

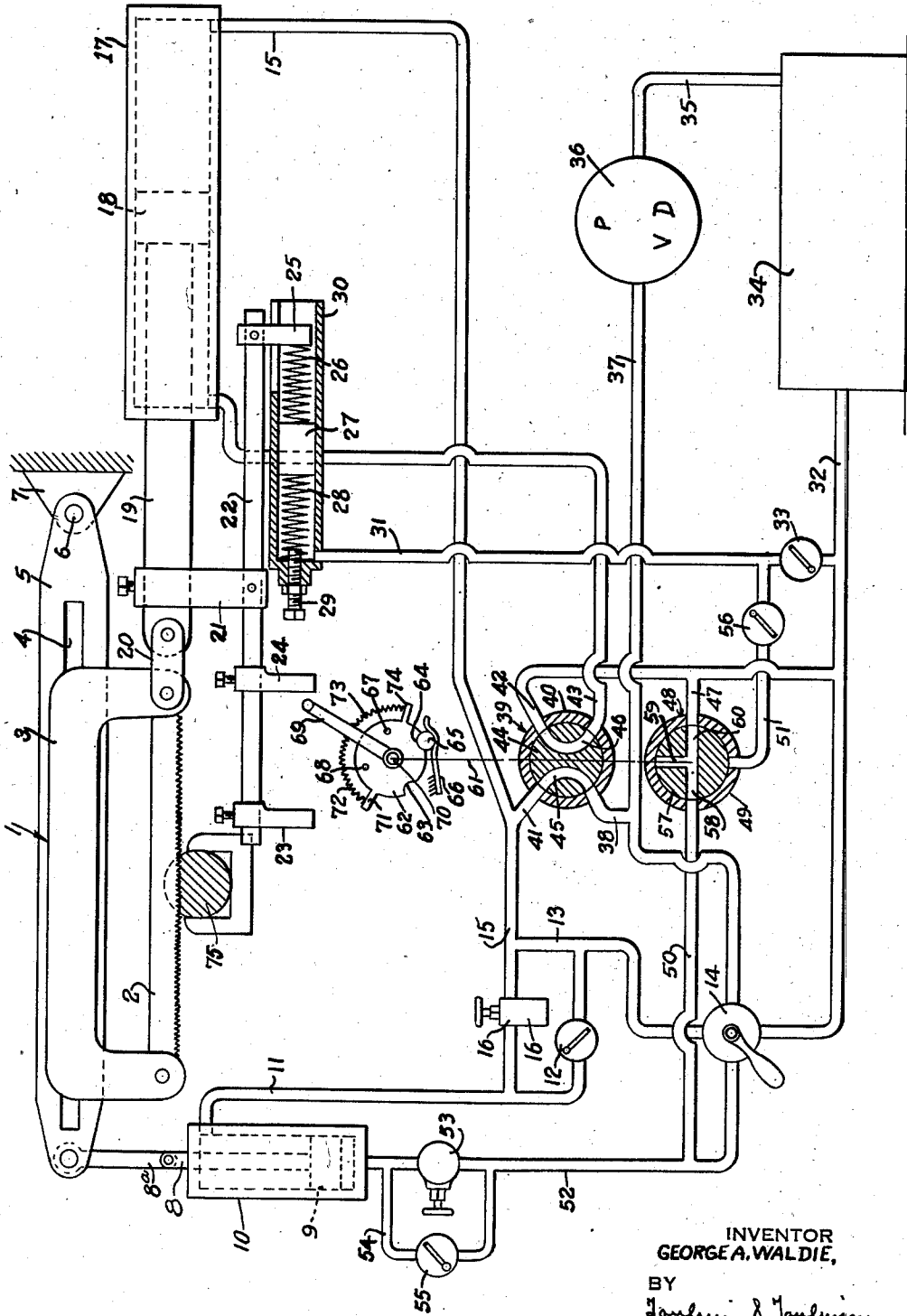
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CONTROL SYSTEM

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CONTROL SYSTEM

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This invention relates to control systems and, in particular, to control systems, including two movable members, the movements of which have to be coordinated with each other.

It is an object of this invention to provide a control system including two members movable relative to each other in a predetermined coordinated manner, in which the coordinated movement of the said members is controlled hydraulically.

It is another object to provide a hydraulic control system including a reciprocable member adapted to be controlled in its movement by two fluid operable elements movable simultaneously in two different directions, in which supply of actuating fluid pressure to said elements is controlled by the movement of one of said elements.

