

Jan. 16, 1945.

T. F. STACY

2,367,241

CONTROL FOR FLUID OPERATED MOTORS

Filed March 18, 1939

3 Sheets-Sheet 1

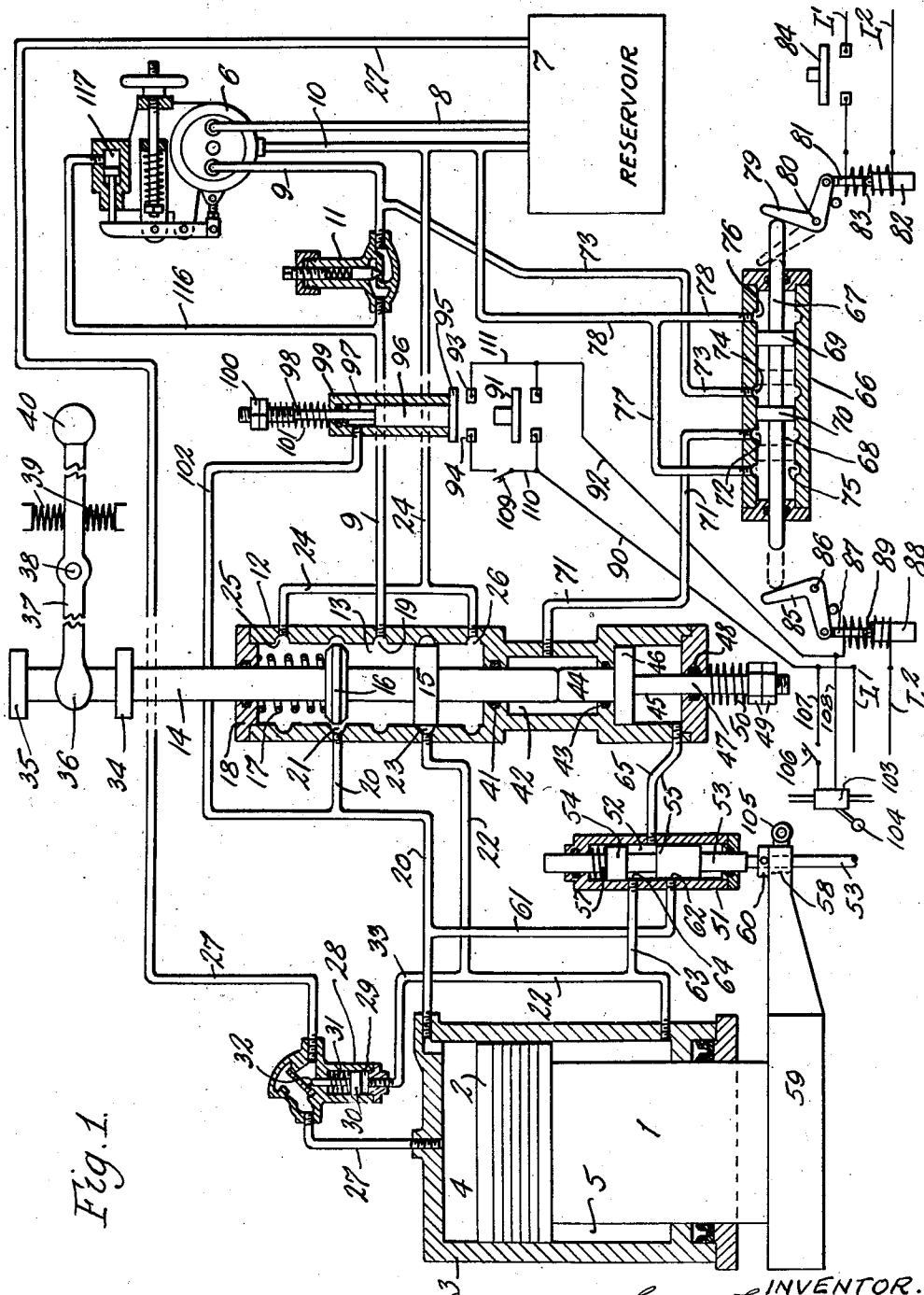


Fig. 1.

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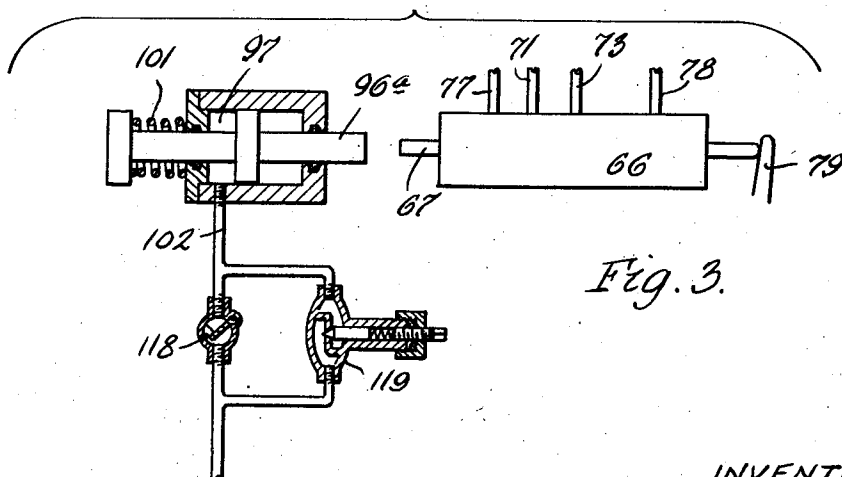
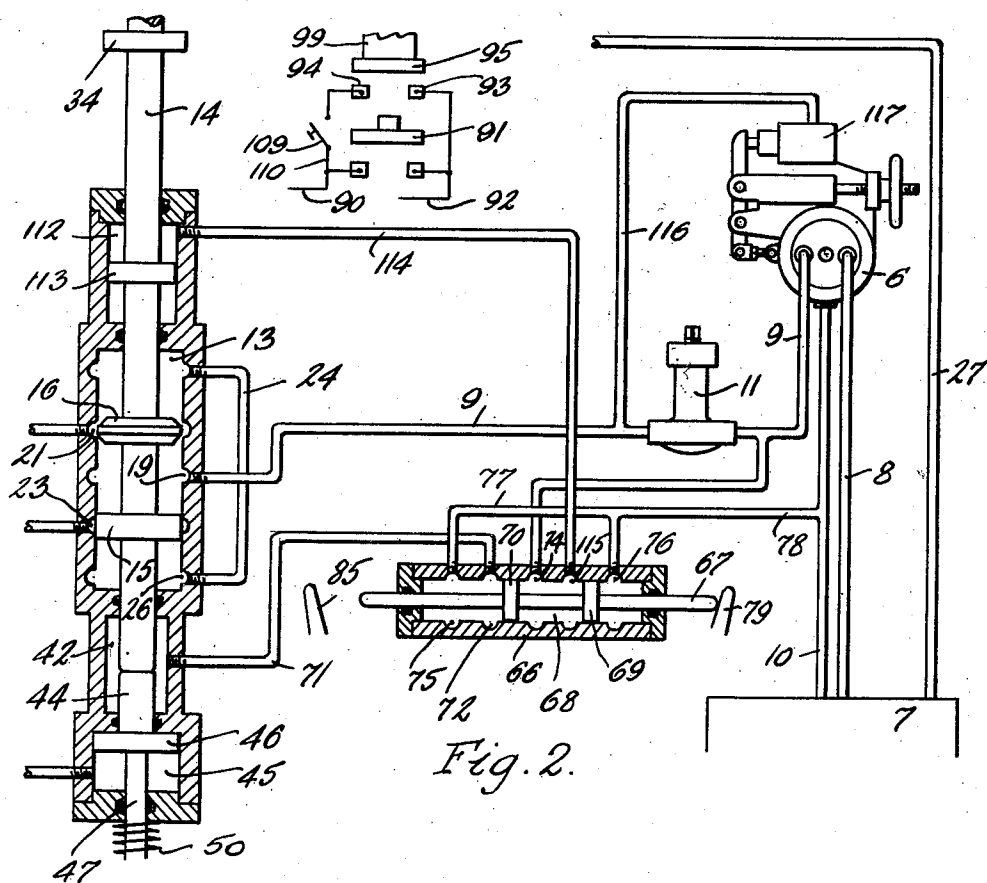
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Filed March 18, 1939

