Dec. 26, 1933. W. ERNST 1,940,668

HYDRAULIC PRESS SURGE CONTROL

Filed March 23, 1931 2 Sheets-Sheet 1

Fig. 1.

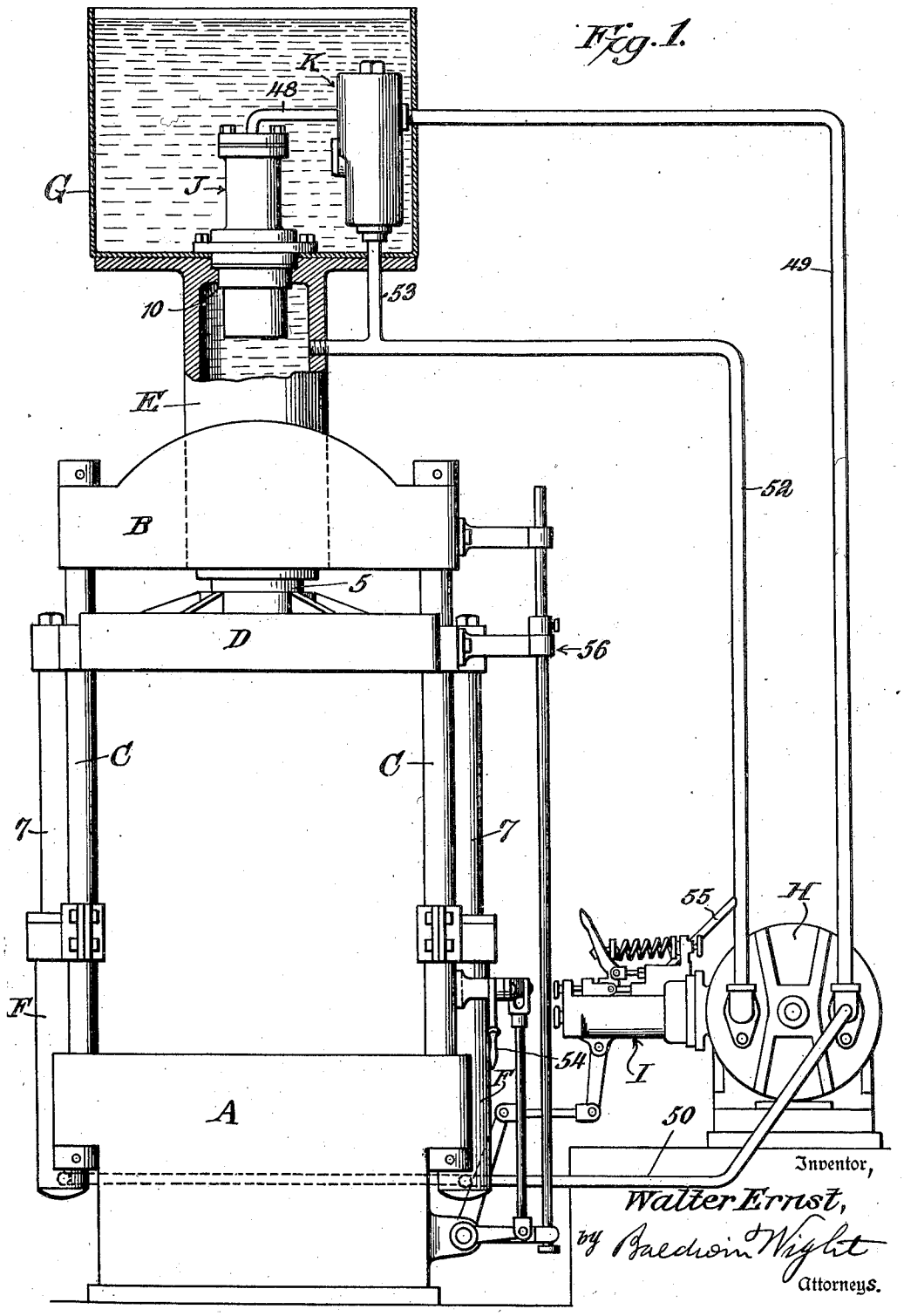

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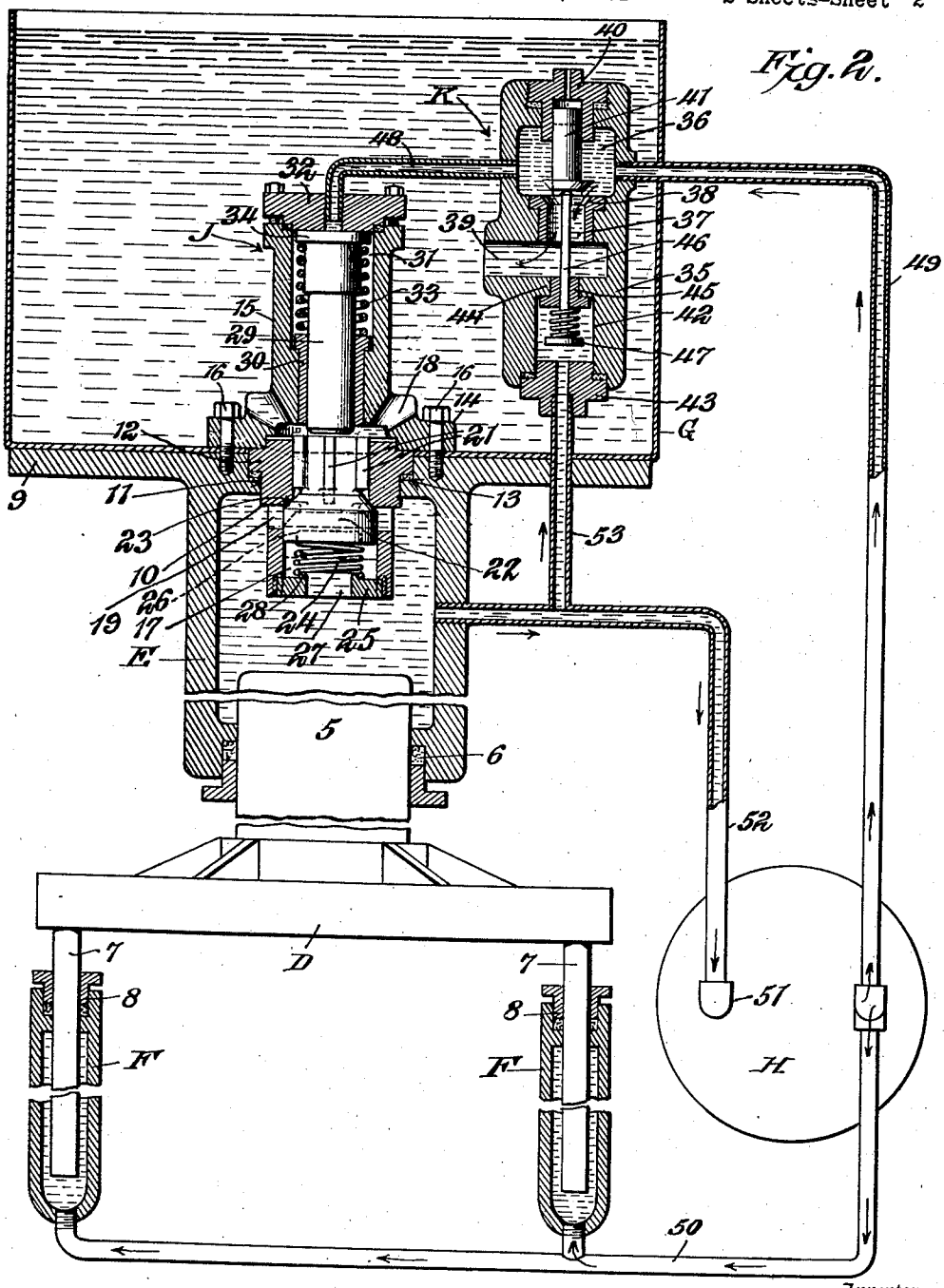
Fig. 2.



