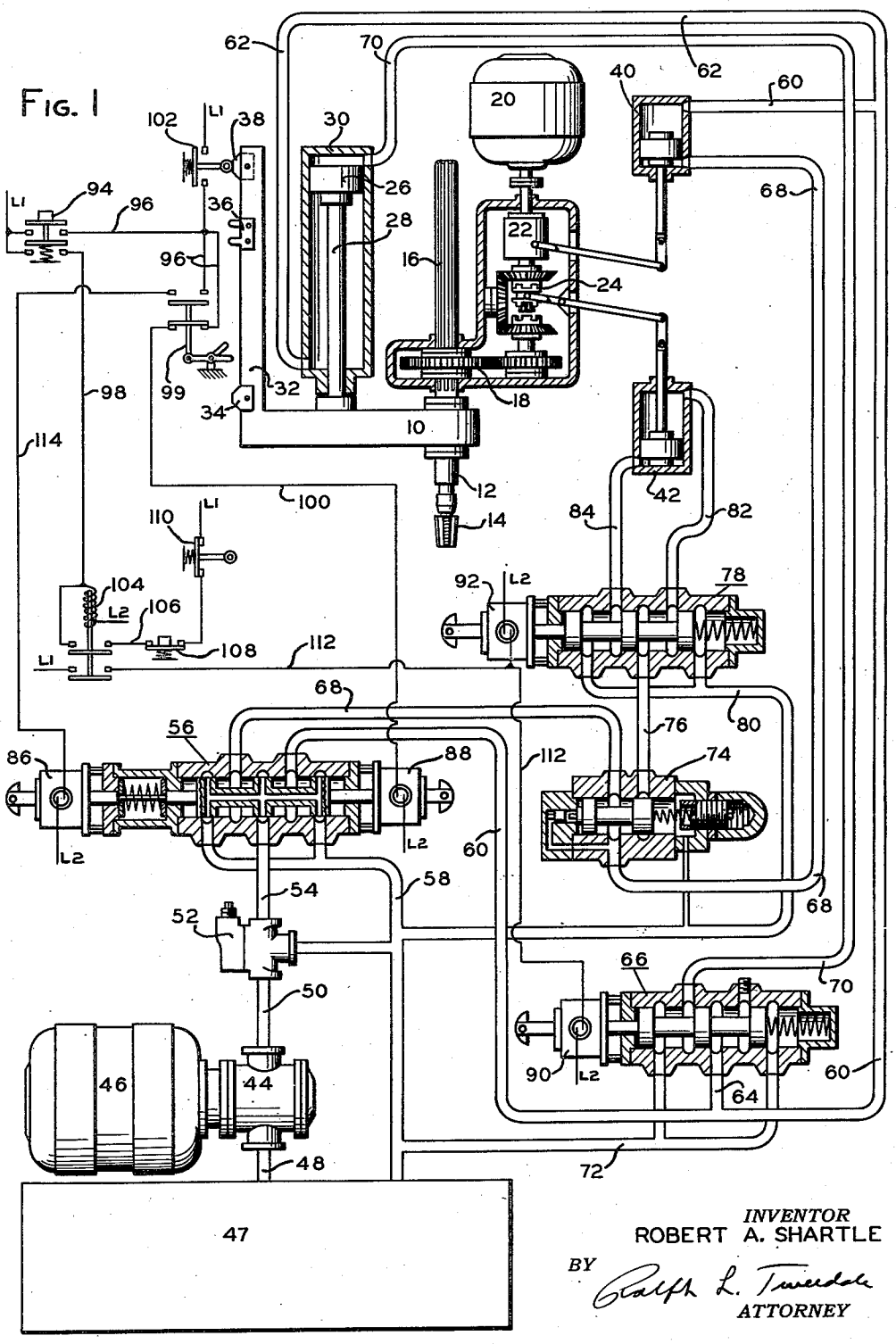
Feb. 2, 1943. R. A. SHARTLE 2,310,124

POWER TRANSMISSION

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FIG. 1



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POWER TRANSMISSION

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FIG. 2
STOP

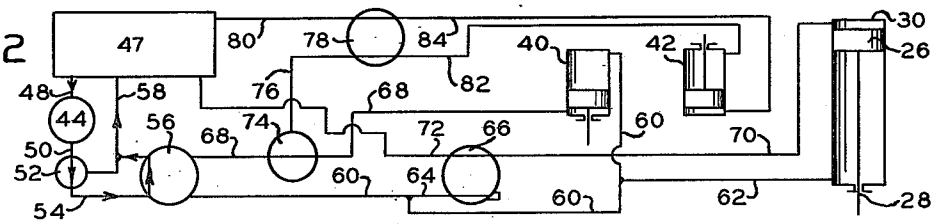


FIG. 3
RAPID ADVANCE

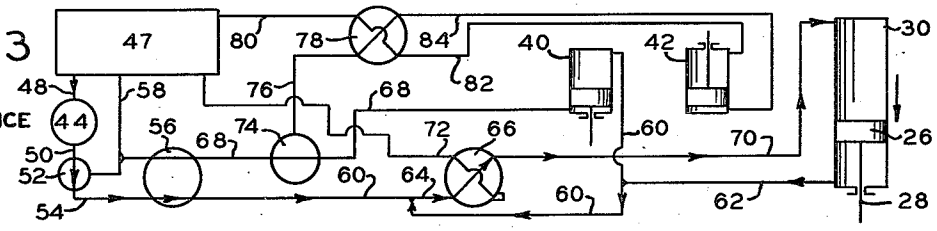


FIG. 4
