first to neutral position and thereafter responsive to a predetermined pressure fall at said one side of the motor for then causing shifting of the valve to reverse position.

3. In a hydraulic power transmission system for operating a press or the like the combination with a source of pressure fluid and a reversible fluid motor of a valve shiftable to forward and reverse positions to direct fluid to the motor in either direction and having a neutral position in which fluid is exhausted from one side of the motor, an electric operator for shifting said valve to forward position, an electric operator for shifting the valve to reverse position, means normally biasing the valve to neutral position, means for initially energizing the first electric operator, and a single pressure responsive switch for controlling the deenergization of the first operator in response to a predetermined rise in pressure at said one side of the motor and arranged to control the energization of the second operator in response to a predetermined fall in pressure at said one side of the motor thereafter.

4. In a hydraulic power transmission system for operating a press or the like the combination with a source of pressure fluid and a reversible fluid motor of a valve shiftable to forward and reverse positions to direct fluid to the motor in either direction and having a neutral position in which fluid is exhausted from one side of the motor, an electric operator for shifting said valve to forward position, an electric operator for shifting the valve to reverse position, means normally biasing the valve to neutral position, a three-position, two-circuit holding relay for controlling the energization of each operator selectively, means for initially energizing said relay to start said motor forwardly, means for deenergizing said relay to start the motor reversely, and means operated by the platen for shifting said relay to a neutral position where both operators are deenergized to stop the motor.

5. In a hydraulic power transmission system for operating a press or the like the combination with a source of pressure fluid and a reversible fluid motor of a valve shiftable to forward and reverse positions to direct fluid to the motor in either direction and having a neutral position in which fluid is exhausted from one side of the motor, an electric operator for shifting said valve to forward position, an electric operator for shifting the valve to reverse position, means normally biasing the valve to neutral position, a pair of electric circuits for controlling each operator separately, switch means in the first circuit for initiating and terminating energization of the first operator to cause the motor to move through a forward stroke and to stop, and switch means including a switch in the second circuit and responsive to pressure at said one side of the motor for controlling energization of the second operator and arranged to prevent initial energization thereof while the motor pressure is above a predetermined value.

6. In a hydraulic power transmission system for operating a press or the like the combination with a source of pressure fluid and a reversible fluid motor of a valve shiftable to forward and reverse positions to direct fluid to the motor in either direction and having a neutral position in which fluid is exhausted from one side of the motor, electric means for shifting said valve to reverse position, and a pressure responsive switch arranged in circuit with said means to prevent shifting of the valve to reverse position until the motor pressure effective during a forward stroke has fallen to a predetermined value.

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