

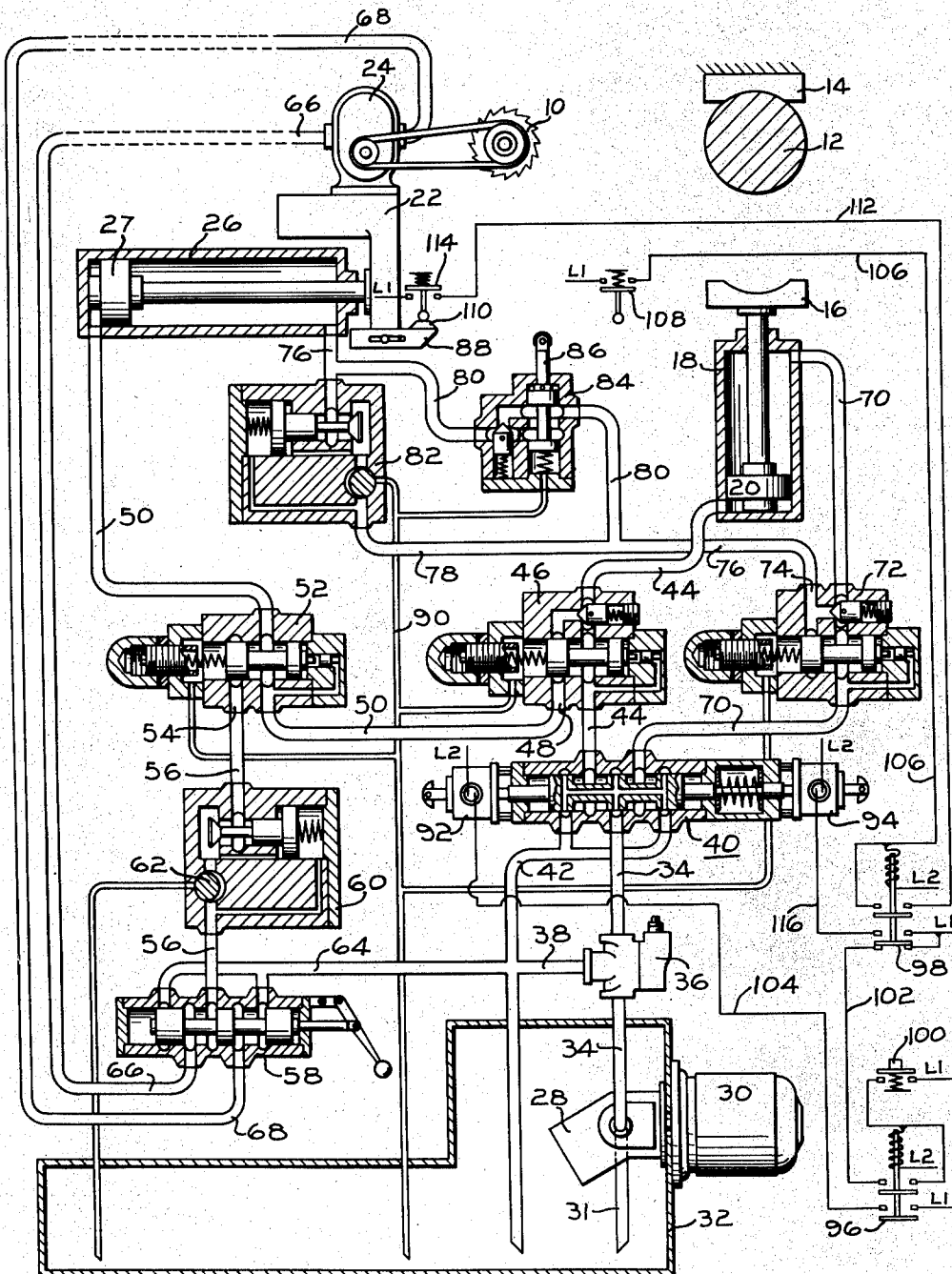
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POWER TRANSMISSION

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POWER TRANSMISSION

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This invention relates to power transmissions, 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 fluid motor.

