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W. ERNST

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HYDRAULIC PRESS OPERATING CIRCUITS

Filed Oct. 19, 1931

2 Sheets-Sheet 2

Fig. 3.

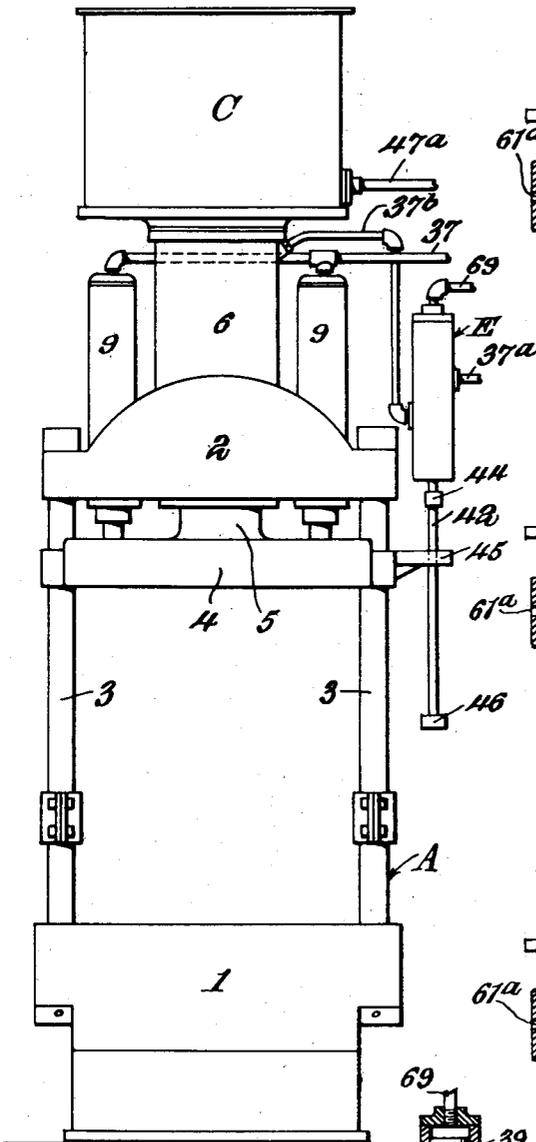


Fig. 4.

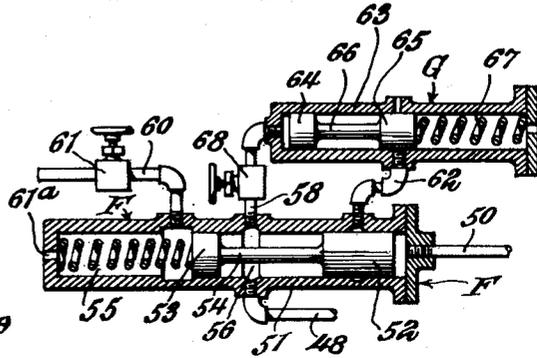


Fig. 5.

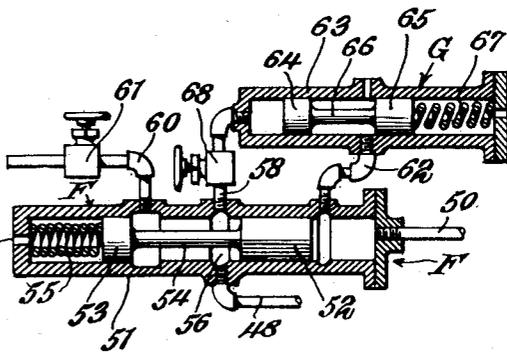


Fig. 6.

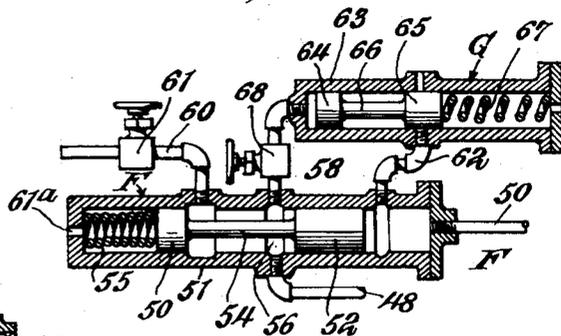
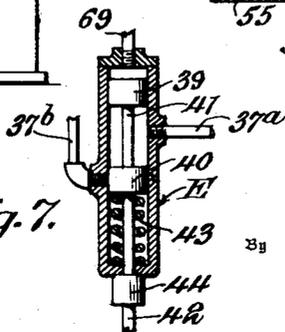


Fig. 7.



