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HYDRAULIC PRESS WITH LOW PRESSURE AND HIGH PRESSURE PUMP

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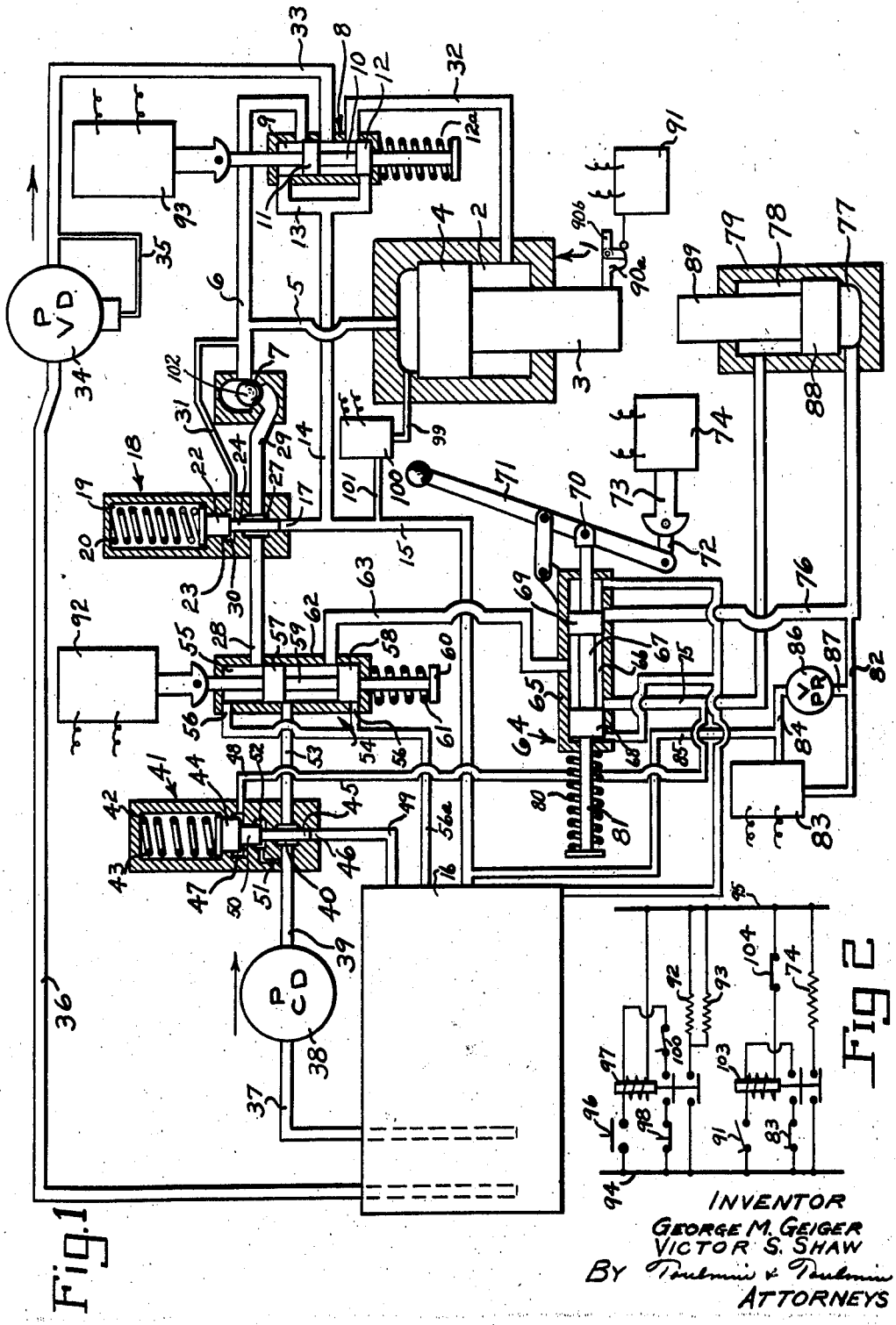


Fig. 1

Fig 2

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HYDRAULIC PRESS WITH LOW PRESSURE AND HIGH PRESSURE PUMP

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10 Claims. (Cl. 60—52)

This invention relates to hydraulic presses, and in particular to hydraulic presses having a high pressure pump and a low pressure pump.

