Nov. 30, 1948. T. F. STACY 2,454,893

FLUID OPERATED MOTOR

Filed July 1, 1941

2 Sheets-Sheet 1

Fig. 2.

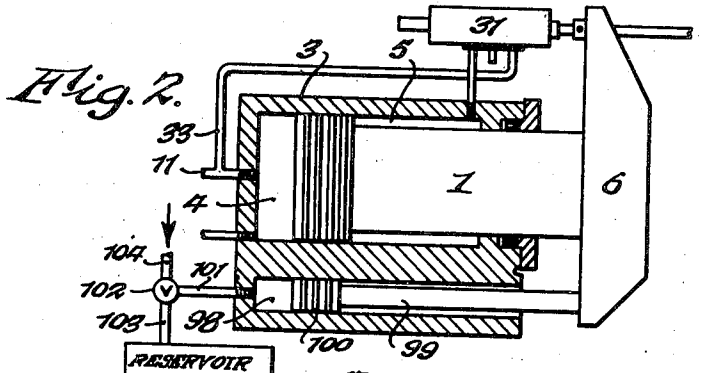
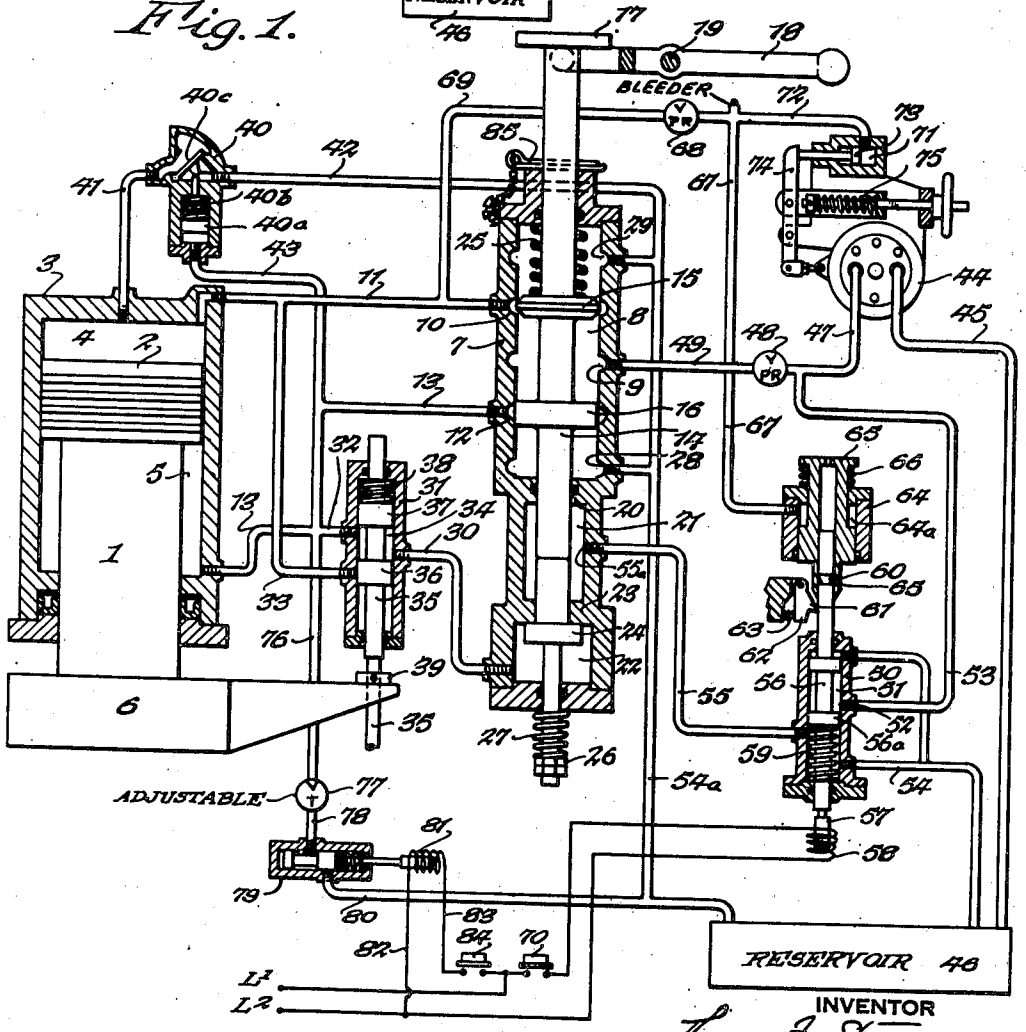


Fig. 1.



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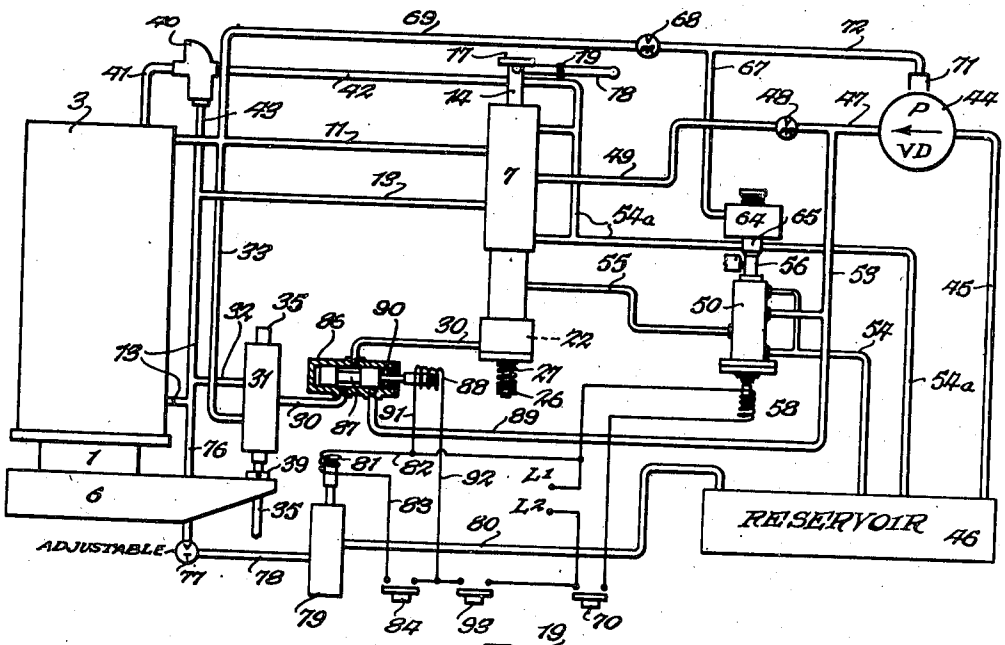
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2 Sheets-Sheet 2

Fig. 3.



