March 4, 1947. G. A. WALDIE 2,416,722

VALVE FOR HYDRAULIC CIRCUITS

Filed April 17, 1944 2 Sheets-Sheet 1

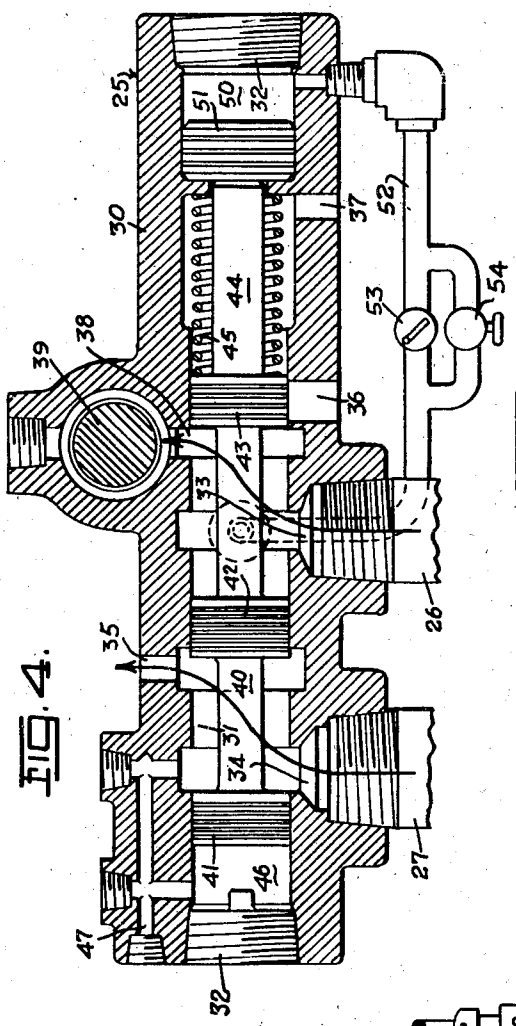

FIG. 4.

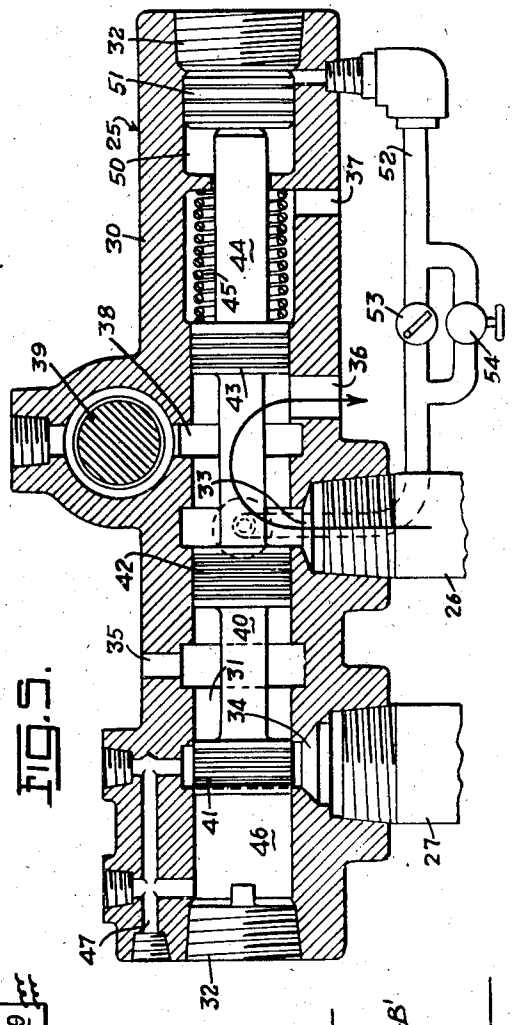

FIG. 5.

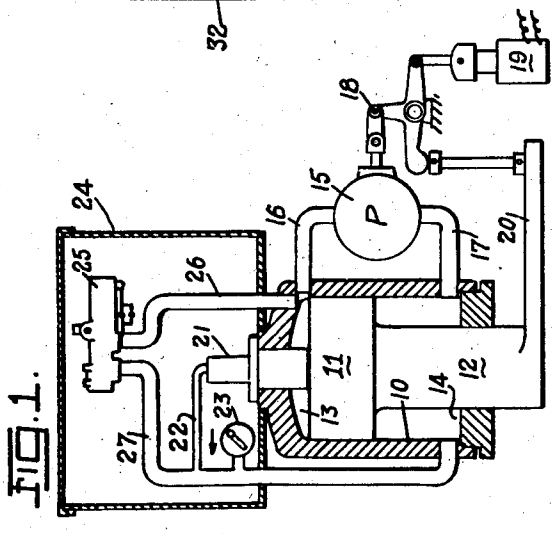

FIG. 1.

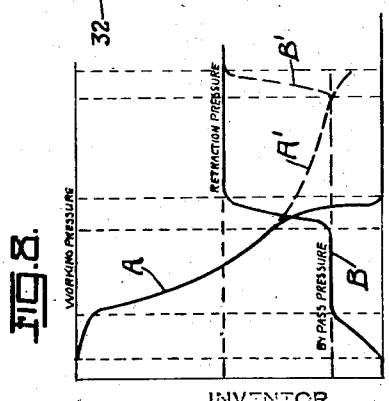

FIG. 8.

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VALVE FOR HYDRAULIC CIRCUITS

Filed April 17, 1944 2 Sheets-Sheet 2

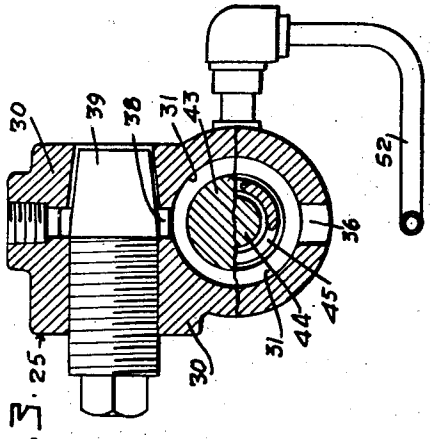

FIG. 3.

