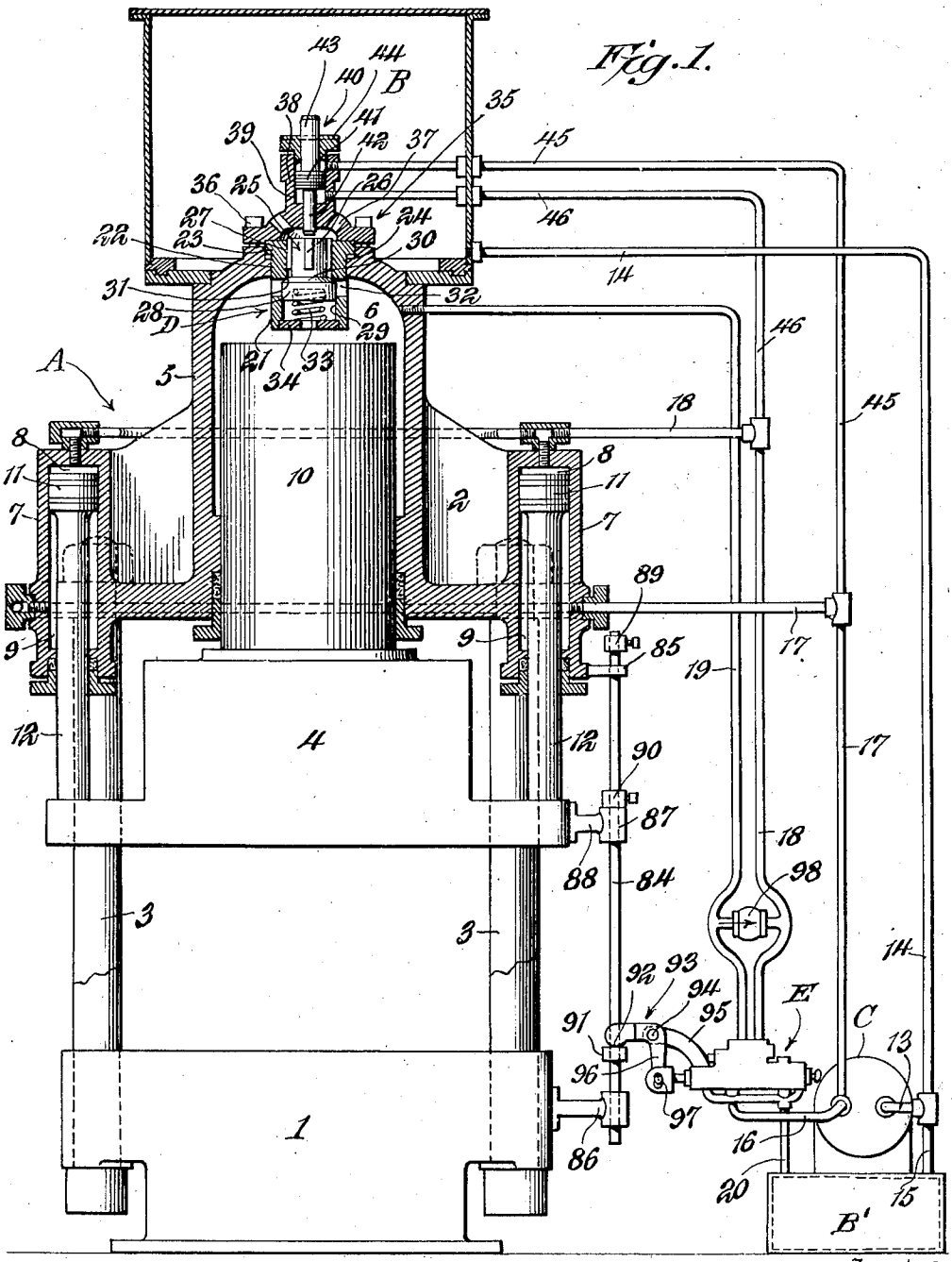
Jan. 31, 1933. W. ERNST ET AL 1,895,710

HYDRAULIC PRESS

Filed Nov. 24, 1931 2 Sheets-Sheet 1

Fig. 1.