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1,940,668

HYDRAULIC PRESS SURGE CONTROL

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6 Claims. (Cl. 138—17)

This invention relates to hydraulic presses or other similar machinery in which a platen is moved in one or opposite directions by hydraulic pressure applied at different stages of the travel of the platen to rams of different areas to cause the platen to travel faster or slower during certain phases of operation.

Such an apparatus is exemplified in the hydraulic press shown herein and wherein is embodied a platen, a main cylinder and large area ram to force the platen in one direction and a push-back cylinder and small area ram to force the platen in the opposite direction, the cylinders being connected in a common hydraulic circuit including a pump which is reversible to cause one or the other of the rams to control movement of the platen. The differential in ram displacements during the phases of operation of apparatus of this type makes it necessary to provide a surge tank and a surge valve connected in the pump circuit so that the pump may at times draw upon the tank supply, and so that pressure fluid may surge back and forth between the tank and the main cylinder to compensate for the displacement differential occasioned by reversal of the pump.

It is desirable to employ a surge valve of large area so as to reduce to the minimum resistance to flow between the main cylinder and the surge tank. Naturally, the larger the area of the surge valve, the greater will be the resistance to opening movement of the valve set up by pressure within the main cylinder. To force this valve open suddenly in order to free fluid pressure within the main cylinder and thus enable the push-back ram to be operated, would result in a considerable shock to the apparatus which is very undesirable.

Therefore, it is an object of my present invention to provide a novel means for first bringing about a reduction of pressure in the main cylinder and thereafter opening the surge valve and permitting pressure fluid to flow from the main cylinder into the surge tank.

In its detailed nature the invention resides in the provision in a hydraulic press embodying a platen, a main cylinder and large area ram to project the platen, an auxiliary cylinder and small area ram to retract the platen, a surge tank, a surge valve controlling communication between the main cylinder and the tank and capable of being opened automatically when the platen is projected, a pressure actuated plunger for forcing the surge valve open during the retractive movement of the platen, and a reversible pump having its pair of composite intake and output ports connected in circuit with the main and auxiliary cylinders; of a surge control unit having a pressure chamber connected by one pipe with the pump port connected with the auxiliary cylinder, and by another pipe in communication with the pressure actuated plunger, said pressure chamber being in communication through a check valve with the interior of the surge tank, and a check valve unseating plunger communicating through a branch pipe line with the pressure circuit line between the main cylinder and the remaining composite pump port so that the plunger will be pressure actuated to hold the check valve unseated whenever pressure is built up in the main cylinder and release and permit seating of the check valve when pressure in the main cylinder is suitably reduced to cause pump pressure to be exerted on the pressure actuated plunger for the purpose of unseating the surge valve.

Another object of the invention is to provide a surge control unit so constructed as to adapt it for being mounted directly in the surge tank.

Other objects will in part be obvious and in part be pointed out hereinafter.

The invention still further resides in the novel details of construction, the combination and arrangement of parts, all of which will be first fully described in the following detailed description, then be particularly pointed out in the appended claims, reference being had to the accompanying drawings, in which:—

Figure 1 is a somewhat diagrammatic side elevation illustrating the invention in use upon a hydraulic press, parts being broken away and in section;

Figure 2 is an enlarged view illustrating the main cylinder, the surge tank, the surge valve and the surge control unit in detail section, the remainder of the operating circuit being indicated diagrammatically; the position of the parts at the beginning of the platen push-back function being illustrated in full lines, and the change of position of the valves gradually effected by reduction of pressure in the main cylinder being illustrated in dotted lines.

The invention may be embodied in various types of presses employed for various purposes, but is illustrated in connection with a press of the four column downward pressure type including push-back ram and cylinder equipments for returning the platen and control devices for causing the platen to operate through a cycle, name-

ly, an advance or working stroke and a retractive or return stroke.

There is shown a base A and a head B which is supported upon the base by four strain rods C in the usual manner. The platen is designated D and the main cylinder E is supported upon the head, while the push-back cylinders F may be supported by the strain rods. A surge tank G is mounted directly upon the main cylinder E. A reversible pump H serves to suitably force the pressure fluid through the pressure circuit under control of the control devices indicated at I in order to operate the platen through successive cycles when the press is in actual use.

