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W. ERNST

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HYDRAULIC PRESS

Filed July 30, 1928

3 Sheets-Sheet 2

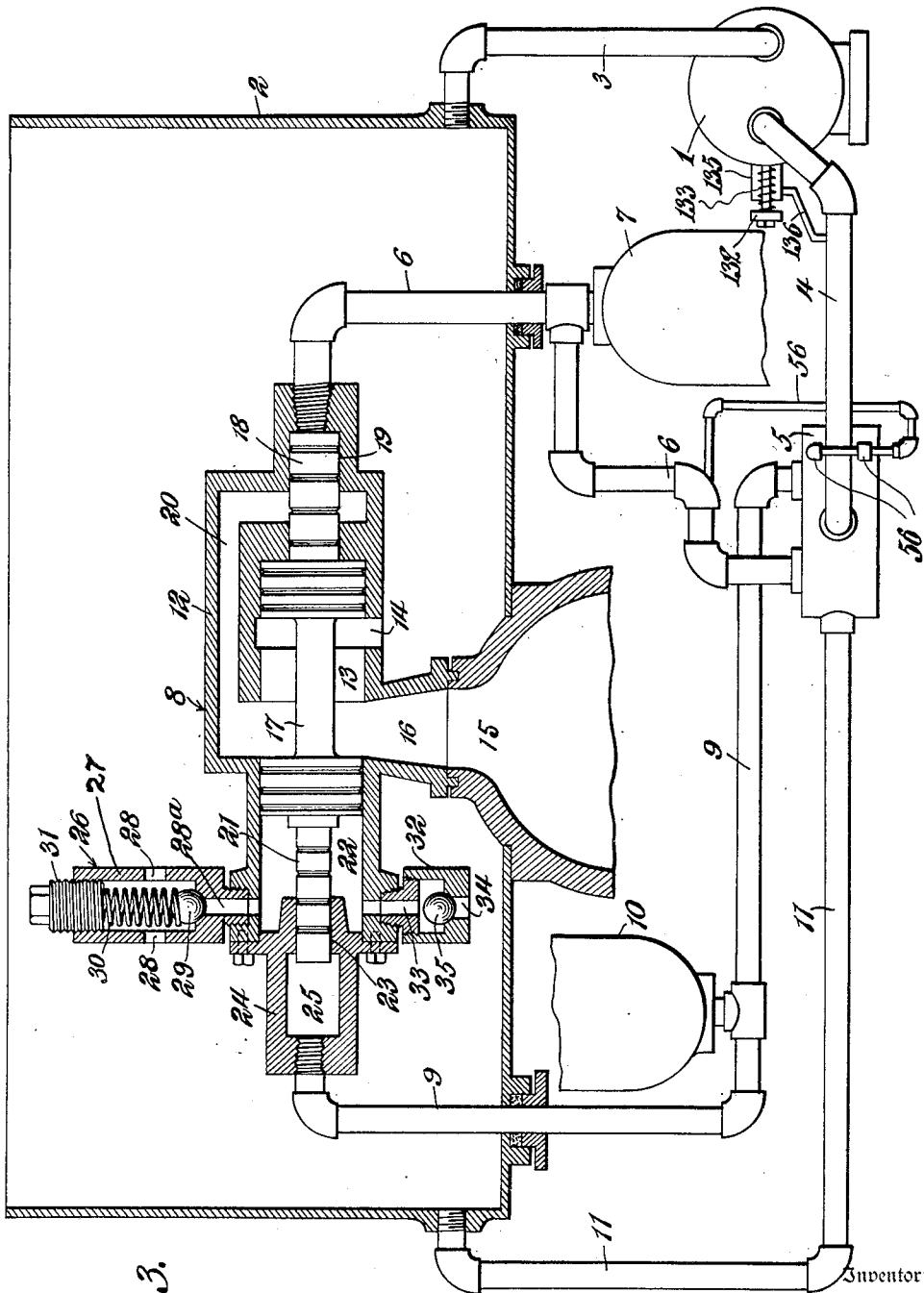


Fig. 3.