It is still another object to provide a hydraulic control system including two reciprocable members and power storage means, in which the power storage means is charged in response to the travel of one of the said reciprocable members and is adapted, at a predetermined point of travel of said one reciprocable member, to release stored energy to the other reciprocable member for actuating the same.

A still further object of this invention consists in the provision of a hydraulic control system including two fluid operable plungers adapted to be moved in one direction by pressure fluid from one and the same fluid source, whereas one of the said plungers is movable in the opposite direction by energy stored in response to the movement of the other plunger during movement thereof in said one direction.

These and other objects and advantages of the invention will appear more clearly from the following specification in connection with the accompanying drawing which illustrates the invention by way of example in connection with a hack saw.

General arrangement

The hydraulic system according to the invention comprises a reciprocable element reciprocable by a first hydraulic motor, while a second hydraulic motor is provided for imposing upon said reciprocable member an additional movement.

While the first hydraulic motor is actuated for movement in both directions by a pressure fluid source, the second hydraulic motor is actuated for movement in one direction by the said fluid source, while its movement in the opposite direction is brought about by pressure fluid delivered

by accumulator means charged in response to the movement of said first hydraulic motor.

Structural arrangement

Referring to the drawing in detail, the system shown therein comprises a hack saw, generally designated 1, and composed of a saw blade 2 fastened to the frame 3, which latter is provided with a ledge-shaped portion, not shown in the drawing, and slidably mounted in a slot 4 of a link 5 for guiding the frame 3.

The link 5 is pivotally connected by means of the pivot 6 to a stationarily mounted ear 7, while the other end of the link 5 is pivotally connected to a piston rod 8 through a link 8a. The piston rod 8 has connected thereto a double-acting piston 9 reciprocably mounted in a cylinder 10. One end of the cylinder 10 communicates with a conduit 11 comprising a check valve 12 and leading to a conduit 13. The conduit 13 leads to a manually controlled four-way valve 14 and also communicates with a conduit 15, which latter has one end connected to the conduit 11 and includes a pressure regulating valve 16. The pressure regulating valve 16 may be of any conventional design and is so constructed that it maintains a predetermined pressure at its outlet, in this instance, at its left side, irrespective of pressure variations at its inlet, in the drawing at its right side.

The other end of the conduit is connected with a cylinder 17 having reciprocably mounted therein a double-acting piston 18, which latter is connected through piston rod 19 and a link 20 with one end of the saw frame 3. The piston rod 19 has adjustably mounted thereon an arm 21 which in its turn is connected with a control rod 22. The control rod 22 has adjustably mounted thereon two control members 23 and 24, and has furthermore connected thereto an abutment member 25, which latter is connected to or abuts one end of a spring 26, the other end of which is in engagement with one side of a plunger 27. The other side of the plunger 27 engages one end of a spring 28, the opposite end of which is connected to an adjusting screw 29. The springs 26 and 28 may be of the same strength and structure. However, if desired, the spring 28 may be lighter than the spring 26, since the spring 28 serves only to return the plunger 27 sucking in oil, whereas the spring 26 serves as the energy source of an accumulator. This accumulator is made up of the plunger 27 and a cylinder 30 which houses the plunger 27 and springs 26 and 28, and is closed at one end adjacent the adjust-

ing screw 29. A conduit 31 leads from this end to a conduit 32 and comprises a check valve 33. The conduit 32 has one end connected to the manually controlled four-way valve 14, while the other end is connected to a fluid reservoir or tank 34. Connected to the tank 34 is a conduit 35 leading to the suction side of a pump 36, the pressure side of which is connected to the conduit 37 leading to the valve 14.

Branching off from the conduit 37 is a conduit 38 leading to a rotary four-way valve, generally designated 39. The valve 39 includes a casing 40 connected with the conduits 41, 42 and 43 and also comprises a valve rotor 44 with passageways 45 and 46 therein for controlling fluid connection between the conduits 38, 41, 42 and 43. The conduit 43 is connected to one end of the cylinder 17.

Branching off from the conduit 42 is a conduit 47 leading to a rotary valve, generally designated 48, comprising a casing 49, which latter is connected with the conduits 50 and 51. The conduit 50 communicates with a conduit 52, which latter comprises a choke valve 53 and communicates with one end of the cylinder 10. The choke valve 53 is adapted to be by-passed by a conduit 54 including a check valve 55. The conduit 51 comprises a check valve 56 and communicates with the conduit 31.