The invention is more particularly concerned with a hydraulic transmission for use in a machine tool of the type having a rotary cutter for operating on a work piece together with a reciprocating slide for causing relative movement between the cutter and work piece. In machines of this character it is frequently customary to operate the slide with an initial rapid traverse movement followed by a slow feeding movement as the cutter reaches the work piece and at the completion of the feeding movement to return the slide by a rapid traverse reverse movement.

In certain machines, such as milling machines, for example, it has heretofore been customary to drive the rotary tool continuously whether it is operating on the work piece or not. An object of the present invention is to provide an improved hydraulic circuit for operating a machine tool of this character wherein the tool is driven only during the feeding movement and is stopped during the rapid approach and rapid return movement.

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 hydraulic power transmission system embodying a preferred form of the present invention.

Referring now to the drawing, there is illustrated a rotary tool exemplified by a milling cutter 10 adapted to operate upon a work piece 12. The latter may be clamped between a stationary clamping jaw 14 and a movable clamping jaw 16 by operation of a hydraulic cylinder 18 having a piston 20 therein which carries the movable jaw 16. The cutter 10 is mounted upon a reciprocating slide 22 and is driven by a rotary hydraulic motor 24 also mounted on the slide 22. The motor 24 may be of any suitable type, for example, the well-known gear motor. The slide 22 is adapted to be driven by a reciprocating hydraulic motor 26 having a slidable piston 27 therein which is connected to the slide 22.

For the purpose of supplying fluid under pressure to operate the hydraulic motors 18, 24 and 26, a pump 28 is provided and is arranged to be driven by a suitable prime mover such as an elec-

tric motor 30. The pump 28 has a suction conduit 31 leading to the bottom of a fluid reservoir or tank 32. It also has a delivery conduit 34 in which is mounted the customary relief valve 36 for limiting the pressure in the line 34 to a predetermined maximum. The valve 36 has a discharge conduit 38 by which overflow discharge may be returned to the tank 32.

The delivery conduit 34 extends beyond the relief valve 36 to the pressure port of a conventional spring-centered, open-center, solenoid-operated, four-way valve 40. The tank ports of the latter are connected by a conduit 42 to the tank. From the lefthand cylinder port of the valve 40 a conduit 44 extends to the lower end of cylinder 18. Conduit 44 has connected therein as a T a pressure-responsive sequence valve 46, the outlet port 48 of which connects by a conduit 50 with the large end of cylinder 26. The conduit 50 also has a similar sequence valve 52 connected therein, the outlet port 54 of which connects by a conduit 56 with the pressure port of a conventional four-way reverse valve 58.

Incorporated in the conduit 56 is a hydrostatically-controlled flow-regulating valve 60 having a manually adjustable throttle 62 therein for the purpose of regulating the rate of flow through the conduit 56 independently of pressure. The valve 60 may be similar to that illustrated in Figure 2 of British Patent No. 399,609 to Harry F. Vickers.

The tank ports of the valve 58 are connected to the tank by a conduit 64. The cylinder ports of the valve 58 connect by conduits 66 and 68 with the opposite sides of the gear motor 24. Thus, the valve 58 acts as a directional control valve for supplying fluid delivered through conduit 56 either to one port or the other port of the motor 24 and for connecting the opposite port of the motor 24 with tank. Thus the direction of rotation of the motor 24 may be reversed by shifting the valve 58. The conduits 66 and 68 may have flexible sections indicated by dotted lines to permit of the relative motion between motor 24 and valve 58 which occurs when the piston 27 and slide 22 are shifted.

The righthand cylinder port of valve 40 connects by a conduit 70 with the upper end of cylinder 18. The conduit 70 has T'd in thereto a third sequence valve 72 similar to the valve 46, the outlet port 74 thereof connecting by a conduit 76 with the small end of cylinder 26. The conduit 76 is provided with two parallel branches 78 and 80, the former having a flow control or regulating valve 82 therein similar to the valve 60. The branch 80 is provided with a combined

blocking valve and check valve 84 which always permits free flow from the right to the lefthand side of the valve through the check valve, and which permits flow in either direction whenever the operating stem 86 is in its raised position, as shown. When the stem is depressed by a cam 88 carried by the slide 22, the flow from left to right through the valve is blocked by the combined action of the check valve and the blocking valve.

