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R. J. LINDSEY

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HYDRAULIC CIRCUIT FOR TWO PHASE RETURN STROKE RAM

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2 Sheets-Sheet 1

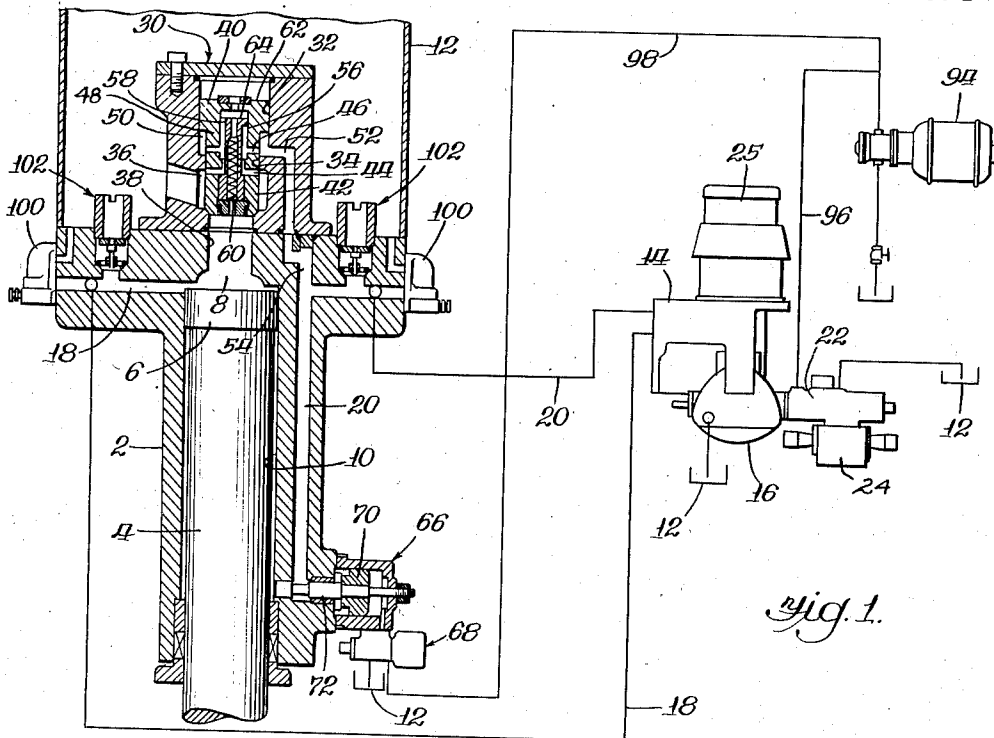


Fig. 1.

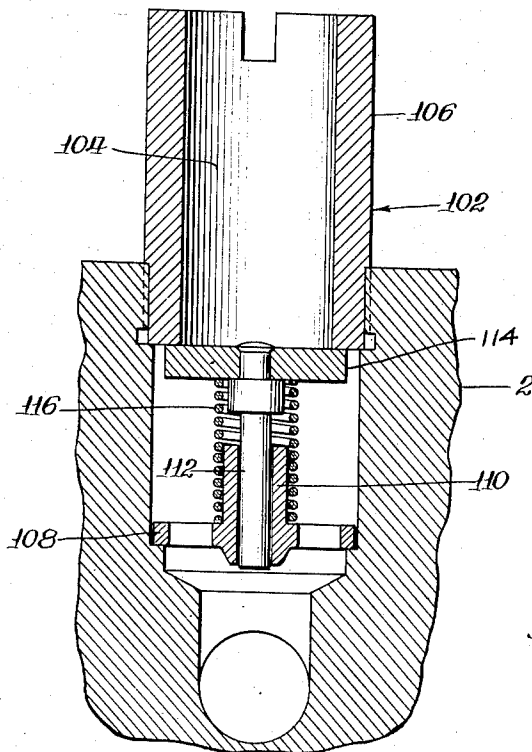


Fig. 5.