ENGAGE CLUTCH

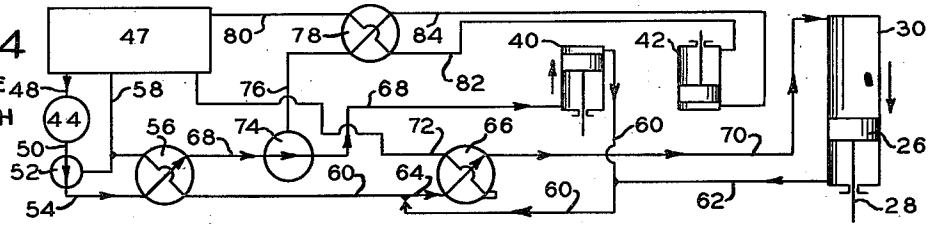


FIG. 5
FEED IN

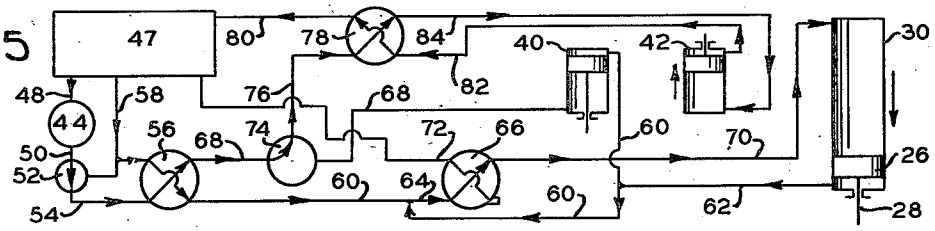


FIG. 6
FEED OUT

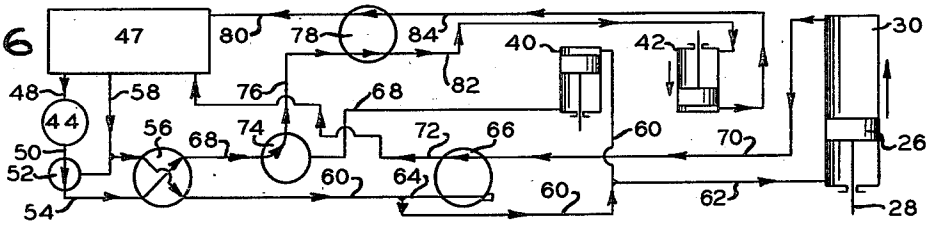
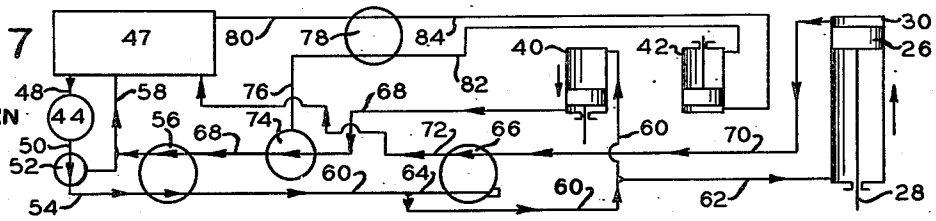


FIG. 7
RAPID RETURN



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POWER TRANSMISSION

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Application July 24, 1940, Serial No. 347,253