3 Sheets-Sheet 2



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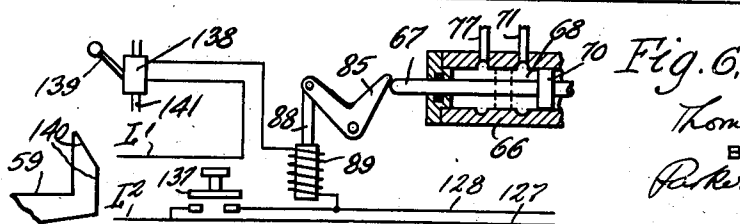
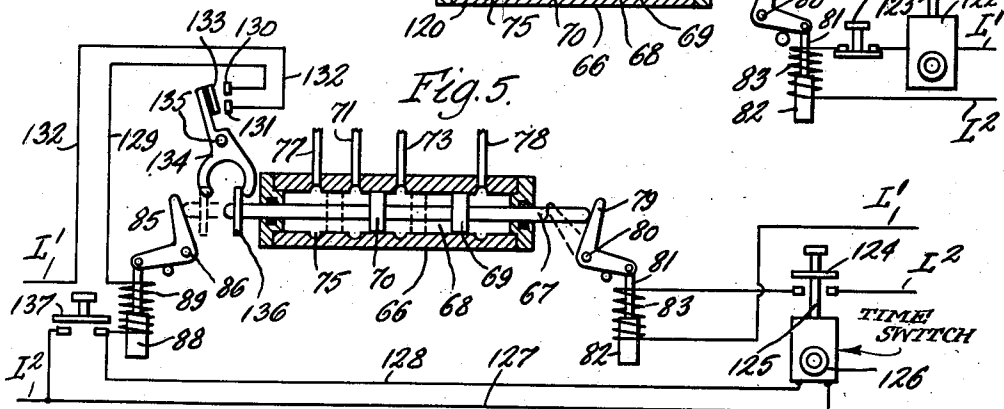
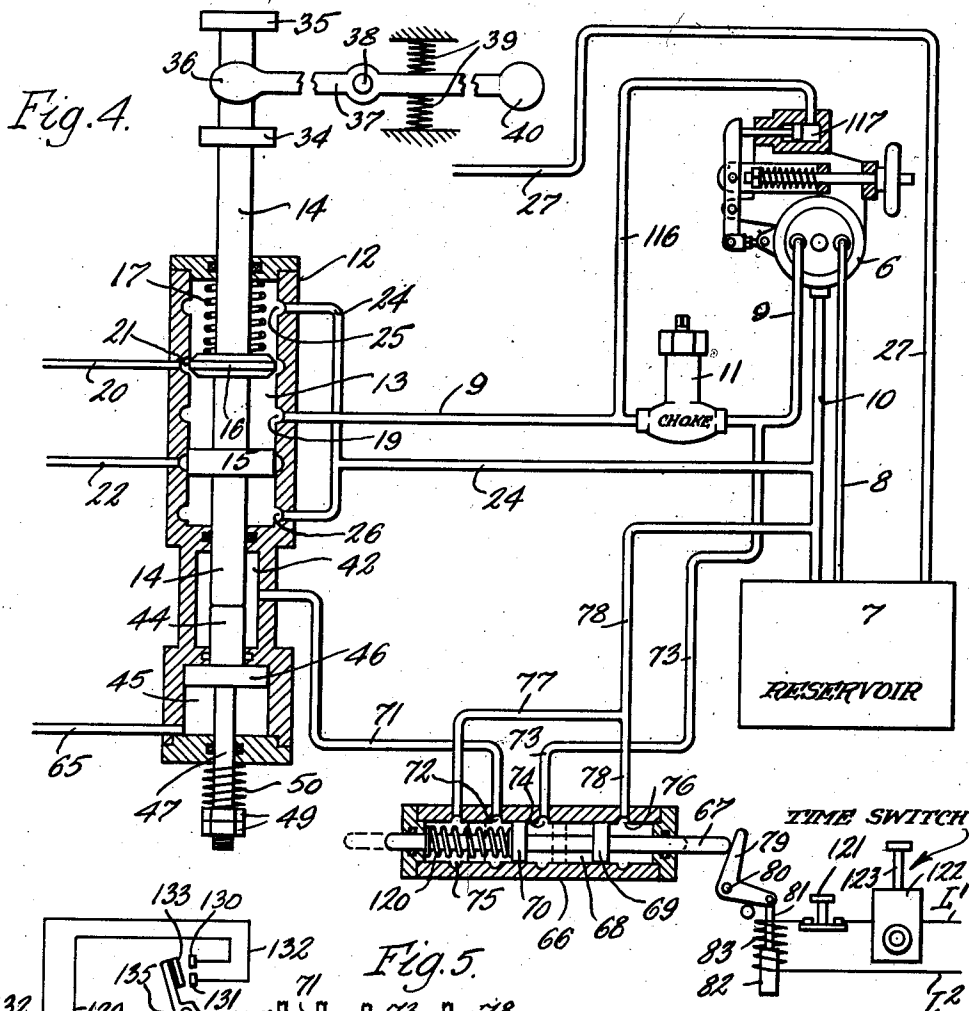
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Filed March 18, 1939

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UNITED STATES PATENT OFFICE

2,367,241

CONTROL FOR FLUID OPERATED MOTORS

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Application March 18, 1939, Serial No. 262,709

9 Claims. (Cl. 60—52)

This invention relates to fluid operated motors such as hydraulic presses, and more particularly to a hydraulic circuit and control means therefor. It is in the nature of an improvement upon the subject matter disclosed and claimed in my copending application Serial No. 204,375 filed April 26, 1938, now Patent No. 2,335,809, dated November 30, 1943.

One object of the invention is to provide an improved hydraulic system and control means for fluid actuated motors, which may be successfully applied to various types of fluid operated motors including the standard, high speed, self-contained, hydraulic press, with automatic reversing means either when a predetermined pressure on the work has been reached or the working member of the motor has reached a predetermined position in its travel, and which will be relatively smooth, efficient, and dependable in operation, and relatively simple, compact and inexpensive.

Another object of the invention is to provide an improved operating system and control for hydraulic presses and the like, with which rapid operation of the press in both directions will be possible, with which the advance travel of the working member or ram may be terminated by manual control or automatically, with which objectionable shocks in the system will be prevented, and which will be exceptionally free from operating troubles.

Other objects and advantages will appear from the following description of some embodiments of the invention, and the novel features will be particularly pointed out hereinafter in connection with the appended claims.

In the accompanying drawings:

Fig. 1 is a schematic diagram of portions of a fluid actuated motor having the control of the hydraulic system therefor constructed and arranged in accordance with this invention;

Fig. 2 is a schematic diagram of a portion of the same system and controls shown in Fig. 1, but illustrating a slight modification thereof;

Fig. 3 is a schematic diagram of a portion of the system of Fig. 1 and showing another slight modification thereof;

Fig. 4 is a schematic diagram similar to Fig. 1, but illustrating another modification thereof,

Fig. 5 is a schematic diagram of a portion of the system of Fig. 1, but illustrating still another modification thereof; and

Fig. 6 is a schematic diagram illustrating a slight modification of the portion of the system shown in Fig. 5.

