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SEQUENTIAL MOTOR OPERATION UNDER CONTROL OF INDIVIDUAL, FLUID ACTUATED, RELIEVED PRESSURE VALVES

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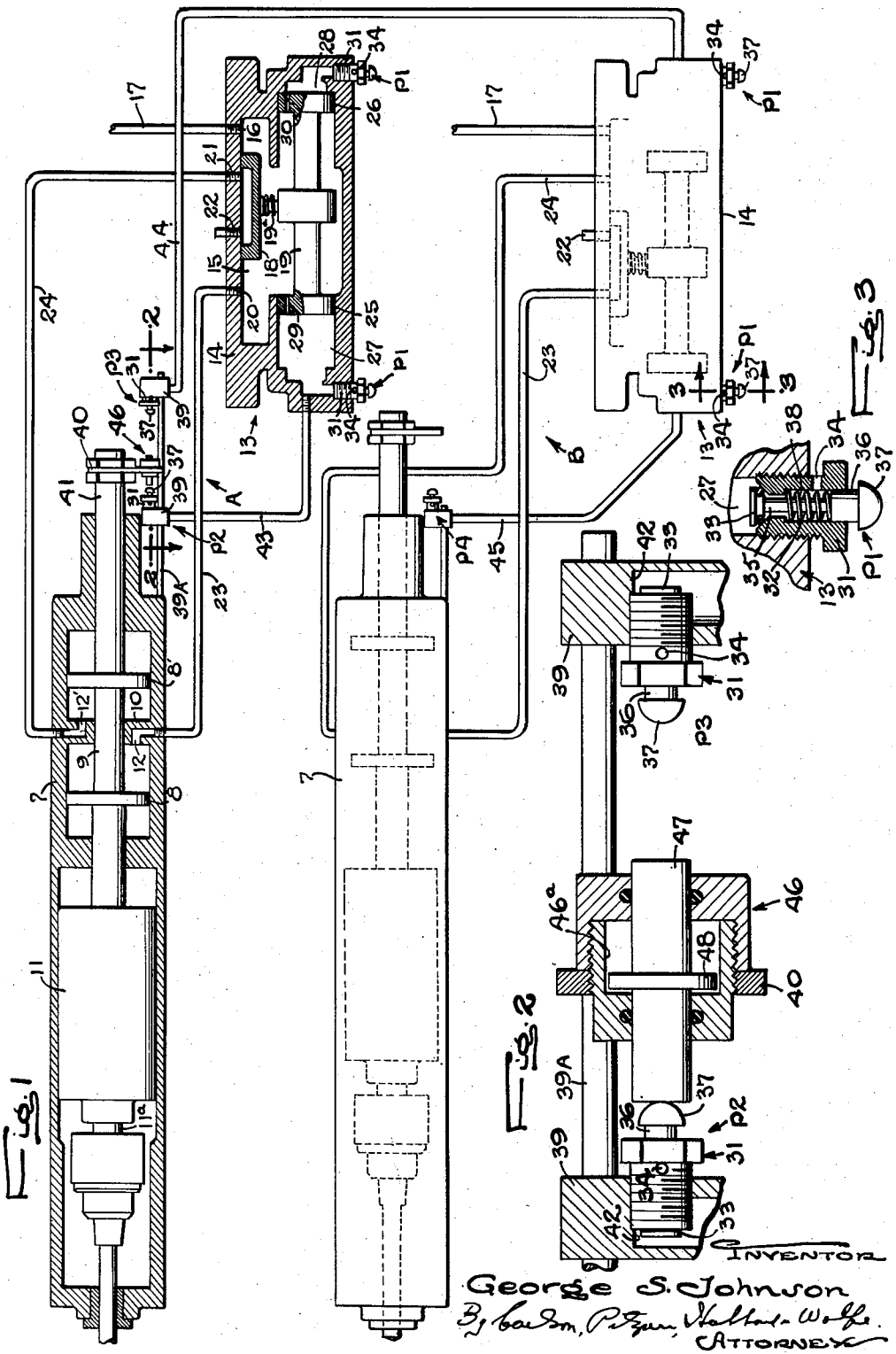