Inventor,  
*Walter Ernst,*  
By *Baldwin & Wight*  
his Attorneys.

# UNITED STATES PATENT OFFICE

1,956,758

## HYDRAULIC PRESS OPERATING CIRCUITS

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Mount Gilead, Ohio

Application October 19, 1931, Serial No. 569,785

13 Claims. (Cl. 138—17)

This invention relates to hydraulic press operating circuits and more particularly to valve mechanism for controlling the admission and release of pressure fluid to the press cylinder or cylinders.

In my copending application Serial No. 524,692, filed March 23, 1931, I have disclosed a press operating circuit so arranged that when a pressing stroke has been completed, the pump will exhaust part of the fluid from the main cylinder prior to opening of the surge valve, the effect being that pressure in the cylinder is reduced to such an extent that the surge valve can be subsequently opened against this reduced pressure without danger of a shock's occurring. I have found that the operating speed of the press and consequently its production capacity can be materially increased by providing means for augmenting the action of the pump in relieving the pressure in the main cylinder prior to the opening of the surge valve. In my prior arrangement, the rate at which main cylinder pressure is relieved is dependent entirely upon the rate of discharge of the pump, and since such rate is usually constant, it is not possible in the prior arrangement to vary the rate of main cylinder pressure release, and consequently the operating speed of the press can not be varied without changing the speed of the pump.

An object of the present invention is to provide a novel arrangement of pressure release valve means for effecting controlled augmenting of the action of the pump in the release of pressure fluid from the main cylinder prior to the opening of the surge valve. A further object is to provide a novel by-pass valve mechanism for effecting return of the pump discharge to a reservoir or the like during the release of pressure fluid by the release valve referred to. 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 diagrammatic view of a press operating circuit, certain parts being shown in section;

Figure 2 is a central vertical sectional view of a surge valve drawn to an enlarged scale;

Figure 3 is a view in front elevation of a press and certain of the valves and pipes connected thereto in accordance with the invention;

Figures 4, 5 and 6 are vertical sectional views of a release valve and a by-pass valve, each of these figures showing the positions occupied by the valves at different times during an operating cycle; and

Figure 7 is a detail sectional view of a control valve shown in closed position.

A practical embodiment of the invention is illustrated in the accompanying drawings which show a hydraulic press A of the downward pressure kind adapted to be operated by means of a reversible flow circuit including, in the present instance, a radial reversible flow pump B of a well known kind, and a surge tank or reservoir C mounted on top of the press. It will be understood that the reversible flow type of pump is shown by way of example and that a unidirectional discharge pump provided with a suitable reversing valve or valves may also be employed in carrying out the invention.

The press A includes a base 1, a press head 2 connected to the base by strain rods 3 and a platen 4 mounted for reciprocatory movements on the strain rods. A main ram 5 is connected to the platen and is mounted for movement within a main cylinder 6 having a main pressing chamber 7, and two double-acting auxiliary rams 8—8 are mounted for reciprocation in auxiliary cylinders 9—9, each of the latter having an auxiliary pressing or booster chamber 10 above the associated ram 8 and a ram returning chamber 11 below the ram. Rods 12—12 extend from the platen into the respective auxiliary cylinders for connecting the platen to the auxiliary rams 8—8.

A surge valve D of the kind disclosed in my copending application Serial No. 501,994 referred to above is provided for effecting relatively open communication between the pressing chamber 7 and the tank C.

The surge valve includes a cylindrical valve casing 13 positioned in an opening 14 in the top of the cylinder 6 and extending downwardly into the cylinder, the casing being provided with a peripheral flange 15 positioned in a seat 16 on the top of the cylinder. The valve casing is clamped in place by means of a clamping ring 17 which forms part of a separate casing member 18 disposed directly above the valve casing 13 and which is drawn downwardly against the flange 15 by means of suitable securing means such as bolts 19.