In the embodiment of the invention illustrated in Fig. 1 the fluid actuated motor includes a ram element or working member 1 having a piston 2 reciprocating in a ram casing 3, with a main cylinder 4 at one side of the piston to force the ram element forwardly in a working stroke and a pullback cylinder 5 at the opposite side of the piston 2 for retracting the ram element 1 from the work. These parts are typical of fluid actuated motors such as are employed in hydraulic presses, for example. In many cases the pullback cylinder is in a separate housing from the main cylinder 3, but connected to the ram element or working member 1, and it will be understood that the ram element or working member is actuated in one direction by pressure in the main cylinder and in the opposite or retracting direction by gravity or a pullback cylinder, whether the main and pullback cylinders operate on the same or different pistons connected to the working member 1.

Any source of operating fluid under pressure may be employed, but the source is preferably a pump 6 which draws liquid from a suitable reservoir 7 through a passage 8 and delivers it under pressure through a pipe 9. Any suitable type of pump may be employed, the one illustrated being of the variable displacement or variable delivery type, in which any slippage of liquid is returned by pipe 10 to the reservoir 7. A light pressure opened check valve 11 of any suitable construction is connected in series in the pipe 9 between the pump 6 and the main controlling or operating valve 12. This valve 11 is set to open on a predetermined light pressure, and thus it operates as a choke valve to provide a sufficient back pressure for a purpose which will appear presently. The valve 12 includes a casing for a valve chamber 13, in which reciprocates a valve element 14. The valve element 14 is provided with a pair of spaced lands 15 and 16 which are of a size to fit closely with the wall of the chamber 13 and cooperate with ports in the wall of chamber 13 in a manner which will be described presently.

A helical compression spring 17 is compressed between one of the lands, such as 16, and an end wall 18 of the housing 12, and urges the valve element 14 in a downward direction (Fig. 1). The pipe 9 opens into the valve chamber 13 through a port 19 which is located between the lands 15 and 16 when the valve element 14 is in an intermediate position, which is the position shown by full lines in Fig. 1. A pipe 20 opens into the valve chamber 13 through a port aligned with the land 16 when the valve element is in

said intermediate position, and also is connected to the main cylinder 4. Another pipe 22 opens into the chamber 13 through a port 23 which is aligned with the land 15 when the valve element 14 is in its said intermediate position. The land 15 is of a width which normally closes this port 23, so as to close communication to that end of the pipe 22. It will be understood that the ports 19, 21 and 23 may be annular grooves in the wall of the chamber 13, into which grooves the pipes open.

The land 16 is bevelled on opposite faces at the periphery thereof, as shown in Fig. 1, so that when it is aligned with the port 21 there will be clearance between the land and the sides of the port 21, and fluid in the chamber 13 received through the port 19 and pipe 9 may pass through port 21 around the land 16 to the upper end of the chamber 13, as well as pass to the pipe 20. An exhaust pipe 24 opens into the upper end of the chamber 13 through a port 25, and in turn is connected to the pipe 10 leading back to the reservoir 7. The lower end of the chamber 13 also has a port 26 opening into the pipe 24. The pipe 22 is connected to the pullback cylinder 5. A pipe 27 leads from the reservoir 7 to the cylinder 4 and it contains in series therein a pilot operated, free check valve 28. This check valve opens freely to pass liquid from the reservoir 7 to the main cylinder 4 but normally closes automatically to prevent all reverse flow.

The reservoir 7 should preferably be elevated above the cylinder 4 to facilitate free flow of oil or liquid from the reservoir into the cylinder during the prefill portion of the movement of the ram or working member 1, or else the liquid in the reservoir 7 may be under air or other similar pressure. When fluid pressure is supplied to the pilot cylinder 29, however, it forces the pilot piston 30 upwardly or outwardly against the action of the pilot spring 31, so as to engage and force open the movable free valve element 32 of the check valve 28, and thus allow fluid to flow from the cylinder 4 through the pipe 27 back to the reservoir 7. The pilot cylinder 29 is connected by a pipe 33 to the pipe 22 which leads to the pullback cylinder 5.

The valve element 14 extends outwardly through one end of the valve housing 12, and this projecting end has two annular flanges 34 and 35 spaced apart. Between these flanges is disposed a forked end 36 of a lever 37, which is pivoted at 38 and urged into a neutral or intermediate position by two oppositely disposed springs 39. The free end of the lever 37 has a handle 40 by which it may be operated in either or both directions.

The lower end of the valve element 14 passes through a packing 41 and into a chamber 42. Also extending upwardly into the same chamber 42 through a packing 43 in the bottom wall of that chamber is a stop or limit piston 44 which abuts against the lower end of the valve element 14 when the latter is in the intermediate position shown in Fig. 1. The piston 44 extends from the chamber 42 into still another but larger chamber 45 where it is provided with a piston flange or head 46. A rod 47 extends from the head 46 outwardly through the bottom of the chamber 45, through a packing 48 in said bottom wall, and exteriorly of the chamber 45 carries an adjustable abutment 49 which may be a pair of nuts threaded onto the rod, and one acting as a lock nut for the other. A helical compression spring 50 is compressed between the nuts 49

and the bottom wall of the chamber 45 so as to normally urge the piston head 46 downwardly and lower the piston 44 in the chamber 42, or in other words to withdraw it from contact with an end of the valve element 14.

The press is also provided with an auxiliary valve casing 51 having a chamber 52 therein in which reciprocates a valve element 53. The valve element 53 extends through both ends of the casing 51, suitable packing glands being provided in the end walls through which the valve element extends. The portion of the valve element within the chamber 52 is provided with two lands 54 and 55 which are arranged in spaced relation to one another along the chamber 52. A helical spring 57 is compressed between the upper part of the chamber 52 and the land 54, so as to normally urge the valve element 53 downwardly. The lower end of the valve element 53 depends through a slot or aperture 58 provided in a laterally extending arm of the platen 59 which is carried by the working member or ram 1.

This element 53 carries an adjustable collar 60 at a point above the platen 59, so that as the platen 59 is elevated during a retraction, it will pick up the collar 60 and shift the valve element 53 upwardly against the action of spring 57. It is shown in its upper position in Fig. 1. A pipe 61 connects the pipe 20, leading to the main chamber 4, to a port 62 in the chamber 52 at a point where it is covered by land 55 when the valve element 53 is in its upper position as shown in Fig. 1. Similarly, a pipe 63 connects the pipe 22, leading to the pullback chamber, to a port 64 opening into the chamber 52 at a point between the lands 54 and 55 when the valve element 53 is in its elevated position shown in Fig. 1. Another pipe 65 leads from the chamber 52 between the lands 54 and 55, but close to the land 55, when the valve element 53 is in its elevated position and at its other end is connected to the chamber 45 in the lower part of the housing of the valve 12.

The port 64 is at a point substantially above the opening into pipe 65 so that when the valve element 53 is released by the platen 59 and moved downwardly by the spring 57, the land 54 will cover or pass port 64 and interrupt communication between pipes 63 and 65. It will be noted that when the valve element 53 is in the position shown in Fig. 1, which is its elevated position, the chamber 45 of the main control valve 12 will be in communication through the chamber 52 and pipes 63 and 22 with the pullback chamber 5. When the valve element 53 is released and is moved downwardly by its spring 57, this communication of the chamber 45 with the pullback chamber of the ram will be broken by land 54 covering port 64, and since the land 55 will then be below the port 62, the pipe 65 from the chamber 45 will then be in communication with the pipe 61 leading to the pipe 20 and the main chamber 4.