In presses of this kind the low pressure pump is generally used only at the first portion of the working stroke of the press in combination with a high pressure pump, to speed up the advancing movement of the press ram. Then at the attainment of a predetermined pressure acting upon the press ram, the low pressure pump unloads and from that point on, including the return stroke of the press, the entire operation is under the control of the high pressure pump, while the low pressure pump is merely idling.

When ejector or other hydraulic machinery associated with the press is to be actuated during the operation of the press ram, it has been customary heretofore to furnish an additional pump for the said purpose, which constitutes an increase in the cost of the press, the operation and maintenance thereof.

With some kinds of presses it is usual to operate the ejector by the push-back pressure delivered by the main pump. However, this is carried out at the expense of the return speed of the press ram.

Accordingly it is another object of the invention to provide a hydraulic press having a high pressure pump and a low pressure pump, in which the low pressure pump, in addition to speeding up the advancing stroke of the press ram, is also operative for actuating additional machinery associated with the press.

It is a further object of the invention to provide a hydraulic press as set forth in the preceding paragraph, in which the operation of the low pressure pump may selectively be controlled manually or automatically.

Still another object of the invention consists in the provision of a hydraulic press with a low pressure pump and a high pressure pump, in which the low pressure pump has associated therewith controlling means connected with additional machinery pertaining to the press so as selectively to allow operation of said additional machinery or to maintain said additional machinery in inoperative position.

These and other objects and advantages of the invention will appear more clearly from the following specification in connection with the accompanying drawing, in which:

Figure 1 is a diagrammatic illustration of a hydraulic press circuit, comprising a high pressure pump and a low pressure pump in connection with a press.

Figure 2 is a simplified wiring diagram for an electric circuit which may be used in connection with the press circuit shown in Figure 1.

General arrangement

In the press according to the present invention which comprises a high pressure pump and a low pressure pump, the low pressure pump operates first in combination with the high pressure pump for speeding up the first portion of the working stroke of the press ram, whereupon the low pressure pump stops its delivery of fluid to the press cylinder. A predetermined time thereafter a controlling mechanism is operated, either manually, or automatically in response to the movement of the press ram or a predetermined pressure acting thereupon, so as to establish hydraulic communication between the low pressure pump and additional hydraulically operable machinery as for example an ejector. When the press ram has performed a cycle, the connection between the low pressure pump and the additional machinery is interrupted so that the low pressure pump is again in a position to cooperate with the high pressure pump during the first portion of the working stroke of the press.

Structural arrangement

Referring now to the drawing in detail, 1 designates a press comprising a cylinder 2 and a press ram 3 with a double-acting piston 4. Communicating with the upper portion of the press cylinder 2 is a conduit 5 leading to a conduit 6, one end of which communicates with a check valve 7, while the other end of the conduit 6 leads to a four-way valve, generally designated 8. The four-way valve 8 has a cylinder bore 9 in which is reciprocably mounted a valve member 10 with two spaced pistons 11 and 12. The valve member 10 with the pistons 11 and 12 is constantly urged to its lower position by a spring 12a. Also communicating with the cylinder bore 9 of the valve 8 is a fork shaped conduit 13 which is controlled by the valve member 10 in such a manner that alternately the upper branch of the conduit 13 is connected with the line 6, and the lower branch of conduit 13 is connected with conduit 32. The conduit 13 communicates with a conduit 14 leading to a conduit 15 which communicates with the fluid tank 16. The unloading valve 18 comprises a spring chamber 19 housing a spring 20 which with its upper end engages the upper portion of the spring chamber 19 while the lower end of the spring 20 engages a plunger 22 reciprocable in a bore 23 and carrying a plunger

24 of a smaller diameter than the plunger 22. The plunger 24 passes through a recess 27 communicating on one hand with a conduit 28 and on the other hand with a conduit 29 leading to the check valve 7. The plunger 22 protrudes into a recess 30 communicating through a conduit 31 with the conduit 6 leading to the four-way valve 8. Also communicating with the cylinder bore of the four-way valve 8 is a conduit 32 leading to the lower portion of the press cylinder 2. The upper portion of the cylinder bore 2 communicates with a conduit 99 leading to the main tonnage control valve 100. The tonnage control valve 100 is so constructed that it normally closes a circuit but is adapted to break said circuit at a predetermined pressure acting upon the tonnage control valve 100. In this instance the valve 100 allows fluid operating the same to discharge through conduit 101 into conduit 15. The tonnage control valve 100 does not form a part of the present invention and for a more detailed description thereof reference may be had to U. S. patent application, Serial No. 214,772 to Walter Ernst, filed June 20, 1938 which has matured to Patent No. 2,224,957.