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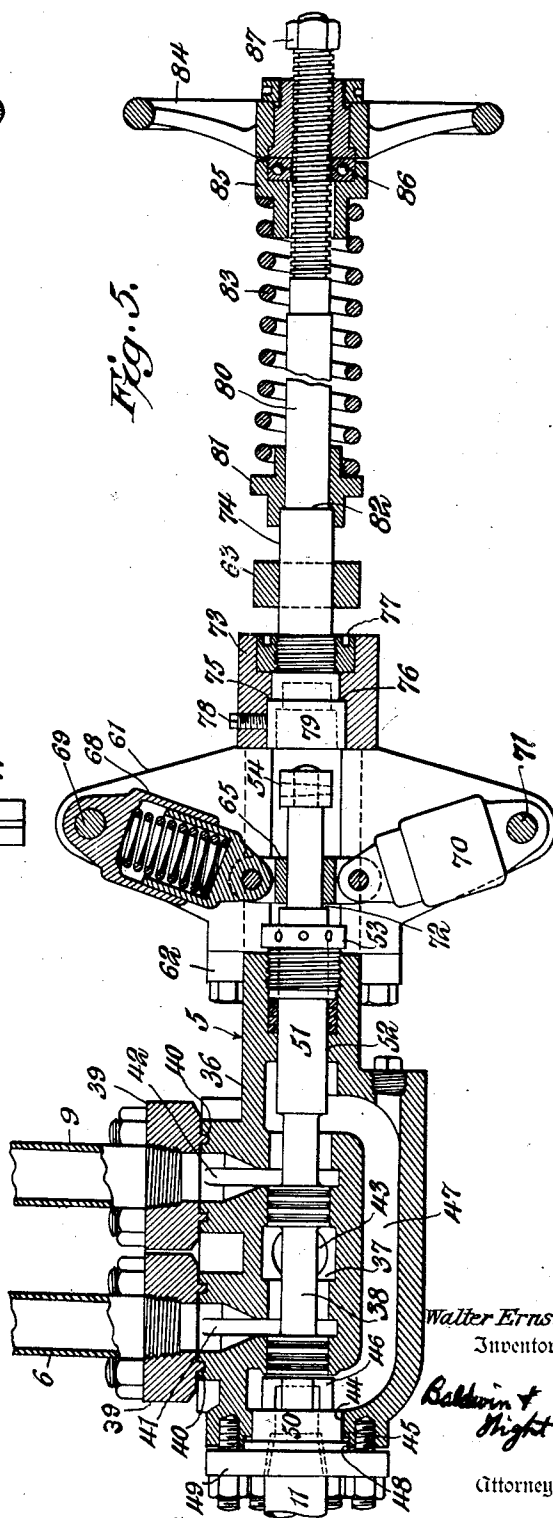
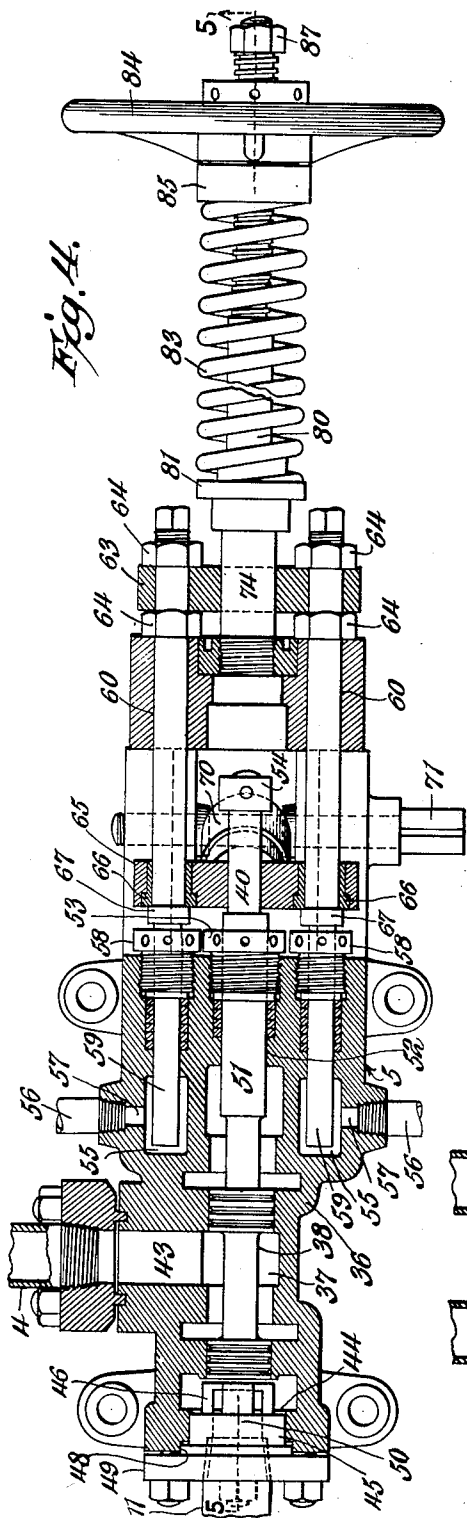
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3 Sheets-Sheet 3



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HYDRAULIC PRESS

Application filed July 30, 1928. Serial No. 296,129.