5 Claims. (Cl. 10—136)

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 power transmission system suitable for operating a tapping machine and providing hydraulic rapid advance of a reciprocating tool carrying slide to bring the tool into engagement with the work together with hydraulic control of a rotary drive for the tool. In a tapping machine it is desirable to permit the tapping tool to determine its own speed of advance by the pitch of the thread which it is cutting. Thus, the tool can act as the feeding means for determining the longitudinal advance of the tool carrying slide during the working stroke. It is necessary, however, that the tool slide be retracted to bring the tool out of the work a sufficient distance to permit removal of the work and replacing the new work piece in position. This necessitates additional power-operated means for reciprocating the slide in addition to the tapping tool itself. Automatically controlled tapping machines, wherein the tool is advanced rapidly to the work and then permitted to determine the rate of speed of the tool carriage during the working stroke, have been heretofore constructed but have embodied considerable complex mechanism, particularly where hydraulically operated.

It is an object of the present invention to provide an improved hydraulic driving and controlling system for a tapping machine wherein the cycle of tool movement is controlled automatically by relatively simple control mechanism.

A further object is to provide an improved hydraulic circuit for actuating a plurality of motors under the conjoint control of a plurality of valves.

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

In the drawings:

Figure 1 is a diagrammatic view of a power transmission system embodying a preferred form of the present invention.

Figures 2 through 7 are schematic views of the circuit showing the parts in different positions at various stages in the cycle of operation.

Referring now to Figure 1 there is illustrated a vertically reciprocating slide 10 mounted in suitable ways on a machine frame, not shown, and carrying a rotatable tool spindle 12. The latter has a tapping tool 14 carried by the end thereof. The spindle 12 is provided with the usual splines 16 whereby the spindle may be rotated through the gearing 18. The latter may be driven by an electric motor 20 which drives a clutch 22 from which the drive is carried through gearing 18 by means of customary electro-reverse gearing indicated at 24.

The slide 10 is adapted to be operated by a piston 26 having a rod 28 secured to the slide 10. The piston and rod reciprocate in a cylinder 30 which, due to the rod projecting from the lower end thereof, is of the differential area type. The slide 10 may carry an upwardly extending arm 32 on which are positioned various cams 34, 36 and 38 adjustably mounted thereon for a purpose later to be described.

The clutch 22 may be operated by means of a hydraulic cylinder-and-piston motor 40 while the reverse gearing 24 may be operated by a cylinder-and-piston motor 42. The three hydraulic motors described may be supplied with fluid from a fixed displacement pump 44 driven by a suitable prime mover such as an electric motor 46. The suction side of pump 44 withdraws oil from a tank 47 through a suction conduit 48. The delivery side of the pump is connected by means of a delivery conduit 50 to the customary relief valve 52 and then by a conduit 54 to the pressure port of a four-way valve 56. The latter may be of any suitable solenoid-operated, spring-centered, open-center type as is well known in the art.

The tank ports of valve 56 are connected to tank by a conduit 58. The righthand cylinder port connects by a conduit 60 with the upper end of cylinder 40. Branch conduits 62 and 64 provide connections between conduit 60 and the lower end of cylinder 30 and the pressure port of a three-way valve 66. The latter is of the solenoid-operated, spring-offset type. The lefthand cylinder port of valve 56 connects by a conduit 68 with the lower end of cylinder 40. The cylinder port of valve 66 connects by a conduit 70 with the upper or large end of cylinder 30, the tank ports of valve 66 being connected to tank by a conduit 72.

Incorporated in conduit 68 is a pressure-responsive sequence valve 74 which, when the pressure in conduit 68 rises to a predetermined value, opens communication between conduit 68 and a conduit 76. The latter leads to the pres-

sure port of a solenoid-operated, spring-offset, four-way valve 78 having its tank ports connected to tank by a conduit 80. The cylinder ports connect to opposite ends of motor 42 by conduits 82 and 84.

For the purpose of controlling the solenoids 86, 88, 90 and 92 which operate the valves 56, 66, and 78, respectively, a control circuit is provided as follows: From one side of a suitable source of electric current supply designated as L^1, a normally-open, two circuit, momentary-contact switch 94 is adapted to establish connections to two conductors 96 and 98. The conductor 96 extends to a single-pole, double-throw switch 99 adapted to be tripped by the cam 36 when the slide 10 reaches a point where the tool 14 is about to engage the work. The switch 99 may be of the snap-acting type although for simplicity of illustration it is not thus shown. In the position illustrated, the switch 99 establishes contact between conductor 96 and a conductor 100 extending to the solenoid 88, and to the other side of the power supply designated L^2.