INVENTOR.
Robert J. Lindsey
BY
Gavin O. B. Kerner

Atty.

April 29, 1958

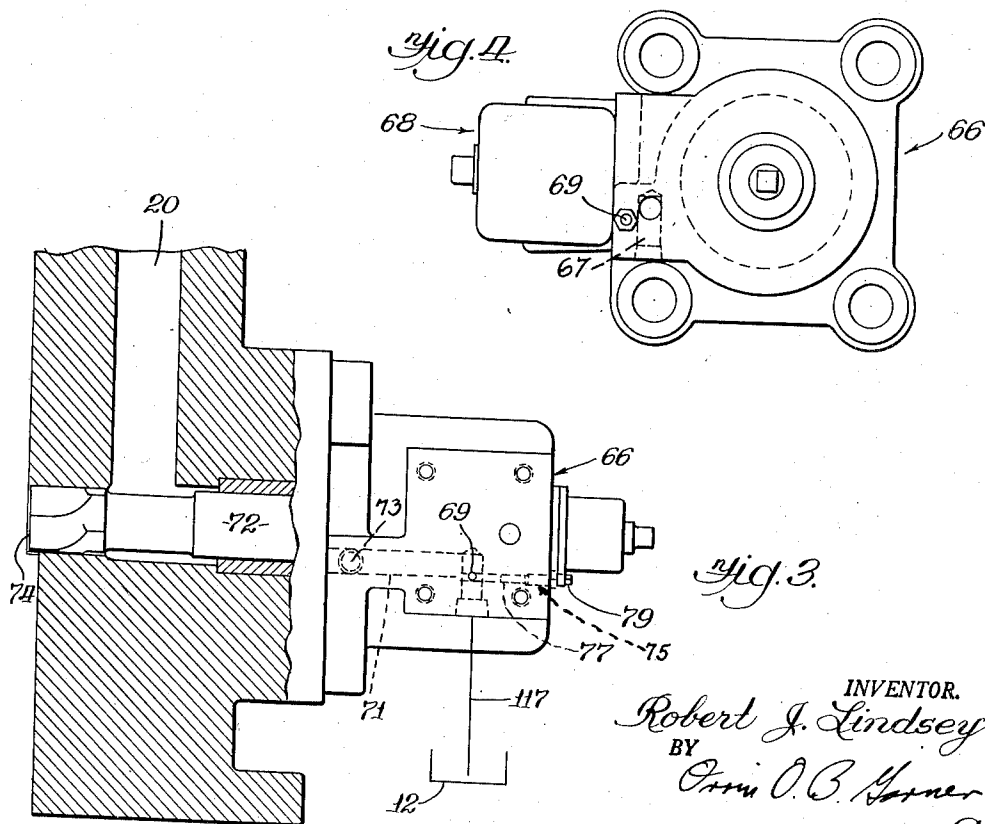
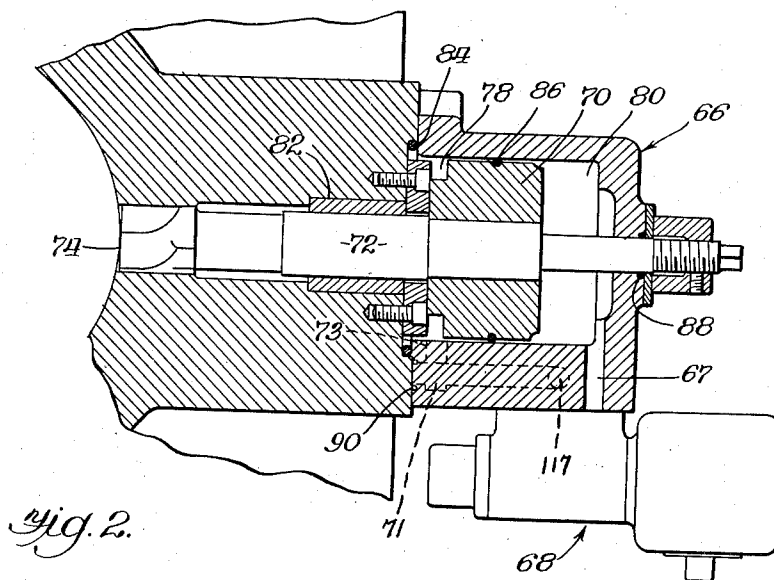
R. J. LINDSEY

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2 Sheets-Sheet 2



INVENTOR.
Robert J. Lindsey
BY
Ervin O. B. Garner
Att'y.