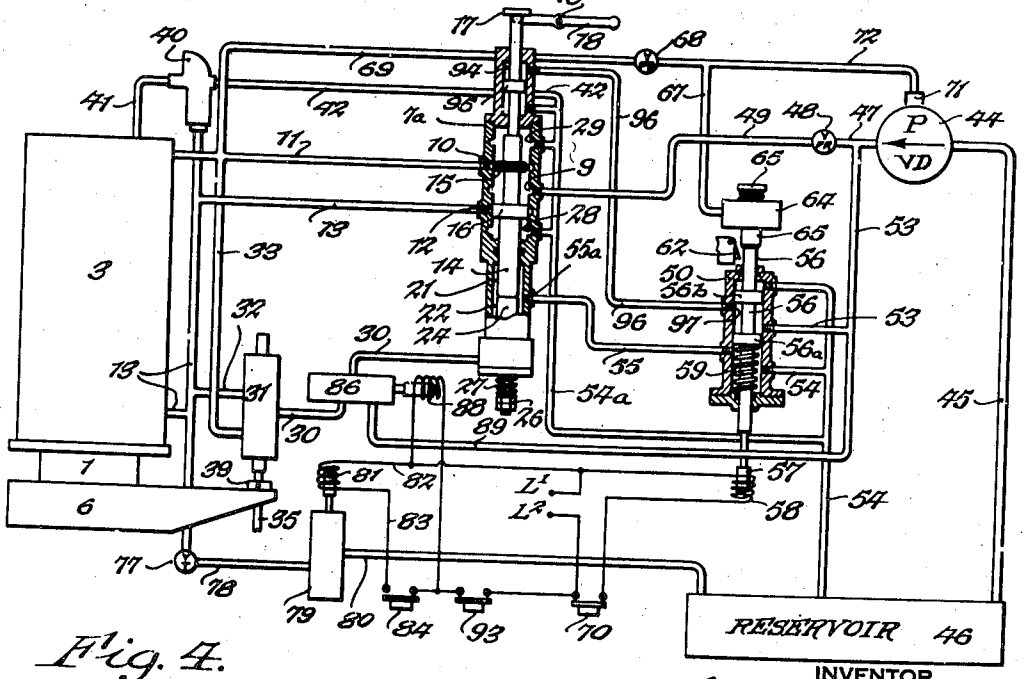


Fig. 4.

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FLUID-OPERATED MOTOR

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Application July 1, 1941, Serial No. 400,607

24 Claims. (Cl. 60—52)

1

This invention relates to fluid operated motors such as hydraulic presses, and more particularly to the mechanism for controlling the oscillations of a ram or working member. It is also in the nature of an improvement on my prior co-pending application Serial No. 204,375 filed April 26, 1938, now Patent No. 2,335,809, issued November 30, 1943.

An object of the invention is to provide improved controlling means for a fluid operated motor, which will be free of objectionable shock to the system due to the sudden release of high pressures in the main cylinder at the time of reversal, with which the full delivery capacity of the pump may be utilized throughout the normal operations of the motor, but with which the pump will automatically set itself to no-delivery condition in the event of failure of the mechanism to reverse the movement of the ram according to a selected control, with which the time cycle of operation of the motor will be relatively small, with which inching of the ram or platen during preliminary setting up of dies is simplified and better and more sensitive control of the platen movments made possible during inching, and which will be relatively simple, dependable, trouble-free, compact, rapid and inexpensive.

Other objects and advantages will be apparent from the following description of several 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 a controlling system therefor constructed in accordance with this invention and illustrating one embodiment thereof;

Fig. 2 is a schematic diagram showing a modification necessary or desirable when the platen moves horizontally instead of vertically;

Fig. 3 is a similar schematic diagram of the motor with further improvements in the control system shown in Fig. 1, and representing a modification or another embodiment thereof; and

Fig. 4 is a schematic diagram of the same motor with a further modification in the control thereof.

In the embodiment of the invention illustrated in Fig. 1, the hydraulic motor is shown as of a type having a ram 1 carrying a piston 2 operating in a head 3, the head having a main cylinder 4 at one end and a pull-back, retraction or return chamber 5 at the other end and operating on the opposite face of the piston 2. The ram 1 at its lower end includes a platen 6 which performs the usual function in hydraulic presses or similar

2

motors. The activity of the ram 1 is controlled by a main valve 7, which is generally the same as the main control valve of my prior co-pending application above identified. It includes a casing having therein a valve chamber 8 provided with an inlet port 9, and an outlet port 10 connected by a pipe 11 to the main cylinder 4. The chamber 8 is also provided with an outlet port 12 which is connected by a pipe 13 to the retraction or return chamber 5. Within the chamber 8 is a reciprocating valve 14 having spaced lands 15 and 16.

One end of the valve element 14 extends outwardly of the valve housing and terminates in a head 17 which may be engaged and operated in an outward direction by one end of a lever 18 pivoted at 19 on a suitable support. The other end of the valve element 14 extends slidingly through a partition 20 in the valve housing into a pressure chamber 21. Disposed endwise of the chamber 21 is a chamber 22 which is separated from the chamber 21 by a partition 23. In the chamber 22 is a piston 24 which has a stem slidably guided in an opening in the partition 23, so as to extend into the chamber 21 and into abutting engagement with the adjacent end of the valve element 14 when the head of the piston 24 engages with the partition 23 to limit its movement, and the valve element 14 is in the position shown in full lines in Fig. 1. A spring 25 disposed in one end of the chamber 8 acts against the land 15 to urge it in a direction toward the piston 24.

The piston 24 has a stem extending outwardly of its housing where it terminates in a collar or head 26, and a compression spring 27 surrounding the stem acts between the head 26 and the housing of chamber 22 so as to normally retract the piston 24 sufficiently to enable movement of the valve element 14 downwardly in Fig. 1, that is, into a position in which the land 15 is between the ports 9 and 10 and the land 16 uncovers the port 12, at which time the ports 9 and 12 are connected through the chamber 8. When the valve element 14 is moved upwardly in Fig. 1 against the action of spring 25, the land 15 is carried upwardly beyond the port 10 but below port 29, which thus connects the ports 9 and 10 through the chamber 8, and the port 12 opens below the land 16. A port 28 at the lower end of chamber 8 thus communicates with port 12 when land 16 moves upwardly beyond port 12, but is disconnected from port 12 when land 16 is in the intermediate position shown by full lines in Fig. 1, or below that position. The chamber 8 is also provided near its opposite end with a port 29

which, when the valve element 14 is in its intermediate position shown in full lines in Fig. 1, is in communication with port 10 while port 16 is in communication with port 9, due to the bevelled edge of land 15. When land 15 moves upwardly, it cuts off communication between ports 10 and 29.

The chamber 22 is connected by a pipe 30 to an intermediate port of a valve 31 which has two spaced ports, one of which is connected by a pipe 32 to the pipe 13 and the other of which is connected by a pipe 33 to the pipe 11 leading to the main cylinder 4. This valve 31 is provided with a chamber 34 in which oscillates a valve element 35 with lands 36 and 37 which cooperate with the ports, so that when the valve element 35 is in one endwise position, which would be its elevated position in Fig. 1, the lands 36 and 37 connect the pipe 30 to the pipe 32 leading to the pipe 13 and the return chamber 5. When the valve element 35 is in its other end or lower position, the lands 36 and 37 connect the pipe 30 to the pipe 33 leading to the pipe 11 and main cylinder 4, and interrupt the connection to the pipe 32 leading to the return chamber 5. A spring 38 in the valve chamber 34 normally urges the valve element 35 downwardly out of the position shown in full lines.

The valve element 35 has a stem that depends a substantial distance and extends slidingly through an opening in platen 6. The element 35 carries a collar 39 adjustably secured thereon at any desired position therealong, so that when the platen 6 approaches its return limit or position, it will engage the collar 39 and shift the valve element 35 upwardly in Fig. 1, so as to connect the return chamber 5 through pipe 13 with pipe 30 leading to chamber 22, thus placing chamber 22 under the same fluid pressure as that existing in return chamber 5 and interrupting the connection from pipe 33 to pipe 30. If desired, a pilot-operated prefill and check valve 40 may be connected to the main cylinder 4 by a pipe 41 and to the reservoir by a pipe 42. The pilot chamber of valve 40 is connected by a pipe 43 to the pipe 13, and piston 40a of that chamber is urged in a retracted direction by spring 40b to release free check valve element 40c.

A suitable source of fluid under pressure is employed for operating the hydraulic motor, and this source may be a variable delivery, constantly running pump 44 which is connected at its intake side by a pipe 45 to a suitable reservoir 46 and at its discharge side by a pipe 47 to one side of a pressure relief or choke valve 48, the other side of that valve being connected by a pipe 49 to the port 9 of the main valve 7. The choke or pressure relief valve 48 is set to operate at a relatively low pressure so as to provide a suitable, relatively small, continuous, minimum pressure at the pump or source of fluid, for a purpose which will appear presently. A pilot valve 50 has a valve chamber 51 with a port 52 connected by a pipe 53 to the pipe 47, which provides a pilot operating fluid under pressure at all times.