This invention relates to hydraulic presses which are intended to be operated by fluid supplied under pressure from a variable discharge pump, and more particularly to that type of press which may be set either to automatically perform an indeterminate number of successive pressing operations, or to perform one complete pressing operation, at the end of which the press platen is automatically brought to rest.

Hydraulic presses have been previously built which were capable of automatically performing an indeterminate number of pressing operations; but due to certain characteristics of the pumps usually employed to furnish the pressure for operating such presses, it has heretofore not been found possible to operate these presses at a high speed, except in the case of small presses where the inertia of the moving parts, and especially that of the pump cross head is comparatively small.

In connection with such automatic presses it has been usual to employ a variable discharge, reversible pump of the type described in U. S. Letters Patent No. 1,250,170 of Dec. 18, 1917 granted to Hele-Shaw et al. Pumps of this type are provided with a cross-head, the shifting of which reverses the flow of the fluid in the hydraulic circuit, the reversals producing the reciprocatory motion of the press platen.

While the construction of this type of pump is now well known to those skilled in the art, for the sake of clearness attention is called to the fact that in such pumps there is usually provided a spring adapted to yieldingly hold the pump cross head in a position permitting the pump to deliver its full discharge, there being also provided either mechanical or pressure operated means adapted to move said cross head against the pressure of said spring, thereby progressively reducing the discharge of the pump to zero, and then progressively increasing the discharge of the pump in the opposite direction.

As stated above, when the system is comparatively small, the inertia of the pump cross head is also small, so that it may be quickly shifted to reverse the flow of the fluid under pressure, and a high press operating speed may be thereby attained. It is obvious that where the press used is large, and the pump cross head correspondingly large, the cross head has an inertia sufficient to oppose the shifting thereof, and to thereby cause a considerable time lag to occur between the strokes of the platen, which naturally is objectionable since it slows down the operating speed of the press.

I have found that by arranging such a pump to discharge in one direction only, and by providing means whereby the fluid discharged by the pump may be directed alternately to the pressing cylinders and to the push back cylinders operating the press platen, it is possible to attain a high operating speed with a large press.

When operating a large hydraulic press, it is of course essential that the discharge of the pump be reduced as the press platen nears the end of the up and the down strokes, since a sudden reversal of flow of the fluid under pressure when the pump is delivering its full discharge would result in a shock or water hammer in the hydraulic system, such shock being injurious to the various associated parts.

It is to be understood that in the description which is to follow, the term "automatic operation" means that kind of operation in which the reciprocatory platen continuously performs an indeterminate number of pressing operations, and the term "semi-automatic operation" means that kind of operation in which the platen performs one complete pressing cycle, and is then brought to rest in its uppermost position.

The main object of this invention is to provide in an automatic hydraulic press means adapted to produce a high operating speed even when the press and correlated parts are comparatively large.

Another object of this invention is to provide means whereby the pump may be arranged to discharge fluid under pressure at a variable rate, but in one direction only, and to also provide means whereby the discharge from the pump may be caused to flow alter-

nately into the pressing and into the push back cylinders which operate the press platen.

Another object of this invention is to provide means whereby a hydraulic press may be adapted to operate either automatically or semi-automatically.

A further object of this invention is to provide a simple and efficient valve mechanism by means of which the proper sequence of operations will be carried out automatically.

With these and other objects in view, which will more fully appear, the nature of the invention will be more clearly understood by following the description, the appended claims, and the several views illustrated in the accompanying drawings, in which:

Figure 1 is a front elevation of a hydraulic press, showing some essential operating parts of my invention,

Figure 2 is an enlarged partial side elevation taken at right angles to Figure 1, with certain parts shown in section,

Figure 3 is a diagrammatic view of the hydraulic circuit, certain of the parts being shown in section,

Figure 4 is a longitudinal sectional view of a reversing valve,

Figure 5 is a section on the line 5—5 of Figure 4,

Figure 6 is a detail view of a manually operable control lever, and parts attached thereto, and

Figure 7 is a plan view of a pump cross head.

The invention may be embodied in various types of hydraulic presses, but in the accompanying drawings it is illustrated in connection with a press of the four column downward pressure type. Referring to the drawings, there is shown a hydraulic press A, having a base B, a stationary table C, a press head D connected to said table by four strain rods E, and a reciprocatory platen F. The platen F is guided on the strain rods E in the usual manner.

A variable displacement pump 1 of the type above referred to is connected to a surge tank 2 by means of the suction pipe 3, as shown in Figure 3. The discharge of the pump is directed through a pipe line 4 which is connected to the reversing valve 5. The valve 5 also has connected to it the pipe line 6, which leads to booster cylinders 7 and to one side of a surge shifting valve 8, located in the surge tank 2, a pipe line 9 which leads to the push back cylinders 10 and to the other side of the surge shifting valve 8, and a pipe line 11 which leads to and opens into the surge tank 2.