An auxiliary or activities control valve 66 is provided with a reciprocating valve element 67 which has portions of the same diameter extending through opposite ends of its housing, so as to be a balanced valve. Within the chamber 68 of this valve, the valve element 67 is provided with spaced lands 69 and 70 of equal diameters or face areas. A pipe 71 opens at one end into the chamber 42 and at its other end through a port 72 into the chamber 68 of this activities control valve 66. Another pipe 73 opens into

the chamber 68 of the same valve through the port 74, and this pipe 73 is connected to the portion of the pipe 9 between the pump and the choke or pressure opened valve 11. Ports 75 and 76 in the chamber 68 adjacent the ends thereof are connected by pipes 77 and 78 to the pipe 10 which leads to the reservoir 7.

When the valve element 67 is in the position shown by full lines in Fig. 1, the land 70 will be between the ports 72 and 74, so that the fluid delivered by the pump through the pipes 9 and 73 and entering the chamber 68 will be confined in the chamber 68 by the lands 69 and 70, and by reason of the fact that the lands 69 and 70 are the same size, such pressure between those lands will be balanced and will not urge the valve element 67 in either direction. Since the port 72 will be in free communication, through the chamber 68, with the port 75, the chamber 42 will be in communication with the reservoir, and there will be no fluid under pressure in chamber 42. When the valve element 67 is in its dotted line position shown in Fig. 1, the land 70 will be disposed between the ports 72 and 75, and the land 69 will stay between the ports 74 and 76.

In that situation, the communication between the pipes 71 and 77 will be broken and the pipes 71 and 73 will be placed in communication with one another through the chamber 68 in the space between the lands 69 and 70. The fluid under pressure from the pump will then be free to pass through the pipes 9 and 73, through the chamber 68, thence through pipe 71 to chamber 42 where it exerts a pressure on the inner end of the valve element 14 tending to shift it upwardly against the action of the spring 17 and carry the land 16 into a position between the ports 21 and 25 and the land 15 between the ports 23 and 19. It will be understood that the piston 44 cannot go up at this time because the head 46 in the chamber 45 limits such upward movement.

When the valve element 14 is moved upwardly in Fig. 1, the land 16 is carried into a position between and out of alignment with the ports 21 and 25 and, in this position, since the land 16 is in close fitting relation to the wall of the chamber 13, it prevents flow of fluid from the pipe 9 through the chamber 13 to the port 25. This upward movement of the land 16 leaves the pipe 20 in communication with the chamber 13, and thus the fluid under pressure from the pump 9 passes through the chamber 13 and pipe 20 to the main cylinder 4. At the same time, the upward movement of the land 15 uncovers the port 23, and this places ports 23 and 26 in communication with one another through the lower part of chamber 13. This places the pullback chamber 5 in communication, through the pipe 22 and the lower part of chamber 13, with the pipe 24 leading back to the reservoir, so that the fluid trapped in the pullback cylinder previously is now released and is free to pass back to the reservoir. The working member then is free to descend because of gravity and such descent creates a suction in the main chamber 4 and draws fluid from the reservoir through pipe 27 and check valve 28. When the working member or ram 1 encounters resistance, however, it stops further rapid descent, whereupon the valve element 32 in check valve 28 closes, but continued delivery of fluid from the pump through pipes 9 and 20 to the main chamber 4 builds up pressure in the main chamber and forces continued descent of the member 1.

It will be noted that when the valve element 67

is in the dotted line position of Fig. 1, the fluid under pressure from the pump 9 and passing through valve 66 not only serves to shift the valve element 14 upwardly into the position in which the land 16 is between the ports 21 and 25 to initiate a forward or working movement of the ram 1, but it also holds the valve element 14 hydraulically in that active position with the spring 17 compressed. If now the valve element 67 is returned to the full line position of Fig. 1, the land 70 will cut off the flow of fluid under pressure from the pump to the chamber 42, and will vent the chamber 42 to the pipe 77, whereupon the spring 17 will urge the valve element 14 downwardly or inwardly, and tend to carry the land 16 into a position between the ports 19 and 21 and the land 15 between the ports 23 and 26.

It will be understood, however, that even when the valve element 14 was in its elevated position, during which it caused an advance or working movement of the ram or member 1, the chamber 45 was at first in communication with the pullback chamber 5 through the valve chamber 52, and this caused the piston flange 46 to be held upwardly to the full line position shown in Fig. 1 by the pressure of the operating fluid trapped in the pullback chamber 5. The upward movement of the valve element 14, however, moved the land 15 above the port 23, whereupon the chamber 5 was placed in communication, through the pipes 22 and 24, with the reservoir, whereupon the pressure in the pullback chamber fell and immediately also the pressure in chamber 45. The spring 50 then forced the flange 46 downwardly and moved the piston 44 downwardly and away from the full line position shown in Fig. 1. The platen 59 in moving downwardly, however, released the rod 53 which was then urged downwardly by the spring 57 so as to disconnect the chamber 45 from the pullback chamber and connect it through the pipes 61 and 65 and chamber 52 to the pipe 20 leading to the main chamber 4.

Since the pressure in the main chamber 4 during the closing movement of the ram 1 is very slight, the fluid pressure in chamber 45 will be slight and the spring 50 will continue to hold the stop piston 44 in its downward position clear of the valve element 14. The element 14, however, remains in its elevated position by reason of the hydraulic pressure thereon in the chamber 42. As soon as pressure in the main chamber 4 begins to build up, a corresponding pressure will also build up in the chamber 45 and when sufficient to overcome the action of spring 50 will force the piston 44 upwardly into the full line position shown in Fig. 1, but it will still be out of contact with the element 14 because the latter is then still held hydraulically in its elevated position.

At the end of the forward or working movement of the platen 59, the valve element 67 is to be returned to the position shown in full lines in Fig. 1, whereupon the release of pressure in the chamber 42 allows the spring 17 to shift the valve element downwardly until it engages the piston 44, as shown in full lines in Fig. 1. The piston 44 thus obstructs further movement of the valve element 14 under action of spring 17 until the pressure in the chamber 45 falls sufficiently to be overcome by the pressure of the spring 17. When the valve element 14 is in the full line or intermediate position shown in Fig. 1, the pipe 20 leading to the main chamber 4 is connected to the pipe 24 and the reservoir, and con-

sequently the pressure in chamber 4 will fall as rapidly as the fluid can be drained into the reservoir. At this time the pump will be by-passing through the chamber 13 and around land 16 at substantially no pressure. When the pressure in chamber 4 has fallen sufficiently, the pressure in chamber 45, which has also simultaneously fallen, will be overcome by spring 17 and the valve element 14 will continue downwardly until the land 16 is disposed between the ports 19 and 21 and the land 15 is disposed between the ports 23 and 26. This places the pipe 9 from the pump in communication with the pullback chamber 5 and connects the pipe 20 from the main chamber 4 to the return to the reservoir.

The pump then delivers operating fluid to the pullback chamber to return the working member or ram 1 and the platen to the elevated or retracted position, and as the pressure in the pullback chamber builds up, the same pressure will be communicated through the pipe 33 to the pilot chamber 29 of the pilot valve 28 and forcibly open the check valve 32, so that liquid may not only escape from chamber 4 through the pipe 20 and valve chamber 13 back to the reservoir, but also may directly pass through pipe 27 and valve 28 back to the reservoir, which expedites the return of the platen.

The valve element 67 may of course be operated manually in both directions if desired, and inasmuch as it is a balanced valve it will remain in either position in which it is placed. A convenient means for operating the valve 67 in one direction to start a downward movement of the platen, which would be to operate the valve element 67 from the full to the dotted line position in Fig. 1 includes a bell crank lever 79 pivoted at 80 to a suitable support adjacent the one side of the element 67, one arm of the bell crank lever being connected by a link 81 to an armature 82 of a solenoid 83. The solenoid 83 is connected to line wires L¹ and L² with a switch 84 included in series therein. The switch 84 is a normally open switch, and by closing it momentarily, the solenoid 83 will be energized, drawing the armature 82 upwardly. Through the bell crank lever 79, the armature will shift the valve element 67 to the left in Fig. 1 from the full to the dotted line position. The valve element 67 is operated in the opposite direction, either automatically through the activity or operation of the platen or manually, as may be desired, and mechanism suitable for accomplishing this result will now be described.

