

May 29, 1951

F. G. CIZEK
HYDRAULIC DECOMPRESSION CIRCUIT
WITH AUTOMATIC REVERSE

2,555,115

Filed June 14, 1946

3 Sheets-Sheet 1

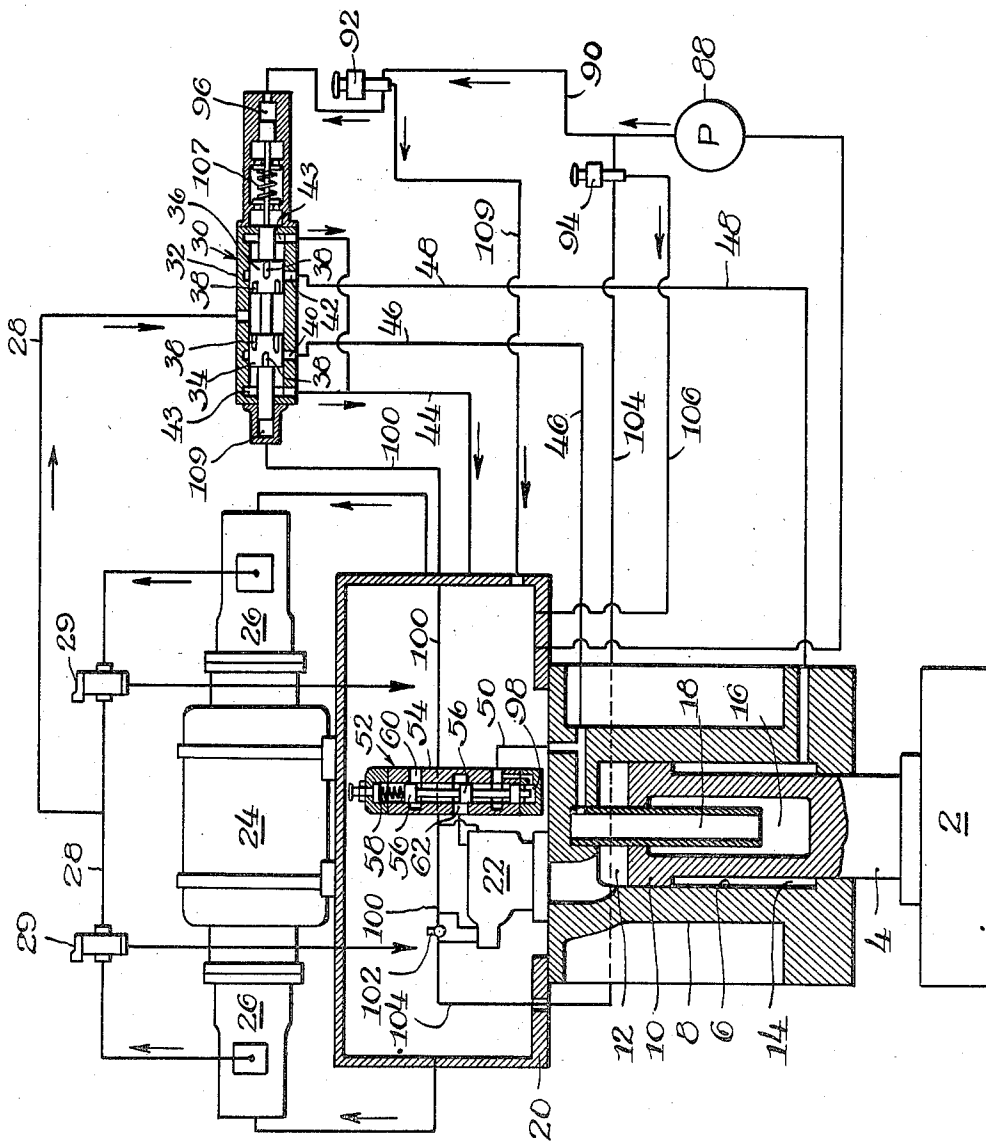