Fig. 1

Fig. 2

Fig. 3

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SEQUENTIAL MOTOR OPERATION UNDER CONTROL OF INDIVIDUAL, FLUID ACTUATED, RELIEVED PRESSURE VALVES

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The invention relates to fluid pressure operated tools, and more particularly to an automatic control mechanism therefor; and the primary object of the invention is to provide an improved form of control mechanism including a normally balanced control valve with means of a simple character operative in response to the movement of a power driven member, such as the spindle of an associated tool, to effect an unbalancing of the valve whereby to initiate the operation of the tool.

A further object is to provide for the momentary unbalancing of the control valve to initiate the operation of the tool whereupon the valve is restored to its normal operative condition.

A further object is to provide a control mechanism comprising a normally balanced control valve and means for automatically unbalancing the same including a spring biased poppet valve and a dashpot type actuator therefor.

The objects of the invention thus generally set forth, together with other and ancillary advantages are attained by the construction and arrangement shown by way of illustration in the accompanying drawing, in which:

Figure 1 is a schematic view showing the improved control mechanism as applied to a drilling apparatus composed of two tool units, one of which is initiated in operation to advance its spindle in response to the retraction of the spindle of the other unit.

Fig. 2 is a longitudinal sectional view taken approximately in the plane of line 2—2 of Fig. 1, but on an enlarged scale, and illustrating the construction and mode of operation of the poppet valves and the dashpot actuator therefor.

Fig. 3 is a fragmentary sectional view, taken similarly on line 3—3 of Fig. 1, showing the poppet valve construction.

My invention is shown for purposes of illustration as applied to the control of a plurality of (herein two) tool units arranged for actuation by air or other fluid under pressure, in an arrangement such that one unit is initiated in operation to advance the tool spindle, as an incident to the retraction of the spindle of the other unit. The tool units are of the type disclosed in Taylor application Serial No. 81,050 and form per se no part of the present invention. Each comprises a cylinder 7 having pistons 8 and 8' spaced apart on a rod 9 and disposed upon opposite sides of a stationary abutment 10. An air motor 11 connected with the rod 9 is arranged to drive a tool spindle 11a.

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The cylinder abutment 10 is provided with two ports 12 and 12' communicating respectively with the piston chambers formed at the forward and rear sides of the abutment. As set forth in said Taylor application, air is supplied to the motor 11 coincidentally with the supply of air to the forward piston chamber to advance the piston and therefor the tool spindle 11a.

The supply and exhaust of air to and from each unit is under the control of a valve 13 shown remote from the cylinder instead of being applied directly to the cylinder as in said Taylor application. The valve is of the balanced type and comprises a casing 14 (Fig. 1) providing a main valve chamber 15 to which air under pressure is constantly supplied through an inlet port 16 connected by a line 17 to a suitable or convenient source. In the present instance one wall of the chamber 15 provides a seat for a slide valve 18 connected with an actuating plunger 19 and normally urged by a spring 19a against its seat. The port 16 is located beyond the range of movement of the valve so that air is constantly supplied to the chamber 15. The valve casing 14 has three passages 20, 21 and 22 opening into the casing through the valve seat. Passage 20 is connected by a conduit 23 to cylinder port 12, and passage 21 is connected by a conduit 24 to cylinder port 12'. Passage 22 disposed between passages 20 and 21 communicates with the atmosphere.

In general the arrangement is such that when the valve member 18 occupies its right hand position (see unit A) air under pressure passes from the valve chamber through passage 20 and conduit 23 to cylinder port 12 for delivery to the forward piston chamber so as to advance the tool spindle, and air from the rear piston chamber escapes therefrom through port 12' and conduit 24 to passage 21 and thence to exhaust passage 22, the latter two passages being then connected by slide valve 18. When the valve is shifted to the left (see unit B) air is delivered from the chamber 15 to passage 21 and thence through conduit 24 to cylinder port 12' for delivery to the rear piston chamber. Concurrently, air from the forward piston chamber exhausts through port 12, conduit 23, valve passage 20 and exhaust passage 22.