A bell crank lever 85, similar to the lever 79, is disposed at the opposite end of the valve element 67 for operating the latter in the other direction. The lever 85 is pivoted at 86 to a suitable part of the frame, and is connected through a link 87 to an armature 88 of a solenoid 89. The solenoid 89 is also connected to the line wires L¹ and L², but included in the connection to one of these line wires is a suitable controlling switch mechanism. The line wire L¹ is connected by a wire 90 to a normally open switch 91, the other side of the switch being connected by a wire 92 to the solenoid 89. Thus when the switch 91 is closed, it energizes the solenoid 89 and causes the attraction of the armature 88 and a rocking of the bell crank lever 85 in a direction to shift the valve element 67 from the dotted to the full line position of Fig. 1. Connected in parallel across the switch 91 is another switch including a pair of contacts 93 and 94 which are arranged to be bridged by a con-

ducting bar 95 carried by a small piston 96 which reciprocates in a chamber 97.

The piston 96 has a reduced extension 98 extending through the closed end of the casing 99 which provides the chamber 97, and carrying an adjustable abutment 100. A helical compression spring 101 is compressed between the abutment 100 and the casing 99 so as to yieldingly urge or retract the piston 96 into the chamber 97. The abutments 100 are preferably nuts threaded on the end of the rod 98, and by adjusting the nuts 100 along the rod 98, such as by threading them therealong, the initial stress on the spring 101 may be varied. The spring 101 normally keeps the piston 96 retracted into the chamber 97, and the contact bar 95 out of bridging engagement with the contacts 93 and 94. The chamber 97 at its inner or closed end is connected by a pipe 102 to the pipe 20 leading to the main chamber 4, so that the chamber 97 will at all times be subject to the pressure in the main cylinder 4 of the hydraulic motor or ram. During the working stroke, when the fluid pressure in the chamber 4 becomes sufficiently great or exceeds a predetermined pressure, such pressure in the chamber 97 will be sufficient to overcome the spring 101 and force the piston 96 outwardly or downwardly and cause the contact bar 95 to bridge contacts 93 and 94.

Thus the circuit through the solenoid 89 will be closed automatically whenever the pressure in the main chamber of the ram or hydraulic motor exceeds a predetermined pressure depending upon the resistance of the spring 101, and as soon as the pressure in the main chamber 4 falls, the spring 101 will return the piston 96 to its elevated or retracted position and open the circuit through the solenoid 89. This arrangement provides for the automatic shifting of the valve element 67 into the full line position of Fig. 1 to release the hydraulic holding pressure on the valve element 14 automatically after the pressure on the main ram has exceeded the predetermined pressure.

The circuit through the solenoid 89 may also be closed automatically by disposing an electric switch 103 in a position to be operated by the platen at a selected point in the latter's travel, and this switch 103 is connected in parallel across the wires 90 and 92 to the contacts of switch 91. The switch 103 may have an operating arm 104 disposed in the path of travel of a cam 105 on the platen 59, and the switch 103 may be mounted on the press frame in a position to be shifted in a direction along the path of travel of the platen so that the point in the travel of the platen 59 at which the switch 103 will be operated to reverse the direction of travel of the platen may be varied.

In order that the action of the switch 103, and the pressure operated switch formed by contacts 93 and 94 and 95, may be selectively rendered inoperative at will, a switch 106 may be connected in series in the wires 107 and 108 connecting the switch 103 to the wires 90 and 92 respectively, and a switch 109 may be connected in the wire 110 which connects the wire 90 to the contact 94. The contact 93 is connected to one side of the switch 91 by a wire 111. The valve element 67 may be returned to its normal position shown in Fig. 1 by operation of the button 91, which is a selective manual control, or by the pressure responsive device which bridges contacts 93 and 94 by the bar 95, or by the operation of the position responsive switch 103.

The button 91 also functions as a safety button which enables the press to be immediately reversed at any point in its forward stroke merely by pressing the button 91.

By operating the handle 40 the valve element 14 may be shifted in one direction or the other to cause small increments of movement of the platen in either direction such as may be necessary in certain work in preliminary mounting of dies. As soon as the handle 40 is released it is returned to the neutral position and the valve element 14 is then under the control of the auxiliary valve 66.

In the operation of the press with this system, when one desires to start a forward or downward movement of the platen 59, one merely presses the button 84 which causes a movement of the valve element 67 from the full to the dotted line position in Fig. 1. This causes a hydraulic actuation of the valve element 14 into its upper position where it initiates a forward movement of the main ram 1. This forward movement is stopped either by a manual operation of the button 91, by the position responsive switch 103 when the cam 105 engages and operates the switch arm 104, or by the pressure on the main ram or work which, when it reaches a predetermined pressure, forces the piston 96 outwardly and closes the circuit between the contacts 93 and 94. The operation of the solenoid 89 through any of these three switches causes a return movement of the valve element 67 to the full line position of Fig. 1 and the parts return to their normal retracted positions.

It should be noted that when the platen 59 has nearly reached its upper limit of movement, as determined by its engagement with the collar 60, it shifts the valve element 53 upwardly and breaks the connection between the chamber 45 and the main ram chamber 4, and establishes communication between the chamber 45 and the pullback chamber 5. At this time the pressure in the pullback chamber 5 is communicated to the chamber 45 which forces the piston 44 upwardly, and thus forcibly holds the valve element 14 in the intermediate position shown in full lines in Fig. 1 and this establishes the normal idle condition of the press, which remains until a new operation is started by a closing of the switch 84. When in this position the pump is by-passing at no pressure through pipe 9, port 19, around land 16 through port 21, and through the port 25 to pipes 24 and 10 to reservoir 7.

Referring now to Fig. 2, a slight modification of the system shown in Fig. 1 has been illustrated. The system is substantially the same as in Fig. 1 except that the spring 17 is omitted and in place thereof the valve element 14 extends through a chamber 112 which is preferably smaller than and separate from the chamber 13. Within the chamber 112 the valve element 14 carries a piston flange or collar 113 fitting the side walls of chamber 112. A pipe 114 is connected to the upper end of the chamber 112 and also to a port 115 in the valve chamber 68 of the valve 66. The port 115 is disposed between the ports 76 and 74 and between the lands 69 and 70 when the valve element 67 is in the full line position shown in Fig. 1. Thus when the valve element 67 is in its normal or idle position shown in full lines in Figs. 1 and 2, the pipe 73 from the pump will deliver fluid under pressure through the pipe 114 to the chamber 112 and hydraulically urge the piston flange 113 downwardly and through it urge the valve element 14 downwardly in the

same manner as the spring 17. The chamber 112 and the head or flange 113 are sufficiently small, however, so that the pressure thereof can be overcome by the pressure in the chamber 45. Thus the only difference between the embodiment shown in Fig. 2 and that shown in Fig. 1 is the replacement of the spring 17 with the hydraulic pressure through the chamber 112, and the control of that pressure by the auxiliary or activities valve 66. The operation is otherwise the same as in Fig. 1.

It will be noted that the pump 6, in both Figs. 1 and 2, may be of the type which automatically sets itself to neutral delivery position to maintain a predetermined pressure in the pipe 9, a pipe 116 being connected for this purpose between the pipe 9 and the small piston chamber 117 of the pump. A piston in chamber 117 operates on the yoke of the pump to decrease the rate of delivery of the pump when the pressure of liquid delivered by the pump equals a predetermined pressure, as is well known in the art.