Fig. 1

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Fig. 2

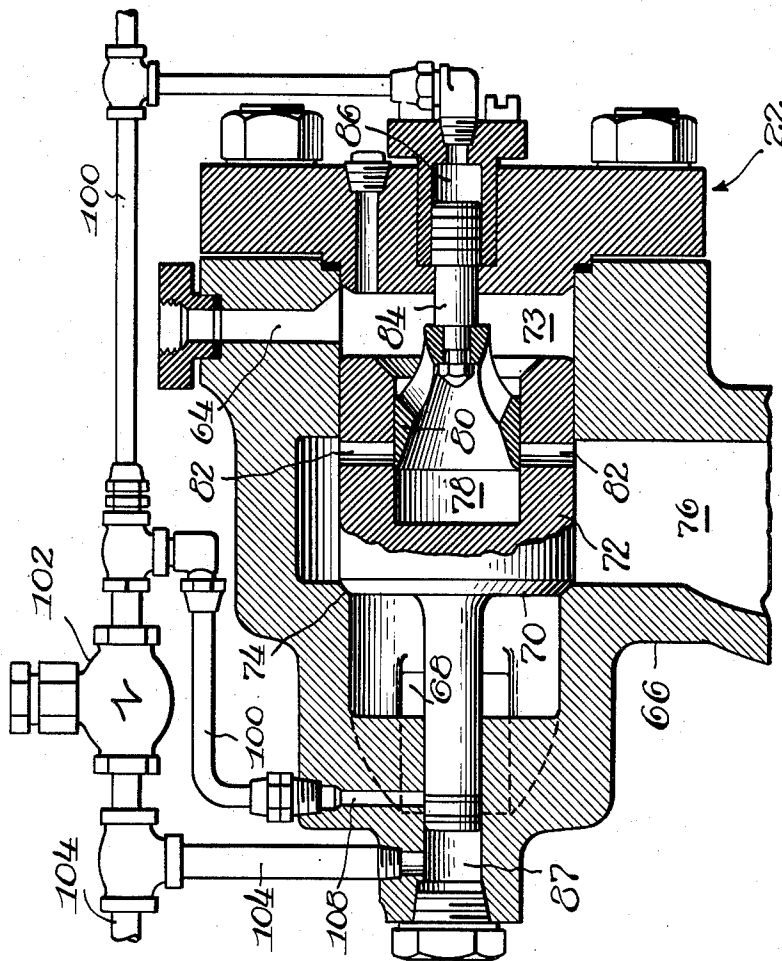
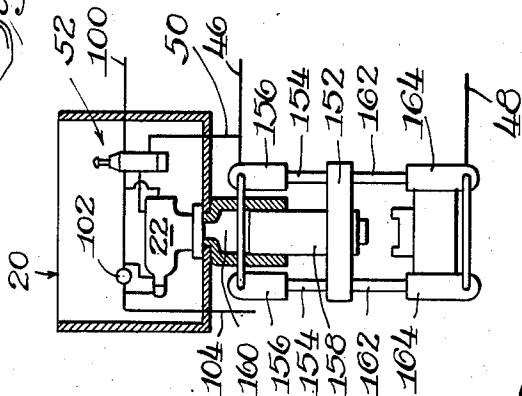