The sequence valves 46, 52 and 72 are each similar in construction except that the valve 52 lacks a check valve for permitting free return flow from the normal outlet port into the main line of each valve. These valves may be similar in construction to the valve illustrated and described in the patent to Kenneth R. Herman, No. 2,200,824. Briefly, these valves serve to normally maintain the outlet port cut off from the main line in which the valve is connected until the pressure in the main line rises to a predetermined point. When this value is reached, the spool of the valve shifts to the left in the drawing, thus connecting the outlet port with the main line. There are illustrated in the drawing various seepage drain conduits which are as a whole designated 90 and merely serve to provide a return to the tank of any oil which may seep past the sliding fits in the various valves concerned.

The solenoids 92 and 94 for shifting the spool of valve 40 are controlled by electric circuits comprising holding relays 96 and 98 for the respective solenoids. The initial energizing circuit of the solenoid 92 is controlled by a normally-open, momentary-contact, push-button, starting switch 100. The holding circuit of the relay 96 extends by a conductor 102 to the normally closed contacts of the relay 98 so that the relay 96 will be held closed so long as relay 98 is deenergized. Relay 96 controls the solenoid 92 through a conductor 104. Relay 98 has its initial energizing circuit comprising a conductor 106 controlled by a normally-open, momentary-contact limit switch 108 adapted to be depressed by a cam 110 carried by the slide 22. The holding circuit 112 of the relay 98 is under the control of a normally-closed limit switch 114 also under the control of cam 110. Limit switch 108 is closed when the slide 22 reaches the righthand limit of its movement while the limit switch 114 is open when the slide 22 reaches the lefthand limit of its movement, as shown in the drawing. Relay 98 controls the energization of solenoid 94 through a conductor 116.

In operation, with the parts in the position illustrated in the drawing, the full discharge of pump 28 is bypassed through the open-center connection established at valve 40 when the spool is in its spring-centered position. This is the normal at-rest position of the device.

When it is desired to start a cycle of operation, the starting switch 100 may be closed momentarily to energize relay 96 which in turn energizes solenoid 92 through conductor 104. This solenoid accordingly pushes the spool of valve 40 to the right directing pressure oil from supply conduit 34 through conduit 44 to the lower end of cylinder 18. The piston 20 accordingly moves upward clamping the work 12 against the jaw 14. Oil discharged from the upper end of cylinder 18 returns through conduit 70, valve 40 and conduit 42 to tank.

When the jaw 16 clamps tightly against the work piece 12 the pressure in conduit 44 builds

up to the setting of sequence valve 46 which accordingly opens permitting pressure oil to flow from line 44 to the outlet port 48 and through conduit 50 to the left end of cylinder 26. Piston 27 and slide 22 are accordingly projected to the right at a speed determined by the full discharge volume of pump 28. The oil returning from the righthand end of cylinder 26 flows through branch 80 of conduit 76, valve 84 at this time being open to such flow, and from there returns through the check valve in valve 72 and through conduit 70, valve 40 and conduit 42 to tank. Accordingly, under these conditions the return flow from the righthand end of motor 26 is unrestricted.

When the slide 22 has reached a point where the cutter 10 is about to engage the work piece 12, the cam 88 engages the stem 86 of valve 84 to close the latter and thus prevent further return flow through the branch 80. Accordingly, all return flow from cylinder 26 must now take place through the branch 78 and flow regulating valve 82. The valve 82 is normally set to pass a much smaller quantity of fluid than the full discharge of the pump 28 so that the slide 22 continues its movement to the right at a slower feed rate. The restriction to flow imposed by valve 82 causes pressure in conduits 34, 44 and 50 to build up still higher to the setting of sequence valve 52, and the latter accordingly opens permitting part of the oil delivered by the pump to flow out of the port 54 through conduit 56, flow regulating valve 60, valve 58 and conduit 66 to the gear motor 24. The latter accordingly starts rotating driving the cutter 10 and discharging oil through the conduit 68, valve 58 and conduit 64 to the tank.