The valve casing 13 is formed with a bore 20, the upper end portion of which is of reduced diameter. This bore faces directly up toward the surge tank and communicates therewith by means of a plurality of openings 21 in the separate casing member 18. The bore communicates with the main cylinder by means of a plurality of radial passages 22 extending through the casing

and lying in a common horizontal plane disposed substantially at the vertical center of the casing 13. A valve element 23 is mounted for vertical sliding movements within the bore and is provided with a plurality of vertically extending ribs or wings 24 which cooperate with the reduced upper portion of the bore for guiding the valve element. This element is formed with a seat engaging surface 25 which is tapered outwardly and downwardly and which is adapted to seat upon a peripheral seat 26 formed in the bore 20, the seat being similarly tapered outwardly and downwardly, and being disposed above and immediately adjacent to the radial passages 22. The lower part of the valve element 23 is hollow and accommodates a spring 27 interposed between a plate 28 secured to the lower end of the casing 13 and a spring seat 29 formed in the hollow part of the valve element. The plate 28 is perforated as at 30 and is provided with a spring centering rib 31. The spring 27 is just strong enough to maintain the valve element in its upper position against its own weight and is readily yieldable to permit the element to move downwardly when the pressure on the lower side thereof is slightly less than that on the top side.

In operation, when the platen and main and booster rams are being moved downwardly under the action of high pressure fluid directed to the booster chambers only, as will be described, the vacating of the main cylinder by the main ram will tend to create a suction in this cylinder. As soon as this takes place, the static pressure due to the head of fluid in the surge tank will move the valve element 23 downwardly and fluid will flow downwardly from the surge tank through the openings 21, the spaces between the ribs 24 and thence through the radial passages 22 and into the cylinder. It will be observed that with the exception of the change from downward to outward flow at the plane of the radial passages 22, the fluid has a direct and unobstructed path over which to travel in passing from the surge tank to the cylinder so that a minimum of resistance to fluid flow is offered. The drag on the descent of the platen and rams usually due to restricted flow is therefore reduced to a minimum and more efficient operation of the press is made possible.

In certain kinds of press operating circuits, such as that illustrated in the accompanying drawings, it is necessary that the surge valve be opened when fluid is introduced into the push back cylinders to effect a return movement of the platen. This is necessary in order to provide for the expelling from the cylinder of the fluid remaining therein at the end of a working stroke. For this purpose, I provide a pressure actuated plunger 31 mounted for vertical sliding movements in a bushing 32 in the separate casing member 18, the upper end of the plunger extending into a pressure chamber 33 closed at its upper end by means of a plate 34. A spring 35 is interposed between a head 36 on the upper end of the plunger 31 and the top face of the bushing, this spring serving to normally maintain the plunger out of contact with the top of the movable valve element 23. When a pressing stroke has been completed, fluid under pressure is admitted to the chamber 33 to act on the plunger 31 for forcing the latter downwardly to engage and open the surge valve element 23. Since the surge valve is preferably large in order to provide for most efficient prefilling and exhausting of the main cylinder, considerable

force would be required to open the valve against the high pressure in the main cylinder.

In accordance with the present invention a novel circuit arrangement including a pressure release valve is provided for effecting a release of pressure fluid from the main cylinder prior to the opening of the surge valve.

The circuit shown in the accompanying drawings and arranged in accordance with the present invention includes the press A, the pump B, the surge tank C and connecting piping including a novel arrangement of valve mechanism to be described. A pipe 37 leads from one side of the pump to the booster chambers 10 of the auxiliary cylinders 9 for supplying fluid under pressure to drive the platen downwardly during the first part of a pressing stroke. A branch pipe 37a leads from the pipe 37 to a control valve E, and a second branch pipe 37b in turn leads from the valve E to the pressing chamber 7 of the main cylinder.

The valve E includes a casing 38 and a piston valve element mounted therein for vertical sliding movements, this valve element comprising spaced heads 39 and 40 connected by a reduced portion 41 and a stem 42 extending through the bottom end of the valve casing. A spring 43 interposed between the bottom end of the casing and the head 40 constantly urges the piston valve to its upper position, i. e., the position shown in Figure 7, this upward movement of the piston valve being limited by a collar 44 on the stem 42 which is adapted to engage the lower end of the valve casing. The stem 42 extends downwardly and slidably through a lug 45 on the platen and at its lower end is provided with a head 46 adapted to be engaged by the lug 45 when the platen reaches a predetermined point during its downward travel, after which continued movement of the platen will serve to move the piston valve from its Figure 7 to its Figure 1 position.