All of the equipment above-described is more or less conventional and the specific details thereof form no part of my present invention. The pump is preferably of the Hele-Shaw type such as is disclosed in U. S. Letters Patent No. 1,250,170, issued December 18, 1917, and the control device, generally designated I, is disclosed in detail in U. S. Letters Patent No. 1,711,378 issued April 30, 1929.

In the drawings, 5 designates the main ram which is of large area and operates in the main cylinder E, passing through a suitable gland 6 for connection with the platen D. Small area push-back rams 7 are operable in the push-back cylinders F and project through glands 8 for connection with the platen. The general operation of presses of this type is well understood. The platen initially proceeds downwardly under action of gravity until it comes in contact with the work when pressure will be built up and the pressing function of the platen accomplished thereby in the usual manner. As described in Patent 1,711,378, above referred to, the pump is automatically reversed when a certain pressure is built up in the main cylinder and the pump then acts to bring the push-back rams into operation for forcing the platen upwardly. The relative areas of the main and push-back rams provide for a relatively slow working stroke and a relatively fast return stroke of the platen in the usual manner.

The surge tank G is flange connected as at 9 directly upon the main cylinder E and the surge tank communicates with the interior of the main cylinder through the relatively large opening controlled by the surge valve generally designated J. It is desirable that this surge valve should have the largest possible area so that when communication is opened between the surge tank and the main cylinder the freest possible flow of fluid is provided for to overcome any tendency toward a throttling effect.

The surge valve disclosed herein comprises a cylindrical valve casing 10 positioned in an opening 11 in the top of the cylinder E and extending downwardly into the cylinder, the casing being provided with a peripheral flange 12 positioned in a seat 13 on the top of the cylinder. The valve casing is clamped in place by means of a clamping ring 14 which forms part of a separate casing member 15 disposed directly above the casing 10 and which is drawn downwardly against the flange 12 by means of suitable securing bolts 16.

The valve casing 10 is formed with a bore 17, the upper end portion of which is of reduced diameter. This bore faces directly toward the surge tank and communicates therewith by means of a plurality of openings 18 in the separate casing member 15. The bore communicates with the main cylinder by means of a plurality of radial passages 19 extending through the casing and lying in a common horizontal plane disposed substantially at the vertical center of the casing 10.

A valve element 20 is mounted for vertical sliding movements within the bore and is provided with a plurality of vertically extending ribs or wings 21 which cooperate with the reduced upper portion of the bore for guiding the valve element. This element is formed with a seat engaging surface 22 which is tapered outwardly and downwardly and which is adapted to seat upon a peripheral seat 23 formed in the bore 17, the seat being similarly tapered outwardly and downwardly and being above and immediately adjacent to the radial passages 19.

The lower part of the valve element 20 is hollow and accommodates a spring 24 interposed between a plate 25 secured to the lower end of the casing 10 and a spring seat 26 formed in the hollow part of the valve element. The plate 25 is perforate as at 27 and is provided with a spring centering rib 28. The spring 24 is just strong enough to maintain the valve element in its upper position against its own weight and is readily yieldable to form the element to move outwardly when the pressure on the lower side thereof is slightly less than that on the upper side.

In operation when the platen moves downwardly, 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 20 downwardly and fluid will flow downwardly from the surge tank 3 through the openings 18, the spaces between the ribs 21 and thence through the radial passages 19 into the cylinder E.

It will be observed that with the exception of the change from downward to outward flow at the plane of radial passages 19, the fluid has a direct and unobstructed path through which to travel in passing from the surge tank to the main cylinder so that a minimum of resistance to fluid flow is offered. The drag or the descent of the platen and the throttling effect due to the usual restriction of surge flow is therefore reduced to a minimum and more efficient operation of the press is made possible. It will also be observed that due to the particular arrangement of the valve engaging surface 23, the fluid is deflected smoothly forward through passages 19 so that no seriously abrupt changes in the direction of fluid flow take place.