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HYDRAULIC CIRCUIT FOR TWO PHASE RETURN STROKE RAM

Robert J. Lindsey, Cincinnati, Ohio, assignor to American Steel Foundries, Chicago, Ill., a corporation of New Jersey

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8 Claims. (Cl. 60—52)

The invention relates to hydraulic presses and more particularly to a novel actuating circuit for that type of hydraulic press known in the art as a pipeless press.

A general object of the invention is to provide a novel circuit for a hydraulic press which provides means to vary the action of the ram during the press cycle.

It is a more specific object of the invention to provide a novel, externally adjustable speed change valve in a press circuit of the type described.

It is a further object of the invention to provide in said press circuit, novel check valves to aid in the functioning of the circuit.

These and other objects of the invention will become apparent in the course of the following description and from an examination of the concerned drawings wherein:

Figure 1 is a schematic view of the novel pipeless press circuit employed in the invention;

Figures 2, 3 and 4 are detailed views of the novel speed change valve employed, Figure 2 being a longitudinal horizontal view with the flanged valve shown in section, Figure 3 is a side elevational view of the structure shown in Figure 2 and Figure 4 is an end elevational view of the structure shown in Figure 2;

Figure 5 is a central sectional view of the novel check valves employed in the circuit.

Describing the invention in detail and referring to Figure 1 the press comprises a main cylinder casting 2 containing a moveable ram 4 having a liquid sealed head 6 defining an advance chamber 8 and a return or pullback chamber 10.

The casting 2 supports a tank or reservoir 12 which contains a suitable supply of hydraulic fluid such as oil. A bracket 14 may also be provided, either mounted on the casting 2 or separated therefrom as indicated in the schematic Figure 1, said bracket carrying a conventional pump 16. Advance and return lines 18 and 20 communicate with the pump 16, said advance and return lines communicating respectively with the advance and return chambers 8 and 10. The pump 16 may be provided with a shifting cylinder 22 and a solenoid operated valve 24. Additionally, an electric motor 25 serves as an operating power source for the operating pump 16. It will be understood that the pump 16, the cylinder 22 and valve 24 operate to alternately deliver pressure fluid to and exhaust pressure fluid from respective advance and return lines during the operation of the press as hereinafter described. If desired this reversing feature may be accomplished by any conventional reversible delivery pump such as are well known to those skilled in the art.

The casting or body 2 also supports a prefill valve indicated generally at 30, said valve having a chamber 32 with a smaller diameter portion 34 adapted to communicate through a passage 36 to a port 38 which communicates with advance chamber 8. A hollow piston 40 reciprocates within chamber 32 and comprises a small diameter portion 42 adapted to close port 38 when the valve 30 is in closed position. The portion 42 comprises port 44 communicating with passage 36 and other

ports 46 communicating with chamber 32. The large diameter portion 48 of piston 40 defines an annular chamber 50 connected to a passage 52 which in turn is connected to the upper end of the pullback line 20 via passage 54.

The prefill piston 40 comprises a cylindrical chamber 56 having a hollow valve stem 58 reciprocal therein. The stem 53 is spring pressed by the spring 60 to its closed position whereat the ports 44 are closed from communication with ports 46 and annular chamber 50. It may be noted that piston 40 and stem 58 are formed with variable pressure areas whereby oil pressure during the action hereinafter described acts to urge the piston 40 downwardly to closed position and the stem 58 downwardly to the open position against the action of spring 60. The piston 40 has this larger pressure area at the surface 62 while the stem 58 has this larger pressure area at the surface 64.