Fig. 4



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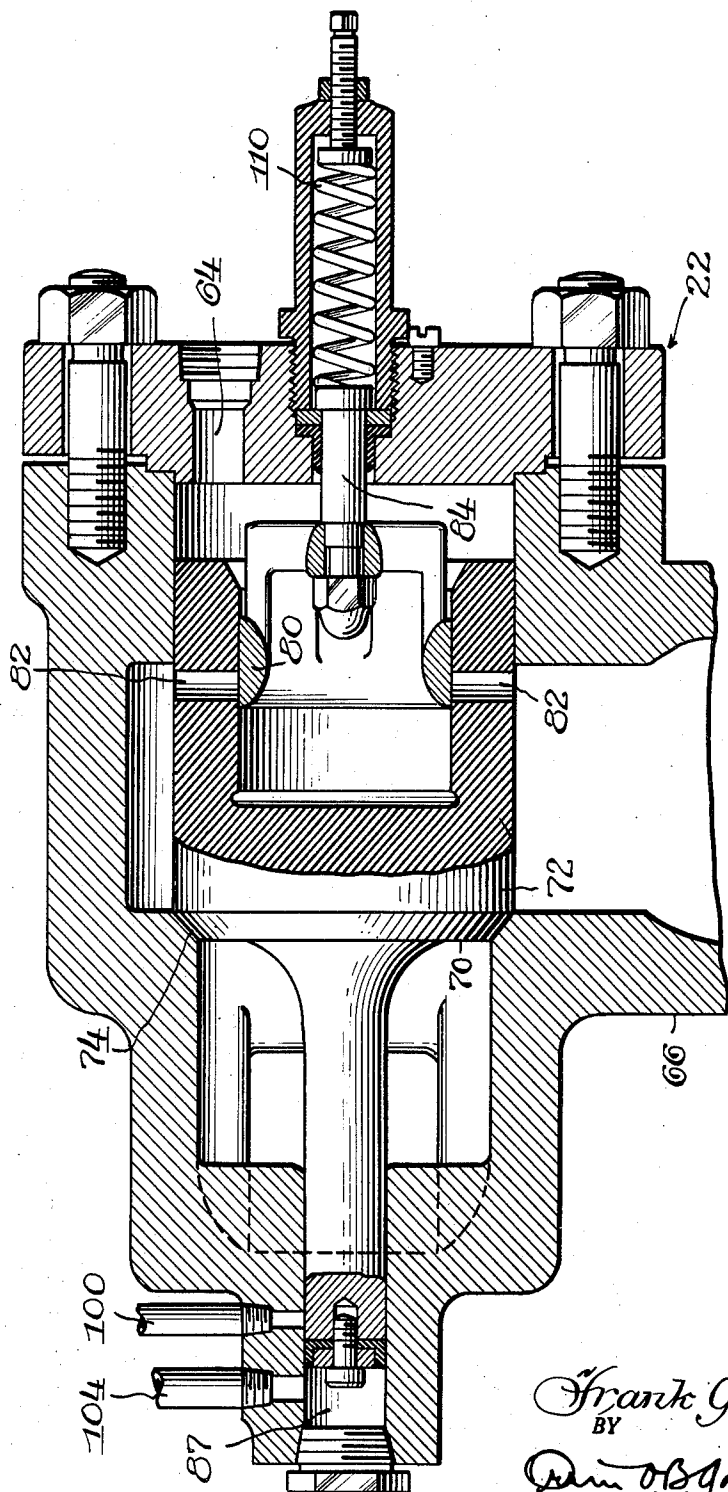


Fig. 3

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UNITED STATES PATENT OFFICE

2,555,115

HYDRAULIC DECOMPRESSION CIRCUIT
WITH AUTOMATIC REVERSE

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Application June 14, 1946, Serial No. 676,837

11 Claims. (Cl. 60—52)

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This invention relates to hydraulic equipment and more particularly to a novel hydraulic circuit adapted to actuate a hydraulic machine such as a press.

In many hydraulic presses, after the ram has accomplished its working stroke, the work tends to spring back against the ram and this condition is often aggravated by the presence of a cushion in the bed of the machine which tends to lift the ram when the tonnage has dropped off a sufficient amount. In hydraulic machines, such as presses, having a surge or prefill valve, the lifting forces on the ram tend to build up pressure in the main cylinder and thus often tend to prevent the prefill valve from moving to the open position thereof. As a result of this condition, the main ram is lifted from the work very slowly and when the pressure fluid is directed to the return side of the ram, the lifting force thereagainst aggravates the condition by increasing the pressure in the main cylinder with the result that the press "locks up" with its prefill valve closed so that the ram creeps upwardly forcing the fluid in the main cylinder outwardly therefrom through whatever valves may be open, generally the main operating valve.

Various decompression circuits have been proposed to solve this problem and have been used with some success; however, decompression circuits known in the art frequently involve extra valves, known as decompression valves. Furthermore, in known systems of this type comprising reversing pumps and a closed circuit, the pump has been used to decompress the main cylinder, such an arrangement being necessarily limited to a system including a reversible pump.

The present invention relates to a decompression circuit for use with a system comprising a unidirectional pump and is so designed as to eliminate the necessity of so-called decompression valves.

A general object of the invention is to design a circuit which will accommodate back pressure in hydraulic machines, such as valve controlled presses, without the use of extra valving, usually associated with decompression circuits.

Another object of the invention is to provide a system which will decompress the main cylinder in the shortest possible time consistent with shockless operation and which will be self-regulating in this respect.

A more specific object of the invention is to provide, in a system such as above described, means for causing the main operating valve to pause in its neutral position for a short period

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of time during the reversal phase of the cycle, thus permitting the main cylinder to decompress before pressure fluid is admitted to the return side of the ram. Attempts have been made in the prior art to produce such a delay by the use of timers and restrictions in pilot lines controlling the operating valve; however, mechanism of this type must be set to accommodate maximum conditions plus a little additional time to accommodate viscosity changes, so that the delay is always longer than absolutely required and is often objectionably long. The present invention comprises a circuit which is self-regulating in that the delay period is automatically adjusted long enough to accommodate decompression under the particular conditions obtained momentarily and no longer.