In the embodiment of the invention shown in Fig. 3, the system is the same as in Figs. 1 and 2, except that instead of having electrical circuits controlling the solenoid 89 which operates the valve element 67 back into its normal full line position of Fig. 1, a pressure responsive piston 96a is disposed in alignment with and adjacent one end of the valve element 67 so as to force the latter to the right in Fig. 1, into its normal return and idle position. The piston 96a corresponds to the piston 96 of Fig. 1, and its chamber is connected to the pipe 20 leading to the main cylinder 4 through the pipe 102, as in Fig. 1. It will be understood, of course, that in the pipe 102 in this embodiment, I prefer to include a free check valve 118 which opens freely to pass fluid from the chamber 97 and which closes automatically to prevent reverse flow.

Connected in parallel across the check valve 118 is a pressure relief valve 119 which may be of any well known type, and which is pressure closed but which opens to pass fluid from the pipe 102 towards the piston chamber 97. Thus fluid will flow from the pipes 20 and 102 to the pressure responsive piston chamber 97 only after the pressure built up in the pipe 20 is sufficient to unseat the spring or pressure closed valve element of valve 119. In such a case the spring or resistance pressure in the valve 119 will be set for an amount greater than that for which the spring 101 is set so that as soon as the valve 119 opens, the pressure then created in chamber 97 will immediately cause a relatively rapid movement of the piston 96a and a prompt movement of the valve element 67, so as to prevent wire drawing in the activities valve 66. The check valve 118 permits free escape of the actuating fluid from the chamber 97 as soon as the pressure in the pipe 20 and chamber 4 falls.

In the embodiment of the invention shown in Figs. 1 to 3, it will be noted that the main controlling element is the valve element of the main reversing valve. It is hydraulically operated into and held in one position, and yieldingly urged into the other position by spring or hydraulic means, so that the controlling element may be said to be hydraulically operated and controlled. It will also be noted that this hydraulic holding of the reversing valve element may be discontinued or interrupted to change the direction of movement of the working member, by means which is responsive to the activities of the working member. One of such means is the pressure

responsive switch or device which is responsive to the pressure of the working member on the work, or the resistance encountered by the working member. Another of such means is the position responsive switch which is disposed in a position to be operated by the platen when the platen reaches a predetermined point in its movement, and which position may be adjusted by shifting of the position operated switch along the path of travel of the platen. Either or both of these means may be rendered effective or ineffective as desired, and I have also provided the safety switch which may be operated at any point in the travel of the platen to cause an immediate reversal of the motor. In some instances it may be desirable to stop the press ram on its return stroke at some intermediate position, and to make this possible the collar 60 is made adjustable into different positions along the rod 53. Thus the point at which the ram is brought to rest and the pump set for idle delivery at substantially no pressure, may be varied by shifting collar 60 along rod 53.

In the modifications of the invention shown in Figs. 4 to 6, those parts which correspond to similar parts in Figs. 1 to 3 are given similar reference characters and will not be again specifically described. These modifications are similar to the system shown in Fig. 1, except that the reversal of the press at the end of the working stroke is responsive to a time interval after the forward working stroke is started, instead of being responsive to the working pressure or platen position. In the system as modified in the manner shown in Fig. 4, the pressure responsive switch, the switch operated by the platen, and the solenoid 89 and bell crank lever 85 are omitted. Instead, a helical compression spring 120 is disposed in the chamber 68, under compression between one end of the chamber and the land 70. This spring 120 yieldingly urges the valve element 67 to the right whenever the valve element is released.

The solenoid 83 is supplied with current from line wires L¹ and L², as in Figs. 1 and 2, but the circuit of the solenoid 83 is controlled by a normally closed switch 121 and a time switch 122. This time switch 122 is in series with the switch 121, and when idle opens the circuit to the solenoid 83. When the operating or control button 123 of the time switch 122 is operated, the time switch closes the circuit to the solenoid 83 and keeps its closed for a predetermined interval of time and then automatically opens it. The switch 121 is merely a safety switch which may be operated to open the circuit and deenergize solenoid 83 when one desires to reverse the travel of the press before the time interval for which the time switch is set, has been completed. Thus, to start the press the attendant operates the button 123 to set the time switch into operation and close the circuit to the solenoid 83.

The solenoid 83 when energized, operates the valve element 67 to the left into the dotted line position of Fig. 4 against the action of spring 120. This causes an advance of the press in the same manner as explained in connection with Fig. 1, except that the solenoid 83 remains energized to hold the valve element 67 in the dotted line until the end of a predetermined interval of time, whereupon the circuit is opened automatically. The spring 120 then shifts the valve element 67 to the right to cause a return of the platen to the normal, retracted position. The

travel of the platen is thus automatically reversed after the lapse of a predetermined interval of time, regardless of the position of the platen or the pressure developed on the working member, but if the pump 6 is of the type which automatically sets itself to neutral or non-delivery position when a predetermined pressure has been reached, the press could move into pressing position, build up a selected pressure, and maintain it until the lapse of the predetermined interval of time, whereupon the platen would be automatically retracted.

The time switches of the types which will perform such a function are common articles of commerce, and per se form no part of the present invention. One type of switch which may be adapted for this purpose is known as a "Microflex" timer switch manufactured under U. S. Patents Nos. 1,383,533, 1,460,707 and 1,794,762, to which reference may be had for further information. Similar time switches which may be used to perform the same function are, for example, those which have also been employed as circuit controlling timers for vehicle direction signals. Examples of these are found in U. S. Patents Nos. 1,672,791 and 2,001,266.

In Fig. 5, the valve 66 is substantially the same as in Fig. 1, and its element 67 is shifted in opposite directions by the solenoids 83 and 89 operating through the bell cranks 79 and 85. The solenoid 83 is supplied with current from the line wires L¹ and L², and this circuit is controlled by a normally open switch 124. The operating part of the switch 124 also preferably operates the stem 125 of a time switch 126 which may be similar to the switch 122 of Fig. 4, except that the circuit through switch 126 is normally closed, but when the switch 126 is operated, it opens the circuit therethrough and holds it open for a selected time interval, then recloses it automatically. The time switch 126 is included in series with the solenoid 89 which operates the valve element 67 to the right of Fig. 5, and the solenoid 89 is supplied with current from line wires L¹ and L². The time switch 126 is connected by a wire 127 to the line wire L², and the other side of switch 126 is connected by a wire 128 to one side of the solenoid 89. The other side of solenoid 89 is connected by a wire 129 to a contact 130 of a suitable switch, the other contact 131 of which is connected by a wire 132 to the other line wire L¹.

A wiper blade 133 is arranged to bridge the contacts 130 and 131 and complete a circuit therethrough under conditions which will be explained presently. The wiper blade 133 is carried by a lever 134 which is pivoted at 135, and which has a forked end that loosely straddles a collar 136 provided on the valve element 67 exteriorly of the valve casing 68. When the solenoid 83 is energized and the valve element 67 is shifted to the left in Fig. 5, the collar 136 will engage one arm of the forked end of lever 135 and rock the lever in a manner to shift the wiper 133 across the contacts 130 and 131 as the valve element 67 reaches its dotted line position in Fig. 5. This completes a circuit through the solenoid 89 except as controlled by the time switch 126. The valve element 67, being balanced, will remain in that position and will hold the wiper blade 133 across the contacts 130 and 131.

To start an operation of the press with this modification, the attendant closes switch 124 to energize solenoid 83, and this causes a shifting of the valve element 67 from the full line to the dotted line position of Fig. 5. At the same time

that the switch 124 is closed, the stem 125 is operated to start an operation of the time switch 126 which immediately opens the circuit between the wires 127 and 128 leading to the solenoid 89. Since the time switch 126 is set in operation before or simultaneously with the movement of the valve element 67 into the dotted line position, the circuit through the solenoid 89 will be opened at the time switch 126 before or simultaneously with the closing of the circuit across the contacts 130 and 131, so that the solenoid 89 will remain deenergized. The switch 124 may be immediately reopened or it may remain closed until the time switch completes its period of time, but after the lapse of a predetermined interval of time, which of course may be adjustable the same as that for the time switch 122, the time switch 126 will complete a circuit between the wires 127 and 128 and thus complete an energization of the solenoid 89. This solenoid 89 then operates the valve element 67 into the right or full line position of Fig. 5 to cause a retraction of the platen.