A speed change valve indicated generally at 66, is carried by the casting 2 and comprises a solenoid operated four-way valve 68. The valve 66 is illustrated in detail in Figures 2 to 4 and comprises an operating piston 70 having a rod 72 affixed thereto. The rod 72 has a fluted end portion 74 which is disposed in the return line 20 and serves to regulate the flow of pressure fluid during certain parts of the machine operating cycle. In the closed position illustrated, the rod portion 74 affords maximum restriction to the flow of fluid in line 20. As the piston 70 and the rod 72 move to the right as seen in Figures 1, 2 and 3, fluid flow in line 20 increases until at the full right position, maximum flow is accomplished with practically no restriction afforded by the portion 74. It should be noted that the piston 70 divides the speed change valve 66 into closing chamber 80 and opening chamber 78 which is connected to the tank 12 through passage 71 and conduit 117. Appropriate fluid seals are provided at 82, 84, 86, 88 and 90 to prevent the leaking of fluid during reciprocation of the piston and rod.

The operating solenoid valve 68 controls the flow of actuating fluid to the speed change valve 66. Directing attention to Figures 2 and 3 it will be seen that the solenoid valve 68 communicates with passage 67 which in turn communicates with chamber 80. Another portion of the operating solenoid valve 68 communicates with line 69 which in turn is connected to passage 71 and passage 73 which connects to the return or opening chamber 78 and to the tank 12 through line 117. A restricting or throttle mechanism, indicated generally at 75, is provided in the valve 66, said restricting mechanism comprising a threadably mounted needle valve 77 extending into passage 69. Externally of the valve 66 the restriction mechanism 75 is provided with a polygonal head 79, said head serving as a convenient means to rotate the needle valve 77. Rotation of the needle valve 77 in its threaded mounting allows said needle valve to move in and out of the passage 69, thus providing convenient means of restricting or throttling flow of pressure fluid in the passages 69 and 71 and then to the tank 12 through line 117.

An auxiliary motor pump 94 (Figure 1) serves, during press operation, to afford a continuous supply of pressure fluid to the shifting cylinder 22 via line 96, said pressure fluid serving as an actuating fluid. Additionally, pump 94 supplies actuating fluid to the speed change valve 66 via line 98 and the solenoid valve 68.

Considering Figure 1, it will be seen that the advance and return lines 18 and 20 are provided with relief valves 100 which are preset to prevent damage to the press in the event that excessive pressures are developed. Additionally, both the advance and return lines have make-up check valves 102 which establish one-way com-

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munication between the reservoir 12 and the respective lines to assure a continuous supply of fluid to said lines during evacuation thereof as hereinafter explained in connection with the operating cycle. The valves 102 serve to prevent any temporary hiatus in oil flow as frequently occurs in presses not having this feature at approximately the time in the cycle that the operating pump is reversed.

Figure 5 illustrates in detail the construction of the make-up check valves 102, said valves comprising a passage 104 partially defined by the cylinder 106 which is mounted in the casting 2. An apertured mounting plate 103 centrally carries a bushing 110 which in turn carries a rod 112 the rod being vertically movable in the bushing. A valve plate 114 is fixedly mounted on the upper end of the rod 112, said plate 114 being urged upwardly by a spring 116 to abut the lower end of the cylinder 106 and thereby close the passageway 104. The valve 102 thus prevents the flow of pressure fluid upwardly into the reservoir 12 and yet accommodates fluid flow from the reservoir to the related line when the pressure condition in the line so requires.