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Fig. 2.

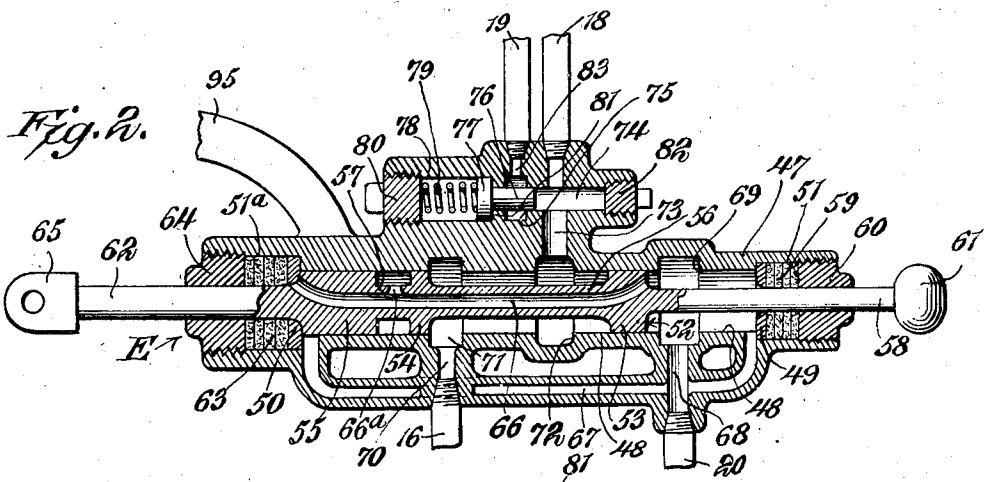



Fig. 3.

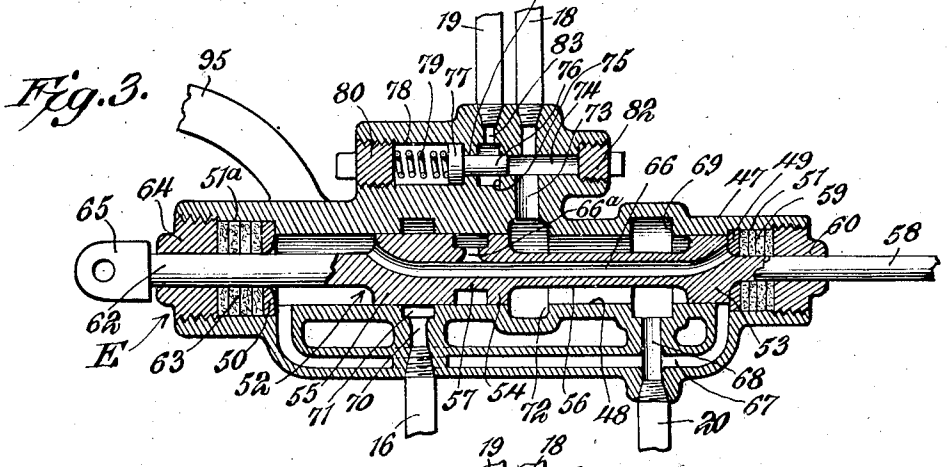
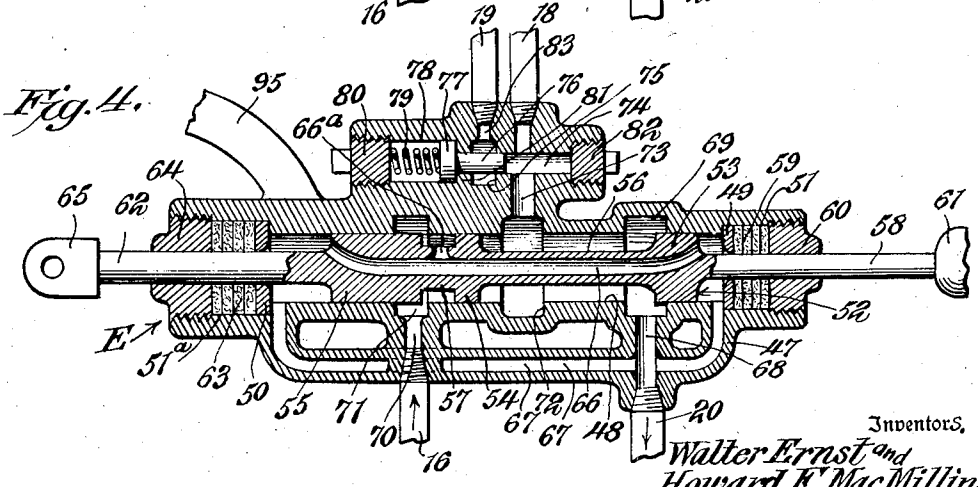