Parallel with the switch 94 there is provided a normally-closed limit switch 102 which is held open by the cam 38 when the slide is in the position illustrated on the drawing. The switch 102, when closed, completes a circuit from line L^1 to conductor 96 which effectively shunts the upper circuit of switch 94.

The conductor 98 extends to the operating coil of a holding relay 104, the holding circuit 106 of which is normally closed through a normally-closed manual switch 108 and a normally-closed limit switch 110, the latter being opened by the cam 34 when the slide 10 reaches a position where the work is completed. The relay 104, when energized, is adapted to close a circuit extending from line L^1 by a conductor 112 to the solenoids 90 and 92. The switch 99, when shifted, is adapted to establish a circuit extending from conductor 96 through a conductor 114 to the solenoid 86.

In operation, with the parts in the position shown in Figures 1 and 2, the device is in its at-rest position, the full delivery of pump 44 passing through conduits 50 and 54, through the valve 56 to the tank port, and through conduit 58 to the tank 47. The pump is thus effectively bypassed, and no fluid is delivered to any of the hydraulic motors.

When it is desired to start a cycle of operation consisting of a rapid advance movement, inward and outward feeding movement, and rapid return, the manual switch 94 may be closed to condition the circuit for the flow conditions illustrated in Figure 3. This energizes solenoid 88 through conductors 96 and 100 thereby shifting the spool of valve 56 to the left and admitting pressure oil from conduit 54 to conduit 60 where it flows to the upper end of cylinder 40 and to the small end of cylinder 30. The closing of switch 94 also establishes the initiating circuit 98 for relay 104 which accordingly becomes energized and establishes its own holding circuit 106 as well as energizing solenoids 90 and 92 through conductor 112.

The spools of valves 66 and 78 are accordingly shifted to the right, the former establishing connection between conduits 64 and 70 to thereby admit pressure oil to the large end of cylinder 30. With the same pressure applied to both ends of this cylinder, the slide 10 is accordingly advanced rapidly, the oil discharged from the small end being returned through conduits 62, 60 and 64 through the conduit 70 to the large end. Thus the slide 10 is advanced downwardly at a speed determined by the effective area of the rod 28 with respect to the delivery capacity of pump 44. Motor 40 is held with its piston in the downward position in which clutch 22 is disengaged so that there is no rotary motion of the tool 14. Shifting of valve 78 establishes a connection from conduit 76 to conduit 84 which connection is ineffective, however, because there is no pressure in conduit 68 to open valve 74.

As the slide 10 advances downwardly, the tool is brought into engagement with the work at which point the cam 36 trips the switch 99 to deenergize solenoid 88 and to energize solenoid 86 through conductor 114. It will be noted that conductor 96 still remains connected to line L^1 after switch 94 has been released because the cam 38 slides off the limit switch 102 during the first movement of the slide 10 downwardly.

Energization of the solenoid 86 shifts the spool of valve 56 to the right connecting conduit 60 to tank and admitting pressure fluid from conduit 54 to conduit 68. This pressure fluid first flows through conduit 68 to the lower end of motor 40 thus shifting the piston thereof upwardly to engage the clutch 22 as shown in Figure 4. As soon as this movement is completed, the pressure in conduit 68 builds up to open valve 74 thereby admitting pressure oil to conduits 76 and 84 as shown in Figure 5. The piston of motor 42 is accordingly projected upwardly to shift the reversing mechanism 24 to the position of forward rotation of the tool 14. The latter accordingly begins its cutting work and forms the sole driving means for advancing the slide 10 further downwardly.

It will be noted that, in this position of the parts, the two ends of cylinder 30 are connected together through conduits 62, 60, 64, valve 66 and conduit 70. Thus, oil is free to pass from one end of the cylinder to the other without imposing any significant drag on the downward movement of slide 10. As the slide 10 reaches a point where the work is completed, cam 34 contacts limit switch 110 opening the latter to deenergize the holding relay 104. The latter accordingly deenergizes solenoids 90 and 92 permitting the spools of valves 66 and 78 to return to their lefthand position. This is shown in Figure 6.