An exhaust or drain port of the pilot valve 50 is connected by a pipe 54 to the reservoir 46, and a pipe 54a also connects the exhaust ports 28 and 29 of the valve 7 to reservoir 46. The pilot valve 50 also has a port connected by a pipe 55 to the port 55a in chamber 21. The valve element 56 of the pilot 50 extends outwardly of the valve housing and terminates in a core 57 which is actuated by a solenoid 58 in one direction against the action of a spring 59. Thus, when the solenoid 58 is de-energized, the spring 59 urges the valve element 56 into the position shown in full lines, Fig. 1, in which the pipes 54 and 55 are connected together and both are disconnected from the pipe 53. When this happens, the fluid in the chamber 21 is free to escape back to the reservoir through pipes 54 and 55 and the pilot valve chamber. When the solenoid 58 is energized, it shifts the valve element 56 against the action of spring 59 in a manner to connect pipes 53 and 55 and interrupt the connection between the pipes 54 and 55 by shifting a land 56a between the ports leading to those pipes.

The valve element 56 also extends outwardly at the opposite end and is provided with a notch 60 which moves into alinement with a nose 61 of the latch 62 which is pressed by the spring 63 into latching engagement in the notch 60 when the valve element 56 is moved by the solenoid 58 sufficiently to bring notch 60 into alignment with nose 61. This prevents return of the valve element 56 when the solenoid is then de-energized. The valve element 56 extends through a housing 64 having a chamber 64a, and in this chamber is a piston 65 sliding on the valve element toward and from the latch 62 through one end of the chamber. An end of piston 65 is movable into a position to engage the latch 62 and cam it out of latching engagement with the valve element 56 when fluid under pressure is admitted to the chamber 64a of the housing 64. A spring 66 normally urges the piston 65 away from the latch 62 and in the opposite direction from its movement under the action of fluid pressure in the housing 64.

The chamber 64a is connected by a pipe 67 to one side of a pressure relief valve 68, the other side of which is connected by a pipe 69 to the pipe 11 connecting the valve 7 to the main cylinder 4. When the pressure in the main cylinder 4 and the pipe 11 reaches the selected pressure for which the relief valve 68 is set, and which pressure setting may be adjustable as usual in this type of valve, the valve 68 opens and passes fluid under pressure from the pipe 11 through valve 68 and pipe 67 to chamber 64a, and the pressure therein acts against spring 66 and forces piston 65 in a direction to engage latch 62 and disengage the latter from the notch 60, thereby releasing the valve element 56. The spring 59 then shifts the valve element back into the position in which it disconnects the pipe 53 from pipe 55 and reconnects the pipe 55 to the exhaust pipe 54, which removes pressure from chamber 21 of main valve. The solenoid 58 is energized in any suitable manner, such as from line wires L', L^2 having a switch 70 in series with one of them.

The pump 44 has a pilot cylinder 71 which is connected by a pipe 72 to the pipe 67 so that when the pressure relief valve 68 opens and passes fluid under pressure through pipe 67 to chamber 64a, some of the fluid under pressure entering pipe 67 will also pass through pipe 72 to pilot cylinder 71. A piston 73 in the pilot cylinder 71 acts against a yoke-shifting member 74 against the action of a spring 75 which may be adjusted in stress, so that when pressure in the pilot cylinder 71 is sufficient to overcome spring 75, it will shift the yoke of the pump and set the pump for no-delivery condition, even though the pump continues to rotate. This type of pump is well known and is shown only schematically, and the spring 75 may be set so that it will not operate until after the pressure is

higher than sufficient to operate relief valve 68. Thus, if the latch piston 65 sticks and does not release the valve element 56 and thus stop the advance of the ram, the pump will then automatically set itself in no-delivery condition, and will maintain that pressure for which it is set to operate. Thus further operation of the press ram will be stopped. This is a desirable safety factor, and since the pilot cylinder 71 of the pump is not connected to fluid under pressure until valve 68 opens to cause a release of valve element 56, there will be no diminution in the rate of the fluid delivered by the pump during normal operation of the ram.

It is desirable at times, in presses of this type, to inch the platen along in an advancing direction by small increments of movements when setting up dies and getting the machine ready for operation. Heretofore, this inching commonly has been done by operation of the lever 18 to shift the valve element 14 upwardly in Fig. 1, and then releasing it at the end of the desired movement increment. I have provided improved means for inching the platen which is supplemental to or may be used in place of the lever 18, and this will now be described.

The pipe 13 leading from the return cylinder 5 is connected by a pipe 76 to one side of an adjustable throttle valve 77 and the other side of that valve is connected by a pipe 78 to a simple solenoid-operated valve 79, also connected by a pipe 80 to exhaust or reservoir 46. The solenoid 81 which operates this valve 79 is connected at one side by a wire 82 to line wire L^2 and at its other side by wire 83 to line wire L'. One of these wires, such as the wire 83, has in series therein a manually operable switch 84, so that by operating switch 84, the valve 79 may be opened to bleed operating fluid from return cylinder 5 through pipes 13 and 76, throttle valve 77, pipe 78, valve 79 and pipe 80. The throttle valve 77, which is preferably adjustable, thus regulates the rate of escape of fluid from the return chamber 5, while valve 7 remains unchanged.

When the valve element 14 of main valve 7 is in its normal or intermediate position, in which the platen 6 is held in its elevated position, the pipe 13 is connected through valve 31 to the chamber 22, so that the pressure of fluid in return chamber 5 created by supporting the weight of ram 1 and platen 6 will be transmitted through pipe 30 to chamber 22 and piston 24 which holds valve element 14 in the intermediate or inactive position shown in Fig. 1, in which the escape of fluid from the return cylinder 5 through pipe 13 and valve 7 is prevented by the land 16, and the main cylinder is connected through pipe 11 and valve 7 to the reservoir 46. By closing the switch 84, operating fluid is drained from return cylinder 5, and as this is done, the ram 1 descends as rapidly as fluid escapes from cylinder 5, which rate is determined by throttle valve 77. During this descent of ram 1, fluid enters main cylinder 4 from the pump which is continuously operating. As soon as the switch 84 is released, the valve 79 closes and stops the escape of fluid from cylinder 5, and this stops the descent of platen 6.

When liquid is released from pipe 13 in this manner, the pressure therein will fall momentarily, and since this pipe is connected to chamber 22 in the main valve 7, it may release the valve element 14 sufficiently to cause a return of the ram 1 to its elevated position. As soon as the platen 6 drops sufficiently, by escape of liquid through valve 79, to release valve element 35, the latter connects chamber 22 to cylinder 4 which

is under no pressure. Hence valve element 14 would be free to move, under urge of spring 25, in a direction to connect the pump to return cylinder 5, and if such movement of element 14 occurred, it would cause a return of the platen and thus interfere with the inching operation, except as such discharge was released through valve 79. To prevent this, the valve element 14 is provided with a passage transversely therethrough, just above the upper end of the housing of valve 7 when valve element 14 is in its intermediate position, and a removable pin 85 may be temporarily passed through this opening in element 14 so as to engage with the top of housing of valve 7 and prevent movement of valve element 14 upon decrease of pressure in chamber 22 during this inching of the ram. Of course, when the press is in normal operation, the pin 85 is removed and kept removed until one is ready to inch the ram again.