Fig. 4.




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# UNITED STATES PATENT OFFICE

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## HYDRAULIC PRESS

Application filed November 24, 1931. Serial No. 577,142.

This invention relates to hydraulic presses and more particularly to hydraulic press operating circuits.

In order to attain high operating speeds in reciprocating presses deriving their power from fluid under pressure it is common to provide cylinders and cooperating rams for positively driving the press platen or other reciprocatory element in both directions, and in many cases to provide both main pressing and auxiliary or booster cylinders and rams of relatively small diameter so that, for a given rate of fluid supply, the reciprocatory press element will be advanced rapidly toward the work during the initial part of a pressing stroke and prior to engagement with the work. In such presses it is desirable to employ what is usually termed a surge valve which controls communication between the main press cylinder and the circuit reservoir and which provides for the prefilling of the main cylinder when the press rams are being moved towards the work under the action of the booster rams. It is necessary that means be provided for positively holding the surge valve open during a return stroke so as to permit the fluid contained in the main cylinder to be readily discharged directly to the surge tank or reservoir.

An object of the present invention is to provide a simplified press operating circuit of the general character referred to above, including a surge valve and a novel device for operating the valve. A more specific object is to provide such a press circuit in which the pump discharge is constantly directed to the push back or ram-returning chamber. Other objects will become apparent from a reading of the following description, the appended claims, and the accompanying drawings, in which:

Figure 1 is a front view of a press with parts shown in elevation and other parts in section, and a somewhat diagrammatic showing of a press operating circuit;

Figure 2 is a central vertical longitudinal sectional view of a control valve, the movable element thereof being shown in the position occupied during a pressing stroke; and

Figures 3 and 4 are views similar to Figure 2 but showing the movable control valve element in the positions occupied during a return stroke, and when the platen is at rest in its retracted position respectively.

The invention may be embodied in various kinds of presses or other similar hydraulic machines, but for the purposes of illustration there is shown a press A of the downward pressure type having a base 1, a press head 2 connected to the base by means of strain rods 3, and a platen 4 guided on the strain rods for reciprocatory movements towards and away from the base. For reciprocating the platen, the press is provided with cylinder means including a main cylinder 5 defining a main pressing chamber 6 and auxiliary cylinders 7—7, the upper ends of which define booster chambers 8—8 and the lower ends of which define ram-returning chambers 9—9. A main ram 10 is connected to the platen and is mounted for reciprocation in the main pressing chamber 6 and auxiliary rams 11—11 are mounted for reciprocation in the respective cylinders 7—7, these auxiliary rams being connected to the platen by means of rods or extensions 12—12.

The press operating circuit includes a surge tank or reservoir B mounted directly on top of the main cylinder 5 of the press, a supplementary tank or reservoir B′, a pump C, and hydraulic connections forming a circuit with the respective chambers of the press, the tanks, and the pump. These connections include a surge valve D, a control valve E, and suitable piping. The piping includes a pump suction pipe 13 being connected at one of its ends to the intake side of the pump and at its other end communicating with intake or suction branches 14 and 15 which respectively communicate with the tanks B and B′. A pump discharge pipe 16 communicates at one of its ends with the discharge side of the pump and at its other end with the control valve E. A pipe 17 also communicates at one of its ends with the discharge side of the pump and at its other end communicates with the ram-returning chambers 9 of the auxiliary cylinders. A delivery pipe 18 communicates at one of its ends with the control valve E and at its upper end with the booster

chambers 8 of the auxiliary cylinders, and a branch delivery pipe 19 communicates at one of its ends with the control valve E and at its other end with the main pressing chamber 6 of the main cylinder 5.