When the slide 22 has proceeded to the right the required distance to accomplish the work desired, the cam 110 contacts limit switch 108 thus initially energizing relay 98. The latter accordingly picks up, breaking the holding circuit of relay 96 to thus deenergize solenoid 92. Energization of relay 98 also energized solenoid 94 which accordingly pushes the spool of valve 40 to the left and directs pressure oil from conduit 34 to conduit 70 and the upper end of cylinder 18. Thus jaw 16 is accordingly retracted permitting the work piece to be removed. During this movement oil from the lower end of cylinder 18 is returned to tank through conduit 44, valve 40 and conduit 42.

When the jaw 16 has been fully retracted, pressure will build up in line 70 to exceed the setting of sequence valve 72 so that the latter opens, directing the pump discharge through port 74 and conduit 76 to the righthand end of cylinder 26. The check valve in valve 84 permits free flow through the branch conduit 80 in this direction. The slide 22 is accordingly retracted to the left, piston 27 discharging oil from the lefthand end of cylinder 26 through conduit 57, through the check valve of valve 46, conduit 44, valve 40 and conduit 42 to tank. Since the conduit 50 is thus relieved of all pressure, the spool of valve 52 will immediately shift to the right closing off the port 54 and stopping the operation of motor 24. This, of course, occurred as soon as the valve 40 shifted.

When the slide 22 reaches the lefthand limit of its stroke, limit switch 114 will be contacted to break the holding circuit of relay 98 permitting the latter to drop and thus deenergize solenoid 94. The spool of valve 40 accordingly shifts to its center position under the urge of its spring-

centering means, thus bypassing the pump delivery to tank as previously described. The parts of the device are thus restored to their original operating position, and another cycle may be repeated by reclosing the starting switch 100.

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 machine tool having a rotary tool for operating on a work piece, and a reciprocating slide for causing relative movement between the tool and work piece, the combination of a hydraulic motor for driving the slide, a rotary hydraulic motor for driving the tool, common pump means for supplying fluid to both motors, control means for directing fluid to operate the slide motor at rapid traverse and feed rates, and a pressure responsive valve normally blocking flow from the pump to the tool motor and arranged to open when the pressure load on the pump builds up to a predetermined value as the slide motor starts a feeding movement.

2. In a machine tool having a rotary tool for operating on a work piece, and a reciprocating slide for causing relative movement between the tool and work piece, the combination of a hydraulic motor for driving the slide, a rotary hydraulic motor for driving the tool, common pump means for supplying fluid to both motors, control means for directing fluid to operate the slide motor at rapid traverse and feed rates, and means responsive to the back pressure on the pump imposed by the slide motor for controlling the flow of fluid to the tool motor.

3. In a machine tool having a rotary tool for operating on a work piece, and a reciprocating slide for causing relative movement between the tool and work piece, the combination of a hydraulic motor for driving the slide, a rotary hy-

draulic motor for driving the tool, means for supplying fluid to operate said motors, control means for causing flow to the slide motor at rapid traverse and at feed rates, and means for blocking flow to the tool motor during rapid traverse of the slide.

4. In a machine tool having a rotary tool for operating on a work piece, and a reciprocating slide for causing relative movement between the tool and work piece, the combination of a hydraulic motor for driving the slide, a rotary hydraulic motor for driving the tool, common pump means for supplying fluid to both motors, a flow regulating valve connected to control the discharge from the slide motor to produce a feeding motion thereof, a bypass valve connected in a parallel with the flow regulating valve to produce, when open, a rapid traverse of the slide, and a pressure responsive sequence valve, normally blocking the supply of fluid to the tool motor, said sequence valve being adjusted to open at a pressure less than the pump pressure required to drive the slide motor during feed movements and greater than that required to drive the slide motor during rapid traverse movements.

5. In a machine tool having a rotary tool for operating on a work piece, and a reciprocating slide for causing relative movement between the tool and work piece, the combination of a hydraulic motor for driving the slide, a motor for driving the tool, pump means for supplying fluid to the slide motor, a flow regulating valve connected to control the discharge from the slide motor to produce a feeding motion thereof, a bypass valve connected in a parallel with the flow regulating valve to produce, when open, a rapid traverse of the slide, and means responsive to an increase in supply pressure of the slide motor caused by closure of said bypass valve for starting the tool motor.

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