Referring now to the embodiment of the invention shown in Fig. 3, the arrangement is generally the same as in Fig. 1 and corresponding parts are given the same reference characters. In this embodiment, however, a valve 86 is included in the pipe 30 connecting the valve 31 to the chamber 22. This valve 86 has a valve element 87 which is operated by a solenoid 88 into a position in which the valve element connects the section of pipe 30 leading to chamber 22 to a pipe 89 and disconnects it from the section leading to valve 31. A spring 90 urges the valve element 87 into a position in which the two sections of the pipe 30 are connected with one another and disconnected from the pipe 89. The pipe 89 is connected to pipe 53 leading to pipe 47 and the pump, so that when the solenoid 88 is energized, it will operate valve 87 and connect the pump 44 through pipes 47, 53 and 89 to the section of the pipe 30 leading to the main valve chamber 22 and to disconnect the two sections of the pipe 30 from one another. This serves to apply the fluid pressure of pump to chamber 22 so that bleeding of pipe 13 while inching the ram will not cause a release of valve element 14 of valve 7. Thus, this valve 86 and pipe 89 serve the same function as pin 85 of Fig. 1, and the pin 85 need not be used with this arrangement.

One side of the solenoid 88 is connected by a wire 91 to wire 82 and the line wire L', and the other side of solenoid 88 is connected by wire 92 to one side of a switch 93, the other side of the switch being connected to line wire L^2. In order to avoid bleeding of the fluid from the return cylinder 5, through pipe 13 by operation of the valve 79, when the valve 86 is not in a position to connect the source of fluid under pressure to the chamber 22, the switch 84 is connected to the wire 92 so that the circuit from line wire L^2 will be through switch 93 controlling the valve 86, then through switch 84, wire 83, solenoid 81 and wire 82 back to line wire L'. Thus, one must always keep the switch 93 closed while operating switch 84 to cause an operation of the valve 79 and inching of the ram. Otherwise the system operates as explained in connection with the embodiment of the invention shown in Fig. 1.

Referring now to the embodiment of the invention shown in Fig. 4, the system is as explained in Fig. 3, except that a modification has been made in the main valve 7, the modified valve being designated as 7a and in pilot valve 50. In this form of the invention, the spring 25 (Fig. 1) which was used in the embodiment shown in Figs. 1 and 3 to operate valve element 14, is omitted,

and the valve element 14 is urged yieldingly in the same direction as the spring 25 urges it in Figs. 1 and 3, by a fluid actuated device, as will now be explained.

The housing of the valve 7a is provided at the end adjacent the lever 18 with a pilot cylinder 94, and the shank of the valve element 14, which normally extends out of the housing of this valve at that end passes through this cylinder 94 from end to end, and within the cylinder 94 carries a land or head 95 which acts as a piston in cylinder 94. The lower part of cylinder 94 is connected to pipe 54a, and the upper end of said cylinder 94 is connected by a pipe 96 to a port 97 in the pilot valve 50. When the valve element 56 of pilot valve 50 is in its normal position, shown in full lines in Fig. 4, where it is held by the spring 59, the pipe 53 leading from the pump is in communication through the interior of the valve 50 with port 97 and pipe 96. In this type of valve, a second land 56b is spaced from the land 56a so that when this pilot valve is in its normal position, fluid from the pump will pass to the upper or outer end of pilot cylinder 94 and will exert a pressure on the head 95 so as to urge the valve element 14 against the piston 24 in the same manner that the spring 25 urged the same valve element in Fig. 1.

The pressure on the upper or outer face of piston head 95 is preferably less than the pressure on the piston 24, so that the piston 24 will hold valve element 14 in its intermediate position, shown in Fig. 4. When the valve element 56 of valve 50 is operated by energization of solenoid 58 under control of switch 70, the land 56b will move into a position between port 97 and the inlet port from pipe 53, and the land 56a will move beyond the port opening into pipe 55 and into a position between the latter port and the port opening into pipe 54 which serves to connect pipe 55 to pipe 53 instead of pipe 54, and to connect pipe 96 to exhaust pipe 54 leading to the reservoir 46. This removes pressure from the piston head 95 on the valve element 14 and causes a pressure on the lower end of valve element 14 which forces it into the position which causes a normal advance of platen 6, the same as for Fig. 1.

In both embodiments of the invention as shown in Figs. 3 and 4, the pump 44 is shown schematically as a variable delivery type of pump, and the pilot cylinder 71 is shown associated therewith schematically, but it will be understood that the pump 44 in Figs. 3 and 4 may be identical with the pump 44 of Fig. 1.

In the embodiments of the invention shown in Figs. 1, 3 and 4, the ram 1 is disposed in an upright position, so as to descend by gravity in an advancing direction, and the weight of the ram 1 with its platen 6 furnishes the motive power for inching the ram by bleeding of the operating fluid from return cylinder 5. If the ram is disposed to operate generally horizontally, the force of gravity is not available to perform this inching, and I have shown in Fig. 2, a manner in which this may be accomplished. In the form of the invention shown in Fig. 2, the ram 1 is disposed to operate horizontally and I provide an additional small cylinder 98 and an auxiliary ram 99 having a piston head 100 that reciprocates in this cylinder 98. The ram 99 is also connected to the platen 6 so as to urge it in an advancing direction. The outer end of the cylinder 98 is connected by a pipe 101 to a two-way valve 102, which alternately connects pipe 101 to a pipe 103 leading to the reservoir 46, and to a pipe 104 which is connected to a suitable source of fluid under pressure, such as to the pipe 47 leading from pump 44.

In the normal operation of the hydraulic motor, the valve 102 is set to connect the pipes 101 and 103, and the platen may be advanced and returned in performing press operation without any interference or aid from the ram 99. The chamber of cylinder 98 behind the piston 100 merely fills and discharges fluid from the reservoir. If now, one desires to inch such a horizontally moving ram 1, the valve 102 is operated to disconnect the pipe 103 from pipe 101 and connect the latter to pipe 104 which applies a small urging fluid pressure in cylinder 98, that tends to urge the platen 6 in an advancing direction by approximately the same pressure that would be exerted by gravity on the vertically moving ram 1 in the other embodiments of the invention. The press may then be inched by any of the mechanisms shown and described in connection with Figs. 1, 3 and 4, it being understood that this modification shown in Fig. 2 may be used with the mechanisms shown in Figs. 1, 3 and 4 when the ram 1 is disposed to move horizontally.

It is believed that the operation of the hydraulic motor under the systems which have been hereinabove explained, will be clear from the description that has been given, but it will be briefly summarized.

Referring first to Fig. 1, the device is shown as in the normal, inoperative position, in which the platen 6 is elevated and held elevated by the blocking of escape of fluid from the return cylinder 5 through pipe 13 by reason of the land 16 closing port 12 in the main valve 7. In setting up the work to be performed by the press or motor, such as in mounting dies, it is usually desirable to inch the platen 6 downwardly and to stop it in the different inched positions, such movements being through small increments. When performing this operation with the mechanism of Fig. 1, the pin 85 is inserted through the valve element 14 to prevent movement of the said element under action of spring 25 upon a fall of pressure in the chamber 22.

The operator may perform this inching by rocking the lever 18 clockwise in Fig. 1 sufficiently to elevate the valve element 14 as usual heretofore, but preferably the operator merely closes the switch 84 which energizes solenoid 81 and causes an operation of valve 79 to connect pipes 78 and 80, whereupon fluid escapes from return cylinder 5 through pipes 13 and 76, adjustable throttle valve 77 and pipe 78, valve 79 and pipe 80. The rate of escape as provided for by valve 77 determines the rate of descent of platen 6, and upon releasing switch 84, the latter automatically opens, the electromagnet 81 is de-energized, valve 79 is closed and platen 6 at once stops and remains in that stopped position. At this time, the return cylinder 5 is in communication through pipe 13, valve 31 and pipe 30 with chamber 22, until the movement of platen 6 releases valve rod 35 and thereafter valve 31 places chamber 22 in communication with cylinder 4. Hence any fallen pressure in chamber 22 during such initial increments of descent of platen 6 will not release valve element 14 for movement in a direction to cause return of the platen 6 to its elevated position until valve 31 is released and operates to connect chamber 22 to cylinder 4.