The surge valve D is interposed between the pressing chamber 6 and the tank or reservoir B for the purpose of providing communication therebetween to effect a prefilling of the main pressing chamber during the initial part of a pressing stroke and for the exhausting of the pressing chamber during a return stroke. This valve includes a casing or cage 21 which extends through an opening 22 in the upper end of the main cylinder and which is formed with a top peripheral flange 23 which fits within a counter-bore 24 in the top of the cylinder. A movable valve element 25 is mounted within the cage 21 and is provided with spaced vertically extending ribs 26 which slide within a reduced bore 27 in the cage. The element 25 is formed at its lower end with an enlarged part 28 which slides within an enlarged bore 29 at the lower end of the cage, and is formed with a tapered seat-engaging surface 30 intervening between the upper reduced and the lower enlarged portions of the valve element. This tapered surface is adapted to engage a correspondingly tapered seat 31 formed at the bottom of the reduced bore 27 in the cage. Just below the tapered seat 31 the cage is formed with a plurality of ports 32 providing communication between the inside of the cage and the main pressing chamber. A biasing spring 33 is interposed between the valve element 25 and an end plate 34 secured in the bottom end of the cage, this spring serving normally to maintain the element in closed position. The surge valve as so far described is similar to the surge valve shown, described, and claimed in the application of Walter Ernst, Serial No. 501,994, filed December 12, 1930, and does not per se constitute the present invention.

A frame member 35 is mounted on top of the cylinder 5, being clamped down against the surge valve cage by means of bolts 36, thus serving to maintain the valve cage in place. This frame member is formed with a plurality of ports 37 which provide communication between the interior of the valve cage and the surge tank B. The frame is provided with an upwardly extended portion providing a cylinder 38 formed with a bore 39 disposed coaxially with the valve cage 21.

Mounted in the cylinder 38 is a differential hydraulic plunger 40 comprising a head 41 slidable within the bore 39, a small stem 42 extending from the head downwardly through an opening in the frame to a point just above the valve element 25, and a large stem 43 extending upwardly from the head 41 through a cylinder end plate or collar 44. In accordance with the invention, the differential plunger has its opposite sides respectively exposed to pressure in the ram-returning chambers and the booster chambers, and in order to effect this condition a branch pipe 45 is interposed between the pipe 17 and the upper end of the cylinder bore 39, and a branch pipe 46 is interposed between the delivery pipe 18 and the lower end of the bore 39 of the cylinder 38, the arrangement as shown being such that the upper or smaller area of the head 41 is constantly exposed to the pressure existing in the ram-returning chambers while the lower and larger area of the head 41 is constantly exposed to the pressure existing in the booster chambers.

The control valve E includes a casing 47 formed with a central bore 48 closed at its ends by discs 49 and 50 respectively positioned in counter bores 51 and 51*a* and a movable piston valve element 52 mounted for sliding movements within the bore 48. The piston valve 52 comprises three spaced heads 53, 54, and 55, a reduced portion 56 interposed between and connecting the heads 53 and 54, a reduced portion 57 interposed between and connecting the heads 54 and 55, a stem 58 which extends through the disc 49 and through packing 59 held in place by an exteriorly threaded nut 60 and provided at its outer end with a hand grasp or knob 61, and a stem 62 which extends from the head 55 through the disc 50 and through packing 63 held in place by an exteriorly threaded nut 64 and provided at its outer end with a clevis 65. An internal passage 66 formed within the piston valve affords constant communication between the portions of the valve chamber disposed between the respective ends thereof and the adjacent heads 53 and 55, and a branch passage 66*a* is formed in the piston valve for providing communication between the passage 66 and the space intervening between the heads 54 and 55.