Connected to the four-way valve 8 is furthermore a conduit 33 which communicates with the pressure side of a high pressure one-way variable delivery pump 34. Branching off from the conduit 33 is a conduit 35 leading to the control of the pump 34. The pump 34 is normally urged by spring means into full stroke position but is provided with a control mechanism which, in response to a predetermined pressure on the pressure side of the pump 34, shifts the flow control member of the pump 34 toward neutral or no-delivery position. The pump 34, which if desired may be replaced by any other kind of suitable pump, does not form a part of the present invention and for a more detailed description thereof reference may be had to U. S. Patent No. 2,193,248 to Walter Ernst.

The suction side of the pump 34 communicates through conduit 36 with the fluid tank 16. Also communicating with the fluid tank 16 is a suction conduit 37 leading to the suction side of the low pressure constant delivery fluid pump 38. The pressure side of the pump 38 communicates through a conduit 39 with a recess 40 in a relief valve 41. The relief valve 41 is similar to the unloading valve 18 and likewise comprises a spring chamber 42 housing a spring 43 which normally urges the piston 44 downwardly so that the plunger 45 connected thereto closes the port 46. The piston 44 extends into a recess 47 communicating through a conduit 48 with a conduit 75 leading to the cylinder bore 78. The piston portion connected with the piston 44 is adapted to be lifted by pressure fluid passing from the conduit 39 through a passageway 51 and the recess 52 in the relief valve 41. The recess 40 of the relief valve 41 also communicates through a conduit 53 with a three-way valve, generally designated 54. The three-way valve 54 comprises a cylinder bore 55 having at the end thereof slippage apertures 56 which are connected to the tank 16 through conduit 56a. Reciprocably mounted in the cylinder bore 55 are two pistons 57 and 58 interconnected with each other by a valve rod 59 passing through the pistons 57 and 58 and having a head 60 at its lower end which engages the lower portion of a spring 61. The upper portion of the spring 61 engages the casing 62 of the three-way valve 54 so that the spring 61 tends to hold the pistons 57 and 58 in their lowermost position in which the communication between conduits 28 and 53 is interrupted, while communication is effected between the conduit 53 and conduit 63 leading to the control valve, generally designated 64. The control valve 64 comprises a casing 65 with a cylinder bore 66 having reciprocably mounted therein a valve member 67 with two spaced interconnecting pistons 68 and 69. The valve member 67 is connected by a pivot 70 with an arm 71, the upper end of which is provided with a handle for allowing manual operation thereof, while the lower end of the arm 71 is connected by a link 72 with an armature 73 of a solenoid 74. The arrangement is such that when the solenoid 74 is energized it pulls the link 72 and armature 73 toward the right with respect to Figure 1, so as to shift the pistons 68 and 69 toward their outermost right-hand position, thereby breaking the hydraulic connection between conduit 63 and the conduit 75, while establishing hydraulic connection between conduit 63 and the conduit 76 leading to the chamber 77, which is adapted to communicate with the cylinder bore 78 of the ejector 79. If the solenoid 74 is de-energized, the spring 80 moves the pistons 68 and 69 through the intervention of the rod 81 toward the left-hand position shown in the drawing.

Branching off from the conduit 76 is a conduit 82 leading to the tonnage control valve 83. The construction of the tonnage control valve 83 corresponds to that of the main tonnage control valve 100. The conduit 84 communicates with one side of a safety valve 86, the other side of which is connected by means of a conduit 87 with the conduit 82. The safety valve 86 prevents the accumulation of undue pressure in the conduit 76 and operates in such a manner that at a predetermined pressure higher than the pressure for which the tonnage control valve 83 is set, communication is effected between the conduits 82 and 85. The cylinder bore 78 of the ejector 79 has reciprocably mounted therein a double-acting piston 88 with the ejector plunger 89.