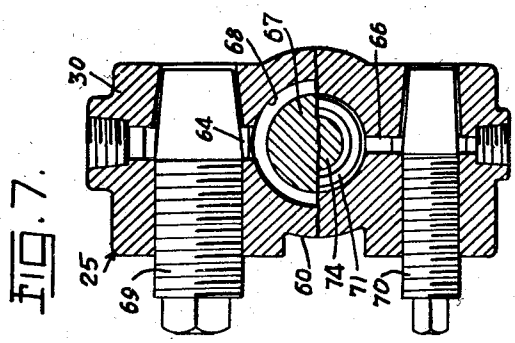

FIG. 7.

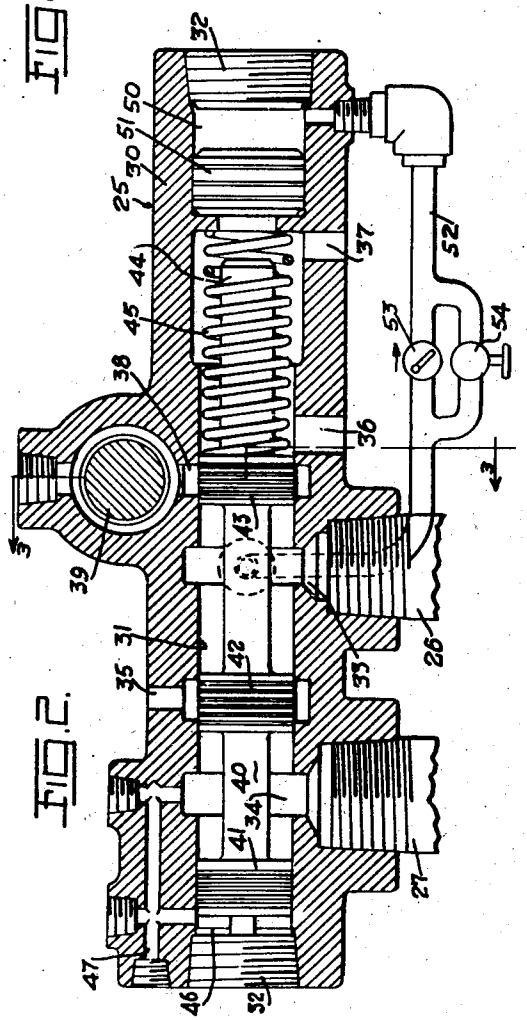

FIG. 2.

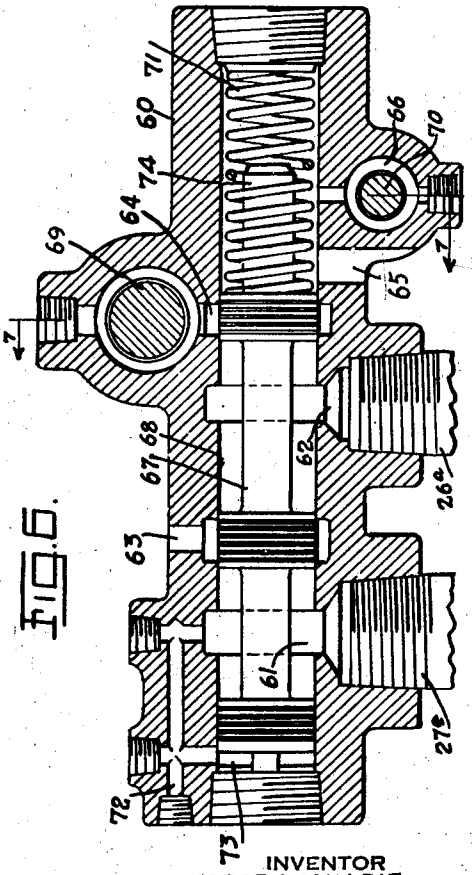

FIG. 6.

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VALVE FOR HYDRAULIC CIRCUIT

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Application April 17, 1944, Serial No. 531,327

21 Claims. (Cl. 60—52)

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This invention relates to valves and, in particular, to hydraulic control valves for use in connection with high pressure hydraulic circuits. In the operation of hydraulic motors such as hydraulic presses it is desired to reverse the ram at the end of a pressure stroke as rapidly as possible and without shock or vibration within the hydraulic circuit. One way of accomplishing this is by relieving the pressure within the working chamber of the motor while simultaneously bypassing the delivery of the fluid source to a reservoir. In the patents to Walter Ernst Nos. 1,956,758 and 2,268,205 there are shown valve means comprising a pair of pistons for accomplishing this result.

One of the principal objects of this invention is to provide a valve comprising a single movable valve member for relieving the pressure from the working side of a hydraulic device while simultaneously bypassing the delivery to the other side thereof.

It is still another object to provide a valve according to the foregoing object wherein the various functions thereof are positively synchronized through the employment of a single movable valve member and a casing including ports for making the necessary connections.

In the operation of a hydraulic system such as a press circuit having a release and bypass valve as set forth above, the release passage must be so adjusted that there is no shock within the system during the initial period of operation of the valve. Then, as the high pressure which is being released decays, the rate of release thereof ever diminishes until a predetermined low pressure has been attained whereupon the pressure is completely relieved and a surge valve is opened and the retraction movement of the ram commences.

Another object of the present invention is to provide a release and bypass valve wherein the release passage restriction is reduced as the said release progresses so that the total time of operation of the valve is substantially reduced.

It is still another object to provide a release and bypass valve in combination with a hydraulic press circuit which releases fluid at a first controlled rate and thereafter at a greater rate so that the total release period is substantially reduced thereby permitting more rapid operation of the hydraulic press.