The valve casing is formed with a passage 67 which connects the extreme end portions of the valve chamber, or bore 48, and a short passage 68 formed within the valve casing provides constant communication between the passage 67 and an annular enlarged part 69 of the bore 48. The valve casing is threaded to receive the exhaust pipe 20 at a point adjacent the intersection of the passages 67 and 68, so that these passages always communicate with the exhaust pipe 20 and consequently with the reservoirs B′ and B.

The valve casing is also formed near its left hand end as viewed in Figures 2, 3, and 4 with an inlet passage 70 which communicates with an annular enlarged part 71 of the bore 48, the casing being threaded at the outer end of the inlet passage 70 for the reception of the pump discharge pipe 16.

Intermediate the enlarged bore parts 69 and 71 the valve casing is formed with an

annular enlarged part 72 which communicates with an outlet port 73, the casing being threaded at the outer end of this port for the reception of the delivery pipe 18.

In operation, the valve is moved to three different positions to effect the desired communication between the respective pipes.

In the position shown in Figure 2, the fluid entering through the pump discharge pipe 16 will flow first through the inlet port 70, then through the enlarged bore 71, then through that part of the bore 48 included between the heads 53 and 54, then through the enlarged bore 72, and then through the outlet port 73 into the delivery pipe 18. There will be no flow of fluid through the exhaust pipe 20 when the valve is in this position, since communication of the passages 67 and 68 is cut off from the pipes 16 and 18 by means of the head 55 and the head 53 respectively.

When the valve is in the position shown in Figure 3, the head 55 will cut off flow of fluid through the pump discharge pipe 16 and the pipe 18 will communicate with the exhaust pipe 20 by means of the inlet port 73, the enlarged bore 72, that part of the bore 48 included between the head 54 and the head 53, the enlarged bore 69, and the passage 68.

When the valve is in the position shown in Figure 4, fluid entering through the pump discharge pipe 16 will flow through the passage 70, the enlarged bore part 71, the passages 66*a* and 66 within the valve element 52, that part of the bore 48 included between the head 53 and the disc 49, the passage 67, and through the passage 68 into the exhaust pipe 20 and thence to the tank B′. At this time the delivery pipe 18 will communicate with the exhaust pipe 20 by means of the passage 73, the enlarged bore part 72, that part of the bore 48 included between the heads 53 and 54, and the passage 68.

It is desirable that, when the valve 52 is in its Figure 2 position, communication be established between the pipes 18 and 19 when the pressure in the pipe 18 has built up to a predetermined extent. To this end the valve casing 47 is provided with an upper extension or enlargement formed with a bore 74 traversing and intersecting the auxiliary port 73, there being formed at its left hand end an enlarged part or annular depression 75. A plunger valve 76 is mounted for sliding movements within the bore 74 and is provided with a head 77 arranged to slide within an enlarged bore 78 coaxial with the bore 74. A spring 79 is interposed between the head 77 and a threaded plug 80 which closes the left hand end of the bore 78, this spring serving normally to maintain the valve 76 in its closed position, a flange 81 intervening between the bores 74 and 78 serving to limit the movement of the valve to the right. A plug 82 serves to close the right hand end of the bore 74. A port 83 provides constant communication between the enlarged bore 75 and the branch delivery pipe 19 which is connected to the casing at the upper end of the port 83. In operation, when pressure builds up in the pipe 18 and consequently in the bore 74 to a point dependent upon the force exerted by the spring 79, the valve 76 will be moved to the left so as to afford communication between the bore 74 and the enlarged bore 75, consequently providing communication between the pipe 18 and the pipe 19.