The foregoing and other objects and advantages of the invention will be more fully understood by reference to the following specification and the accompanying drawings, wherein:

Figure 1 is a flow diagram of a novel hydraulic circuit embodying the invention, portions of the hydraulic press and associated valving being shown in section to clarify the illustration;

Figure 2 is a sectional view through the prefill or surge valve shown in Figure 1, a portion of the valve and associated piping being shown in elevation;

Figure 3 is a sectional view showing a modified prefill valve; and

Figure 4 is a fragmentary diagrammatic view, partially in section, illustrating the invention as applied to another type of hydraulic press.

Describing the invention in detail and referring first to Figure 1, the hydraulic device comprises a working member such as a platen 2 supported by a ram 4 which is reciprocable within a cylinder 6 in a cylinder casting 8, said ram having a head 10 defining advance and return chambers 12 and 14 within the cylinder. The device preferably comprises a rapid advance motor, here shown in the form of a rapid advance cylinder or chamber 16 within the ram 4 receiving a tube or pipe 18 supported by the casting 8.

A tank or reservoir 20 is supported by the casting 8 and is adapted to contain a supply of hydraulic fluid such as oil. The tank is connected to the advance chamber 12 by means of a prefill valve 22, hereinafter described in detail, said valve being adapted to open and close communication between the chamber 12 and the tank 20 under the conditions hereinafter described.

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Mounted on the tank 20 is a motor 24 operatively connected to a pair of pumps 26 having their suction sides connected to the tank 20 and their discharge sides connected to a main supply line 28 comprising conventional relief valves 29 adapted to discharge into the tank 20 when the pressure in the line 28 reaches a predetermined maximum value. The main supply line 28 is connected to an operating valve, generally designated 30, comprising a body 32 with an internal cylindrical bore and a valve stem with spaced cylindrical spools 34 and 36 slidably fitted in said bore in substantially fluid-tight engagement therewith. The spools are notched as at 38 so that when the valve stem is in its neutral position, shown in Figure 1, fluid from the line 28 is delivered through annular distribution chambers 40 and 42 into discharge chambers 43, and from the discharge chambers to a discharge line 44 connected to the tank 20.

The distribution chambers 40 and 42 are connected respectively to advance and return lines 46 and 48, the line 46 being connected to the chambers 12 and 16, as hereinafter described in detail, and the line 48 being connected to the return chamber 14. The advance line 46 is connected through the tube 18 to the rapid advance chamber 16 and is connected by a branch line 50 to a conventional sequence valve 52 including a casing 54 with an internal cylindrical bore affording a slidable substantially fluid-tight fit for three spaced spools 56 of a valve stem which is spring-pressed to its closed position by a spring 58, thus restricting passage of fluid from the line 50 into the prefill valve 22 but accommodating flow of fluid from the prefill valve to the tank 20 through the ports 60 and 62 for the purpose hereinafter described.

The port 62 is connected to the port 64 (Figure 2) of the prefill valve 22. The prefill valve is described in detail in a copending Sedgwick application, Serial No. 516,207, filed December 30, 1943, now Patent No. 2,423,120, issued July 1, 1947, and comprises a body 66 with the before-mentioned port 64 and a low pressure chamber with an opening or port 68 communicating with the tank 20. The prefill valve also comprises a stem 70 with a larger-diameter portion 72 slidably fitted within a high pressure chamber 73 in the body 66 and adapted to seat at 74 to close the port 68 from communication with an outlet passage or a chamber 76 which is connected to the advance chamber 12 of the hydraulic press.

The larger-diameter portion 72 of the prefill valve stem comprises a cylindrical chamber 78 with a ring valve 80 slidably fitted therewithin and adapted to close ports 82 communicating with the chamber 76. The ring valve is connected to a spindle or piston 84 reciprocable within a cylinder 86 associated with the body 66. The prefill valve stem also comprises a smaller-diameter portion slidably fitted within a cylinder 87 of the body 66.