These and other objects and advantages will become more apparent upon reference to the accompanying drawings, in which:

Figure 1 is a diagrammatic view of a typical hydraulic circuit employing the valve of this invention;

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Figure 2 is a longitudinal section through the release and bypass valve of this invention;

Figure 3 is a transverse section indicated by the line 3—3 on Figure 2;

Figures 4 and 5 are views similar to Figure 2 but show the valve in different operating positions;

Figure 6 is a longitudinal section through a modified form of the valve; and

Figure 7 is a cross-section through the valve of Figure 6 as is indicated by the line 7—7 on Figure 6.

Figure 8 is a graph of the pressure conditions existing in the circuit during the period of operation of the valve of this invention.

General arrangement

According to this invention a reciprocable hydraulic motor having a working chamber and a retraction chamber has connected thereto a reversible pump for supplying pressure fluid selectively to the said chambers. Suitable means are provided for reversing the pump so as to cause the same to deliver selectively to the working chamber for causing the hydraulic motor to perform a work stroke or, to the retraction chamber for causing the motor to perform a retraction stroke.

A surge valve is provided for communicating between the advancing chamber and a surge tank so that the advancing chamber may be freely discharged during the retraction stroke. The surge valve also provides a means for filling the advancing chamber during the initial portion of the working stroke of the motor.

In order to accomplish the objects of this invention, a valve is provided which is connected with the advancing chamber and retraction chamber and also with the surge tank. The valve includes a yieldable means continuously urging the valve into position to interrupt fluid communication between the advancing chamber and the surge tank and also between the retraction chamber and the surge tank.

The valve is operable, in response to a predetermined pressure on the advancing chamber, to move to establish fluid communication between the retraction chamber and the surge tank so as to bypass the pump discharge when the same is delivering to the retraction chamber. Simultaneously, the valve effects a choked or restricted communication between the advancing chamber and the surge tank so as to relieve the pressure

in the former at a controlled rate. According to this invention, a means is provided which, when the pressure within the advancing chamber has been reduced to a predetermined value, permits the valve to move to interrupt the fluid communication between the retraction chamber and the surge tank and also to establish an unrestricted fluid connection between the advancing chamber and the surge tank.

Detailed description of the embodiment of Figures 2 and 3

Referring to Figure 1, there is shown a hydraulic motor comprising a cylinder 10 having reciprocably mounted therein a piston 11 to which is attached a ram or plunger 12. The cylinder 10 and piston 11 define an advancing chamber 13 and a retraction chamber 14.

A reversible pump at 15 is connected by a conduit 16 with the advancing chamber and, by a conduit 17, with the retraction chamber. The pump 15 is controlled so as to deliver into the conduit 16 or the conduit 17, selectively, by a control mechanism generally indicated at 18 which may include a solenoid 19 which, when energized, places the pump into position to deliver into the conduit 16. An arm 20 attached to the platen is arranged to engage the linkage 18 to move the pump 15 towards neutral or no delivery position as the plunger 12 approaches the end of the retraction stroke.

Mounted in the top of the cylinder 10 is a surge valve 21 constructed according to any of several well known methods and operable to prefill the chamber 13 during the downward travel of the piston 11 and, to effect free exhaust from the chamber 13 during the upward travel of the said piston. A conduit 22 connects the operating cylinder of the valve 21 with the retraction chamber 14 so that the said valve is responsive to a predetermined pressure in said chamber. A check valve 23 is arranged to permit fluid to pass from the surge tank 24 into the conduit 22 for a purpose which will become more apparent hereinafter.

A valve generally indicated at 25 is mounted within the surge tank 24 and is connected by a conduit 26 with the advancing chamber 13 and, by the conduit 27 with the conduit 22.

The valve 25 is more particularly illustrated in Figures 2 and 3 and will be seen therein to comprise a casing 30 having a bore 31 therethrough which may be closed at the ends by the plugs 32.

An inlet port 33 is provided for the purpose of effecting fluid communication between the bore 31 and the conduit 26 and, an inlet port 34 provides for fluid communication between the said bore and the conduit 27. The valve casing 30 is provided with an outlet port 35 of a somewhat reduced diameter, the function of which is to serve as the bypass port when the valve is in operation. The casing 30 is likewise provided with outlet ports at 36 and 37, the former functioning as the exhaust port for the advancing chamber after the valve has been shifted.

Also in communication with the bore 31 is a choked or restricted outlet port best seen in Figure 3. This port comprises a tapered aperture 38 which has associated therewith the tapered plug 39 threaded into the valve casing 30. The plug 39 may be adjusted so as more or less to restrict the port 38.

Reciprocably mounted within the bore 31 is a valve member 40 which comprises the spool portions 41, 42 and 43. The spool portions are suitably connected by a reduced diameter portion, thus forming a rigid member. The member 40 also includes an extension 44 about which is mounted a spring 45. The spring 45 continuously urges the member 40 into the position which it occupies in Figure 2. The portion 41 of the member 40 defines, in cooperation with the bore 31, a chamber 46 which is continuously connected by the passage 47 with the inlet port 34. The pressure conducted from the port 34 through the passage 47 to the chamber 46 is effective to urge the valve member 40 rightwardly against the thrust of the spring 45 in a manner which will become apparent in the following description of the operation of the valve.

At the right hand end of the casing 30 is a chamber 50 within which is reciprocable a piston 51. The chamber 50 is connected by a conduit 52 with the inlet port 33. A check valve 53 permits free fluid flow from the said inlet port to the said chamber but not vice-versa. The check valve 53 is bypassed by an adjustable choke valve 54 which controls the rate of flow from the chamber 50 toward the inlet port 33.

The left end wall of the chamber 50 is apertured to receive the extension 44 which abuts the piston 50 when the valve member 40 is shifted from its Figure 2 position. After the member 40 engages the piston 51, continued movement of the member 40 is effective also to move the said piston.