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 F to effect the return movement of the platen. This is necessary in order to provide for the expelling from the cylinder E of the fluid remaining therein at the end of a working stroke. In order to accomplish this I provide a pressure actuated plunger 29 mounted for vertical sliding movements in a bushing 30 in the separate casing member 15, the upper end of the plunger extending into a pressure chamber 31 closed at its upper end by means of a plate 32. A spring 33 is interposed between a head 34 on the upper end of the plunger 29 and the top face of the bushing, this spring serving to normally maintain the plunger out of contact with the movable valve element 20.

As before stated the retractive or upward travel of the platen D, occasioned by the push-back cylinders F and rams 7, is much faster than the

downward travel of the platen and in view of the large area of the main ram 5 and the capacity of the main cylinder E, provision must be made for releasing a considerable quantity of the fluid from the cylinder E in advance of the now relatively fast travelling ram 5. As before explained this is accomplished by opening the surge valve. It will be obvious, however, that any sudden opening of the surge valve would subject the whole system to considerable shock which is detrimental and, therefore, undesirable. It is an object of my present invention to provide means for assuring a gradual opening of the surge valve. I accomplish this by use of mechanism which I will now proceed to describe.

In order to thus control the operation of the surge valve I provide a surge valve operation control unit K, and I prefer to mount this unit directly in the surge tank so as to avoid the necessity of piping connections between the unit and the surge tank.

The control unit K comprises a casing 35 having a pressure chamber 36 communicating through a valve controlled passage 37 including a seat 38 with a chamber 39 which communicates directly with the fluid within the surge tank G. The unit may, of course, be mounted outside the tank and indirectly connected therewith by a pipe connected with the chamber 39 if desired.

The casing 35 is provided at its upper end with a threaded bore to receive a vented valve guide cap 40 which serves as a guide for the check valve 41 which cooperates with the seat 38 and which is biased to closed position, in the present instance by gravity. The casing is also provided with a lower bore 42 closed by a screw cap 43 and providing a pressure chamber which is separated from the chamber 39 by a wall 44. The wall 44 is equipped with a guide 45 to slidably and snugly receive the plunger 46 which projects upwardly through the guide 45 into close proximity with the valve 41 and is provided at its lower end with a head 47, the latter being engaged by a spring interposed between it and the wall 44 and serving to hold the plunger against the screw cap 43 and with its upper end just out of contact with the valve 41. The control unit chamber 36 is in constant communication with the pressure chamber 31 of the surge valve casing through a pipe 48, and through a pipe 49 with one of the combined inlet and outlet ports of the reversible pump H. This same port of the pump is connected by a pipe line 50 with the push-back cylinders as illustrated in Figure 2 of the drawings. The other pump port 51 is connected by a pipe line 52 with the main cylinder E, a branch 53 of this pipe being connected to communicate, through a duct provided in the screw cap 43, with the pressure chamber provided by the lower bore 42 so that pressure within the pipe line 52, 53 will act against the plunger 46, 47.

The control mechanism generally designated I and disclosed in detail in Patent 1,711,378 hereinbefore referred to is designed to cause the platen to operate through a complete working stroke and retractive stroke cycle. The control lever of this mechanism, generally designated 54, when depressed, sets into motion the mechanism for causing the reversible pump to operate in a direction for forcing the platen, which has previously travelled into engagement with the work by action of gravity, to actively press the work positioned thereunder. As will be evident after perusal of the patent just above referred to, the pressure built up during this operative function of the platen will automatically act to effect a reversal of the pump and thereby bring the push-back cylinders F into control for retracting or elevating the platen. The pressure pipe line for bringing about communication of this built-up pressure from the main cylinder to pump is generally indicated at 55 and the trip devices disclosed in detail in the patent referred to and which serve to readjust the pump to throw it into neutral when the platen has reached a suitable retracted position are generally indicated at 56. Through this mechanism described as stated in U. S. Letters Patent No. 1,711,378 of April 30, 1929, the platen is caused to act upon the work and then automatically return to its elevated position whereupon the pump is adjusted to an inactive condition.