As above indicated, the control valve 13 is of the balanced type so that actuation of the valve in one direction or the other is effected by causing an unbalancing of the valve. To this end, the plunger 19 connected with the valve is provided with two opposed pistons 25 and 26 respectively

operating in control chambers 27 and 28 normally closed except for communication with the main pressure chamber 15 through small ports 29 and 30 in the responsive pistons. Thus both chambers 27 and 28 are maintained under constant pressure so that the plunger and therefore the valve is normally in a state of balance. Shifting of the valve in one direction or the other may be effected by unbalancing the valve, and this is accomplished by the provision of poppet valves P1 (Fig. 1) spring biased toward closed position and arranged for operation either manually or automatically to establish communication between the respective control chambers and the atmosphere.

These poppet valves may be of any suitable or preferred construction. As herein shown, each valve 13 is equipped with a pair of manually operable poppets, each comprising a fitting 31 mounted in the valve casing and having a bore 32 communicating with one of the control chambers 27, 28 (Fig. 3). Within the bore 32 is a spring biased valve member 33 operative to establish communication between the control chamber and the atmosphere through an exhaust port 34 in the fitting. It will be understood, of course, that the port 34 and connecting passages have a substantially greater effective area than the ports 29, 30 through which pressure fluid is supplied to the chambers 27, 28. The valve member 33 is formed upon the inner end of a plunger 35 having a stem 36 equipped with an actuating head 37, the valve member being held in closed position by a spring 38. It will be obvious that by depressing the head 37, the pressure in the control chamber will be relieved so as to cause the valve 18 to be shifted by the pressure exerted thereon in the opposing control chamber.

In addition to or as an alternative to manual control by the poppet valves P1 provision is made for the automatic actuation of the control valves 13. I have herein shown by way of example the automatic operation of the main control valves 13 of tool units A and B in response to the movements of their respective spindles, and also the automatic advance of tool unit B in response to the movement of some other power driven member such as the spindle of unit A so that unit B will be initiated on operation in timed relation to the movement of such member.

Referring then to Fig. 1, I have shown two poppet valves P2 and P3 associated with the spindle of tool unit A, and a third poppet valve P4 associated with the spindle of tool unit B. These poppet valves P2, P3 and P4 are per se of the same construction as the valve P1 above described, but instead of being mounted on the valve casing 14, each is mounted on a suitable stationary support on one or the other of the tool units. Thus the valves P2 and P3 are mounted upon a pair of blocks 39 connected by a rod 39A so as to be spaced apart in a direction parallel with the axis of the unit A, at the rear end thereof, and thus alined with a dog 40 mounted on a rod 41 which projects rearwardly from the cylinder and constitutes an extension of the piston rod 9.

As shown in Fig. 2, the fitting 31 of each of the poppet valves P2, P3 and P4 is threaded into a bore 42 in the supporting block with the head 37 projecting toward one side of the block for engagement by the dog 40 on the piston rod extension 41. In the case of unit A, the valve P2 is connected by a conduit 43 to a bore opening into the control chamber 27 of the associated control valve 13, and valve P3 is similarly connected by a conduit 44 with control chamber 28 of the main control valve associated with unit B. Valve P4 of unit B is connected by a conduit 45 with control chamber 27 of the associated main control valve.

Assuming that in the arrangement shown in Fig. 1 unit A is advancing and unit B is in condition to be advanced in response to the return of unit A to its initial position: Upon engagement of the dog 40 of unit A with poppet valve P2, control chamber 27 is momentarily vented to the atmosphere to unbalance the associated main control valve and cause shifting of its valve member 18 to the left thereby uncovering passage 21 and connecting passages 20 and 22. Air under pressure is thus delivered through conduit 24 to the rear piston chamber of unit A to retract the spindle, and air from the forward piston chamber is exhausted through conduit 23, passage 20 and exhaust passage 22.