When the valve is in its upper and Figure 7 position, the flow through the pipe 37b is cut off by the head 40, which it will be observed constitutes the actual flow controlling part of the valve, the head 39 serving to balance the valve and also serving a further purpose to be later described.

In operation, assuming the pump to be discharging through the pipe 37, fluid will be delivered to the upper ends of the auxiliary cylinders by moving the platen downwardly, no fluid being delivered by the pump to the main cylinder at this time because of the pipe 37b being cut off from communication with the pipe 37a by the valve head 40. During descent of the platen, fluid will be drawn from the surge tank into the main cylinder through the medium of the surge valve D to effect the desired prefill of the cylinder. When the platen has reached a predetermined point during its downward travel, the piston valve of the control valve E will be moved to its Figure 1 position in the manner described above, so that fluid will be delivered from the pipe 37 through the pipe 37a, the valve E, and the pipe 37b to the main cylinder as well as through the pipe 37 to the booster cylinders, after which the pressing stroke will be completed in the usual manner.

A pipe 47 is connected to provide communication between the opposite side of the pump and the ram returning chambers 11 of the auxiliary cylinders, and a branch pipe 47a provides communication between the platen returning chambers and surge tank, a check valve 48 being connected at the end of the branch pipe 47a and be-

ing arranged to permit flow of fluid from the tank into the branch pipe 47a, but not in the reverse direction. A branch pipe 49 connected to the branch 47a provides communication between the latter and the chamber 33 of the casing 18 disposed above the surge valve, the arrangement being such that the chamber 33 is always under the same fluid pressure as are the ram returning chambers of the auxiliary cylinders.

10 A branch pipe 50 leads from the pipe 47a to one end of the casing 51 of a pressure release valve F which is arranged to control direct communication between the pressing chamber 7 and the tank or reservoir. This valve includes the casing 51 and a balanced piston valve mounted therein for sliding movements and comprising spaced heads 52, 53 connected by a reduced portion 54 and a spring 55 interposed between the head 53 and the adjacent end of the casing for urging the piston valve to its Figure 1 position. At an intermediate point the casing is formed with an internal annular passage 56 with which communicates a pipe 57 connected to the pressing chamber and also a pipe 58, the purpose of which will be later described. A second annular passage 59 is formed in the valve casing to the left of the annular passage 56 as viewed in Figure 1 and communication between this passage and the surge tank is afforded by means of the pipe 60 interposed in which is an adjustable choke valve 61 which is adapted to be adjusted to variably restrict flow of fluid through the pipe 60. Communication between the pipe 57 and the pipe 60 is controlled by the head 53 of the piston valve, it being noted that 35 when said valve is in the position shown in Figure 1 communication between the pipes 57 and 60 is cut off, while when the valve is moved to the left to its Figures 5 and 6 position, the pipes named communicate with each other. A vent 61a is 40 formed in the end of the valve casing to prevent trapping of air or fluid therein.

The choke valve 61 functions to prevent fluid under pressure from escaping from the main cylinder so rapidly as to cause an objectionable 45 shock. It is desirable that fluid be released through the valve F in order to augment the action of the pump in relieving pressure in the main cylinder, but if the release took place too suddenly, a shock might occur. By adjusting the choke 50 valve 61 the rate of release through the valve G may be fixed so that such shocks will be prevented and yet the speed of pressure relief will be considerably higher than that due to the action of the pump alone.

55 A pipe 62 is connected at one end to the valve casing 51 adjacent the right hand end thereof, and at its other end is connected to communicate with the interior of the casing 63 of a by-pass valve G, this valve comprising the casing 63, a 60 piston valve comprising spaced heads 64, 65 connected by a reduced portion 66 and a spring 67 interposed between the head 65 and the right hand end of the casing. The pipe 58 previously referred to leads from the release valve to the left hand end of the by-pass valve G for admitting fluid under pressure from the release valve to the space between the head 64 of the by-pass valve and the adjacent end of the casing 63. A choke valve 68 is interposed in the pipe 58 for restricting 70 flow of fluid therethrough, this valve being preferably adjusted to present more resistance to flow of fluid than does the choke valve 61, for a purpose to be pointed out.