In operation, the platen descends by gravity until it comes in contact with the work, the oil from the surge tank passing through the surge valve to fill the evacuated space above the main ram 5 in the cylinder E as previously described. As soon as the platen comes in contact with the work, the check valve closes. Pressure will now build up in the system, flowing through the pipe line 52 into cylinder E. This pressure will act through the branch line 53 to actuate the plunger 46, 47 and force open the check valve 41, allowing the pump to take its suction freely through pipe line 49 and chambers 36 and 39 from the surge tank G. When the press platen movement is automatically reversed as above-described, the pipe line 52 will be placed under suction and the pipe line 49 under discharge, due to the reversal of the pump. As soon as the pump has drawn enough oil from the cylinder E to drop its pressure so that pressure in the pipe line 52, 53 is no longer sufficient to cause the plunger 46, 47 to hold the check valve 41 unseated, the check valve will return to its seat and pressure in the pipe line 49 will build up and act, through the chamber 36 and pipe line 48, to force downwardly the plunger 29 to unseat the surge valve. In this manner the surge valve is opened gradually, after pressure in the main cylinder E has been suitably reduced, and thus the system is relieved of the shock and other parts relieved of the strain which would be occasioned by suddenly forcing open the surge valve while pressure within the main cylinder E was at its maximum just after completion of the pressing function. This mechanism also makes it possible to employ a surge valve of maximum diameter so as to provide for the freest possible communication between the main cylinder E and the surge tank G.

After pressure within the cylinder E is thus suitably reduced, the push-back rams 7, heretofore resisted by the great pressure within the main cylinder E, are acted upon by pump pressure built up in the pipe line 50 to return the platen to its elevated position.

Although the invention has been shown by way of illustration as being embodied in a circuit including a press having separate main and auxiliary rams, it will be understood that the invention also may be used in connection with presses having a single double acting ram, one face of which acts to advance the ram and the lower face of which acts to retract the ram.

From the foregoing description taken in connection with the accompanying drawings, it is thought that the novel details of construction, manner of use and the advantages of my invention will be readily apparent to those skilled in the art to which it relates.

I claim:

1. In apparatus of the character described wherein is provided a platen, a main cylinder and main ram for moving the platen in one direction, an auxiliary cylinder and auxiliary ram for moving the platen in the opposite direction, a surge tank, a surge valve to open communication at times between the surge tank and the main cylinder, means including a hydraulic pressure circuit and a pump operable to exert fluid pressure against the main cylinder ram to project the platen and reversible to exert fluid pressure against the auxiliary cylinder ram to retract the platen, and means active upon each reversal of the pump from the platen projecting to the platen retracting condition for first bringing about a reduction of pressure in the main cylinder and thereafter positively opening the surge valve, said last named means including a surge valve operation control unit comprising a casing having a pressure chamber in communication with the pressure circuit and being adapted to communicate through a by-pass with the surge tank, a check valve in said by-pass and being biased to closed position, a pressure responsive check valve opening plunger mounted for movements in said chamber, said check valve opening plunger being active upon subjection to high pressure for unseating and holding unseated the check valve, a spring engaging said plunger and urging the latter to inactive position, and a pressure duct for subjecting the check valve opening plunger to the pressure within the main cylinder.

2. In apparatus of the character described wherein is provided a platen, a main cylinder and main ram for moving the platen in one direction, an auxiliary cylinder and auxiliary ram for moving the platen in the opposite direction, a surge tank, a surge valve to open communication at times between the surge tank and the main cylinder, means to apply pressure to the rams to effect movement thereof including two fluid conduit lines alternately active to supply and withdraw fluid respectively from the main and auxiliary cylinder, pressure responsive surge valve opening means, a surge valve control unit having a pressure chamber, a second chamber in constant communication with the surge tank, a conduit communicating between the pressure chamber and the auxiliary cylinder conduit, a second conduit communicating between the pressure chamber and the pressure responsive opening means, a check valve in the control unit controlling communication between the pressure and second chambers thereof and being biased to closed position, and means biased to inactive position and being responsive to pressure in the main cylinder for being moved to active position to unseat said check valve during high pressure conditions in the main cylinder.