Upon the return of the spindle of unit A to its retracted position, dog 40 engages poppet valve P3, venting control chamber 28 of the valve of unit B to the atmosphere, and causing valve member 18 of this unit to shift to the right. Thereupon air is delivered from the valve chamber 15 through passage 20 and conduit 23 to cylinder port 12, thereby advancing the spindle of unit B, the air in the rear piston chamber exhausting through conduit 24 and valve passages 21 and 22.

At the end of the advancing stroke of unit B poppet valve P4 is actuated to unbalance its valve 13 so as to effect retraction of the spindle; and at the end of such retracting movement, this unit comes to rest, the valve 13 remaining in the "retract" position subject to operation in response to the retraction of unit A in the next cycle of the apparatus. Similarly, the valve 13 of unit A has remained in its "retract" position. To initiate a new cycle of the apparatus, unit A is advanced under manual control by depressing the poppet valve P1 to vent control chamber 28 of the associated control valve 13.

It will be observed that the construction and arrangement employed requires that the poppet valves be operated only momentarily, just long enough to effect the unbalancing of the main control valves. In the case of poppet valves P2 and P4, the valves 13 associated therewith, after being opened by their respective dogs are closed in the ensuing reversal of the units; but in the case of poppet valve P3, there is no ensuing movement of the spindle of unit A following the opening of the valve by dog 40 inasmuch as this valve is utilized to control unit B upon the termination of the retracting movement of unit A. Thus the opening of poppet valve P3 would normally render the control valve of unit B inoperative, since dog 40, if allowed to bear continuously on poppet valve P3 would cause the control chamber 28 of the valve of unit B to remain vented to the atmosphere and therefor render control valve 13 of this unit inoperative in response to the opening of poppet valve P4. To overcome this, dog 40 of unit A is provided with an actuator 46 (Fig. 2) operating upon the principal of a dashpot to effect closure of poppet valve P3 after a short time interval. As shown, the actuator 46 comprises a cylinder 46a having a plunger 47 equipped with a loose fitting piston 48. The cylinder is made in two sections screw threaded together and suitably mounted on the dog 40, the latter being in the present instance in the

form of a flat plate adjustably mounted on the extension 41 of the piston rod 9. The cylinder 46a is filled with oil or other suitable liquid and the plunger 47 projects from opposite sides of the dog plate, the cylinder being equipped with suitable packing rings to prevent the escape of oil. The parts are so proportioned that upon the retraction of the spindle of unit A, the plunger engages with poppet valve P3, its movement relative to the cylinder being sufficiently retarded by the oil contained therein to cause momentary opening of the valve. However, because of the loose fit of the piston in the cylinder, oil on one side of the piston escapes slowly to the other side under the force of the poppet valve spring 38 so that after a lapse of a predetermined time interval the valve closes and thereby closes control chamber 28 of the valve of unit B to condition the same for operation under the control of poppet valve P4.

It should be observed that the dashpot actuator 46 is constructed with a view to the operation of the poppet valve P3 in the return movement of the spindle of unit A, which occurs at high speed as set forth in Taylor application Serial No. 81,050, whereas the actuation of poppet valve P2 occurs at the end of the feeding movement of a spindle and therefore at a very slow speed. Accordingly, upon engagement of the plunger 47 of actuator 46 with poppet valve P2, the rate of movement of the dog 40 is so slow as to permit relative shifting movement of the plunger 47 in the cylinder 46a so that opening of the poppet valve occurs at the end of such relative movement between the parts of the actuator. Accordingly, the plunger is positioned in its cylinder so as to be conditioned for the actuation of poppet valve P3 at the end of the rapid return stroke of the spindle of unit A.