It is desirable that, when the platen reaches a predetermined position during an upward or return stroke, the valve 52 be moved to its Figure 4 position. To accomplish this purpose, we have provided platen-operated means comprising a rod 84 mounted for vertical sliding movements in guides 85 and 86 respectively carried by one of the auxiliary cylinders 7 and the press base 1, the rod 84 extending through and being slidable relative to a boss 87 on the end of an arm 88 connected to the platen. A collar 89 secured to the upper end of the rod 84 is engageable with the guide 85 for limiting downward movement of the rod, and a collar 90 secured to the rod in adjusted position is adapted to be engaged by the boss 87 when the platen reaches a predetermined point during its upward travel for raising the rod to move the valve to its Figure 4 position through the medium of connections interposed between the rod and valve. These connections include a collar 91 secured to the rod adjacent the lower end thereof and being adapted when raised to engage the round head 92 of one arm of the bell crank lever 93 pivoted as at 94 to a bracket 95 for rocking the bell crank in a clockwise direction, the other arm 96 of the bell crank lever being connected to the clevis 65 on the valve stem 62 by means of a pin and slot connection 97. Thus, when the rod 83 is raised by engagement of the boss 87 with the collar 90, the collar 91 will engage the round head 92 of the bell crank lever, thereby rocking the latter in a clockwise direction and moving the piston valve 52 to the left to its Figure 4 position.

In order that the invention may be readily understood, the sequence of operations of the several parts during a complete operating cycle will be set forth. It will be assumed that the platen and rams are in their upper positions and that the piston valve 52 is in the position shown in Figure 4. With the valve in this position, the pipe 18 leading from the booster chambers will communicate with the exhaust pipe 20 and tank B′ in the manner already described. The pipe 16 will have restricted communication with the exhaust pipe 20 by means of the inlet passage 70, the enlarged bore 71, the passages 66*a* and 66 in

the valve 52, the bore 48, and the passage 67. The position of the valve 52 is such that the head 55 thereof extends partly through the enlarged bore 71, thus providing a throttled communication between the bore 71 and the passage 66*a*, so that there will be some back pressure in the discharge pipe 16. This back pressure acting through the pipe 17 and hence on the lower sides of the auxiliary rams 11 will be sufficient to maintain the movable press parts in their upper positions.

To initiate a downward movement of the rams, the valve 52 is moved from its Figure 4 position to its Figure 2 position. The discharge from the pump will then be directed to the delivery pipe 18 through the medium of the discharge pipe 16, the inlet port 70, that part of the bore 48 intervening between the heads 53 and 54, and the outlet port 73, this fluid being delivered to the booster chambers 8. At the same time fluid under the same unit pressure will be delivered through the pipe 17 to the ram-returning chambers 9, so that the same unit pressures will act on the upper and lower sides of the rams 11. However, since the effective pressure areas of the upper sides of these rams are considerably greater than the effective pressure areas of the lower sides thereof, the total pressure acting on the rams will be greater on the top sides than the bottom sides, so that the rams will be moved downwardly. This will positively move the platen 4 and the main ram 10 downwardly, the movement of the ram 10 tending to create a vacuum in the main pressing cylinder 6 which will result in the opening of the surge valve against the pressure of the spring 33, thus permitting prefilling of the pressing chamber 6 from the surge tank B. When the platen encounters resistance to its downward travel, pressure will build up in the delivery pipe 18 causing the valve 76 to open against the pressure of the spring 79, thus placing the branch delivery pipe 19 in communication with the delivery pipe 18 and with the pump discharge pipe 16. Fluid will then be delivered from the pump to the booster chambers 8 and to the main pressing chamber 6, causing a building up of pressure in the latter with consequent closing of the surge valve. The platen will then be moved downwardly under the combined action of the booster rams 11 and main ram 10, it being noted that during the entire downward movement of the platen and rams the ram-returning chambers 9 have been in constant communication with the discharge side of the pump.

When the desired pressure has been exerted upon the work, the piston valve 52 will be moved to its Figure 3 position, in which position of the valve communication will be afforded between the delivery pipe 18 and the exhaust pipe 20 in the manner heretofore described, and at the same time flow of fluid through the discharge pipe 16 is effectively cut off by means of the head 55 of the piston valve. At this time the only outlet for the discharge of the pump will be through the pipe line 17, so that the pump discharge will be directed to the ram-returning chambers 9, and the latter, together with the main ram 10 and the platen 4, will be moved upwardly. During upward movement of the rams, the fluid contained in the booster chambers 8 will be returned to the tanks by means of the pipe 18, the control valve E, and the exhaust pipe 20. Since the booster chambers are in communication with the exhaust at this time, the pressure in the delivery pipe 18 and consequently in the branch pipe 46 and lower end of the cylinder 38 will be small, so that the pressure acting through the pipe 17 and consequently through the branch pipe 45 and in the upper end of the cylinder 38 will act upon the smaller area of the head 41 of the differential plunger 40, thereby moving the latter downwardly into engagement with the surge valve and opening the latter to permit the free discharge of fluid from the pressing chamber 6 into the surge tank B.