In operation of the press, with the prefill valve piston 40 in open position due to pressure in the chamber 50 caused by the weight of the ram 4, the operator initiates the rapid advance part of the cycle by actuating the pump 16 and thereby shifting the cylinder 22 to the advance position thereof whereat the fluid is drawn to the suction side of the pump from the return line 20 and is delivered to the advance line 18. Because of the relatively small volume of fluid in the return chamber 10 and return line 20, the associated make-up check valve 102 will open assuring a continuous flow of fluid to the suction side of the pump if a momentary vacuum occurs before valve piston 40 is moved upwardly. The descending ram 4 causes pressure to be exerted on the fluid in the return chamber 10 said pressure being distributed through passages 20, 54 and 52 to the chamber 50 whereby the prefill valve piston 40 is held in open position. With the piston 40 in open position, fluid will flow from the reservoir 12 through passage 36 to the advance chamber 8. The pump 16, of course, continues to discharge fluid to the advance chamber 8 via the advance line 18.

At a predetermined point in the advance stroke of the ram the valve 68 is actuated whereby actuating fluid is directed to the closing chamber 30 of the valve 66 thus urging the fluted portion 74 into position in the return line 20. The actuation of the valve 68 may be manual or may be automatically responsive to a predetermined position of the ram in its downward stroke. With the fluted portion 74 disposed in the return line 20, a rapid drop of pressure occurs because of the restriction present in said line immediately adjacent the return chamber 10. The drop of pressure spreads throughout the return system causing a similar drop in pressure in chamber 50 at the lower portion of the piston 40 of the prefill valve 30. Thus the piston 40 is moved to closed position illustrated in Figure 1. With the piston 40 in closed position, pressure rapidly builds up in the advance chamber 8 and acts through the hollow stem 58 to exert force on the surfaces 62 and 64 and thus hold the piston 40 and stem 58 in the closed and opened positions respectively. With the piston 40 closed, communication is established between the reservoir 12 and the passages 44, 46 and 52 and thence to the return line 20 to assure an ample supply of fluid to the suction side of the pump during the continuation of the advance stroke.

The high pressure against the ram 4 during the working portion of the ram stroke forces the fluid in the pullback chamber 10 into the return line 20 and then to the pump 16.

The pullback phase of the cycle is initiated by reversing the cylinder 22 whereby the pump 24 now draws

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fluid from the advance chamber 8 and directs it to the return line 20 and thence to chamber 10. Again the associated make-up check valve 102 in the advance line 18 serves to supply fluid from the reservoir in the event of any momentary pressure drop or hiatus during or shortly after the shifting of the pump 16. This may occur if the valve piston 40 stays closed momentarily after the shifting of the pump to the return stroke. It will also be understood that flow in line 20 during the initial portion of the return phase of the cycle is transmitted through passages 54 and 52 to the chamber 50. This flow is bypassed through passages 46, 44 and 36 during the time the pump is decompressing chamber 8. As the pressure drops in the advance chamber 8, the piston 40 and stem 58 are returned to the opened and closed position respectively. Thus, as the return stroke of the ram is completed, fluid in the advance chamber 8 may exhaust to the reservoir 12 through the passage 36 and the prefill valve 30.

It will be evident that a considerably larger amount of fluid is accommodated in the advance chamber 8 than in the return chamber 10. Hence upon shifting the pump, the tendency would be to urge the ram 4 upwardly at a rapid pace in view of the fact that considerably less fluid is required to fill the pullback chamber 10. Valve 68 is deenergized at the same time the pump starts delivery of fluid into line 20. Deenergizing valve 68 reduces the amount of work required to be performed by the pump in order to pump fluid to the return chamber 10 through fluted end portion 74. In other words, portion 74 will be disposed at the right, as seen in Figures 1, 2, and 3, and maximum flow of fluid into chamber 10 will be afforded with practically no restriction afforded by the portion 74. As soon as chamber 8 is decompressed and stem 58 closes passage 46, pressure fluid passes through flutes 74 and exerts force against rod 72. Chamber 80 is connected to tank 12 through passage 67 to valve 68 then to passages 69 and 117, with restricting mechanism or screw 75 interposed. Therefore, the speed of opening of passage 20 is controlled by screw 75 by controlling the discharge from chamber 80 to the tank to prevent too rapid admission of fluid to chamber 10 and resultant shock. As piston 70 moves to the right, fluid is drawn into chamber 78 through passages 117 and 71 to fill the space. To attain rapid acceleration to return speed, mechanism 75 is adjusted to afford less restriction to the flow of fluid through the passage 69 from chamber 80 with the result that the fluted portion 74 of the rod 72 is urged out of the line 20 during an earlier portion of the return stroke of the ram 4.