The hydraulic circuit above described is operated by a pilot circuit which is hereinafter described in connection with the operation of the device. This pilot circuit comprises a pilot pump 88 (Figure 1) having its suction side connected to the tank 20, the discharge side of said pump being connected to a pilot line 90 having two conventional three-way pilot valves 92 and 94 therein. In the advance phase of the cycle, the valve 92 is opened by any conventional means such as a solenoid (not shown) and the valve 94 is closed. Under these conditions, fluid is

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delivered from the pilot line 90 to the pilot chamber 96 of the valve 30, moving the stem thereof to the left causing the hydraulic fluid in the supply line 28 to flow into the advance line 46, thus actuating the rapid advance motor of the device to move the ram 4 rapidly downward, thereby moving the platen 2 to work-engaging position. As the ram moves downwardly, fluid in the return chamber 14 is urged through the line 48 and the valve 30 into the discharge line 44.

When the platen 2 reaches work-engaging position, pressure builds up in branch line 50 and in the chamber 98 of the sequence valve, moving the stem thereof upwardly to its open position at which pressure fluid may pass from the branch line 50 through the port 62 of the valve 52 to the port 64 of the prefill valve 22. This pressure moves the prefill valve stem 70 to the closed position shown in Figure 2, cutting off the advance chamber 12 of the press from communication with the tank 20 through the prefill valve port 68. It may be noted at this point that the opening of the prefill valve stem 70 will be described later in connection with the return or retraction phase of the cycle. After the valve stem 70 has closed and a predetermined pressure is built up against the spindle 84, the latter is moved to open position, forcing fluid in line 100 through a one-way check valve 102 adapted to open at said pressure value permitting fluid in the line 100 to flow through pilot line 104 (Figures 1 and 2) to the three-way pilot valve 94 and thence through line 106 to the tank 20. It will be understood that in the closed position of the conventional pilot valve 94, flow of fluid from the line 104 to the line 106 is accommodated.

When the ring valve 80 moves to its open position, pressure from the port 64 enters the chamber 76 through the ports 82 and passes to the advance chamber 12 of the hydraulic press, thus affording pressure against the full cross-sectional area of the ram 4 to urge the platen against the associated work.

In the return or retraction phase of the cycle, the pilot valve 92 is closed to prevent flow of fluid from line 90 to the chamber 96 of the valve 30, and the pilot valve 94 is opened by any conventional actuating means, such as a solenoid (not shown), whereupon pressure fluid from the pilot pump 88 is forced through the line 104 which, under these conditions, is closed from communication with the line 106. The pressure fluid is transmitted through the line 104 to the before-mentioned cylinder 87 inasmuch as the check valve 102 is incapable of opening in response to pressure in the line 104. Under these conditions, the stem of the operating valve 30 is moved by a spring 107 to the neutral position shown in Figure 1 forcing fluid from chamber 96 into the tank 20 through a line 109 which communicates with chamber 96, when valve 92 is closed. It may be noted that the spring 107 is operable to resist movement of the operating valve stem in either direction from its neutral position. When the stem of the operating valve 30 has assumed its neutral position, the pressure in line 46 and branch line 50 is relieved, thus permitting the stem of the sequence valve 52 to move to its closed position shown in Figure 1, whereupon, as heretofore mentioned, pressure fluid may pass from the port 64 of the prefill valve to the port 62 of the sequence valve 52 and outwardly from the port 60 thereof into the tank 20, thus relieving pressure within the chamber 73 of the prefill valve, said pressure tending

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to maintain the prefill valve stem 70 in the closed position inasmuch as the larger-diameter portion thereof affords a relatively great cross-sectional area upon which the pressure within the chamber 70 may act. As soon as the pressure on the larger-diameter portion of the prefill valve stem 70 has been bled off, as above described, the stem 70 moves to the right to its open position uncovering port 108, whereupon pressure fluid from the pilot line 104 is conveyed through the cylinder 87 and port 108 to pilot line 100, and thence to the pilot cylinder or chamber 109 of the operating valve 30, thereby moving the stem thereof to the right to its return position whereat pressure fluid is delivered from the line 28 to the return line 48 and thence to the return chamber 14 moving the ram 4 and the platen 2 upwardly to the return or retracted position thereof illustrated in Figure 1. As the ram 4 moves upwardly, fluid within the chamber 12 is urged back into the tank 20 through the prefill valve port 68 and the fluid in the rapid advance chamber 16 is urged through the line 46 and the operating valve 30 into the discharge line 44 and thence into the tank 20.