When the platen approaches the limit of its upward travel, the boss 87 will engage the collar 90 and will lift the rod 84 in the manner previously described, thereby rocking the bell crank 93 and moving the piston valve 52 from its Figure 3 position to the left. The rams and platen will continue to ascend until the piston valve 52 has been moved to the left to a position wherein the head 55 will effect just sufficient throttling of fluid flow through the valve to the exhaust pipe 20 to produce enough back pressure to maintain the rams and platen at rest in their upper positions. This condition will exist when the valve 52 has been moved to its Figure 4 position, at which time the rams will be brought to rest, thus completing a single operating cycle.

In order to provide for efficient pre-filling and exhausting of the main pressing chamber, it is desirable that the surge valve be of large area. For this reason it is often difficult to open the valve against the high presssure existing in the main pressing chamber at the end of a pressing stroke, and, in order to render the opening of the valve more easy and to prevent the occurrence of shocks which would otherwise occur if the valve were suddenly opened while the fluid in the main pressing chamber were under very high pressure, a check valve 98 is interposed between the branch delivery pipe 19 and the delivery pipe 18, the valve being arranged so as to permit flow of fluid from the pipe 19 to the pipe 18 but not in the reverse direction. When the pressing stroke has been completed and the piston valve 52 is moved to its Figure 3 position so as to place the delivery pipe 18 in communication with

the exhaust pipe 20, the pressure in the pipe 18 will drop below that in the pipe 19, and there will be a limited flow of fluid from the pipe 19 to the pipe 18 thereby relieving the pressure in the main pressing chamber 6 so that the surge valve may be opened easily and without the occurrence of shocks due to the expansion of the compressed fluid.

Although the invention has been illustrated herein as being embodied in a press constructed for the performance of pressing operations, it is to be understood that the invention may be used in connection with hydraulic machines having reciprocatory rams provided with punches, shears, dies, or other similar tools instead of with a platen of the kind illustrated, and that various other modifications and changes may be made in the construction and arrangement of the parts without departing from the spirit of the invention as defined in the appended claims.

We claim:

1. The combination with a press having cylinder means including a main pressing chamber, a booster chamber, a ram-returning chamber, and cooperating ram means in said chambers; of a reservoir; a pump; means forming a hydraulic circuit with said chambers, said reservoir, and said pump comprising a pipe affording constant communication between said pump and said ram-returning chamber, a delivery pipe adapted to afford communication between said pump and said booster chamber, a branch pipe adapted to afford communication between said booster chamber and said main pressing chamber, valve means for controlling flow of fluid through said delivery pipe and said branch pipe and a surge valve independent of said control valve means interposed between said main pressing chamber and said reservoir and including a movable element and biasing means associated with said element for yieldably urging the latter to closed position, said element being movable to open position against the urge of said biasing means during the first part of a pressing stroke by suction in said main pressing chamber; and a differential plunger associated with said surge valve element for operating the latter and having its opposite sides exposed to pressure in said ram returning and booster chambers respectively.