The press ram 3 is provided with an arm 90 which is adapted at a predetermined position during its upward stroke to close the normally open limit switch 91. The arm 90 comprises a fixed portion 90a and a hinged portion 90b, which latter evades the switch 91 during its downward stroke but closes it during its upward stroke.

The valve rod 59 with the pistons 57 and 58 and the valve member 10 with the pistons 11 and 12 are respectively operated by solenoids 92 and 93, the electric circuit of which is illustrated in Figure 2. As will be seen therefrom, the numerals 94 and 95 designate main supply lines so that closure of the push button switch 96 closes a circuit which energizes the contactor 97, controlling the energization of the solenoids 92 and 93. The energization of the solenoid 74, controlling the movement of the pistons 68 and 69 of the control valve 64, is effected by closure of the limit switch 91 when the latter is engaged by the platen arm 90, as previously mentioned.

Operation

Assuming that all parts of the press and the press circuit occupy the position shown in Figure 1, which position corresponds to the position at the end of the retraction stroke of the press ram, and that it is now desired to carry out a drawing operation, the operator starts the pumps 34 and

38 in any desired manner and then closes the push button switch 96. This establishes a circuit through the contactor 97 inasmuch as current now flows from the supply line 94 through the push button switch 96, the contactor 97 and the supply line 95. When, shortly thereafter, push buttton switch 96 returns to its open position, for instance by a spring, the contactor 97 still remains energized due to the holding circuit comprising the main supply line 94, the normally closed emergency switch 98, the upper switch blade, pertaining to the armature which cooperates with the contactor 97, and the main tonnage control valve 100. Energization of the contactor 97 has also closed the lower switch blade of the armature cooperating with the contactor 97 so that current flows through the solenoids 92 and 93. Energization of the solenoid 93 causes upward movement of the pistons 11 and 12 so that communication is effected between the conduit 33 and the conduit 6, while the conduit 32 is connected through the conduits 13, 14 and 15 with the fluid tank 16. At the first moment this causes a pressure drop in the conduit 33 so that the springs (not shown) pertaining to the pump 34 place the said pump on delivery stroke. Pressure fluid now passes from the pump 34 through conduit 33, cylinder bore 9, conduit 6 and conduit 5 into the upper portion of the press cylinder bore 2, while the fluid below the press piston 4 escapes through the conduit 32, the conduits 14 and 15 into the tank 16. While, at this time, the high pressure pump 34 delivers fluid into the upper portion of the press cylinder bore 2, also the low pressure pump 38 delivers fluid into the upper portion of the press cylinder bore 2. This is due to the fact that the energization of the solenoid 92 had caused the pistons 57 and 58 to move to their uppermost position so that fluid from the low pressure pump 38 now passes through the conduit 39, the recess 40, conduit 53, conduit 28, recess 27 and conduit 29 into the conduits 6 and 5 leading to the upper portion of the press cylinder bore 2. It will be appreciated that the pressure in the conduit 29 lifts the ball 102 so that communication is effected between the conduits 29 and 6.

When during the downward stroke of the press piston 4 a predetermined pressure is established in the upper portion of the press cylinder 2, this pressure acts through the conduits 5, 6 and 31 upon the plunger 22 in the unloading valve 18 so as to lift the plungers 24 and 22 against the thrust of the spring 20. This lifting movement establishes communication between the conduit 28 and conduit 15 so that the fluid delivered by the low pressure pump 38 now passes through the conduits 39, 53, 28 and 15 into the tank 16. In other words, the low pressure pump 38 is now bypassed, while the high pressure pump 34 now alone delivers the fluid acting upon the piston 4.