I claim:

1. In a hydraulic press actuating circuit for a press having cylinder means with advance and return chambers and having ram means reciprocal in respective chambers; the combination of means for alternatively delivering pressure fluid to and exhausting pressure fluid from the advance and return chambers, respectively, a reservoir of low pressure fluid having a connection to the advance chamber, prefill valve means for opening and closing said connection, said valve means having opposed pressure areas, one of which is acted on by pressure in the advance chamber tending to close the valve means, and the other of which pressure areas is acted upon by pressure in the return chamber to hold the prefill valve means open during rapid advance stroke of the ram means, check valve means accommodating one-way flow of fluid from the reservoir to the advance and return chambers, respectively, throttle valve means for restricting flow of fluid from the return chamber to said other pressure area to accommodate closing of said prefill valve means whereby full pressure advance stroke of the ram means is initiated, actuating means for said throttle valve means, said throttle valve means having a pressure area acted upon by pressure in said return chamber to urge

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said throttle valve means to inoperative position upon release of said actuating means when said delivering means are delivering pressure fluid to said return chamber, and means for adjustably retarding movement of said throttle valve means to inoperative position whereby return stroke of the ram means is controlled and hydraulic shock in the return chamber is prevented.

2. In a hydraulic press actuating circuit for a press having cylinder means with advance and return chambers and having ram means reciprocal in respective chambers; the combination of reversible pump means, passage means connecting said pump means to the advance and return chambers, respectively, a reservoir of low pressure fluid having a connection to the advance chamber, prefill valve means for opening and closing said connection, said prefill valve means having opposed pressure areas, one of which is acted upon by pressure in the advance chamber tending to close said valve means, and the other of which is acted on by pressure in the return chamber during advance stroke of the ram means tending to hold the prefill valve means open, a make-up check valve in each line communicating with the reservoir and accommodating one-way flow of fluid from the reservoir to the related line, a speed change valve in the line to the return chamber, operating means for said speed change valve, a source of hydraulic actuating fluid, a line connecting the source to said operating means, a four-way solenoid operated valve in said last mentioned line, said solenoid valve having means for alternately directing pressure fluid to and exhausting pressure fluid from said operating means to close and open the speed change valve, and a manually adjustable valve to throttle the exhaust flow of actuating fluid from said operating means whereby the action of said speed change valve may be varied without hydraulic shock in the return chamber.

3. In a hydraulic press actuating circuit for a press having cylinder means with advance and return chambers and ram means reciprocal therein; the combination of means for alternately delivering pressure fluid to and exhausting pressure fluid from the advance and return chambers, a reservoir of low pressure fluid having a connection to the advance chamber, prefill valve means for opening and closing said connection, said prefill valve means having opposed areas, one of which is acted upon by pressure in the advance chamber tending to close the prefill valve means and the other of which areas is acted upon by pressure in the return chamber to hold the prefill valve means open during advance stroke of the ram means, throttle valve means for restricting flow of fluid from the return chamber to said other pressure area to accommodate closing of said prefill valve means and thereby initiate full pressure advance stroke of the ram means, a hydraulic piston and cylinder device for actuating said throttle valve means, said device, when exhausted, accommodating movement of said throttle valve means to inoperative position in response to pressure against said throttle valve means by pressure fluid in said return chamber, operating valve means for admitting hydraulic pressure fluid to said device for actuation thereof, said operating valve means having a passage through which said device is exhausted to said reservoir, and means for adjustably throttling flow of hydraulic fluid through said passage to said reservoir whereby return movement of said ram means is controlled without shock in the return chamber.

4. A hydraulic circuit according to claim 3, wherein each of said advance and return chambers is provided with a one-way make-up check valve accommodating flow of fluid from the reservoir.