Rotatably mounted in the valve casing 49 is a valve rotor 57 with passageways 58, 59 and 60 for controlling fluid connection between the conduits 47, 50 and 51. The valve rotors 44 and 57 are rigidly connected to one and the same shaft, as diagrammatically indicated by line 61, to which shaft is also rigidly connected a control disc 62. The control disc 62 is provided with two notches 63 and 64 adapted alternately to be engaged by a circular shaped latch member 65 carried by a spring 66, one end of which is connected to a stationary point. The disc 62 has rigidly connected thereto two pins 67 and 68 for cooperation with a lever 69 which is slidable about the hub 70 of the disc 62. Arranged between the lever 69 and one ear 71, connected to the disc 62, is a spring 72, while a spring 73, equivalent to the spring 72, is mounted between the lever 69 and an ear 74, likewise connected to the disc 62.

Operation

It may be assumed that all parts of the control system occupy the position shown in the drawing, and that it is now desired to perform a working cycle of the device with automatic control thereof. To this end, the valve 14 is shifted into its effective position, in which fluid connection is interrupted between the conduits 32, 52, 43 and 37 pertaining to the valve 14. Thereupon the operator starts the driving motor, not shown, for the pump 36. As a result thereof, pressure fluid is delivered by the pump 36 through conduits 37 and 38, passageway 45 and conduit 41 into the conduit 15. From here a part of the fluid passes to the right hand end of the cylinder 17 where it acts upon the piston 18 so as to cause the latter to move the hack saw 1 toward the left. Another part of the fluid is conveyed from the conduit 15 through the pressure regulating valve 16 and conduit 11 to the upper portion of the cylinder 10 where the fluid acts upon the piston 9 so as to move the latter downwardly. In this way, the link 5 is moved in anti-clockwise direction, while simultaneously the frame 3 is guided in the slot 4 of the link 5.

It will be clear that, as a result of the combined movements of the piston rods 19 and 9, the saw

blade 2 moves toward the left, while simultaneously moving toward the work piece 75. The saw blade 2 is, therefore, pressed against the work piece while it is actually sawing.

The cutting pressure of the saw is controlled by the pressure regulating valve 16, while the feed of the saw blade 2 toward the work piece 75 is controlled by the choke valve 53, which latter controls the escape of fluid from the lower portion of the cylinder 10 while the piston 9 is moving downwardly.

While the piston 18 and saw blade 2 thus move toward the left, the control rod 22, connected by the arm 21 to the piston rod 19, likewise moves toward the left. This movement causes the abutment member 25 to compress the spring 26, while the plunger 27 is held stationary, due to the fact that the fluid between the plunger 27 and the closed end of the casing 40 is trapped by the check valve 33 and the valve 48.

When, during the leftward movement of the control rod 22, the control member 24 engages the lever 69, the latter is carried along by the control member 24, and since the disc 62 is held stationary by the latch member 65, the lever 69 loads the spring 72. When the piston 18 and, therefore, also the blade 2 approach their desired left hand end position, the lever 69 has been shifted in anticlockwise direction to such an extent that it engages the pin 68. Further leftward movement of the piston 18 and thereby also of the control rod 22, causes the control member 24 to shift the lever 69 further in anticlockwise direction which latter now, due to its engagement with the pin 68, shifts the disc 62 in anticlockwise direction. In this way the latch member 65, carried by the spring 66, is forced to yield, thereby unlocking the disc 62.

Since, as previously mentioned, the spring 72 was loaded, and inasmuch as the disc 62 is now unlocked, the loaded spring 72 instantaneously expands, thereby instantaneously shifting the disc 62 in anticlockwise direction until the disc 62 is again locked by engagement of the member 65 with the notch 63.

Since, as likewise mentioned above, the disc 62 and valve rotors 44 and 57 are rigidly connected to one and the same shaft, the shifting movement of the disc 62 causes a corresponding movement of the valve rotors 44 and 57. As a result thereof, the passageway 46 in the valve rotor 44 now interconnects the conduits 41 and 42, while the passageway 45 interconnects the conduits 38 and 43. Similarly, the valve rotor 57 has been shifted to such an extent that the conduit 58 now communicates with the conduit 51 while the passageway 59 now communicates with the conduit 50. In other words, the valve rotor 57 now interconnects the conduits 50 and 51.