2. The combination with a press having cylinder means including a main pressing chamber, a booster chamber, a ram-returning chamber and cooperating ram means in said chambers; of a reservoir; a pump; means forming a hydraulic circuit with said chambers, said reservoir, and said pump comprising a pipe affording constant communication between said pump and said ram-returning chamber, a delivery pipe adapted to afford communication between said pump and said booster chamber, a branch pipe adapted to afford communication between said booster chamber and said main pressing chamber, valve means for controlling flow of fluid through said booster pipe and said branch pipe, a check valve interposed between said branch pipe and said booster pipe and being arranged to permit flow from the former to the latter but not in the reverse direction, and a surge valve independent of said control valve means interposed between said main pressing chamber and said reservoir and including a movable element and biasing means associated with said element for yieldably urging the latter to closed position, said element being movable to open position against the urge of said biasing means during the first part of a pressing stroke by suction in said main pressing chamber; and a differential plunger associated with said surge valve element for operating the latter and having its opposite sides exposed to pressure in said ram returning and booster chambers respectively.

3. The combination with a press having cylinder means including a main pressing chamber, a booster chamber, a ram-returning chamber and cooperating ram means in said chambers; of a reservoir; a pump; means forming a hydraulic circuit with said chambers, said reservoir, and said pump comprising a pipe affording constant communication between said pump and said ram-returning chamber, a delivery pipe adapted to afford communication between said pump and said booster chamber, a branch pipe adapted to afford communication between said booster chamber and said main pressing chamber, valve means for controlling flow of fluid through said booster pipe and said branch pipe, a surge valve independent of said control valve means interposed between said main pressing chamber and said reservoir and including a movable element and biasing means associated with said element for yieldably urging the latter to closed position, said element being movable to open position against the urge of said biasing means during the first part of a pressing stroke by suction in said main pressing chamber, and means for relieving the pressure in the main cylinder prior to the opening of said surge valve; and a differential plunger associated with said surge valve element for operating the latter and having its opposite sides exposed to pressure in said ram returning and booster chambers respectively.

4. The combination with a press having cylinder means including a main pressing chamber, a booster chamber, a ram-returning chamber, and cooperating ram means mounted in said chambers; of a reservoir; a pump; a pipe affording constant communication between the pump and ram-returning chamber; a discharge pipe connected to the pump; a delivery pipe connected to said booster cham-

ber; a branch delivery pipe adapted to afford communication between said delivery pipe and said main pressing chamber; a pressure operated valve for controlling said communication; an exhaust pipe communicating with said reservoir; a control valve interposed between said discharge pipe, said delivery pipe, and said exhaust pipe and being movable to three positions first to afford communication between said discharge pipe and said delivery pipe, then to cut off flow of fluid through said discharge pipe, and then to afford communication between said discharge pipe and said exhaust pipe; a surge valve independent of said control valve means interposed between said main pressing chamber and said reservoir and including a movable element and biasing means associated with said element for yieldably urging the latter to closed position, said element being movable to open position against the urge of said biasing means during the first part of a pressing stroke by suction in said main pressing chamber; and a differential plunger associated with said surge valve element for operating the latter and having its opposite sides exposed to pressure in said ram returning and booster chambers respectively.

5. The combination with a press having cylinder means including a main pressing chamber, a booster chamber, a ram-returning chamber, and cooperating ram means mounted in said chambers; of a reservoir; a pump; a pipe affording constant communication between the pump and ram-returning chamber; a discharge pipe connected to the pump; a delivery pipe connected to said booster chamber; a branch delivery pipe adapted to afford communication between said delivery pipe and said main pressing chamber; a pressure operated valve for controlling said communication; an exhaust pipe communicating with said reservoir; a control valve interposed between said discharge pipe, said delivery pipe, and said exhaust pipe and including a casing provided with ports and a valve element movable to open and close said ports, said element being movable to three positions first to afford communication between said discharge pipe and said delivery pipe, then to cut off flow of fluid through said discharge pipe, and then to provide for a throttled flow from said discharge pipe to said exhaust pipe; ram operated means for moving said element from its second to its third position at the end of a return stroke whereby said pump will operate against sufficient back pressure to sustain the weight of said ram means; a surge valve interposed between said main pressing chamber and said reservoir; and a differential hydraulic plunger associated with said surge valve for operating the latter and having its opposite sides respectively exposed to pressure in said ram-returning chamber and in said booster chamber.

In testimony whereof, we have hereunto subscribed our names.

WALTER ERNST.
HOWARD F. MacMILLIN.