Shifting of valve 66 closes the direct connection between conduits 64 and 70, but the two ends of cylinder 30 remain connected together through valves 66 and 56 and the tank. Thus the large end of cylinder 30 is now connected to tank through conduit 70 and the tank conduit 72. Likewise, the small end of cylinder 30 is connected to tank through conduits 62, 60, valve 56 and conduit 58.

The shifting of valve 78 reverses the fluid connection to motor 42 thereby admitting pressure oil from conduit 76 to conduit 82, returning the piston 42 downwardly and shifting the reversing mechanism 24 for reverse rotation of tool 14. It will be noted that the cylinder 40 remains connected as before since its direction of movement is controlled by the valve 56. Accordingly, the tool 14 is driven reversely to gradually feed the same out of the work and to feed the slide 10 upwardly at the same time.

As the tool leaves the work, the cam 36 shifts switch 98 to again deenergize solenoid 86 and energize solenoid 88. As shown in Figure 7, pressure oil is again directed from conduit 54 to con-

duit 68 where it shifts the piston of motor 40 downwardly to disengage clutch 22. When this is done, the pressure is transmitted through branch 62 to the lower end of cylinder 30 to raise the piston 26. Since valve 66 is in its left-hand position, the large end of cylinder 30 remains connected to tank through conduits 70 and 72. Thus the slide 10 is rapidly returned until a point is reached where cam 38 opens limit switch 102 to deenergize solenoid 88. The parts are thus restored to their original position, and another cycle may be repeated by again closing the switch 94.

It will be seen that, by the use of a differential-area motor at the cylinder 30 and by the particular arrangement of valves 56 and 66, a circuit has been provided wherein the valve 56 not only controls the direction of movement of motor 40 but also controls the action of differential motor 30. Thus when the valve 56 is shifted to the position for disengaging the clutch, it also supplies pressure fluid for operating the differential motor 30. When the valve 56 is shifted reversely to engage clutch 22, it permits the motor 30 to float on the line, that is, it is bypassed. Likewise, the valve 66 controls the direction of operation of motor 30 during those parts of the cycle when valve 56 directs fluid for operation of motor 30. During the other parts of the cycle, valve 66 is ineffective to prevent bypassing of cylinder 30. It will be seen that cylinder 30 is thus under the conjoint control of valves 56 and 66.

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 tapping machine having a rotatable and translatable tool carrying spindle the combination of hydraulically actuated means for translating the spindle, hydraulically actuated means for controlling the direction of rotation of the spindle, a control element arranged to be actuated when the spindle has been translated forwardly to a predetermined position, means controlled thereby for bypassing fluid around the spindle translating means, and means also controlled by said element for initiating forward rotation of the tool.

2. In a tapping machine having a rotatable and translatable tool carrying spindle the combination of hydraulically actuated means for translating the spindle, hydraulically actuated means for controlling the direction of rotation of the spindle, a valve connected to control the supply of fluid both to the actuating means and the rotation controlling means, a second valve in series between the first valve and one of said actuating means, and connections providing for both forward and reverse motion of one actuating means while the other actuating means is moving in a single direction.

3. In a tapping machine having a rotatable and translatable tool carrying spindle the combination of hydraulically actuated means for translating the spindle to bring the tool into and out of engagement with the work, and means responsive to the arrival of the spindle at a point where the tool engages the work for rendering the translating means freely movable by the further translation of the spindle by the action of the tool in threading itself into the work.

4. A hydraulic power transmission system comprising a pair of reversible fluid motors, one of which is of the differential-area cylinder-and-piston type, means forming a unitary source of pressure fluid for operating said motors, a three-way valve connected to the large end of the differential cylinder and arranged to selectively connect said end either to the small end or to the low pressure side of the source independently of the small end, a four-way reverse valve connected between opposite sides of the source and opposite sides of the other motor, and a conduit connecting the small end of the differential motor to one side of the other motor whereby the differential motor may be operated forward or reversely while the other motor is operated in one direction and the differential motor is bypassed while the other motor is operated in the opposite direction.

5. A hydraulic power transmission system comprising a pair of reversible fluid motors, one of which is of the differential-area cylinder-and-piston type, means forming a unitary source of pressure fluid for operating said motors, a four-way valve connected between opposite sides of the source and opposite sides of the other motor, conduits connecting both ends of the differential motor to one side of the other motor, and means in one of said conduits for selectively cutting off communication with the other motor and connecting one end of the differential motor to one side of the source whereby the differential motor may be controlled both by the four-way valve and by said means.

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