75 The by-pass valve G serves to control discharge of the pump to the surge tank. Normally

the valve head 65 is disposed in its Figure 4 and Figure 6 position to cut off communication between the pipe 62 and the surge tank. When moved to its Figure 1 and Figure 5 position, in a manner to be described, communication between the pipe 62 and the surge tank is provided for. However, in order that the pump discharge be by-passed to the surge tank, it is also necessary that the head 52 of the pressure release valve be moved to the left to its Figure 5 and Figure 6 85 position, so that fluid may flow from the branch pipe 47a through the branch 50 and pipe 62 into the casing 63 of the by-pass valve.

As will be later set forth, it is desirable that the control valve E be maintained open during a return stroke of the platen. To this end a branch pipe 69 is connected from the branch pipe 47a to the upper end of the control valve casing 38. While fluid is being delivered through the pipe 47 to the platen returning chambers 11, fluid pressure will be exerted through the branch pipe 47a and the pipe 69 on the top of the head 39 thereby holding the piston valve down in its Figure 1 position. It will be understood that in the illustrated embodiment of the invention, the press 100 is reversed by reversing the direction of flow of fluid through the pump B. The pump is provided with a suitable flow control device 70 which forms no part of the present invention, and since several kinds of devices for controlling the direction 105 and volume of flow through radial pumps of the type illustrated are well known in the art, the details of the device 70 are not shown or described. Where automatic operation of the press is desired, an arrangement embodying the present invention may include automatic pump control mechanism of the kind disclosed in my United States Patent No. 1,711,378, issued April 30, 1929.

In order that the functions of the circuit and various included valve mechanism comprising the 115 invention be readily understood, a complete operating cycle of the circuit described above will be briefly set forth. It will be assumed that the platen is in its upper position and that the pump is on neutral, i. e., set for no discharge. In this 120 position of the platen, the surge valve will be closed as shown in Figure 2, the control valve E will be in its upper position, as shown in Figure 7, the release valve F and by-pass valve G will be in the respective positions shown in Figure 4. To 125 produce a working stroke of the platen, the pump is set to discharge through the pipe line 37. The pump will draw fluid from the surge tank through the check valve 48 and the branch pipe 47a and also from the platen returning chambers 11 130 through the pipe 47. Fluid will be delivered to the booster chambers 10 of the auxiliary cylinders by means of the pipe 37, and the platen will then be moved downwardly under the action of the auxiliary rams 8. When the lug 45 of the platen 135 engages the head 46 on the control valve stem 42, the control valve will be opened, i. e., will be moved to its Figure 1 position. Fluid will then flow from the pipe 37 through the branch pipe 37a, the control valve E and the branch pipe 37b 140 into the main cylinder, producing a rise of pressure therein and acting to close the surge valve. The platen will then be driven downwardly under the combined action of the main and auxiliary rams. 145

When the desired pressing action has been effected, the pump is reversed so as to deliver fluid in the opposite direction, that is, through the pipe 47 to the ram returning chambers 11 for raising the latter and the platen. At this 150