The arrangement of the ports in the casing 30 is such that, when the member 40 has moved to its Figure 4 position, fluid communication is established between the inlet port 34 and the outlet port 35 and between the inlet port 33 and the outlet port 38. Further movement of the member 40, that is, to its Figure 5 position, is effective to interrupt the fluid communication between the inlet port 34 and the outlet port 35 while establishing fluid communication between the inlet port 33 and the outlet port 36.

The extension 44 on the member 40 and the piston 51 within the chamber 50 are arranged to engage when the member 40 is moved to its Figure 4 position. As the valve member moves from its Figure 4 position into its Figure 5 position, the piston 51 is also moved and fluid is expelled from the chamber 50 through the conduit 52 and the choke valve 54 into the inlet port 33.

Detailed description of the embodiment of Figures 6 and 7

A second embodiment of this invention is illustrated in Figures 6 and 7. Referring to Figure 6, the valve will be seen to comprise a body or casing 60 having inlet ports 61 and 62 and outlet ports 63, 64, 65 and 66.

The inlet port 61 is adapted to be connected with the retraction chamber of a hydraulic motor such as by the conduit 27*a* while the inlet port 62 is adapted to be connected, by the conduit 26*a*, with the advancing or working chamber of the said motor. A valve member 67 is reciprocable within the bore 68 of the casing 60 and is effective, when moved, first to establish fluid communication between the inlet port 61 and the outlet port 63 and between the inlet port 62 and the outlet port 64 and, subsequently, to interrupt the communication between the inlet port 61 and the outlet port 63 while establishing fluid communication between the inlet port 62 and the outlet port 65.

The outlet port 64 is provided with a choke or throttle valve generally indicated at 69 which

may be similar in construction to the choke valve associated with the outlet port 38 of the valve illustrated in Figures 2 and 3.

The outlet port 66, as shown in Figure 3, is similarly provided with an adjustable choke or throttle valve 70 for a purpose which will become more apparent hereinafter.

A spring 71 is mounted in the right hand end of the bore 68 and engages the valve member 67, continuously urging the latter to the left. A passage 72 continuously connects the inlet port 61 with the chamber 73 at the left end of the bore 68 and provides a means for urging the valve member 67 to the right against the thrust of the spring 71. An extension 74 on the valve member 67 provides a stop which limits the rightward movement of the said valve member when the same moves under the influence of the pressure established in the chamber 73.

Operation of the embodiment of Figures 2 and 3

Assuming that the press in Figure 1 is in its fully retracted position, an advancing or downward stroke is instituted by energizing the solenoid 19. The energization of the solenoid 19 is effective, through the linkage 18, to shift the pump 15 into position to deliver fluid through the conduit 16 into the advancing chamber 13 while simultaneously withdrawing fluid from the retraction chamber 14 through the conduit 17.

As the pump draws fluid from the retraction area, the ram 12 and piston 11 descend toward the work. During the initial part of the descent of the ram and piston the chamber 13 receives fluid from the conduit 16 and also from the surge tank 24 through the surge valve 21. When the ram 12 engages the work, the descent thereof under the force of gravity is checked and the pressure within the retracting chamber 14 drops to substantially zero. With the pressure in the retraction chamber and the conduit 22 reduced, the surge valve 21 closes thus sealing off the advancing chamber from the surge tank.

The ram 12 is driven into the work by the piston 11 due to the pressure created within the advancing chamber 13 by the pump 15. At the completion of the working stroke, the retraction or upward stroke of the piston 11 and ram 12 is instituted by deenergizing the solenoid 19 thus permitting the pump to shift to deliver into the retraction chamber 14 through the conduit 17.

At the moment of reversal, that is, at the moment when the pump 15 is shifted to deliver into the retraction chamber, it is desirable that the high pressure established within the advancing chamber 13 during the working stroke of the plunger 12 be reduced or bled off until the energy stored therein is reduced to such a value that no shock will occur within the hydraulic system when the same is suddenly released. It is also desirable that this be accomplished in the shortest possible time in order not to delay the operation of the press. This is accomplished by the valve 25 in the following manner:

During the working stroke of the plunger 12 the pressure within the retraction chamber 14 is substantially zero, and, therefore, the pressure standing in the conduits 22 and 27 and the inlet port 34 of the valve 25 is likewise substantially zero. The low pressure existing in the inlet port 34, passage 47 and chamber 46 permits the spring 45 to urge the valve member 40 into its Figure 2 position. In this position, the valve member 40 closes off communication between the inlet ports 34 and 33 and the outlet ports 35, 38 or 36, respectively.

At the previously mentioned moment of reversal, the pump is shifted to deliver into the retraction chamber 14 thereby increasing the pressure therein and also within the conduits 22 and 27 and within the inlet port 34 of the valve 25. The increased pressure at the inlet port 34 is conducted through the passage 47 to the chamber 46 where it is effective to urge the valve member 40 rightwardly against the thrust of the spring 45.

The valve member 40 then moves from its Figure 2 position to its Figure 4 position where the extension 44 engages the piston 51 and is stopped thereby. It will be noted that in this position the valve member 40 permits fluid communication between the inlet port 34 and the outlet port 35 and also between the inlet port 33 and the outlet port 38. Also, that further movement to the right of the member 40 will permit the piston portion 41 to commence to restrict the inlet port 34 while simultaneously permitting the piston portion 43 to commence to uncover the unrestricted outlet port 36.

The inlet port 33 is connected with the advancing chamber 13 by the conduit 26 and thereby provides for the said chamber a restricted release passage through the outlet port 38 when the valve member 40 is in its Figure 4 position. The passage of fluid from the conduits 26 and 27 into their respective inlet ports 33 and 34 and out their respective outlet ports 38 and 35 is indicated by arrows in Figure 4.