I claim as my invention:

1. In a machine tool comprising a tool unit having a tool spindle, fluid pressure operated spindle reciprocating means including a cylinder and a piston therein and a control system governing the supply of pressure fluid to said cylinder to advance said spindle comprising a valve device and a pair of control chambers normally under pressure to hold said valve device against movement, and means for shifting said valve device to initiate the operation of the pressure fluid actuated means to advance the tool spindle including a poppet valve associated with one of said control chambers having a spring biasing it toward closed position and acting to prevent the escape of pressure fluid from said one control chamber, and a dashpot actuator operable by said power driven member for opening said poppet valve momentarily, said actuator comprising cylinder and plunger elements coacting upon a rapid movement of one of the elements by said member to transmit an actuating force to the other element to open the poppet valve but yieldable relative to each other under the action of said biasing spring to effect closure of the poppet valve.

2. In a machine tool comprising, in combination, a tool unit having a cylinder and a piston actuator, means controlling the admission of pressure fluid to said actuator cylinder to advance the piston comprising a control device having an actuating plunger and a pair of control chambers normally under pressure and holding said plunger against movement, and means for venting one of said control chambers to the atmosphere to effect movement of the plunger by the pressure in the other chamber including a valve, a spring urging said valve to closed position, and a dashpot actuator operative in response to the advance of said piston to open said valve, said actuator including a cylinder and piston device effective to delay reclosure of said valve by said spring for a predetermined time interval following the opening of the valve.

3. In a machine tool comprising a plurality of tool units each having a tool spindle and fluid pressure operated means for reciprocating the spindle including a cylinder and piston actuator, a source of fluid under pressure, and a control system for governing the supply and exhaust of pressure fluid to and from the actuator cylinders comprising, in combination, a control valve associated with each unit including a casing having opposed control chambers connected to receive a restricted supply of fluid under pressure from said source, a movable valve member projecting into said chambers and presenting substantially equal effective areas in each chamber, said member being shifted outwardly from either chamber by the pressure of the fluid therein responsive to the venting of the other chamber to the atmosphere, a pair of poppet valves associated with each actuator cylinder operable to vent respective ones of said chambers to initiate forward and return movements of the associated spindles, and a valve actuator operable by one of said spindles on retraction for actuating the valve for initiating forward movement of the other spindle.

4. In a machine tool comprising a plurality of tool units each having a tool spindle and fluid pressure operated means for reciprocating the spindle including a cylinder and piston actuator, a source of fluid under pressure, and a control system for governing the supply and exhaust of pressure fluid to and from the actuator cylinders comprising, in combination, a control valve associated with each unit including a casing having opposed control chambers connected to receive a restricted supply of fluid under pressure from said source, a movable valve member projecting into said chambers and presenting substantially equal effective areas in each chamber, said member being shifted outwardly from either chamber by the pressure of the fluid therein responsive to the venting of the other chamber to the atmosphere, a pair of poppet valves associated with each actuator cylinder, each of said valves being biased to a closed position and operative when shifted to open position to vent respective ones of said chambers to initiate shifting of said valve member and consequent forward and return movements of the associated spindles, and a valve actuator operable in the retraction of one of said spindles to open the poppet valve for initiating forward movement of the other spindle, said valve actuator being operative to allow the opened poppet valve to close after a predetermined interval.

5. In a machine tool comprising a plurality of tool units each having a tool spindle and fluid pressure operated means for reciprocating the spindle including a cylinder and piston actuator, a source of fluid under pressure, and a control system for governing the supply and exhaust of pressure fluid to and from the actuator cylinders comprising, in combination, a control valve associated with each unit including a casing having opposed control chambers connected to receive a restricted supply of fluid under pressure from said source, a movable valve member projecting into said chambers and presenting substantially equal effective areas in each chamber, said member being shifted outwardly from either chamber by the

pressure of the fluid therein responsive to the venting of the other chamber to the atmosphere, a pair of poppet valves associated with each actuator cylinder, each of said valves being biased to a closed position and operative when shifted to open position to vent respective ones of said chambers to initiate shifting of said valve member and consequent forward and return movements of the associated spindles, valve actuating means operable in the retraction of one of said spindles to actuate the poppet valve for initiating forward movement of the other spindle, said actuating means including an element movable with said one spindle to shift the poppet valve to open position, and a dashpot device associated with

said element allowing said element to retreat under the urging of the biased poppet valve as the valve returns to closed position.

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