The platen may be inched throughout any desired range of its possible advancing movement,

even though platen 6 may release valve element 35, because the pin 85 holds the valve element 14 against movement into a position in which it causes a return of the ram 1 to its elevated position. After the inching operation has been concluded, the operator removes pin 85, and the device is ready for normal operation. The operator, to cause advance of the platen, closes switch 70 which energizes solenoid 58 and operates valve 50 to connect pipe 53 to pipe 55, thus admitting fluid under pressure to chamber 21. This forces valve element 14 against action of spring 25, which would be upwardly in Fig. 1, so as to connect the pump through pipes 47 and 49 with pipe 11 leading to main cylinder 4, and opening pipe 13 at port 12 to exhaust, whereupon the ram descends in the usual manner. During such descent, check valve 40 opens to prefill the cylinder 4, but when the platen 6 encounters resistance, the check valve 40 closes and the fluid from the pump forces the piston head 2 downwardly.

After the piston 6 has descended a short distance, the valve element 35 is released and it connects pipe 11 through pipe 33 with chamber 22, so that when the pressure in the main cylinder 4 is sufficient to overcome the pressure relief valve 68, fluid will pass through pipes 69, valve 66 and pipe 67 to the unlatch cylinder 64a. This causes a disengagement of latch 62 from valve element 56, whereupon the spring 59 returns the valve element 56 to full line position in Fig. 1, which disconnects fluid under pressure from the chamber 21, vents that chamber and allows operation of valve element 14 by spring 25 into press reversing position. The piston 24 prevents movement of valve element 14 beyond intermediate position and into reversing position, until pressure in main cylinder 4, which is at this time transmitted to chamber 22, through valve 31, has fallen sufficiently to allow piston 24 to be overcome by spring 25.

In the embodiment of the invention shown in Fig. 3, the operation is the same as explained in connection with Fig. 1, except that instead of using pin 85 during an inching operation by bleeding the fluid from the return cylinder, the operator merely closes the switch 93 to cause an operation of valve 86 that connects chamber 22 to pump and disconnects it from valve 31, and while that switch 93 is held closed he closes switch 84 to operate valve 79 and bleed operating fluid from the return cylinder in the same manner as explained in connection with Fig. 1.

The embodiment of the invention shown in Fig. 4 operates the same as explained in connection with Fig. 3, except that the pilot valve 50 admits fluid alternately to the opposite ends of the valve element 14 so as to alternately urge the valve element 14 in opposite directions. The fluid admitted to pilot cylinder 94 merely performs the same function as spring 25 in Figs. 1 and 3.

It will be understood that this modification in valves 7a and 50 shown in Fig. 4 may also be included in the forms of the invention shown in Figs. 1 and 2, to replace the spring 25. It will also 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. Improved operating means for a hydraulic motor having a main cylinder, a retraction cylinder, and a ram element operated in opposite directions by fluid pressures in said cylinders, which comprises a source of operating fluid under pressure, a main control valve having a valve element selectively movable between three positions, in one of which it connects said source to said main cylinder and releases fluid from said retraction cylinder, in another of which it connects said source to said retraction cylinder and releases fluid from said main cylinder, and a third position intermediate said two positions at which it prevents escape of fluid from said retraction cylinder, releases fluid from said main cylinder and by-passes fluid from said source, means for yieldingly urging said valve element into said another position, hydraulic means for releasably preventing movement of said valve element by said urging means into said another position, fluid actuated means for moving said valve element into said one position to start an advance of said ram element, an auxiliary valve controlling said fluid actuated means and having a control member, means yieldingly urging said control member into a position in which it makes said fluid actuated means ineffective on said element, means for shifting said control member into a position in which it causes operation of said fluid actuated means, means for latching said control member in said last named position, and means responsive to an operating condition of said motor when said element is moving under pressure existing in said main cylinder for releasing said control member from said latching means to cause a retraction of said element.

2. Improved operating means for a hydraulic motor having a main cylinder, a retraction cylinder, and a ram element operated in opposite directions by fluid pressures in said cylinders, which comprises a source of operating fluid under pressure, a main control valve having a valve element selectively movable between three positions, in one of which it connects said source to said main cylinder and releases fluid from said retraction cylinder, in another of which it connects said source to said retraction cylinder and releases fluid from said main cylinder, and a third position intermediate said two positions at which it prevents escape of fluid from said retraction cylinder, releases fluid from said main cylinder and by-passes fluid from said source, means for yieldingly urging said valve element into said another position, hydraulic means for releasably preventing movement of said valve element by said urging means into said another position, fluid actuated means for moving said valve element into said one position to start an advance of said ram element, an auxiliary valve controlling said fluid actuated means and having a control member, means yieldingly urging said control member into a position in which it makes said fluid actuated means ineffective on said valve element, means for shifting said control member into a position in which it causes operation of said fluid actuated means, means for latching said control member in said last named position, a hydraulic device responsive to fluid pressure and operable on said latching means for releasing said control member, a conduit connected to said hydraulic device and having therein a pressure relief valve for passing fluid to said hydraulic device when pressure in said conduit exceeds a selected pressure, and means for supplying said conduit with fluid under pressure

directly responsive to the fluid pressure in said main cylinder.

3. The combination substantially as set forth in claim 1 in which said responsive means responds to fluid pressure in said main cylinder as said operating condition, and said source of fluid under pressure is a variable delivery pump which automatically sets itself to no delivery condition when pressure in a pilot cylinder thereof reaches a selected pressure, and said pressure responsive means includes a pressure relief valve which remains closed until said selected pressure is reached and then opens, and means for delivering fluid under pressure to said pilot cylinder concurrently with delivery of fluid to said releasing means for said control member, whereby in the event of failure of said releasing means to release said control member at the selected pressure for which it is set to release, said pump will automatically set itself to no delivery condition.

4. Improved operating means for a hydraulic motor having a main cylinder, a retraction cylinder, and a ram element operated in opposite directions by fluid pressures in said cylinders, which comprises a source of operating fluid under pressure, a main control valve having a valve element selectively movable between three positions, in one of which it connects said source to said main cylinder and releases fluid from said retraction cylinder, in another of which it connects said source to said retraction cylinder and releases fluid from said main cylinder, and a third position intermediate said two positions at which it prevents escape of fluid from said retraction cylinder, releases fluid from said main cylinder and by-passes fluid from said source, means for yieldingly urging said valve element into said another position, hydraulic means for releasably preventing movement of said valve element by said urging means into said another position, fluid actuated means for moving said valve element into said one position to start an advance of said ram element, an auxiliary valve controlling said fluid actuated means and having a control member, means yieldingly urging said control member into a position in which it makes said fluid actuated means ineffective on said valve element, means for shifting said control member into a position in which it causes operation of said fluid actuated means, means for latching said control member in said last named position, a hydraulic device responsive to fluid pressure and operable on said latching means for releasing said control member, a conduit connected to said hydraulic device and having therein a pressure relief valve for passing fluid to said hydraulic device when pressure in said conduit exceeds a selected pressure, means for supplying said conduit with fluid under pressure directly responsive to the fluid presssure in said main cylinder, said source of fluid including a variable delivery pump operable to automatically set itself to no delivery condition whenever pressure in a pilot cylinder thereof reaches a selected pressure, and a connection from said pump pilot cylinder to said conduit between said hydraulic device and said pressure relief valve.