The pressure which had previously been established in the advancing chamber 13 during the working stroke of the press and which was transmitted to the inlet port 33 by the conduit 26 likewise was conducted by the conduit 52 to the chamber 50 thus urging the piston 51 into its Figure 2 position. The fluid, under pressure, enclosed within the chamber 50 is forced out through the conduit 52 and the choke valve 54 when the piston 51 is moved to the right by the extension 44 of the valve memmber 40. During the movement rightwardly the valve member 40 and piston 51 from their Figure 4 position, any differences in displacement between the piston portion 43 of the member 40 and the piston 51 is made up from the surge tank 24 through the passage 37.

With the valve in its Figure 4 position, the pressure within the advancing chamber 13 is gradually and controllably reduced through the outlet port 38 while the discharge from the pump is simultaneously bypassed through the outlet 35. The port 35, being somewhat restricted, is effective to maintain a pressure at the inlet 34 and within the passage 47 and the chamber 46 sufficient to urge the valve member 40 rightwardly with a thrust in excess of that of the spring 45. As the pressure within the advancing chamber 13 is reduced, the pressure at the inlet port 33 is likewise reduced and the aforementioned rightward thrust on the valve member 40 is effective to urge the piston 51 to the right to displace a portion of the fluid within the chamber 50 through the choke valve 54 and into the said inlet port 33. It will be apparent that the rightward movement of the valve member 40 is dependent upon the rate at which the pressure within the advancing chamber 13 and, therefore, the inlet port 33, is reduced.

As the valve member 40 moves to the right from its Figure 4 position under the influences mentioned above, the valve piston 41 commences to restrict the inlet port 34 thereby restricting the

bypass connection and also increasing the pressure in the inlet 34, the conduits 27 and 22 and the retraction chamber 14. The increased pressure at the inlet 34 is likewise conducted by the passage 47 to the chamber 46 where the same urges the valve member 40 rightwardly with an ever increasing thrust.

Simultaneously, the piston portion 43 commences to uncover the outlet port 36 thereby providing for a less restricted fluid passage between the advancing chamber 13 and the surge tank 24, and also, substantially reducing the pressure at the inlet port 33.

It will be apparent that the increase in pressure at the inlet port 34 and the chamber 46 and the simultaneous decrease in pressure at the inlet port 33 will be effective to move the valve member 40 from its Figure 4 position to its Figure 5 position where the bypass connection is completely sealed off, while the inlet port 33 is in substantially unrestricted fluid communication with the surge tank 24 through the outlet port 36. With the valve in its Figure 5 position, the delivery of the pump 15 is directed to the retraction chamber 14 and the plunger 12 and piston 11 commence their retraction stroke, which continues until the arm 20 actuates the linkage 18 to move the pump 15 to a neutral or substantially no delivery position. With the pump maintained in substantially neutral position by the arm 20 and linkage 18, as shown in Figure 1, the weight of the piston 11 and plunger 12 is effective to maintain sufficient pressure within the retraction chamber 14, the conduits 22 and 27, the inlet port 34, passage 47 and chamber 46 to maintain the valve member 40 in its Figure 5 position. Normally, the valve member 40 will remain in this position until the plunger 12 engages the work during the forward stroke of the said plunger and piston 11.

It will be noted that the action of the surge valve 21 will be substantially synchronized with the action of the valve 25, tending to open to permit free evacuation of the chamber 13 when the pressures within the chamber 13 and the chamber 14 are such that the valve member 40 is caused to approach its Figure 5 position. However, it will be apparent that the surge valve 21 could be eliminated if the outlet port 36 and the passage therefrom into the advancing chamber 13 were of sufficient size to permit the rapid transfer of fluid between the said chamber and the surge tank 24.

It will also be apparent that the adjustable throttle member 39 and the adjustable choke valve 54 may be adjusted to control the rate at which the pressure within the advancing chamber is reduced and also, the rate at which the bypass connection is interrupted and the free evacuation of the advancing chamber accomplished.

Operation of the embodiment of Figures 6 and 7

The operation of the embodiment shown in Figures 6 and 7 is substantially identical with that of the embodiment of Figures 2 and 3 except that the action of the piston 51 and chamber 50 is substantially duplicated by a portion of the bore 68 in cooperation with the valve member 67.

In operation, the valve member 67 is urged to the right by pressure within the chamber 73 into a position similar to the Figure 4 position of the valve member 40. That is, the member 67 moves to the right to establish a bypass connection for the conduit 27a through the inlet port 61 and

the somewhat restricted outlet port 63, while simultaneously establishing a restricted fluid communication from the conduit 26a to the inlet port 62 and outlet port 64 to the surge tank. The valve member 67 stops, or is checked, in its rightward movement when the right hand piston portion thereof covers the outlet port 65 so as to entrap fluid in the bore 68 to the right of the said piston portion.

In order for the valve member 67 to continue its rightward movement, the fluid entrapped in the right hand end of the bore 68 by the right hand piston portion of the member 67 must be expelled through the outlet port 66 and past the throttle member 70. It will be apparent that the rate of movement of the valve member 67 rightwardly after the port 65 is closed will be a function of the pressure existing within the chamber 73 and the setting of the throttle valve 70.

Thus, the valve member 67 moves, in response to a predetermined pressure established within the conduit 27a into position to establish a bypass connection to the reservoir for the said conduit while simultaneously establishing a restricted fluid connection to the reservoir for the conduit 26a and, thereafter, moves at a reduced rate in the position to interrupt the by-pass connection from the conduit 27a to the reservoir while simultaneously establishing a relatively unrestricted fluid connection between the conduit 26a and the reservoir through the outlet port 65.

In order more clearly to understand the operation and advantages of the present invention, the pressure conditions existing within the advancing and retraction chambers immediately prior to, during, and subsequent to the operation of the valve 25 have been plotted in Figure 8. In this figure, wherein time is the abscissa and pressure the ordinate, the graph of pressure conditions which would prevail in the circuit if a release and bypass valve constructed according to the teachings of the prior art were used, is also plotted.