During this last movement of the valve element 67, the collar 136 will engage the opposite arm of the forked end of lever 134 just before or as the valve element 67 completes its movement to the right or full line position and shift the wiper blade 133 from across the contacts 130 and 131. This opens the circuit through the solenoid 89 so that a new operation of the solenoid 89 by switch 124 can cause a movement of the valve element 67 to the left to start a new advance of the platen. Connected across the wires 127 and 128 is a normally open switch 137 which operates as a safety switch. The time switch 126 should preferably have some optional or selective provision by which it may be returned quickly to starting position without waiting for the lapse of time, so that after the platen has been started on an advancing movement it could be reversed as a safety measure.

Unless the switch 126 is provided with such a selective release and return, the switch 137 should be used, and since it is a normally open switch, its closing causes an energization of the solenoid 89 and a reversal of the platen. In such a case the solenoid 89 should be more powerful than the solenoid 83, so that it may force the valve element 67 to the right against the action of the solenoid 83. The switch 137, if used, is preferably of the reset type so that when closed it will remain closed and keep the valve element 67 in the full line position until the switch 124 is opened, after which the switch 137 is manually reset to open position. If the switch 124 is of the type which immediately opens without waiting for the control stem 125 of the time switch to return to normal position and open the circuit of solenoid 83, then the switch 137 may be merely a normally open switch without the reset feature, because then a momentary closing of the solenoid 89 would be all that would be necessary to cause a return of the platen.

In Fig. 6, the arrangement is the same as explained for Fig. 5, except that the circuit of solenoid 89, instead of being controlled by the lever 134 and contacts 130, 131 and 133, is controlled by a switch 138 which is included in series with the solenoid 89. The switch 138 is a normally closed type but is opened when the switch arm 139 thereof is operated by a cam 140 provided on the platen as the platen approaches or reaches its upper limit of movement. Thus the solenoid 89 could remain energized to hold the valve element 67 to the right or full

line position until the platen completed any part or all of its return stroke, at which time the cam 140 would engage and operate switch arm 139 and open the circuit at the switch 138, and keep it open, and thus deenergize the solenoid 89. The switch 138 may be mounted on a rod 141 for adjustment along the path of travel of the platen. The cam surface 140 may be made sufficiently long so that the switch arm 139 may be engaged and operated to open the switch 138 soon after the platen starts its return stroke, and to keep it open until the platen has again advanced approximately to its full extent. The operation is otherwise the same as in Fig. 5.

It will be understood that various changes in the details and arrangements of parts, which have been herein described and illustrated in order to explain the nature of the invention, may be made by those skilled in the art within the principle and scope of the invention, as expressed in the appended claims.

I claim as my invention:

1. In a hydraulic motor, a working member, fluid actuated means including a continuously running pump, a main cylinder and a pull-back cylinder connected to said member for operating it toward and from work, and pipes connecting the pump and cylinders to form a hydraulic circuit, a controlling valve connected to said fluid actuated means in said pipes for causing an advance, a return or a stopping of said member and having a valve element operable into three positions, in one end position of which it causes delivery of actuating fluid to the main cylinder and opens the pull-back cylinder for escape of actuating fluid, and in another end position of which it connects the actuating fluid to the pull-back cylinder and opens the main cylinder for escape of actuating fluid, and in an intermediate position of which it closes the pull-back cylinder against escape of actuating fluid, opens said main cylinder for the escape of actuating fluid and bypasses the fluid from said pump away from both cylinders, a choke in said pipe connections to said pump to create a desirable minimum back pressure on the pump, hydraulic means supplied directly from said pump before said choke for urging said valve element into one of said end positions and holding it there, hydraulic means also connected to said pump before said choke and also operable on said valve element for forcibly actuating said valve element into the other of said end positions, and holding it there, an auxiliary valve for rendering both of said hydraulic means alternately effective on said element to determine the direction of travel of said working member, a fluid operated device for overcoming the pressure of one of said hydraulic means and forcing said element into said intermediate position to stop the actuation of said member, and valve controlled means operable by said member while in a selected zone of retraction for connecting said device to said pull-back cylinder and while out of said zone for connecting said device to said main cylinder.

2. In a hydraulic motor, a working member, fluid actuated means including a continuously running pump, a main cylinder and a pull-back cylinder connected to said member for operating it toward and from work, and pipes connecting the pump and cylinders to form a hydraulic circuit, a controlling valve connected to said fluid actuated means in said pipes for causing an advance, a return or a stopping of said member and having a valve element operable into three

positions, in one end position of which it causes delivery of actuating fluid to the main cylinder and opens the pull-back cylinder for escape of actuating fluid, and in another end position of which it connects the actuating fluid to the pull-back cylinder and opens the main cylinder for escape of actuating fluid, and in an intermediate position of which it closes the pull-back cylinder against escape of actuating fluid, opens said main cylinder for the escape of actuating fluid and bypasses the fluid from said pump away from both cylinders, a choke in said pipe connections to said pump to create a desirable minimum back pressure on the pump, hydraulic means supplied directly from said pump before said choke for urging said valve element into one of said end positions, and holding it there, hydraulic means also connected to said pump before said choke and also operable on said valve element for forcibly actuating said valve element into the other of said end positions and holding it there, an auxiliary valve for rendering both of said hydraulic means alternately effective on said element to determine the direction of travel of said working member, a hydraulic device operable on said valve element to shift it from said other position into said intermediate position against the action of said urging means, and means controlled by said working member at a desired point in its return movement for connecting said pull-back cylinder to said hydraulic device and by the pressure of fluid from the pull-back cylinder operating said valve element into said intermediate position and holding it in that position after the valve element reaches said intermediate position.

3. An improved operating system for a hydraulic motor of the type having a working member, hydraulic means for advancing said member, hydraulic means for retracting said member, and a source of operating fluid under pressure, which comprises the combination therewith of a main valve having a chamber, and a valve element movable back and forth in said chamber along a selected path, said element having lands spaced apart in a direction along said path, said casing having ports connected in groups by the spaces between said lands and covered and uncovered by the lands as they pass, one of said ports being connected to said advancing means, another to said retracting means, another disposed between these two and connected to said source, others beyond both of said first two ports and connected to exhaust, means operable on said element and urging it yieldingly into one end position in which it connects said retracting means to said source and said advancing means to exhaust, and holding it yieldingly in that position, a hydraulic device having a piston normally inoperative to oppose movement of said element into said one end position, but movable under hydraulic pressure into a position in which it releasably limits movement of said element under the action of said urging means to an intermediate position in which a land closes said port connected to said retracting means and said source port and said port connected to said advancing means are connected to exhaust, means including a valve controlled by said member and operable to connect said retracting means to said hydraulic device and cause said movement of said piston when said member is retracted within a selected extent and to disconnect said retracting means from said hydraulic device when said member is away from said selected extent of retraction, fluid actuated

means for moving said element into the opposite end position in which it connects said source to said advancing means and said retracting means to exhaust and holds said element releasably in that end position solely by a continuance of the fluid moving pressure on said element until release of said element is desired, a valve controlling the activity of said fluid actuated means, and unbiased into any of its positions, means for moving said last mentioned valve in a manner to admit fluid to said fluid actuated means to cause movement of said element into said opposite end position, and additional and separate means responsive to a selected operation of said motor for operating said last mentioned valve in a manner to cause release of actuating fluid from said element through said fluid actuated means.