5. In a hydraulic circuit for a hydraulic device comprising advance and return chambers and ram means reciprocal therein; the combination of advance and return lines connected to respective chambers, means for alternately delivering high pressure fluid to one line and exhausting the other line, a reservoir of low pressure hy-

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draulic fluid, prefill valve means for alternately opening and closing said reservoir with respect to said advance chamber, speed change valve means for restricting flow of fluid from the return chamber to the return line on advance and return strokes of said ram means, means responsive to restriction of said flow on advance stroke of said ram means for automatically closing said prefill valve means, said speed change valve means comprising a cylinder having a reciprocal piston therein defining a closing chamber in said cylinder, a rod connected to said piston and having a fluted end portion movable into and out of said return line in response to closing and opening strokes, respectively, of said piston, a drain line connected to the reservoir, a fluid operated valve for alternately directing hydraulic actuating fluid to said closing chamber and exhausting hydraulic actuating fluid from said closing chamber to said drain line, and means to throttle flow of said actuating fluid to said drain line for controlling the action of said speed change valve means without hydraulic shock in the return chamber.

6. A hydraulic circuit according to claim 5, wherein the means to throttle flow of said actuating fluid are manually adjustable to selectively control operation of said speed change valve means.

7. In a hydraulic circuit for a device having advance and return chambers and ram means reciprocal therein; the combination of a reservoir of low pressure fluid, prefill valve means adapted to connect the reservoir to the advance chamber on the rapid advance stroke of the ram means and on the return stroke thereof and adapted on the full pressure stroke of said ram means to cut off communication between the reservoir and the advance chamber, said valve means comprising a pressure area acted upon by fluid pressure in the return chamber for maintaining the valve means in open position thereof during rapid advance stroke of the ram means, make-up check valves accommodating flow of fluid from the reservoir to the advance and return chambers, respectively, to assure a continuous flow of fluid from said chambers upon evacuation thereof, and means for restricting flow of fluid from the return chamber to said area on the rapid advance stroke of said ram means whereby the full pressure stroke of said ram is initiated, cylinder and piston means for actuating said restricting means, means for delivering hydraulic pressure fluid to and exhausting hydraulic pressure fluid from said cylinder and piston means, and means to throttle exhaust flow of hydraulic fluid from said cylinder and piston means to control said ram means on return stroke thereof without hydraulic shock in the return chamber.

8. In a hydraulic circuit for a hydraulic device comprising a cylinder and a ram reciprocal in said cylinder and having a head defining advance and return chambers therein; the combination of an advance line connected to the advance chamber, a return line extending downwardly through said cylinder and connected to the return chamber at the lower extremity thereof, a reservoir of low pressure hydraulic fluid, a passage through said cylinder aligned with said head centrally thereof and connected to said reservoir, prefill valve means for opening and closing said passage, said valve means having a closing area acted on by pressure in said passage to hold said valve means in closed position and said valve means having an opening area opposed to said closing area and connected to the return line for holding said valve means open on rapid advance stroke of the ram and on return stroke thereof, a one-way make-up check valve connecting each line to the reservoir and accommodating flow of fluid therefrom, a cylinder mounted on the first mentioned cylinder adjacent its lower end, a piston in said second mentioned cylinder defining a closing chamber therein, a piston rod connected to said piston, extending through an opening in the first mentioned cylinder and having a fluted portion received within a complementary portion

of the return line to throttle flow of fluid to and from the return chamber in closed position of said fluted portion, means for alternately directing pressure fluid to and exhausting pressure fluid from said closing chamber, and means for throttling exhaust flow of pressure fluid from the closing chamber whereby upon delivery of hydraulic high pressure fluid to the return chamber with said closing chamber open to exhaust, the ram moves on return stroke at a predetermined rate of speed until pressure fluid in the return chamber forces the fluted portion

from the relation portion of the return line, whereupon the ram moves on said return stroke thereof at a greater rate of speed without development of hydraulic shock in the return chamber.

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