When, at the end of the pressing operation, a predetermined pressure higher than the pressure which previously actuated the unloading valve 18 is established, this pressure actuates the tonnage control valve 100 so that the latter breaks the holding circuit for the contactor 97. As a result thereof, the solenoids 92 and 93 are de-energized whereupon the springs 12a and 61 shift the valve members 10 and 59 downwardly so that the valve member 10 interrupts communication between the conduits 33 and 6 and establishes communication between the conduit 33 and the conduit 32 leading to the lower portion of the press cylinder 2. Similarly, the pistons 57 and 58 of the three-way valve 54 interrupt the communication between the conduits 53 and 28, while establishing communication between the conduits 53 and 63. Now pressure fluid delivered by the high pressure pump 34 passes through the conduit 33 and the conduit 32 into the lower portion of the press cylinder 2, thereby starting the upward movement of the press piston 4. Fluid expelled by the upwardly moving piston 4 passes through the conduits 5 and 6, the upper portion of the cylinder bore 9, the conduits 13, 14 and 15, into the tank 16.

Fluid delivered by the low pressure pump 38 passes through the conduit 39, the recess 40, conduit 53, the lower portion of the cylinder bore 55 and the conduit 63 into the cylinder bore 66 of the control valve 64. From here the fluid pressure is conveyed to the upper portion of the ejector cylinder bore 78, thereby holding the ejector in its retracted position at a reduced pressure. Inasmuch as the conduit 75 directly communicates through conduit 48 with the recess 47, the pressure acting on plunger portion 44 need be less than the pressure acting through passageway 51 on piston portion 50 to lift the plunger portion 45. Since the pump 38 constantly delivers fluid and the fluid cannot escape from the conduit 75, a pressure builds up in the conduits 51 and 48 which, at the attainment of a predetermined value, lifts the piston 50 of the relief valve 41, thereby also lifting the plunger 45 so that the fluid delivered by the pump 38 now passes through the conduit 39, the recess 40 and the conduit 49 into the tank 16.

When during the retraction stroke of the press piston the latter has reached a predetermined position, the press platen arm 90 closes the limit switch 91, thereby closing the circuit through the contactor 103 so that the blades pertaining to the armature cooperating with the contactor 103 closes and the solenoid 74 is energized. When during the further upward movement of the press piston 4 the switch arm 91 again drops open, the contactor 103 will remain energized, due to the holding circuit comprising the upper switch blade pertaining thereto and the tonnage control valve 83. Energization of the contactor 103 causes attraction of the armature 73 and thereby, through the intervention of the link 72 and arm 71, a shifting movement of the valve member 67 toward the right. This shifting movement breaks the communication between the conduit 75 and the conduit 63, while establishing communication between the conduits 76 and 63. Consequently, the pressure in the conduit 39 drops temporarily so that the spring 43 moves the piston 44 and plunger 45 downwardly so as to interrupt communication between the conduits 39 and 49. The pressure fluid delivered by the low pressure pump 38 now passes through the conduit 39, the recess 40, the conduit 53, cylinder bore 55, conduit 63, cylinder bore 66 and the conduit 76 into the chamber 77 of the ejector 79, thereby moving the ejector plunger 89 upwardly for ejecting the work piece.

When the press piston 4 has reached its uppermost position, the pressure acting upon the lower portion of the press piston builds up to a predetermined value in response to which the high pressure pump 34 moves to its neutral or no-delivery position in which it remains until a decrease in the presure acting upon the lower portion of the press piston 4 occurs. However, if

preferred, the press platen may be provided with a control rod which, when the press piston approaches its uppermost position, actuates the valve 8 so as to move the valve pistons 11 and 12 to an intermediate or neutral position, thus by-passing the pump 34.

As soon as the ejector plunger 89 has reached the end of its upward stroke so that the work piece is fully ejected, the pressure acting upon the lower area of the ejector piston 88 soon reaches a predetermined value in response to which the tonnage control valve 83 opens, thereby breaking the holding circuit of the contactor 103. As a result thereof, the solenoid 74 is de-energized and the spring 80 moves the valve member 67, with the pistons 68 and 69, to their left-hand position as shown in the drawing, so that the fluid delivered by the pump 38 passes through the conduits 39, 53, 63 and 75 to the upper portion of the ejector cylinder 78, where it causes a downward movement of the ejector plunger 89. When the ejector plunger 89 has reached its lowermost position, the pump 38 still delivers fluid and, consequently, pressure builds up in the upper portion of the ejector cylinder 78 and, therefore, in the conduits 51 and 48. When this pressure reaches a predetermined value, the pressure acts through the passageways 51 and 48 upon the piston portions 44 and 50 so as to lift the plunger 45 and thereby establishing communication between the conduit 39 and the tank 16 through the conduit 49. In other words, the delivery of the pump 38 is now by-passed and no undue pressure can develop in the ejector cylinder 78. All parts are now again in position for starting a new cycle.