time, the pump will draw fluid through the pipe 37 from the booster chambers 10 of the cylinders 9. Since the valve E is held open immediately after reversal of the pump, the latter will also draw fluid from the main cylinder through the pipe 37b, the valve casing 38, the pipe 37a and the pipe 37. When the pump is arranged to discharge through the pipe 47, it will likewise force pressure fluid through the branch pipe 47a and the branch 49 into the chamber 33 of the casing 18 above the surge tank tending to force the plunger 31 downwardly to open the valve 23. However, immediately after reversal of the pump, the fluid in the pressing chamber 7 is under very high pressure which, acting against the lower face of the valve 23, opposes downward movement thereof so that the plunger 31, which is of relatively small area as compared with the valve element 23, can not act to open the surge valve. Fluid pressure will, however, be exerted through the branch pipe 47a and the branch pipe 50 to act on the right hand end of the head 52 of the pressure release valve, thereby forcing the latter to the left against the urge of the spring 55 until the valve has reached the position shown in Figure 5. Fluid under pressure in the pressing chamber 7 will then be released therefrom through the pipe 57, the release valve F, the pipe 60 and the choke valve 61, this valve having been adjusted to present sufficient resistance to the flow of fluid through the pipe 60 to effect the desired rate of release of pressure fluid from the chamber 7. The high pressure existing in the pressing chamber will be transmitted through the pipe 57, the casing of the release valve, the pipe 58 and the choke valve 68 and will act on the head 64 of the by-pass valve, so as to move the latter to the position shown in Figure 5 which figure shows the release valve and by-pass valves in the positions occupied immediately after reversal at the end of a pressing stroke. At this time and during release of pressure fluid from the chamber 7, fluid discharged by the pump will be by-passed to the surge tank through the medium of the branch 47a, the branch 50, the pipe 62, the interior of the by-pass valve G and the passage 63 in the casing of this valve. It will be noted that in order to effect by-passing of the pump discharge, it is necessary that the pressure existing in the pressing chamber move the by-pass valve G to its open or Figure 5 position and that also the pressure existing in the returning chambers 11, and hence in the pipe 50, maintain the release valve F in its open or Figure 5 position. In other words, the by-passing of the pump discharge is dependent upon the pressures existing in both the pressing chamber and the ram returning chambers. The pressure in the pressing chamber 7 will gradually drop, fluid being released from said chamber through the pipe 57, the release valve F and the pipe 60, and consequently the pressure acting on the head 64 of the by-pass valve will eventually drop to such a point as will enable the spring 67 to move the piston valve of the by-pass valve to its Figure 6 position wherein the head 65 cuts off fluid through the pipe 62. The choke valve 68 in the pipe 57 is so arranged as to maintain the piston valve of the by-pass valve open in its Figure 5 position until the pressure in the pipes 57 and 60 has been reduced to such a point as will permit the pressure actuated plunger 31 to open the surge valve and place the pressing chamber 7 in communication with the surge tank. The pump will then no longer discharge fluid through the

by-pass valve, but will deliver fluid to the platen returning chambers 11 to move the auxiliary rams and the platen upwardly, fluid in the pressing chamber being expelled through the surge valve to the tank. At this time, fluid under pump pressure will be conducted through the branch pipes 47a and 69 to the upper end of the control valve E, and acting upon the head 39 thereof will maintain the valve in its open or Figure 1 position. With the control valve open, the surplus fluid contained in the upper ends of auxiliary cylinders will escape through the pipe 37 and branch pipe 37a, the control valve casing, the branch pipe 37b, the main cylinder and the surge valve, finally passing back to the surge tank.

When the ram has reached the top of its stroke, the pump will then be reversed so as to deliver fluid under pressure through the pipe 37. Pressure in the branch pipe 47a and consequently in the upper end of the control valve will then drop, permitting the spring 43 to return said valve to its closed position, as shown in Figure 7. At the same time, the spring 55 will move the piston valve of the release valve to its Figure 1 position, since the pressure in the pipe 50 will have dropped. The pump will then draw fluid through the check valve 48 and the branch pipe 47a and will deliver fluid under pressure through the pipe 37 causing the ram to be moved downwardly, and a second pressing operation will be completed in the manner already described.

In some hydraulic presses, the first part of the pressing stroke is effected by a gravitational descent of the platen, no booster cylinders being provided. It is obvious that the pressure release valve and by-pass valve of the present invention can be used to effect the same results when connected in circuit with such a press as they do in the circuit already described. For example, in a modification of the circuit previously described, the upper ends of the auxiliary cylinders 9—9 are open to the atmosphere and the pipes 37a and 37b and the valve E are omitted; the pipe 37 being directly connected to the main or pressing chamber by means of a pipe 37c shown in dotted lines in Figure 1. In operation, with the modified form of circuit, the pump will deliver fluid to the pressing chamber 7 during the entire pressing stroke, the prefilling of the chamber being effected in part by the pump and in part by the gravitational descent of the ram and consequent flow of fluid from the surge tank through the surge valve D. When high pressure has built up in the pressing chamber and the pump reversed, the pressure release valve F and the by-pass valve will function in the same manner as was set forth in connection with the circuit previously described as including the booster chambers.

From the foregoing, it will be apparent that in accordance with my invention, it is possible to obtain a more rapid release of pressure from the main cylinder than has heretofore been possible, and consequently the operating speed of the press is increased. By virtue of the adjustable choke valve 61, it is possible to regulate the operating speed without varying the rate of discharge of the pump. The form of the invention shown and described herein is considered a practical embodiment of the invention, but it will be understood that various modifications and changes may be made in the actual structure disclosed without departing from the spirit of the invention as defined in the appended claims.