Due to the shifting movement of the valve rotor 44, pressure fluid from the pump 36 is now conveyed through the conduits 37 and 38, passageway 46 and the conduit 43 to the left hand portion of the cylinder 17 where the fluid now acts upon the left or retraction side of the piston 18. The piston 18, therefore, now moves toward the right.

The shifting movement of the valve rotor 57, just described, establishes fluid connection between the conduit 31 and the lower portion of the cylinder 10 and since the spring 26 was previously loaded, it now expands almost instantaneously, thereby causing the plunger 27 almost instantaneously to pump fluid from the portion intermediate the plunger 27 and the closed end

of the cylinder 30 through conduits 31 and 51, passageways 58 and 59, conduits 50, 52 and 54 into the lower portion of the cylinder 10, thereby lifting the piston 9 so that the piston rod 8 moves the link 5 in clockwise direction by a corresponding angle. In this way, the blade 2 is moved upwardly so that no more force is exerted by the blade 2 against the work piece 75. Since, as mentioned before, the piston 18 is now moving toward the right, the saw blade 2 moves toward the right without exerting pressure on the work piece 75.

When the piston 18 has moved toward the right a predetermined distance, corresponding to the position of the control member 23, the latter engages the lever 69 and moves the same in clockwise direction during further rightward movement of the control rod 22 brought about by further rightward movement of the piston 18. This results in a loading of the spring 73 in the same manner as previously described in connection with the loading of the spring 72.

Due to the rightward movement of the control rod 22, the spring 26, as well as the spring 28, again expands, thereby moving the plunger 27 toward the right. The rightward movement of the plunger 27 causes a suction effect in the cylinder portion intermediate the plunger 27 and the closed end of the cylinder 30, which suction effect causes fluid from the tank 34 to enter the cylinder 30 through conduit 32, check valve 33 and conduit 31.

When the piston 18 approaches the end of its rightward movement, the lever 69 engages the pin 67 and, during further rightward movement of the piston 18, and thereby, control member 23, causes the disc 62 likewise to rotate in clockwise direction. As a result thereof, the latch member 65 is forced out of the notch 63 and the spring 73 instantaneously shifts the disc 62 in clockwise direction until the latch member 65 again engages the notch 64. The shifting movement of the disc 62 thus brought about, causes a simultaneous shifting movement of the valve rotors 44 and 57 so that these valve rotors are again moved into the position shown in the drawing. Pressure fluid from the pump 36 is then again conveyed to the right hand end of the cylinder 17 and will force the piston 18 to move toward the left. The cycle is then repeated in the manner previously described.

For purposes of loading and unloading the work piece, it is desirable to control the piston 9 manually. This may be effected by actuation of the valve 14 selectively into a first position, in which fluid connection is established between the conduit 37 and the conduit 13, while simultaneously the conduits 52 and 32 are interconnected. It will then be clear that pressure fluid delivered by the pump 36 will pass through conduits 37, 13 and 11 into the upper portion of the cylinder 10, thereby moving the piston rod 8 and the hack saw 1 downwardly so that the latter properly engages the work piece.

When it is desired to unload the work piece, the valve 14 is shifted into a second position, in which fluid connection is established between the conduits 37 and 52, while the conduit 13 is brought into communication with the conduit 32. Pressure fluid delivered by the pump 36 will then pass through conduits 37, 52 and 54 into the lower portion of the cylinder 10 and lift the piston 9 and thereby the hack saw 1 so that the latter will completely release the work piece 75 and allow removal thereof.

When the valve 14 is in the position shown in the drawing, no fluid connection is established between the conduits leading to the said valve.

While, according to the showing in the drawing, the saw performs a cutting stroke whenever it is pushed outwardly, it is, of course, understood, that, if desired, the saw may perform a working stroke whenever it is drawn inwardly. To this end, it is merely necessary to reverse the connections of conduits 11 and 54 with the cylinder 10.

It will also be appreciated that, while the invention has been described in connection with a hack saw, it is, of course, understood that the invention is by no means limited thereto, and may be applied in connection with other elements adapted to perform movements which have to be coordinated with each other.

It will be understood that I desire to comprehend within my invention such modifications as come within the scope of the claims.

Having thus fully described my invention, what I claim as new and desire to secure by Letters Patent, is:

1. In a hydraulic control system, first fluid operable motor means, a fluid source for selectively supplying pressure fluid to said motor means for actuating the same, second fluid operable motor means, valve means for conveying pressure fluid from said fluid source to said first motor means, power storage means adapted to be charged in response to a movement of said first motor means, and means associated with said first motor means and operable in response to a predetermined travel thereof for actuating said valve means to convey power from said power storage means to said second motor means to actuate the same, while maintaining fluid connection between said first motor means and said fluid source.