5. Improved operating means for a hydraulic motor having a main cylinder, a return cylinder, and a ram advanced by the main cylinder and returned by the return cylinder, and urged yieldingly in the direction of said advance, which comprises a source of operating fluid under pressure, means having a single control member for controlling the admission of operating fluid from said source alternately to said cylinders and the escape of fluid from said cylinders selectively to cause an advance of said ram, a return of said ram and a stoppage of said ram, said means being operable when said ram is stopped to by-pass fluid from said source while said source is in communication with said main cylinder, thereby to prevent escape of fluid from said return cylinder and thus hold said ram against advance by said yielding urge, ram controlled means for holding said control member in travel stopping position when said ram reaches its desired limit of return movement, means by which said control member may be held in its travel stopping position when it is released by said ram controlled means, and means for releasing fluid from said return cylinder selectively and separately from said controlling means, and while escape of fluid from said return cylinder is blocked by said controlling means, to allow advance of said ram through selected increments by said yielding urge, and restrict said release of fluid from said return cylinder and thereby control the rate of such advance of said ram in said increments, whereby the ram may be inched without operation of said main control valve.

6. Improved operating means for a hydraulic motor having a main cylinder, a return cylinder, and a ram advanced by the main cylinder and returned by the return cylinder, and urged yieldingly in the direction of said advance, which comprises a source of operating fluid under pressure, means for controlling the admission of operating fluid from said source to said cylinders and the escape of fluid from said cylinders selectively to cause an advance of said ram, a return of said ram and a stoppage of said ram, said means being operable when said ram is stopped thereby to prevent escape of fluid from said return cylinder and release pressure in said main cylinder and thus hold said ram against advance by said yielding urge, ram controlled means for holding said control member in travel stopping position when said ram reaches its desired limit of return movement, means by which said control member may be held in its travel stopping position when it is released by said ram controlled means, and means for releasing fluid from said return cylinder selectively and separately from said controlling means, and while escape of fluid from said return cylinder is blocked by said controlling means, to allow advance of said ram through selected increments by said yielding urge, and restricting said release of fluid from said return cylinder to thereby control the rate of such advance of said ram in said increments, whereby the ram may be inched without operation of said main control valve, said fluid releasing means including a throttle-controlled escape passage for regulating the rate of escape of operating fluid, and a manually controlled valve for selectively opening and closing said escape passage, whereby the ram may be inched without operation of said main control valve.

7. Improved operating means for a hydraulic motor having a main cylinder, a retraction cylinder, and a ram element operated in opposite directions by fluid pressures in said cylinders, which comprises a source of operating fluid under pressure, a main control valve having a valve element selectively movable between three positions, in one of which it connects said source to said main cylinder and releases fluid from said retraction cylinder, in another of which it connects said source to said retraction cylinder and releases fluid from said main cylinder, and a third position intermediate said two positions at which it

prevents escape of fluid from said retraction cylinder, releases fluid from said main cylinder and by-passes fluid from said source, means for yieldingly urging said valve element into said another position, hydraulic means for releasably preventing movement of said valve element by said urging means into said another position, ram-controlled means including a ram-controlled valve connecting said hydraulic means to said cylinders alternately, said ram controlled valve being operable when said ram is within a selected zone for connecting said hydraulic means to said retraction cylinder, and when out of said zone for connecting said hydraulic means to said main cylinder, and means for releasing fluid from said retraction cylinder separately from said main valve in selected increments at will while said main valve element remains in said intermediate position, to inch the ram in an advancing direction and means by which said main valve element may be held in said third position, while said ram is being inched.

8. Improved operating means for a hydraulic motor having a main cylinder, a retraction cylinder, and a ram element operated in opposite directions by fluid pressures in said cylinders, which comprises a source of operating fluid under pressure, a main control valve having a valve element selectively movable between three positions, in one of which it connects said source to said main cylinder and releases fluid from said retraction cylinder, in another of which it connects said source to said retraction cylinder and releases fluid from said main cylinder, and a third position intermediate said two positions at which it prevents escape of fluid from said retraction cylinder, releases fluid from said main cylinder and by-passes fluid from said source, means for yieldingly urging said valve element into said another position, hydraulic means for releasably preventing movement of said valve element by said urging means past said third position, ram-controlled means including a ram-controlled valve connecting said hydraulic means to said cylinders alternately, said ram-controlled valve being operable when said ram is within a selected zone for connecting said hydraulic means to said retraction cylinder, and when out of said zone for connecting said hydraulic means to said main cylinder, means by which said main valve element may be held in said third position or released, a bleed passage for releasing fluid from said retraction cylinder separately from said main valve, a throttle valve in said passage for regulating the rate of said escape of fluid, and a manually controlled valve for selectively opening and closing said escape passage to inch the ram in an advancing direction.

9. Improved operating means for a hydraulic motor having a main cylinder, a retraction cylinder, and a ram element operated in opposite directions by fluid pressures in said cylinders, which comprises a source of operating fluid under pressure, a main control valve having a valve element selectively movable between three positions, in one of which it connects said source to said main cylinder and releases fluid from said retraction cylinder, in another of which it connects said source to said retraction cylinder and releases fluid from said main cylinder, and a third position intermediate said two positions at which it prevents escape of fluid from said retraction cylinder, releases fluid from said main cylinder and by-passes fluid from said source, means for yieldingly urging said valve element into said another position, hydraulic means for releasably preventing movement of said valve element by said urging means past said third position, ram-controlled means including a ram-controlled valve connecting said hydraulic means to said cylinders alternately, said ram-controlled valve being operable when said ram is within a selected zone for connecting said hydraulic means to said retraction cylinder, and when out of said zone for connecting said hydraulic means to said main cylinder, means for releasing fluid from said retraction cylinder separately from said main valve in selected increments at will while said main valve element remains in said intermediate position, to inch the ram in an advancing direction, and means selectively operable to prevent movement of said main valve element from said intermediate position to said another position while inching said ram.

10. Improved operating means for a hydraulic motor having a main cylinder, a retraction cylinder, and a ram element operated in opposite directions by fluid pressures in said cylinders, which comprises a source of operating fluid under pressure, a main control valve having a valve element selectively movable between three positions, in one of which it connects said source to said main cylinder and releases fluid from said retraction cylinder, in another of which it connects said source to said retraction cylinder and releases fluid from said main cylinder, and a third position intermediate said two positions at which it prevents escape of fluid from said retraction cylinder, releases fluid from said main cylinder and by-passes fluid from said source, means for yieldingly urging said valve element into said another position, hydraulic means for releasably preventing movement of said valve element by said urging means past said third position, ram-controlled means including a ram-controlled valve connecting said hydraulic means to said cylinders alternately, said ram-controlled valve being operable when said ram is within a selected zone for connecting said hydraulic means to said retraction cylinder, and when out of said zone for connecting said hydraulic means to said main cylinder, means for releasing fluid from said retraction cylinder separately from said main valve in selected increments at will while said main valve element remains in said intermediate position, to inch the ram in an advancing direction, and means for applying fluid pressure from said source to said hydraulic means and interrupting the connection from said ram-controlled valve to said hydraulic means while inching said ram.

11. Improved operating means for a hydraulic motor having a main cylinder, a retraction cylinder, and a ram element operated in opposite directions by fluid pressures in said cylinders, which comprises a source of operating fluid under pressure, a main control valve having a valve element selectively movable between three positions, in one of which it connects said source to said main cylinder and releases fluid from said retraction cylinder, in another of which it connects said source to said retraction cylinder and releases fluid from said main cylinder, and a third position intermediate said two positions at which it prevents escape of fluid from said retraction cylinder, releases fluid from said main cylinder and by-passes fluid from said source, means for yieldingly urging said valve element into said another position, hydraulic means for releasably preventing movement of said valve element by said urging means past said third position, ram-

controlled means including a ram-controlled valve connecting said hydraulic means to said cylinders alternately, said ram-controlled valve being operable when said ram is within a selected zone for connecting said hydraulic means to said retraction cylinder, and when out of said zone for connecting said hydraulic means to said main cylinder, means for releasing fluid from said retraction cylinder, separately from said main valve in selected increments at will while said main valve element remains in said intermediate position, to inch the ram in an advancing direction, means included in the connection between said source and said main valve for maintaining a minimum pressure at said source, a selector valve in the connection from said ram-controlled valve to said hydraulic means connected directly to said source and operable to connect said hydraulic means alternately and selectively to said source and to said ram-controlled valve, whereby during inching of said ram, fluid from said source may be applied to said hydraulic means to prevent movement of said valve element into said another position.