When a new cycle is started, the valve member 59 is shifted as previously described so as to establish communication between the conduit 39 and the conduit 5 so that the pressure in the conduit 39 drops and the spring 43 moves the plunger 45 to its lowermost position. The drawing operation will then continue in the manner previously disclosed.

While the invention has been described in connection with an ejector it is, of course, understood that the ejector system may as well be replaced by any other hydraulically operable machinery, for instance, a clamping mechanism for a work piece or a feeding mechanism for feeding a work piece. It is also understood that, instead of starting the return movement of the ejector or similar machinery by a pressure responsive means, also position responsive means may be employed for this purpose.

If, for some reason, no automatic operation of the valve member 67 is desired, it is merely necessary to open the normally closed switch 104 (see Figure 2) which prevents energization of the contactor 103 and thereby also of the solenoid 74. The shifting operation of the valve member 67 may then be effected by manipulation of the arm 71.

It will be understood that we desire to comprehend within our invention such modifications as come within the scope of the claims.

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

1. In a hydraulic system, a main plunger having associated therewith fluid operable advancing and retracting means for reciprocating the same, an auxiliary plunger having associated therewith fluid operable actuating means for reciprocating said auxiliary plunger, a first fluid pressure source, a second fluid pressure source, means responsive to the initiation of an advancing stroke of said main plunger for admitting pressure fluid jointly from said first and said second fluid source to said main plunger advancing means, means responsive to a predetermined pressure on said main plunger for by-passing the delivery of said second fluid source to an exhaust without affecting the delivery of said first fluid source, means for directing pressure fluid from said first fluid source only to said main plunger retracting means for retracting said main plunger, and means operable automatically and subsequently to the initiation of said retracting stroke for conveying pressure fluid from said second fluid source only to said auxiliary plunger to effect an advancing stroke thereof.

2. In a hydraulic system, a main plunger having associated therewith fluid operable advancing and retracting means for reciprocating the same, an auxiliary plunger having associated therewith fluid operable actuating means for reciprocating said auxiliary plunger, a first fluid pressure source, a second fluid pressure source, means responsive to the initiation of an advancing stroke of said main plunger for admitting pressure fluid jointly from said first and said second fluid source to said main plunger advancing means, means responsive to a predetermined pressure on said main plunger for by-passing the delivery of said second fluid source to an exhaust without affecting the delivery of said first fluid source, means for directing pressure fluid from said first fluid source only to said main plunger retracting means for retracting said main plunger, means operable automatically and subsequently to the initiation of said retracting stroke for conveying pressure fluid from said second fluid source only to said auxiliary plunger to effect an advancing stroke thereof, and means operable at the end of said last mentioned advancing stroke for reversing the flow of fluid from said second fluid source to said auxiliary plunger for causing a retracting stroke thereof.

3. In a hydraulic system, a plunger, a first pressure fluid source adapted to supply pressure fluid to said plunger, fluid operable motor means operable independently of said plunger, a second pressure fluid source adapted selectively to supply pressure fluid to said plunger or said motor means, means responsive to the reversal of said plunger for conveying fluid pressure from said second pressure fluid source to said motor means to positively maintain the latter stationary during a predetermined portion of the movement of said plunger following said reversal, and means responsive to a predetermined point of travel of said plunger during said last mentioned movement for causing pressure fluid from said second pressure fluid source to actuate said motor means.

4. In a hydraulic system, a plunger having associated therewith fluid operable advancing and retracting means for reciprocating the same, a first fluid source for supplying pressure fluid selectively to said advancing or retracting means, hydraulic motor means operable independently of said plunger, a second fluid source for supplying pressure fluid selectively to said advancing means or to said motor means, means responsive to the initiation of a working cycle of said plunger for effecting fluid connection between said first fluid source and said advancing means, and also between the latter and said second fluid source, means responsive to a first fluid pressure on said

advancing means for by-passing the delivery of said second fluid source to an exhaust, while said first fluid source continues its delivery to said advancing means, and means responsive to a second pressure on said advancing means for interrupting the supply of pressure fluid to said advancing means and causing only said first fluid source to supply pressure fluid to said retracting means, while simultaneously causing fluid connection between said motor means and said second fluid source.