At this time the pressure in pilot line 100 moves the piston 84 and ring valve 80 to the closed position illustrated in Figure 2, whereupon as the valve stem 70 moves to the closed position in the advance phase of the next cycle of the press, the ring valve 80 is effective to close the ports 32 as heretofore described.

It will be understood that if desired the rapid advance motor of the hydraulic press may be eliminated and the line 46 may be connected to the prefill valve port 64 directly, under which conditions the ram 4 may be moved to work-engaging position by a force of gravity or manually, or by any other suitable actuating means. After the ram has been moved to work-engaging position pressure fluid may be directed to the line 46 by means of the valve 30 as above described.

Figure 3 shows a modification of the prefill valve which is identical with the embodiment disclosed in Figure 2 except that the ring valve 80 and spindle 84 are moved to their closed positions by means of a spring 110 rather than the hydraulic means described in connection with Figure 2.

Referring now to Figure 4, a modification of the invention is disclosed, wherein the novel hydraulic circuit described in connection with Figures 1 and 2 is applied to a different type of hydraulic motor wherein the platen 152 is moved to work-engaging position by rapid advance pistons or rams 154 reciprocable within rapid advance cylinders 156 connected to the advance line 46 of the hydraulic circuit. The main ram 158 of the device is reciprocable within a main cylinder 160 which is connected to the advance line 46 through the prefill valve 22, the sequence valve 52 and the branch line 50 of the advance line 46, as in the embodiment of Figures 1 and 2. The platen 152 is urged to its return or retracted position by push-back rams 162 received within push-back cylinders 164 which are connected to the return line 48 of the hydraulic circuit.

It will be understood that in the embodiment of Figure 4 the hydraulic circuit associated with the press is identical with that described in connection with Figures 1 and 2, the sole difference being the above-described modification of the hydraulic actuating motors associated with the platen 152. The portions of the hydraulic circuit which correspond with those shown in Fig-

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ures 1 and 2 are identified by the corresponding numerals.

It is to be understood that I do not wish to be limited by the exact embodiments of the device shown which are merely by way of illustration and not limitation as various and other forms of the device will, of course, be apparent to those skilled in the art without departing from the spirit of the invention or the scope of the claims.

I claim:

1. In combination, a platen, a booster motor associated with said platen for actuating the same to work-engaging position, hydraulic motor means associated with said platen comprising advance and return chambers and ram means reciprocable therein, a reservoir having a connection to said advance chamber, prefill valve means adapted in the open and closed positions thereof to open and close said connection, an advance line connected to said advance chamber and to said valve means, said valve means being adapted to move to its closed position in response to fluid pressure from said line, a return line connected to said return chamber, operating valve means having passage means in the advance position thereof for directing pressure fluid to said advance line and for opening said return line to discharge, said operating valve means having passage means in the return position thereof for directing pressure fluid to said return line and for opening said advance line to discharge, and said operating valve means having passage means in its neutral position for relieving pressure in said advance line, means for yieldingly urging said operating valve means to the neutral position thereof, means for moving said operating valve means to its advance position against the resistance of said yielding means, and means responsive to opening of said prefill valve means for automatically moving said operating valve means to the return position thereof against the resistance of said yielding means, and operating means independent of hydraulic pressure in the return line for opening said prefill valve means when said operating valve means is in the neutral position thereof.

2. In an hydraulic device comprising a working member, a rapid advance motor operatively associated therewith for moving said member to work-engaging position, and hydraulic motor means operatively associated with said member comprising advance and return chambers and ram means reciprocable therein, the combination of a source of low pressure fluid having connection to the advance chamber, prefill valve means for opening and closing said connection, a source of high pressure fluid, operating valve means adapted in the advance position thereof to direct fluid from said high pressure source to said prefill valve means to close the same and thereby admit fluid from said source to said advance chamber, said operating valve means being adapted in the neutral position thereof to relieve the pressure in said prefill valve means, spring means for biasing said operating valve means to the neutral position thereof, said operating valve means being adapted in the return position thereof to direct pressure fluid from said high pressure source to said return chamber, power means independent of hydraulic pressure from said source for opening said prefill valve means when the pressure in said advance chamber has been relieved, and means responsive to the position of said prefill valve

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means for automatically actuating said operating valve means to the return position thereof against the resistance of said spring means when said prefill valve means has opened.