I claim:

1. The combination with a hydraulic press having cylinder means including pressing and ram-returning chambers and cooperating ram means mounted therein for reciprocatory movements; of a pump; means connecting said pump with said cylinder means for furnishing pressure fluid to said chambers; a reservoir; a surge valve for controlling communication between said reservoir and pressing chamber; a pressure release valve connected to said pressing chamber and being responsive to pressure in said ram-returning chamber for effecting release of pressure fluid from said pressing cylinder prior to opening of said surge valve; and a by-pass valve connected between said returning chamber and said reservoir and being responsive to pressure in said pressing cylinder for effecting discharge of the pump to the reservoir during release of pressure from said pressing chamber and prior to opening of said surge valve.

2. The combination with a hydraulic press having cylinder means including pressing and ram-returning chambers and cooperating ram means mounted therein for reciprocatory movements; of a pump; means connecting said pump with said cylinder means for furnishing pressure fluid to said chambers; a reservoir; a surge valve for controlling communication between said reservoir and pressing chamber; a pressure release valve connected to said pressing chamber and being responsive to pressure in said ram-returning chamber for effecting release of pressure fluid from said pressing cylinder prior to opening of said surge valve; a choke valve in series with said pressure release valve and restricting flow there-through; a pressure responsive by-pass valve connected between said returning chamber and said reservoir; a hydraulic connection between said pressing chamber and said by-pass valve; and a second choke valve interposed in said connection and offering less restriction to fluid flow than does said first named choke valve.

3. The combination with a hydraulic press including cylinder means having pressing and ram-returning chambers and ram means mounted therein for reciprocatory movements; of a pump; a reservoir; means forming a hydraulic circuit with said pump, said reservoir and said cylinder chambers for operating said ram means; a surge valve for affording communication between said pressing chamber and said reservoir; a pressure release valve connected between said pressing cylinder and said reservoir and being operable to open position by pressure in said returning chamber; and a by-pass valve connected between said returning chamber and said reservoir and being operable to open position by pressure in said pressing chamber.

4. The combination with a hydraulic press including cylinder means having a pressing chamber and a ram-returning chamber of less capacity than said pressing chamber, and cooperating ram means; of a reservoir; a surge valve for controlling communication between said pressing chamber and said reservoir; a pump; a hydraulic connection between said returning chamber and said pump through which said pump is arranged to discharge fluid during a return stroke; a hydraulic connection between said pressing chamber and said pump through which fluid in said pressing chamber is discharged partially to said pump during a return stroke; a pressure release valve connected to said pressing chamber for augmenting the discharging action of said pump prior to opening of said surge valve; and by-

pass valve means connected between said returning chamber and said reservoir and being controlled by pressure in both the pressing and return chambers.

5. The combination with a hydraulic press including a platen, a main cylinder and cooperating main ram connected to said platen, auxiliary cylinder means having booster and ram-returning chambers, double-acting auxiliary ram means therein, and a connection between said auxiliary ram means and said platen; of a reservoir; a surge valve connected between said main cylinder and reservoir; a pump; a hydraulic connection between said pump and said ram-returning chamber; a second hydraulic connection between said pump and said booster chamber; a pressure responsive valve interposed between said booster chamber and said main cylinder and being biased to closed position; and a hydraulic connection between said pressure responsive valve and said ram-returning chamber for supplying fluid under pressure to the valve to open the latter during a return stroke.

6. The combination with a hydraulic press including a platen, a main cylinder and cooperating main ram connected to said platen, an auxiliary cylinder having booster and ram-returning chambers, a double-acting auxiliary ram therein, and a connection between said auxiliary ram and said platen extending through said ram-returning chamber; of a reservoir; a surge valve connected between said main cylinder and reservoir; a pump; a hydraulic connection between said pump and said ram-returning chamber; a second hydraulic connection between said pump and said booster chamber; a valve interposed between said booster chamber and said main cylinder; a yieldable means for urging said last-named valve to closed position; platen actuated means for opening said valve during part of a pressing stroke; and means responsive to pressure in said returning chamber for holding said valve open during a return stroke.