12. Improved operating means for a hydraulic motor having a main cylinder, a retraction cylinder, and a ram element operated in opposite directions by fluid pressures in said cylinders, which comprises a source of operating fluid under pressure, means having a single control member for delivering fluid from said source alternately to said cylinders to control the direction of travel and the activity of said ram, for releasing fluid from either cylinder automatically when fluid is applied to the other, and for stopping travel of said ram by releasing fluid pressure in said main cylinder and preventing escape of fluid from said retraction cylinder, means controlled by said ram element for moving said control member into travel stopping position and holding it there at the end of a return movement of said ram element, means for releasing fluid from said retraction cylinder in selected increments while said main cylinder is free of pressure and said control member is in travel stopping position, to inch said ram in an advancing direction while said fluid delivering means remains unchanged and means by which said control member may be held in its travel stopping position during its release by said ram element in an inching operation.

13. Improved operating means for a hydraulic motor having a main cylinder, a retraction cylinder, and a ram element operated in opposite directions by fluid pressures in said cylinders, which comprises a source of operating fluid under pressure, means having a single control member for delivering fluid from said source alternately to said cylinders to control the direction of travel and the activity of said ram, for releasing fluid from either cylinder automatically when fluid is applied to the other, and for stopping travel of said ram by releasing fluid pressure in said main cylinder and preventing escape of fluid from said retraction cylinder, means controlled by said ram element for moving said control member into travel stopping position and holding it there at the end of a return movement of said ram element, means for releasing fluid from said retraction cylinder in selected increments to inch said ram in an advancing direction while said fluid delivering means remains unchanged and free of pressure in said main cylinder, means by which said control member may be held in its travel stopping position during its release by said ram element in an inching operation, and means for regulating the rate of escape of said fluid from said retraction cylinder by said inching means.

14. Improved operating means for a hydraulic motor having a main cylinder, a retraction cylinder, and a ram element operated in opposite directions by fluid pressures in said cylinders, which comprises a source of operating fluid under pressure, means having a single control member for delivering fluid from said source alternately to said cylinders to control the direction of travel and the activity of said ram, for releasing fluid from either cylinder automatically when fluid is applied to the other, and for stopping travel of said ram by releasing fluid pressure in said main cylinder and preventing escape of fluid from said retraction cylinder, means controlled by said ram element for moving said control member into travel stopping position and holding it there at the end of a return movement of said ram element, means separate from said first means for releasing fluid from said retraction cylinder in selected increments while pressure is released from said main cylinder to inch said ram in an advancing direction while said fluid delivering means remains unchanged, means by which said control member may be held in its travel stopping position during its release by said ram element in an inching operation, and means for preventing operation of said delivering means in a manner to cause retraction of said ram while said inching means is active in inching said ram.

15. Improved operating means for a hydraulic motor having a main cylinder, a retraction cylinder, and a ram element operated in opposite directions by fluid pressures in said cylinders, which comprises a source of operating fluid under pressure, means including a main valve connected to said source and to said cylinders for delivering fluid from said source alternately to said cylinders to cause movement of said ram in opposite directions and for releasing fluid from said main cylinder and preventing escape of fluid from said retraction cylinder to stop said ram, means in the connection from said source to said valve for insuring a minimum fluid pressure at said source, a fluid operated system having a pilot control valve connected directly to said source for controlling and operating said main valve and thereby determining the direction of travel of said ram, means for operating said pilot valve in one direction, means yieldingly urging it in the opposite direction, latch means for releasably holding said pilot valve after operation in said one direction against operation by said urging means in the opposite direction, a hydraulically operated device for operating said latch means and means responsive to the pressure in said main cylinder for passing operating fluid to said device and causing release of said pilot valve from said latch means when a selected pressure in said main cylinder is reached, said pressure responsive means operating at a higher pressure than that required to operate said device, whereby operation of said device will be rapid when said selected pressure in said main cylinder is reached.

16. Improved operating means for a hydraulic motor having a main cylinder, a retraction cylinder, and a ram element operated in opposite directions by fluid pressures in said cylinders, which comprises a source of operating fluid under pressure, means including a main valve connected to said source and to said cylinders for delivering fluid from said source alternately to said cylinders to cause movement of said ram in

opposite directions and for releasing fluid from said main cylinder and preventing escape of fluid from said retraction cylinder to stop said ram, means in the connection from said source to said valve for insuring a minimum fluid pressure at said source, a fluid operated system having a pilot control valve connected directly to said source for controlling and operating said main valve and thereby determining the direction of travel of said ram, means for operating said pilot valve in one direction, means yieldingly urging it in the opposite direction, latch means for releasably holding said pilot valve after operation in said one direction against operation by said urging means in the opposite direction, means responsive to the pressure in said main cylinder for releasing said pilot valve from said latch means when a selected pressure in said main cylinder is reached, and ram controlled means for also controlling said main valve and setting it releasably to prevent escape of fluid from said retraction cylinder and release fluid from said main cylinder to stop the ram at a selected position in its travel.

17. Improved operating means for a hydraulic motor having a main cylinder, a retraction cylinder, and a ram element operated in opposite directions by fluid pressures in said cylinders, which comprises a source of operating fluid under pressure, means including a main valve connected to said source and to said cylinders for delivering fluid from said source alternately to said cylinders to cause movement of said ram in opposite directions and for releasing fluid from said main cylinder and preventing escape of fluid from said retraction cylinder to stop said ram, means in the connection from said source to said valve for insuring a minimum fluid pressure at said source, a fluid operated system having a pilot control valve connected directly to said source for controlling and operating said main valve and thereby determining the direction of travel of said ram, means for operating said pilot valve in one direction, means yieldingly urging it in the opposite direction, latch means for releasably holding said pilot valve after operation in said one direction against operation by said urging means in the opposite direction, means responsive to the pressure in said main cylinder for releasing said pilot valve from said latch means when a selected pressure in said main cylinder is reached, ram-controlled means for also controlling said main valve and setting it releasably to prevent escape of fluid from said retraction cylinder and release fluid from said main cylinder to stop the ram at a selected position in its return travel, means for releasing fluid from said retraction cylinder in selected increments at a selected rate, while said main valve remains unchanged, to cause selected inching of said ram and means by which said main valve may be held in the position in which it releases fluid from the main cylinder and prevents escape of fluid therethrough from said retraction cylinder while inching the ram.

18. Improved operating means for a hydraulic motor having a main cylinder, a retraction cylinder, and a ram element operated in opposite directions by fluid pressures in said cylinders, which comprises a source of operating fluid under pressure, means including a main valve connected to said source and to said cylinders for delivering fluid from said source alternately to said cylinders to cause movement of said ram in opposite directions and for releasing fluid from said main

cylinder and preventing escape of fluid from said retraction cylinder to stop said ram, means in the connection from said source to said valve for insuring a minimum fluid pressure at said source, a fluid operated system having a pilot control valve connected directly to said source for controlling and operating said main valve and thereby determining the direction of travel of said ram, means for operating said pilot valve in one direction, means yieldingly urging it in the opposite direction, latch means for releasably holding said pilot valve after operation in said one direction against operation by said urging means in the opposite direction, means responsive to the pressure in said main cylinder for releasing said pilot valve from said latch means when a selected pressure in said main cylinder is reached, ram controlled means for also controlling said main valve and setting it releasably to prevent escape of fluid from said retraction cylinder and release fluid from said main cylinder to stop the ram at a selected position in its travel, means for releasing fluid from said retraction cylinder in selected increments at a selected rate, while said main valve remains unchanged, to cause selected inching of said ram, said ram controlled means including a stop and hydraulic means for operating the stop into a position to prevent operation of said valve in a direction to connect said source to said retraction cylinder, and means also connected directly to said source and operable for supplying fluid under pressure directly to said hydraulic means to hold said stop in its said valve movement preventing position while said ram is being inched by releasing fluid from said retraction cylinder and said main valve remains unchanged.