5. A hydraulic press comprising in combination a double-acting press piston, a high pressure variable delivery pump for supplying pressure fluid to said piston, means for controlling the direction of flow of fluid from said variable delivery pump to said piston, hydraulic motor means, a low pressure pump, controlling means operable selectively to admit pressure fluid from both pumps jointly or from said high pressure pump only to said press piston to actuate the same, means responsive to a predetermined pressure on the advancing side of said press piston to by-pass said low pressure pump only, and means responsive to a predetermined travel of said piston during its retraction stroke for conveying pressure fluid from said low pressure pump only to said motor means to actuate the same.

6. A hydraulic press comprising in combination a press ram, a high pressure fluid source adapted to supply pressure fluid to said ram, hydraulic motor means operable independently of said press ram, a low pressure fluid source adapted selectively to supply pressure fluid to said press ram or said motor means, fluid pressure responsive means adapted at a predetermined pressure acting on said press ram to hydraulically disconnect said low pressure fluid source from said ram, and means for reversing the movement of said press ram and simultaneously establishing hydraulic connection between said low pressure fluid source and said motor means for actuating the latter.

7. A hydraulic press comprising in combination a press ram, a high pressure fluid source adapted to supply pressure fluid to said ram, hydraulic motor means operable independently of said ram, a low pressure fluid source adapted selectively to supply pressure fluid to said ram or to said motor means, a fluid storage tank, means responsive to a first predetermined pressure acting on said ram for disconnecting the hydraulic communication between said low pressure fluid source and said ram and for by-passing the delivery of said low pressure fluid source to said storage tank, and means responsive to a second predetermined pressure acting on said ram for causing hydraulic communication between said low pressure fluid source and said motor means while interrupting hydraulic communication between said storage tank and said low pressure fluid source.

8. In a hydraulic press, a press ram, a high pressure fluid source for supplying pressure fluid to said press ram, hydraulic motor means operable independently of said press ram, a low pressure fluid source adapted hydraulically to be connected selectively with said ram or with said motor means, means for by-passing the delivery of said low pressure fluid source to exhaust during the last portion of the working stroke of said press ram, and means for reversing the direction of flow of fluid from said high pressure fluid source to said press ram while simultaneously interrupting the by-passing of said low pressure fluid source and effecting hydraulic communication between said low pressure fluid source and said motor means.

9. In a hydraulic press, a press ram, a high pressure fluid source adapted to supply pressure fluid to said ram, hydraulic motor means operable independently of said press ram, a low pressure fluid source for selectively supplying pressure fluid to said press ram or to said motor means, first valve means for controlling the direction of flow of fluid from said high pressure fluid source to said ram, second valve means for controlling the direction of flow of fluid from said low pressure fluid source to said ram and to said motor means, means responsive to a first predetermined pressure acting on said ram for interrupting the hydraulic connection between said low pressure fluid source and said press ram, means responsive to a second predetermined pressure acting on said ram for establishing hydraulic communication between said low pressure fluid source and said motor means, and electric means for controlling the operation of said first valve means and said second valve means.

10. In a hydraulic press, a press ram, a variable delivery pump for supplying pressure fluid to said ram, an ejector operable independently of said press ram, a constant delivery pump adapted selectively to supply pressure fluid either to said press ram or to said ejector, a fluid tank connected to the suction side of said pump, first valve means for controlling the direction of flow of fluid from said variable delivery pump to said press ram, second valve means for controlling the supply of pressure fluid from said constant delivery pump to said press ram and to said ejector, means for simultaneously operating said first valve means and said second valve means for initiation of the retraction stroke of said press ram and holding said ejector in its inoperative position, means responsive to the retracting movement of said ram for moving said ejector into operative position, means for returning said ejector to inoperative position at the end of the ejection stroke, and means for automatically by-passing the delivery of fluid of said constant delivery pump to said fluid tank at the attainment of a predetermined pressure acting on said ejector in its inoperative position.

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