In the graph the solid line marked A represents the pressure within the advancing chamber and passes successively, as indicated by the vertical dotted lines, from a high working pressure through a first release period and subsequently through a second release period to substantially zero pressure. At the same time, the pressure within the retraction chamber, indicated by the solid line B passes from substantially zero through a period of increasing pressure, a period of substantially constant pressure during which the pump discharge is bypassed and subsequently through a period of increasing pressure during which time the bypass connection is interrupted.

The dashed lines A' and B' represent, respectively, the pressure conditions within the advancing chamber and the retraction chamber during the operation of a release and bypass valve according to the prior art. It will be noted that the period of time required to reduce the pressure within the advancing area to a point where the surge valve may be opened is substantially greater than the same period when a release and bypass valve according to the present invention is employed.

It will also be apparent, upon reference to Figure 8, that the rate of operation of a press equipped with the valve of this invention will be increased, thereby permitting more working strokes of the press to be made during any period of time. Likewise, in certain classes of work, such as hot forging, the reduction of the dwell

period at the end of the advancing stroke is of distinct value. The reduction of the dwell period, which is accomplished by the reduction of time required for a shockless reversal of the press ram, not only permits the forging press to accomplish a greater number of work strokes on the workpiece while the same is still at forging temperature, but also reduce the chilling effect which the movable die has on the said workpiece by being in contact therewith.

It will be apparent that various modifications may be made in the construction of either of the embodiments of this valve without in any way departing from the spirit of the invention. For example, the piston 51 could be urged into its left hand position by means of a spring and the conduit 52 be replaced by a throttle valve and similar results would obtain. Likewise, it will be apparent that the arrangement, relative sizes and shapes of the various inlet and outlet ports could be considerably modified without effecting the mode of operation of the device in any way whatsoever.

Accordingly, it will be understood that I desire to comprehend such modifications and substitution of equivalents as may be considered to come within the scope of the appended claims.

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

1. In a release and bypass valve, a valve casing, a release passage and a bypass passage in said casing, a single valve member movable in said casing into a first position simultaneously to interrupt said passages or, into a second position to establish said passages or, into a third position to interrupt said bypass passage while maintaining said release passage, means operable automatically initially to move said valve member into said first position, thereafter to move it into said second position and finally gradually to move said valve member into said third position.

2. In a release and bypass valve, a valve casing having a bypass inlet, a release inlet, a bypass outlet, and a release outlet, a single valve member movable in said casing for controlling the communication between said inlets and their respective outlets, yielding means associated with said valve member for continuously urging the same into position to interrupt fluid communication between said inlets and their respective outlets, fluid operable means continuously hydraulically connected with said bypass inlet and operable in response to a predetermined pressure therein to move said valve member into position to establish fluid communication selectively between said inlet ports and their respective outlet ports, said bypass outlet offering a predetermined restriction to the flow of fluid therethrough so as to maintain a predetermined pressure at said bypass inlet and, therefore, in said fluid operable means.

3. In a valve; a casing having a first inlet port and a second inlet port; outlet means for each of said inlet ports and a bore interconnecting said ports and said outlet means; a single valve member movable in said bore for controlling said ports; yielding means associated with said valve member for continuously urging the same into position to interrupt fluid communication between said inlets and their respective outlets; fluid operable means hydraulically connected with one of said inlets and associated with said valve member and operable in response to a predetermined pressure at said inlet to move said valve member into position to establish fluid communication between said inlets and their respective outlets; and means associated with said valve operable subsequent to the operation of said last mentioned means to permit said valve member to move into position to interrupt fluid communication between one of said inlets and its respective outlet.

4. In a release and bypass valve, a valve casing having a bypass inlet and a release inlet; a restricted bypass outlet port, a restricted release outlet port and an unrestricted release outlet port; a bore in said casing interconnecting said ports; a valve member reciprocably mounted in said bore for controlling said ports and movable into a first end position for interrupting fluid communication between said inlet ports and their respective outlet ports or, into an intermediate position for establishing fluid communication between said bypass inlet port and said bypass outlet port and between said release inlet port and said restricted release outlet port or, into a second end position for again interrupting said bypass connection while establishing fluid communication between said release inlet port and said unrestricted release outlet port; and means automatically operable for actuating said valve member from said first end position into said intermediate position and then gradually into said second end position.

5. In a release and bypass valve; a valve casing having a bypass inlet and a release inlet; a restricted bypass outlet port, a restricted release outlet port and an unrestricted release outlet port; a bore in said casing interconnecting said ports; a valve member reciprocably mounted in said bore for controlling said ports and movable into a first end position for interrupting fluid communication between said inlet ports and their respective outlet ports or, into an intermediate position for establishing fluid communication between said bypass inlet port and said bypass outlet port and between said release inlet port and said restricted release outlet port or, into a second end position for again interrupting said bypass connection while establishing fluid communication between said release inlet port and said unrestricted release outlet port; and fluid pressure responsive means hydraulically connected with said bypass inlet port and operable in response to a predetermined pressure therein to move said valve member freely from said first end position into said intermediate position and thereafter at controlled speed from said intermediate position into said second end position.

6. In a valve; a casing having a first, a second and a third passage therethrough; a valve member in said casing for controlling said passages and movable into a first position for interrupting said passages and, into a second position for establishing the first and second of said passages and, into a third position for interrupting the first of said passages while establishing the third thereof; yielding means for continuously urging said valve member toward said first position; fluid operable means for urging said valve member from said first position toward said third position; and means for interrupting the movement of said valve member at said second position as said valve member is being moved by said fluid operable means.