3. In apparatus of the character described wherein is provided a platen, a main cylinder and main ram for moving the platen in one direction, an auxiliary cylinder and auxiliary ram for moving the platen in the opposite direction, a surge tank, a surge valve to open communication at times between the surge tank and the main cylinder, means to apply pressure to the rams to effect movement thereof including two fluid conduit lines alternately active to supply and withdraw fluid respectively from the main and auxiliary cylinder, pressure responsive surge valve opening means, a surge valve control unit having a pressure chamber, a second chamber in constant communication with the surge tank, a conduit communicating between the pressure chamber and the auxiliary cylinder conduit, a second conduit communicating between the pressure chamber and the pressure responsive opening means, a gravity seated check valve in the control unit controlling communication between the pressure and second chambers thereof, said unit also having a plunger chamber, a plunger projecting into the plunger chamber and adapted when active to engage said check valve for opening the latter, means for biasing said plunger to inactive position, and a branch conduit communicating with the plunger chamber and with the main cylinder to subject the plunger to fluid pressure in said main cylinder.

4. In apparatus of the character described wherein is provided a platen, a main cylinder and main ram for moving the platen in one direction, an auxiliary cylinder and auxiliary ram for moving the platen in the opposite direction, a surge tank, a surge valve to open communication at times between the surge tank and the main cylinder, means to apply pressure to the rams to effect movement thereof including two fluid conduit lines alternately active to supply and withdraw fluid respectively from the main and auxiliary cylinder, pressure responsive surge valve opening means, a surge valve control unit having a pressure chamber, a second chamber in constant communication with the surge tank, a conduit communicating between the pressure chamber and the auxiliary cylinder conduit, a second conduit communicating between the pressure chamber and the pressure responsive opening means, a check valve in the control unit controlling communication between the pressure and second chambers thereof and being biased to closed position means active in response to pressure in the main cylinder to hold the check valve unseated during high pressure conditions in the main cylinder, and a biasing spring for urging said means to inactive position to permit said check valve to seat upon relief of said high pressure condition and enable pressure in the pressure chamber to build up and bring about actuation of the surge valve opening means.

5. In an apparatus of the character described wherein is provided a platen, a main cylinder and main ram for moving the platen in one direction, an auxiliary cylinder and auxiliary ram for moving the platen in the opposite direction, a surge tank, a surge valve to open communication at times between the surge tank and the main cylinder, means including a hydraulic pressure circuit and a pump operable to exert fluid pressure against the main cylinder ram to project the platen and to exert fluid pressure against the auxiliary cylinder ram to retract the platen, and means active at the end of a stroke under main ram drive for first bringing about a reduction of pressure in the main cylinder to permit opening of said surge valve, said last named means including a casing having a pressure chamber in communication with said auxiliary cylinder and being adapted to communicate with said surge tank, a check valve for controlling communication between said chamber and surge tank and being biased to closed position, means defining a separate pressure chamber, means providing communication between said second pressure chamber and said main cylinder, a bore in a wall of said second chamber, and a plunger extending through and fitting snugly in said bore for sliding movements and being adapted to respond to pressure in said main cylinder for being

moved to active position to open said check valve and being biased to inactive position.

6. In a hydraulic press circuit, the combination of a press having main and ram-returning cylinders and cooperating ram means; a pump; a pipe line affording communication between said pump and said main cylinder; a pipe line affording communication between said pump and said ram-returning cylinder; means for reversing the flow of fluid in said pipe lines; a surge tank; a surge valve interposed between said tank and said main cylinder and biased to closed position; means defining a pressure chamber; a pressure responsive plunger therein adapted to open said surge valve; a branch pipe interposed between said ram-returning cylinder and said pressure chamber; a by-pass between said branch pipe and said surge tank; a check valve in said by-pass biased to closed position; means defining a second pressure chamber; a pressure responsive device therein adapted when active to move said check valve to open position; biasing means for urging said device in one direction only for normally holding said device in inactive position; and a branch pipe interposed between said main cylinder and said second pressure chamber.

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