3. In an hydraulic device comprising a working member, a rapid advance motor operatively associated therewith for moving said member to work-engaging position, and hydraulic motor means operatively associated with said member comprising advance and return chambers and ram means reciprocable therein, the combination of a source of low pressure hydraulic fluid connected to the advance chamber, prefill valve means for opening and closing said connection, a source of high pressure fluid, operating valve means for directing fluid from said high pressure source to said prefill valve means to close the same, said prefill valve means being adapted when closed to deliver fluid from said operating valve means to said advance chamber, said operating valve means being adapted in the neutral position thereof to relieve the pressure in said prefill valve means and being adapted in the return position thereof to direct pressure fluid from said source to said return chamber, operating means independent of hydraulic pressure fluid delivered by said operating valve means to said return chamber for opening said prefill valve means when the pressure therein has been relieved, and means responsive to the opening of said prefill valve means for automatically actuating said operating valve means to the return position thereof after said prefill valve means has opened.

4. In an hydraulic device comprising a work-engaging member and an hydraulic motor operatively associated therewith comprising advance and return chambers and ram means reciprocable therein, the combination of a reservoir containing low pressure hydraulic fluid, prefill valve means connecting said reservoir to said advance chamber, said member being movable to and from the work-engaging position thereof when said valve means is open to accommodate flow of fluid between said reservoir and said advance chamber, a high pressure line connected to said valve means, said valve means being adapted to move to the closed position thereof in response to the pressure of fluid in said line and having passage means in said closed position for accommodating flow of fluid from said line to said advance chamber, operating means entirely independent of hydraulic pressure in the return chamber for moving said valve means to the open position thereof when the pressure in said line is relieved, and means responsive to the position of said prefill valve means for automatically directing pressure fluid to said return chamber after said valve means has been moved to the open position thereof.

5. In a system of the class described comprising a working member, and a hydraulic motor for actuating said member including advance and return chambers and ram means reciprocable therein; the combination of a reservoir containing low pressure hydraulic fluid, prefill valve means for connecting and disconnecting said advance chamber with respect to said tank, advance and return lines connected to said advance and return chambers respectively, means for alternately connecting said lines to a source of pressure fluid and to a discharge line so that one of said advance and return lines is connected to said source when the other is connected to said discharge line, a hydraulic piston and

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cylinder device for opening said prefill valve means, a pilot line closed by said piston when the prefill valve means are closed, said pilot line being open to flow of fluid from said cylinder when the prefill valve means are opened, and another piston and cylinder device connected to said pilot line for operation by fluid pressure therein to actuate said connecting means so as to connect said source to said return line when said prefill valve means has opened to connect said advance chamber to said reservoir.

6. In an hydraulic device including a work-engaging member and actuating means therefor comprising an hydraulic motor with advance and return chambers and ram means reciprocable therein, the combination of a reservoir of low pressure hydraulic fluid connected to said advance chamber, prefill valve means in said connection for opening and closing the same, said member being movable to and from the work-engaging position thereof when said valve means is open, a source of high pressure hydraulic fluid, means for closing said valve means thereby directing fluid from said source to said advance chamber, means entirely independent of hydraulic pressure in said return chamber for opening said valve means when said advance chamber has been disconnected from said source, and means responsive to opening of said prefill valve means for automatically directing pressure fluid to said return chamber.

7. In an hydraulic device comprising advance and return chambers and ram means reciprocable therein, the combination of a source of low pressure fluid, valve means associated with said source and said advance chamber for opening and closing communication therebetween, means for delivering fluid under relatively high pressure to said advance chamber when said valve means is closed, means entirely independent of pressure fluid from said delivering means for opening said valve means when the pressure in said advance chamber has been relieved, and condition responsive means effective upon opening of said valve means to automatically direct relatively high pressure fluid to said return chamber.

8. In an hydraulic circuit for an hydraulic motor comprising advance and return chambers and ram means therein; the combination of a reservoir of low pressure fluid, a prefill valve comprising a body with a low pressure inlet chamber connected to said reservoir, said valve comprising a high pressure inlet chamber and an outlet passage connected to said inlet chambers and to said advance chamber, an advance line connected to said high pressure chamber, a return line connected to said return chamber, a stem slidably seated in the high pressure chamber and comprising a pistonlike portion of less diameter than the low pressure chamber, a cylinder associated with the body and receiving said portion, said stem being adapted in the closed position thereof to cut off communication between the high and low pressure chambers, a chamber in the stem connected to the high pressure chamber, a port through the stem adapted to connect the stem chamber to the outlet passage in the closed position of said stem, said port being disposed within the high pressure chamber in the open position of the stem, a valve member in the stem chamber adapted to open and close said port, said valve member having passage means accommodating flow of fluid between the stem chamber and the