7. In a release and bypass valve; a casing having a bypass inlet and a release inlet, a bypass

outlet port, a first and a second release outlet port and a bore interconnecting said ports; a valve member in said bore for controlling said ports and movable into a first end position for interrupting fluid communication between said inlets and their respective outlet ports or, into an intermediate position for establishing fluid communication between said bypass inlet and said bypass outlet port and between said release inlet and the first of said release outlet ports or, into a second end position for again interrupting said bypass connection while establishing fluid communication between said release inlet and said second release outlet port; yielding means continuously urging said valve member toward said first end position; fluid operable means associated with said valve member for moving the same from said first end position into said second end position; and means automatically operable to retard the movement of said valve member from said first end position to said second end position when the same has reached said intermediate position.

8. In a release and bypass valve; a casing having a bypass inlet and a release inlet, a bypass outlet port, a first and a second release outlet port and a bore interconnecting said ports; a valve member in said bore for controlling said ports and movable into a first end position for interrupting fluid communication between said inlets and their respective outlet ports or, into an intermediate position for establishing fluid communication between said bypass inlet and said bypass outlet port and between said release inlet and the first of said release outlet ports or, into a second end position for again interrupting said bypass connection while establishing fluid communication between said release inlet and said second release outlet port; yielding means continuously urging said valve member toward said first end position; fluid operable means associated with said valve member for moving the same from said first end position into said second end position; and fluid operable means operable automatically to control the rate of movement of said valve member from said intermediate position to said second end position when said valve member is actuated by said fluid operable means.

9. In a release and bypass valve; a casing having a bypass inlet and a release inlet, a bypass outlet port, a first and a second release outlet port and a bore interconnecting said ports; a valve member in said bore for controlling said ports and movable into a first end position for interrupting fluid communication between said inlets and their respective outlet ports or, into an intermediate position for establishing fluid communication between said bypass inlet and said bypass outlet port and between said release inlet and the first of said release outlet ports or, into a second end position for again interrupting said bypass connection while establishing fluid communication between said release inlet and said second release outlet port; yielding means continuously urging said valve member toward said first end position; fluid operable means associated with said valve member for moving the same from said first end position into said second end position; a fluid operable piston adapted to engage said valve member and to halt the same in said intermediate position; and means associated with said piston for permitting the same together with said valve member to move from said intermediate position into said second end position at a controlled rate.

10. In a release and bypass valve; a casing having a bypass inlet and a release inlet, a bypass outlet port, a first and a second release outlet port and a bore interconnecting said ports; a valve member in said bore for controlling said ports and movable into a first end position for interrupting fluid communication between said inlets and their respective outlet ports or, into an intermediate position for establishing fluid communication between said bypass inlet and said bypass outlet port and between said release inlet and the first of said release outlet ports or, into a second end position for again interrupting said bypass connection while establishing fluid communication between said release inlet and said second release outlet port; yielding means continuously urging said valve member toward said first end position; fluid operable means associated with said valve member for moving the same from said first end position into said second end position; a fluid operable piston adapted to engage and halt said valve member in said intermediate position; and means hydraulically connected with said release inlet and operable in response to a predetermined reduced pressure therein to permit said fluid operable means to move said valve member from said intermediate position into said second end position.

11. In combination in a hydraulic circuit, a fluid operable motor having an advancing chamber and a retraction chamber, a source of fluid pressure for supplying pressure fluid selectively to said advancing chamber or to said retraction chamber, a valve hydraulically connected with said advancing chamber and said retraction chamber and operable in response to a predetermined pressure in said retraction chamber for first establishing a restricted release passage from said advancing chamber to exhaust while simultaneously establishing a restricted bypass passage from said retraction chamber to exhaust and, subsequent thereto gradually to interrupt said bypass connection while simultaneously gradually establishing a relatively unrestricted release passage from said advancing chamber to exhaust.

12. In a release and bypass valve; a casing having a bypass inlet port and a release inlet port, a bypass outlet port, an adjustably restricted release outlet port, a relatively unrestricted release outlet port and a bore interconnecting said ports; a valve member reciprocably mounted in said bore for controlling said ports and movable into a first end position for interrupting communication between said inlet ports and their respective outlet ports or, into an intermediate position for establishing fluid communication between said bypass inlet port and said bypass outlet port and between said release inlet port and said restricted release outlet port or, into a second end position for again interrupting said bypass connection while establishing fluid communication between said release inlet port and said unrestricted release outlet port; fluid pressure responsive means hydraulically connected with said bypass inlet port and operable in response to a predetermined pressure therein to move said valve member from said first end position toward said second end position; fluid operable means for interrupting the movement of said valve member when the same has reached said intermediate position; and adjustable means associated with said last mentioned means for regulating the rate of movement of said valve

member from said intermediate position to said second end position so as gradually to interrupt said bypass connection while gradually establishing said relatively unrestricted release connection.

13. In a release and bypass valve, a casing having a bypass passage and a pair of release passages of varying restrictions therein, a valve member in said casing for controlling said passages and movable into a first end position for interrupting said passages or, into an intermediate position for establishing said bypass passage and one of said release passages or, into a third position to again interrupt said bypass passage while establishing the other of said release passages, yielding means for continuously urging said valve member into said first end position, fluid operable means hydraulically connected with the inlet of said bypass passage and operable in response to a predetermined pressure therein for moving said valve member toward said second end position, fluid operable means comprising a chamber closed by said valve member when the same has reached said intermediate position for interrupting the movement of said valve member at said intermediate position, and an adjustable choke valve hydraulically connected with said chamber for regulating the rate of movement of said valve member from said intermediate position into said second end position so as gradually to interrupt said bypass passage while gradually establishing said second release passage.