7. The combination with a hydraulic press including a platen, a main cylinder and cooperating main ram connected to said platen, an auxiliary cylinder having booster and ram-returning chambers, a double-acting auxiliary ram therein, and a connection between said auxiliary ram and said platen extending through said ram-returning chamber; of a reservoir; a surge valve connected between said main cylinder and reservoir; a pump; a hydraulic connection between said pump and said ram-returning chamber; a second hydraulic connection between said pump and said booster chamber; means responsive to pressure in said returning chamber for opening said surge valve; and a valve interposed between said booster chamber and said main cylinder and being adapted to be held open by pressure in said ram-returning chamber during a return stroke.

8. The combination with a hydraulic press including a platen, a main cylinder and cooperating main ram connected to said platen, an auxiliary cylinder having booster and ram-returning chambers, a double-acting auxiliary ram therein, and a connection between said auxiliary ram and said platen extending through said ram-returning chamber; of a reservoir; a surge valve connected between said main cylinder and reservoir; a pump; a hydraulic connection between said pump and said ram-returning chamber; a second hydraulic connection between said pump and said booster chamber; means responsive to pressure

in said returning chamber for opening said surge valve; a valve interposed between said booster chamber and said main cylinder and being adapted to be held open by pressure in said ram-returning chamber during a return stroke; a pressure release valve connected between said main cylinder and said reservoir and being operable to open position by pressure in said returning chamber; and a by-pass valve connected between said returning chamber and said reservoir and being operable to open position by pressure in said main cylinder.

9. The combination with a hydraulic press including a platen, a main cylinder and cooperating main ram connected to said platen, auxiliary cylinder means having booster and ram-returning chambers, and cooperating auxiliary ram means therein, said booster chamber being of greater capacity than said ram-returning chamber; of a reservoir; a surge valve connected between said main cylinder and reservoir; a pump; a hydraulic connection between said pump and said ram-returning chamber; a second hydraulic connection between said pump and said booster chamber; a pressure responsive valve interposed between said booster chamber and said main cylinder and being biased to closed position; and a hydraulic connection between said pressure responsive valve and said ram-returning chamber for supplying fluid under pressure to the valve to open the latter during a return stroke.

10. The combination with a hydraulic press including cylinder means having pressing and ram-returning chambers and ram means mounted therein for reciprocatory movements; of a pump; a reservoir; means forming a hydraulic circuit with said pump, said reservoir and said cylinder chambers for operating said ram means; a surge valve for affording communication between said pressing chamber and said reservoir; and a by-pass valve connected between said returning chamber and said reservoir and being operable to open position by pressure in said pressing chamber.

11. The combination with a hydraulic press having cylinder means including pressing and ram-returning chambers and cooperating ram means mounted therein for reciprocatory movements; of a pump; means connecting said pump

with said cylinder means for furnishing pressure fluid to said chambers; a reservoir; a surge valve for controlling communication between said reservoir and pressing chamber; and release valve means for relieving pressure in said pressing chamber at a controlled low rate for facilitating opening of said surge valve, said means including a restricted passage between said pressing chamber and said reservoir of such small size as to present sufficient resistance to flow of fluid to retard the flow substantially, thereby preventing water hammer, and means connected to said release valve means and being responsive to an increase in pressure in said ram-returning chamber for moving said release valve to open position.

12. The combination with a hydraulic press having cylinder means including a pressing chamber and a ram returning chamber and cooperating ram means mounted therein; of a pump; means connecting said pump with said chambers for furnishing pressure fluid thereto; a reservoir; a surge valve for controlling relatively open communication between said reservoir and said pressing chamber; means for relieving pressure in said pressing chamber at a controlled low rate including a restricted passage between said chamber and said reservoir of such small size as to present sufficient resistance to flow of fluid to retard the flow substantially, thereby preventing water hammer; and a valve controlled by-pass between said returning chamber and said reservoir.

13. The combination with a hydraulic press having cylinder means including pressing and ram-returning chambers and cooperating ram means mounted therein; of a pump; means connecting said pump with said cylinder means for furnishing pressure fluid to said chambers; a reservoir; a surge valve for controlling communication between said reservoir and pressing chamber; a pressure release valve connected to said pressing chamber for effecting release of pressure fluid from said pressing cylinder prior to opening of said surge valve; and a by-pass valve connected between said returning chamber and said reservoir for effecting discharge of the pump to the reservoir during release of pressure from said pressing chamber and prior to opening of said surge valve.

WALTER ERNST.

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