high pressure chamber, said valve member having a pistonlike element slidably fitted within a complementary opening in the body, operating valve means connected to said lines and adapted in the advance position thereof to direct pressure fluid to the advance line and to exhaust fluid from the return line, said operating valve means being adapted in the return position thereof to direct pressure fluid to the return line and to exhaust fluid from the advance line, and said operating valve means being adapted in the neutral position thereof to exhaust fluid from the advance line, means for actuating said operating valve means to the advance position thereof, means effective upon release of the first-mentioned actuating means for actuating said operating valve means to the neutral position thereof, and means for actuating the operating valve means to the reverse position thereof comprising a pilot line adapted to convey pressure fluid to said cylinder, a port in said cylinder closed by said portion in the closed position of said stem and open to communication with said pilot line in the open position of said stem, another pilot line connected to the last-mentioned port, a piston and cylinder device connected to the last-mentioned pilot line and operatively connected to the operating valve means for actuating the same to the reverse position thereof in response to pressure fluid conveyed to said device through said pilot lines, and check valve means connecting said pilot lines and accommodating flow of fluid from said device to the first-mentioned pilot line, and actuating means associated with said element for moving said valve member to the closed position thereof upon release of pressure in said high pressure chamber.

9. An hydraulic circuit, according to claim 8, wherein the last-mentioned actuating means comprises a cylinder associated with the prefill valve body and receiving the valve member element, and a connection between said cylinder and the second-mentioned pilot line.

10. An hydraulic circuit, according to claim 8, wherein the last-mentioned actuating means comprises a spring disposed externally of the high pressure chamber and operatively connected to the valve member element.

11. In an hydraulic circuit for an hydraulic apparatus comprising a working member and actuating means therefor including hydraulic motor means having advance and return chambers and ram means reciprocal therein, and a booster motor for effecting rapid advance of said motor; the combination of a reservoir of low pressure fluid, a prefill valve comprising a body with a low pressure inlet chamber connected to said reservoir, said body comprising a high pressure inlet chamber and an outlet passage connected to both of said inlet chambers and to said advance passage, an advance line connected to said booster motor and having a connection to said high pressure chamber, said connection comprising valve means adapted to open in response to pressure fluid within the advance line thereby accommodating flow of fluid therefrom to the high pressure chamber and adapted to close when said advance line is exhausted thereby accommodat-

ing flow of fluid from the high pressure chamber to said reservoir, a return line connected to said return chamber, a stem slidably seated in the high pressure chamber and comprising a pistonlike portion of less diameter than the low pressure chamber, a cylinder associated with the body and receiving said portion, said stem being adapted in the closed position thereof to cut off communication between the high and low pressure chambers, a chamber in the stem connected to the high pressure chamber, a port through the stem adapted to connect the stem chamber to the outlet passage in the closed position of said stem, said port being disposed within the high pressure chamber in the open position of the stem, a valve member in the stem chamber adapted to open and close said port, said valve member having passage means accommodating flow of fluid between the stem chamber and the high pressure chamber, said valve member having a pistonlike element slidably fitted within a complementary opening in the body, operating valve means connected to said lines and adapted in the advance position thereof to direct pressure fluid to the advance line and to exhaust fluid from the return line, said operating valve means being adapted in the return position thereof to direct pressure fluid to the return line and to exhaust fluid from the advance line, and said operating valve means being adapted in the neutral position thereof to exhaust fluid from the advance line, means for actuating said operating valve means to the advance position thereof, means effective upon release of the first-mentioned actuating means for actuating said operating valve means to the neutral position thereof, and means for actuating the operating valve means to the reverse position thereof comprising a pilot line adapted to convey pressure fluid to said cylinder, a port in said cylinder closed by said portion in the closed position of said stem and open to communication with said pilot line in the open position of said stem, another pilot line connected to the last-mentioned port, a piston and cylinder device connected to the last-mentioned pilot line and operatively connected to the operating valve means for actuating the same to the reverse position thereof in response to pressure fluid conveyed to said device through said pilot lines, and check valve means connecting said pilot lines and accommodating flow of fluid from said device to the first-mentioned pilot line, and actuating means associated with said element for moving said valve member to the closed position thereof upon release of pressure in said high pressure chamber.

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