14. In a hydraulic system; a press cylinder; a ram reciprocable therein and having fluid operable advancing and retracting means associated therewith; a source of pressure fluid for selectively supplying actuating fluid to said advancing or retracting means for reciprocating said ram; and a valve connected between said advancing means and said retracting means and exhaust operable automatically at the end of an advancing stroke of said ram and in response to a predetermined pressure in said retracting means for establishing a restricted by-pass for the delivery of said fluid source and for releasing the pressure from said advancing means at a predetermined rate, said valve also being automatically operable in response to a predetermined reduced pressure in said advancing means for gradually increasing the rate of release of pressure therefrom while simultaneously gradually restricting said bypass connection, and finally completely to release said pressure while interrupting said bypass connection.

15. In a hydraulic circuit; a fluid operable ram having advancing and retracting means; a surge valve for establishing a free connection between said advancing means and exhaust; a first and a second release passage between said advancing means and exhaust; a restricted bypass passage between said retracting means and exhaust; and means responsive to a predetermined pressure in said retracting means for establishing said bypass passage and the first of said release passages, and for thereafter gradually closing off said bypass passage while gradually establishing the second of said release passages, and finally for completely closing off said bypass passage while opening said surge valve.

16. In a hydraulic circuit; a fluid operable ram having advancing and retracting means; a first valve means comprising a surge passage for freely connecting said advancing means with exhaust; a second valve means comprising a first and a second release passage between said advancing means and exhaust and a restricted bypass passage between said retracting means and exhaust, said second valve means also comprising a valve member for controlling said release and bypass passages; means operable during the advancing stroke of said ram for moving said valve member into position to interrupt said passages; and means operated by pressure in said retracting means and operable at the beginning of the retraction stroke of said ram for moving said valve member into position to establish said bypass passage and the first of said release passages, and for thereafter gradually moving said valve member to close off said bypass passage while establishing said second release passage, and finally to move said valve member completely to close off said bypass passage and also to move said surge valve into open position.

17. In a hydraulic circuit; a fluid operable ram having advancing and retracting means; a surge valve for establishing a free connection between said advancing means and exhaust; a second valve means comprising first and second release passages of different restrictions connected with said advancing means and exhaust; said second valve also comprising a restricted bypass passage connected between said retracting means and exhaust; a valve member in said valve movable into a first position for interrupting said passages and into a second position for establishing one of said release passages and said bypass passage and into a third position for interrupting said bypass passage while establishing the other of said release passages; means operable prior to a working stroke of said ram in the advancing direction for moving said valve member into said first position; means operable at the end of a working stroke of said ram for moving said valve member into said second position; and means operable at the initiation of the retraction stroke of said ram for moving said valve member into said third position and for opening said surge valve.

18. In a hydraulic circuit; a fluid operable ram having advancing and retracting means; a surge valve for establishing a free connection between said advancing means and exhaust; a second valve means connected with said advancing means and with said retracting means and comprising a restricted bypass passage between said retracting means and exhaust, a first release passage between said advancing means and exhaust of a predetermined restriction, and a second release passage between said advancing means and exhaust of a lesser restriction; a valve member in said valve movable into a first position for interrupting said passages, or into a second position for establishing said bypass passage and the first of said release passages, or into a third position for interrupting said bypass passage while establishing the second of said release passages; yielding means continuously urging said valve member toward said first position; fluid operable means connected with said retracting means for urging said valve member toward said second and third position; means automatically operable for retarding the movement of said valve member from said second position to said third position when said valve member is moved by said fluid operable means against the thrust of said yielding means; and means operable to open said surge valve when said valve means is moved into said third position.

19. In a hydraulic circuit; a fluid operable ram having advancing and retracting means; a surge

valve for establishing a free connection between said advancing means and exhaust; a second valve means connected with said advancing means and with said retracting means and comprising a restricted bypass passage between said retracting means and exhaust, a first release passage between said advancing means and exhaust of a predetermined restriction, and a second release passage between said advancing means and exhaust of a lesser restriction; a valve member in said valve movable into a first position for interrupting said passages, or into a second position for establishing said bypass passage and the first of said release passages, or into a third position for interrupting said bypass passage while establishing the second of said release passages; yielding means continuously urging said valve member toward said first position; fluid operable means connected with said retracting means for urging said valve member toward said second and third position; means hydraulically connected with said advancing means operable to halt said valve member in said second position when the same is moved thereto by said fluid operable means, said last mentioned means also being operable in response to a predetermined reduced pressure in said advancing means for permitting said fluid operable means to move said valve member gradually from said second position to said third position; and fluid pressure responsive means connected with said retracting means for opening said surge valve when the pressure in said retracting means is increased by the movement of said valve member into said third position.

20. In a fluid operable system a reciprocable ram having advancing and retracting means, a fluid source adapted selectively to supply said means, and means for effecting a rapid and substantially shockless reversal of said ram comprising, a release passage from said advancing means to exhaust, a bypass passage from said retracting means to exhaust, a valve member movable from a first position where said passages are interrupted to a second position where said passages are established and into a third position where said bypass passage is again interrupted, means for moving said valve member into its first position during an advancing stroke of said ram, means responsive to a predetermined pressure in said retracting means for moving said valve member into its second position and for urging said valve member toward its third position for a dwell period of said ram, and means for retarding the movement of said valve member into its third position comprising means responsive to the pressure in said advancing means.

21. In a fluid operable system, a ram having advancing and retracting means, a fluid source to supply said means selectively, and means for effecting a shockless reversal of said ram comprising a valve member controlling communication between said advancing and retracting means and exhaust and movable from a first position wherein said communication is interrupted into a second position wherein said communication is established and into a third position wherein the communication between the said retracting means and exhaust is again interrupted, fluid operable means connected with said retracting means for moving said valve member from its first through its second and into its third position, other fluid operable means connected with said advancing means for interrupting the movement of said valve member when it reaches its second position and for controlling the movement thereof into its third position, and means for returning said valve member to its first position when the pressure in said retracting means is reduced.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,268,205	Ernst	Dec. 30, 1941
1,956,958	Ernst	May 1, 1934
2,042,186	Peterson	May 26, 1936
2,320,759	Stacy	June 1, 1943