4. An improved operating system for a hydraulic motor of the type having a working member, hydraulic means for advancing said member, hydraulic means for retracting said member, and a source of operating fluid under pressure, which comprises the combination therewith of a main valve having a chamber, and a valve element movable back and forth in said chamber along a selected path, said element having lands spaced apart in a direction along said path, said casing having ports connected in groups by the spaces between said lands and covered and uncovered by the lands as they pass, one of said ports being connected to said advancing means, another to said retracting means, another disposed between these two and connected to said source, others beyond both of said first two ports and connected to exhaust, means operable on said element and urging it yieldingly into one end position in which it connects said retracting means to said source and said advancing means to exhaust, and holding it yieldingly in that position, a hydraulic device having a piston normally inoperative to oppose movement of said element into said one end position, but movable under hydraulic pressure into a position in which it releasably limits movement of said element under the action of said urging means to an intermediate position in which a land closes said port connected to said retracting means and said source port and said port connected to said advancing means are connected to exhaust, means including a valve controlled by said member and operable to connect said retracting means to said hydraulic device and cause said movement of said piston when said member is retracted within a selected extent and to connect said advancing means to said hydraulic device in place of said retracting means whenever said member is away from said selected extent of retraction, fluid actuated means for moving said element into the opposite end position in which it connects said source to said advancing means and said retracting means to exhaust and holds said element releasably in that end position solely by a continuance of fluid pressure on said element moving means until release of said element is desired, whereby said element cannot be moved by said urging means from said opposite end position to said one end position until the pressure on said advancing means has fallen to a selected extent, and a pressure balanced valve unbiased to any position for controlling the admission of operating fluid to, or its release from, said fluid actuated means.

5. In a hydraulic motor system, a working member, hydraulic means for advancing said member, hydraulic means for retracting said member, a source of operating fluid under pres-

sure, a main valve connected to said source and both of said means to form therewith a hydraulic circuit for operating said member, said valve having a control element operable into three different successive positions in one of which positions it connects said source to said advancing means and said retracting means to exhaust to cause an advance of said working member, in another of which positions it connects said source to said retracting means and said advancing means to exhaust to cause a retraction of said member, and in a third, intermediate position in which it closes said retracting means against escape of operating fluid and connects said source and said advancing means to exhaust to cause said member to remain stationary, means for yieldingly urging said element into said another position, a hydraulic device operable into one position in which it directly prevents movement of said element by said urging means beyond said intermediate position and into another position in which it permits movement of said element by said urging means into said another position for that element, fluid actuated means operable on said element for forcing it into said one position to cause an advance of said member, and for releasably holding it in that one position solely by a continuance of the fluid pressure on said element through said fluid actuated means until release of said element is desired, manually movable means also operable on said element for shifting it against the action of said urging means into said one position to cause an advance of said element, whereby said element may be manually moved and held momentarily in said one position selectively, and means controlled by said working member for causing operation of said hydraulic device into said one position when said member is retracted to a selected extent, and into its other position when said member is away from its said retracted extent.

6. In a hydraulic motor system, a working member, hydraulic means for advancing said member, hydraulic means for retracting said member, a source of operating fluid under pressure, a main valve connected to said source and both of said means to form therewith a hydraulic circuit for operating said member, said valve having a control element operable into three different successive positions, in one of which positions it connects said source to said advancing means and said retracting means to exhaust to cause an advance of said working member, in another of which positions it connects said source to said retracting means and said advancing means to exhaust to cause a retraction of said member, and in a third, intermediate position in which it closes said retracting means against escape of operating fluid and connects said source and said advancing means to exhaust to cause said member to remain stationary, means for yieldingly urging said element into said another position, a hydraulic device operable into one position in which it prevents movement of said element by said urging means beyond said intermediate position and into another position in which it permits movement of said element by said urging means into said another position for that element, fluid operated means operable on said element for forcing it into said one position to cause an advance of said member, and for holding it in that one position solely by a continuance of the fluid moving pressure on said element, a pressure balanced valve controlling the admission of operating fluid to said element operating means and its release therefrom, said balanced valve being normally

free of bias into either position, means controlled by the position of said member for connecting said hydraulic device to said retracting means for operation of said device into its said one position automatically when said retracting means is under fluid pressure, and for also connecting said device to said advancing means when said working member is being advanced, for operation into its said one position when fluid pressure on said advancing means is above a predetermined pressure, means for operating said balanced valve in a manner to cause admission of operating fluid to said element operating means, and additional means responsive to a selected operating condition of said system for moving said balanced valve in a manner to release operating fluid from said element operating means.

7. In a hydraulic motor system, a working member, hydraulic means for advancing said member, hydraulic means for retracting said member, a source of operating fluid under pressure, a main valve connected to said source and both of said means to form therewith a hydraulic circuit for operating said member, said valve having a control element operable into three different successive positions, in one of which positions it connects said source to said advancing means and said retracting means to exhaust to cause an advance of said working member, in another of which positions it connects said source to said retracting means and said advancing means to exhaust to cause a retraction of said member, and in a third, intermediate position in which it closes said retracting means against escape of operating fluid and connects said source and said advancing means to exhaust to cause said member to remain stationary, means for yieldingly urging said element into said another position, a hydraulic device operable into one position in which it prevents movement of said element by said urging means beyond said intermediate position and into another position in which it permits movement of said element by said urging means into said another position for that element, fluid operated means selectively operable on said element for forcing it into said one position to cause an advance of said member, and for holding it in that one position solely by a continuance of the fluid operating pressure thereon after movement of said element has occurred, releasing it from that one position by a release of fluid pressure thereon, and means including a valve operated by said member to place said device automatically under the fluid pressure on said retracting means when said member is within a predetermined zone of retraction, and under the fluid pressure on said advancing means when said member is disposed outside of said zone.

8. In a hydraulic motor system, a working member, fluid actuated means for advancing said member, fluid actuated means for retracting said member, a source of actuating fluid under pressure, a circuit having a controlling valve for causing actuation of said member in both advance and retraction, said valve having a control element movable into any of three positions, in one of which it causes actuating fluid pressure on said member advancing means, in another of which it causes actuating fluid pressure on said member retracting means, and in a third of which it is intermediate its other mentioned positions and closes said member retracting means against escape of actuating fluid, means for yieldingly urging said element into its said another position and holding it there, fluid operated means for oper-

ating said element into its said one position and holding it there solely by a continuance of fluid pressure, a pressure balanced valve controlling the admission of operating fluid to, and its release from, said element operating means, but operable selectively to release said element, a fluid operated device effective when operated by fluid pressure to shift said element from its said another position into said intermediate position or limit movement of said element from its said one position past said intermediate position, means including a valve operated automatically by said member during its travel for connecting said fluid operated device to the fluid pressure on said retracting means when said member is in one zone of retraction, and breaking that connection and releasing said device from the fluid pressure obtained from said retracting means when said member is outside said zone.

9. In a hydraulic motor system, a working member, fluid actuated means for advancing said member, fluid actuated means for retracting said member, a source of actuating fluid under pressure, a circuit having a controlling valve for causing actuation of said member in both advance and retraction, said valve having a control element movable into any of three positions, in one of

5 which it causes actuating fluid pressure on said member advancing means, in another of which it causes actuating fluid pressure on said member retracting means, and in a third of which it is intermediate its other mentioned positions and closes said member retracting means against escape of actuating fluid, means for yieldingly urging said element into its said another position and holding it there, means operated by fluid pressure for operating said element into its said one position and holding it there by continuance of fluid pressure, a pressure balanced valve for controlling the admission of fluid under pressure to and its release from said element operating means, 10 a fluid operated device effective when operated by fluid pressure to shift said element from its said another position into said intermediate position or limit movement of said element from its said one position past said intermediate position, 15 means including a valve operated automatically by said member during its travel for connecting said fluid operated device alternately to the fluid pressures on said retracting means and said advancing means, depending upon the zone of movement in which said member happens to be.

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