2. In a control system, a first fluid operable motor, a fluid source for supplying pressure fluid to said motor to reciprocate the same, a second fluid operable motor, means for establishing fluid connection between said second motor and said fluid source to cause movement of said second motor in a first direction, power storage means adapted in response to the travel of said first motor to store power, and means adapted in response to a predetermined travel of said first motor for interrupting fluid connection between said fluid source and said second motor, while establishing fluid connection between the latter and said power storage means to thereby cause movement of said second motor in a second direction.

3. In a control system, first fluid operable motor means, a fluid source for supplying pressure fluid to said motor means for reciprocating the same, second fluid operable motor means, valve means operable to simultaneously effect fluid connection between said fluid source and said first motor means and also between said fluid source and said second motor means for moving said first and second motor means in a first direction, power storage means operable in response to the travel of said first motor means for storing power, and means responsive to a predetermined travel of said first motor means to cause said valve means to interrupt fluid connection between said second motor means and said fluid source, while establishing fluid connection between said power storage means and said second motor means, to thereby move the latter in a second direction while said first motor

means is reversed by fluid from said fluid source.

4. In a control system, a first reciprocable fluid operable member, a second reciprocable fluid operable member, said second member being reciprocable in a direction different from the direction of reciprocation of said first member, power storage means adapted to be charged in response to the travel of said first member and also adapted to convey pressure fluid to said second member, a fluid source, and valve means operable selectively to establish fluid connection between said fluid source and both reciprocable members, or between said fluid source and said first reciprocable member only while connecting said power storage means with said second fluid operable member to actuate the latter by said power storage means.

5. In a control system, a first fluid operable member, a second fluid operable member, power storage means adapted to be charged in response to the travel of said first member and also adapted to release fluid pressure to said second fluid operable member, a fluid source, valve means movable into a first position for simultaneously conveying fluid pressure from said fluid source to said first and second fluid operable members and movable into a second position for conveying fluid pressure from said fluid source to said first fluid operable member while simultaneously preventing said fluid source from conveying fluid pressure to said second fluid operable member and causing said storage means to release fluid pressure to said second fluid operable member, and means responsive to a predetermined position of said first fluid operable member for shifting said valve means from said first position into said second position.

6. In a control system, a first double-acting plunger, a second double-acting plunger, power storage means adapted to be loaded in response to the travel of said first plunger, a fluid source, valve means operable in response to the movement of said first plunger and adapted selectively to be moved into a first position for establishing fluid connection between said fluid source and one side of said first and second plungers to thereby bring about movement of said plungers in a first direction, and adjustable control means for varying the speed of movement of said second plunger in said first direction, said valve means also being movable into a second position for establishing fluid connection between said fluid source and the second side of said first plunger while simultaneously preventing fluid

connection between said second plunger and said fluid source and establishing fluid connection between said power storage means and the second side of said second plunger to move said second plunger in a second direction.

7. In a control system, a first double-acting plunger, a second double-acting plunger, power storage means adapted to be loaded in response to the travel of said first plunger, a fluid source, valve means operable in response to the movement of said first plunger and adapted selectively to be moved into a first position for establishing fluid connection between said fluid source and one side of said first and second plungers to thereby bring about movement of said plungers in a first direction, adjustable control means for varying the speed of movement of said second plunger in said first direction, said valve means also being movable into a second position for establishing fluid connection between said fluid source and the second side of said first plunger while simultaneously preventing fluid connection between said second plunger and said fluid source and establishing fluid connection between said power storage means and the second side of said second plunger to move said second plunger in a second direction, and means for by-passing said control means while fluid connection is established between said second side of said second plunger and said power storage means.

8. In a control system, a first double-acting plunger, a second double-acting plunger, power storage means adapted to be loaded in response to the movement of said first plunger, valve means movable into a first position for establishing fluid connection between said fluid source and one side of said first and second plungers, means for maintaining a predetermined pressure on said one side of said second plunger while said valve means is in said first position, irrespective of variations of pressure at the pressure side of said fluid source, and means responsive to a predetermined position of said first plunger for shifting said valve means into a second position to thereby interrupt fluid connection between said second plunger and said fluid source, while establishing fluid connection between said power storage means and the other side of said second plunger, and also establishing fluid connection between the other side of said first plunger and said fluid source.

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