19. Improved operating means for a hydraulic motor having a main cylinder, a retraction cylinder, and a ram element operated in opposite directions by fluid pressures in said cylinders, which comprises a sourse of operating fluid under pressure, a main control valve having a valve element selectively movable between three positions, in one of which it connects said source to said main cylinder and releases fluid from said retraction cylinder, in another of which it connects said source to said retraction cylinder and releases fluid from said main cylinder, and a third position intermediate said two positions at which it prevents escape of fluid from said retraction cylinder, releases fluid from said main cylinder and by-passes fluid from said source, means for yieldingly urging said valve element into said another position, hydraulic means for releasably preventing movement of said valve element by said urging means past said third position, ram-controlled means including a ram-controlled valve connecting said hydraulic means to said cylinders alternately, said ram controlled valve being operable when said ram is within a selected zone for connecting said hydraulic means to said retraction cylinder, and when out of said zone for connecting said hydraulic means to said main cylinder, means for releasing fluid from said retraction cylinder separately from said main valve in selected increments at will while said main valve element remains in said intermediate position, to inch the ram in an advancing direction, valve means in the connection from said ram-controlled valve to said hydraulic means for alternately applying fluid pressure to said hydraulic means and connecting the latter to said ram-controlled valve to said hydraulic means for operation of said fluid releasing means in a man-

ner to release fluid from said retraction cylinder until said valve means in the connection to said hydraulic means is operated to disconnect the latter from said ram-controlled valve and apply fluid pressure to said hydraulic means.

20. Improved operating means for a hydraulic motor having a main cylinder, a retraction cylinder, and a ram element operated in opposite directions by fluid pressures in said cylinders, which comprises a source of operating fluid under pressure, a main control valve having a valve element selectively movable between three positions, in one of which it connects said source to said main cylinder and releases fluid from said retraction cylinder, in another of which it connects said source to said retraction cylinder and releases fluid from said main cylinder, and a third position intermediate said two positions at which it prevents escape of fluid from said retraction cylinder, releases fluid from said main cylinder and by-passes fluid from said source, means for yieldingly urging said valve element into said another position, hydraulic means for releasably preventing movement of said valve element by said urging means past said third position, ram-controlled means including a ram-controlled valve connecting said hydraulic means to said cylinders alternately, said ram-controlled valve being operable when said ram is within a selected zone for connecting said hydraulic means to said retraction cylinder, and when out of said zone for connecting said hydraulic means to said main cylinder, means for releasing fluid from said retraction cylinder, separately from said main valve, in selected increments at will while said main valve element remains in said intermediate position, to inch the ram in an advancing direction, valve means in the connection from said ram-controlled valve to said hydraulic means for alternately applying fluid pressure to said hydraulic means and connecting the latter to said ram-controlled valve, and individually controlled electrical means for operating said fluid releasing means and said valve means connected to said hydraulic means, said electrical means being so interconnected that operation of said fluid releasing means is possible only while said valve means is in a position to apply fluid pressure to said hydraulic means.

21. Improved operating means for a hydraulic motor of the type having a working member and an advancing cylinder and a return cylinder for operating said working member back and forth, which comprises a variable delivery pump, a reversing valve, connections between said pump, said valve and said cylinders by which the delivery of fluid to said cylinders may be reversed to control the direction of travel of said working member, said reversing valve having a valve element movable into different positions to control the direction of travel of said working member, means for holding said valve element in the position in which it causes an advance of said working member but operable to release said element, means for urging said valve element in a direction to cause a reversal of travel of the working member, means responsive to fluid pressure in the advancing cylinder for causing a release of said valve element from said holding means when a desired pressure in said advancing cylinder is reached, and having a pressure relief valve opening to pass fluid under pressure from said advancing cylinder to said releasing means automatically when a desired pressure has been reached, and means responsive to the pressure in said release means at the discharge side of said pressure relief valve for automatically decreasing the delivery of said pump while the pressure in said releasing means is sufficient to normally cause an actuation of said releasing means, whereby if said releasing means fails to operate, a further rise in pressure in said advancing cylinder will be limited.

22. Improved operating means for a hydraulic motor of the type having a main chamber, a retraction chamber, and a ram element operated in opposite directions by fluid pressure differentials in said chambers, which comprises means for delivering operating fluid under pressure alternately to said chambers to cause movements of said ram element in opposite directions and for closing said retraction chamber to stop an advance of said ram element, and including a control member yieldingly urged into a position to cause a retraction of said ram element, ram controlled means for causing movement of said control member out of a position in which it causes delivery of fluid to said retraction chamber to cause a retraction of said ram, at the end of a return movement of the ram and for releasing it in an initial zone of advance of said ram, a selectively operated, valve-controlled connection to said retraction chamber to selectively, and at will, release fluid therefrom irrespective of the position of said control member, and a device by which said control member may be held against movement into said position in which it causes a retraction of said ram for any desired extent of advance movement of said ram during release of fluid from said retraction chamber.

23. Improved operating means for a hydraulic motor of the type having a main chamber, a retraction chamber, and a ram element operated in opposite directions by fluid pressure differentials in said chambers, which comprises means for delivering operating fluid under pressure alternately to said chambers to cause movements of said ram element in opposite directions and for closing said retraction chamber to stop an advance of said ram element, and including a control member yieldingly urged into a position to cause a retraction of said ram element, ram-controlled means for causing movement of said control member out of a position in which it causes delivery of fluid to said retraction chamber to cause a retraction of said ram, at the end of a return movement of the ram and for releasing it in an initial zone of advance of said ram, a selectively operated, valve-controlled connection to said retraction chamber to selectively, and at will, release fluid therefrom irrespective of the position of said control member, a device by which said control member may be held against movement into said position in which it causes a retraction of said ram for any desired extent of advance movement of said ram during release of fluid from said retraction chamber, and a common control for both said device and said valve-controlled connection, whereby when said valve-controlled connection is opened to release fluid from said retraction chamber, said holding device will be concurrently rendered effective to prevent said movement of said control member.

24. In a control system for a hydraulic motor of the type having a working member advanced and retracted by pressure differentials in advancing and retracting chambers in which said member reciprocates, that improvement which comprises a variable delivery pump having fluid responsive means to decrease the rate of deliv-

ery of the pump, means for connecting said pump and chambers in an operating hydraulic circuit means for controlling the delivery of fluid from said pump to said chambers and thereby controlling the direction of movement of said member, said controlling means having a fluid actuated element effective when operated for causing retraction of said member, and connected to said advancing chamber for actuation by the pressure in said advancing chamber, a pressure relief valve in said connection from said element to said advancing chamber and passing fluid therethrough towards said element only in excess of a selected pressure on the attainment of which a retraction of said member is desired, and a connection from said element to said fluid responsive means at the discharge side of said pressure relief valve for delivering part of any fluid passed by the pressure relief valve to said fluid responsive means to cause a decrease in the rate of delivery of fluid by the pump after the pressure relief valve opens until the pressure in the advancing chamber has fallen to a selected extent.

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