The construction and the operation of the reversing valve 5 will be hereinafter described in detail, but for the sake of clearness it will, for the present, be sufficient to say that the valve is adapted to be set in either of two

positions, in the first of which positions the pipe line 4 is placed in communication with the pipe line 6, and the pipe line 9 with the pipe line 11, and in the second of which positions the pipe line 4 is placed in communication with the pipe line 9, and the pipe line 6 with the pipe line 11.

The surge shifting valve 8 is provided with a valve casing 12 having a valve chamber 13 which communicates with the surge tank 2 by means of a port 14, and with the main cylinder 15 of the press by means of a port 16. Slidably mounted in the chamber 13 is a balanced piston valve 17, said valve being provided at one of its ends with a tail rod 18, the tail rod being slidable in a bore 19. The bore 19 communicates with the chamber 13 by means of the passage 20, and also with the pipe line 6. The valve 17 is also provided with a second tail rod 21 which extends through a chamber 22 into a bore 23 in a casing 24 attached to the casing 12, and into the chamber 25 in said casing 24, the chamber 25 communicating at its outer end with the pipe line 9. It may be noted that when the piston valve 17 is in the position shown in the drawings, the main cylinder 15 communicates with the surge tank 2 by means of the port 16, the chamber 13 and the port 14, but when the piston valve is caused to be shifted to the left in a manner to be hereinafter described, the cylinder 15 will communicate with the pipe line 6 by means of the port 16, the chamber 13, the passage 20, and the bore 19.

Mounted on the top of the valve casing 12 and adapted to communicate with the chamber 22 is a check valve 26, which comprises a casing 27, ports 28, 28 and 28^a and a valve ball 29 which is urged to closed position by a spring 30, the tension of which spring may be adjusted by means of a threaded plug 31 for a purpose hereinafter specified. It is to be noted that when the piston valve 17 is moved to the left in the plane of the drawings, fluid contained in the chamber 22 will be expelled through the check valve 26 into the surge tank 2, but that no fluid will enter the chamber 22 through said check valve.

Mounted on the bottom of the casing is a second check valve 32 adapted to communicate with the chamber 22 by means of the port 33 and with the surge tank 2 by means of the port 34. It is to be noted that though no fluid will be discharged from the chamber 22 through the valve 32 and into the surge tank 2, the valve ball 35 is kept seated by gravity, and by the pressure existing in the chamber 22, so that when the piston valve 17 moves to the right in the plane of the drawings, the ball 35 will be lifted from its seat by the suction created in the chamber 22, thus allowing fluid to flow from the surge tank 2 through the ports 34 and 33 into the chamber 22.

With more particular reference to the reversing valve 5, there is shown in Figures 4 and 5 a valve casing 36 having a central chamber 37 and a piston valve 38 slidable longitudinally in the bore forming said chamber, and being closely fitted therein. In order to facilitate the connecting of the control valve 5 to the pipe lines 6 and 9, there are provided detachable plates 39 which are bolted or otherwise attached to the valve casing 36, tongue and groove connections 40 forming pressure tight joints between the plates 39 and the valve casing 36. The plates 39 are provided with threaded bores which receive the ends of the pipes 6 and 9 thereby placing said pipes in communication with the valve chamber 37 by means of ports 41 and 42 respectively. The pipe line 4 communicates with the valve chamber 37 by means of the port 43, and it is to be noted that when the piston valve 38 is in the position shown in Figures 4 and 5 the pipe line 4 communicates with the pipe line 6 by means of the port 43, the valve chamber 37, and the port 41. When the piston valve is moved to the right in the plane of the drawings in a manner to be hereinafter described, the pipe line 4 will be placed in communication with the pipe line 9 by means of the port 43, the valve chamber 37, and the port 42. In one end of the valve casing 36 is a bore into which is closely fitted a ring 45 provided with spaced abutment ribs 46, which ribs project into one end of a passage 47 and serve to limit the travel of the piston valve 38 in that direction. The ring 45 is provided with a flange 48 which fits into a suitable counter sunk portion of the bore 44, said ring being held firmly in place by a clamping plate 49. The clamping plate 49 is provided with a threaded bore which receives the pipe 11, thus placing said pipe in communication with the valve chamber 37 by means of a port 50 which extends through the plate 49 and the ring 45, and the passage 47. With the piston valve 38 in the position shown in Figures 4 and 5, the pipe line 11 communicates with the pipe line 9 by means of the port 50, the passage 47, the valve chamber 37, and the port 42. When the piston valve 38 is moved to the right from the position shown in the drawings, the pipe line 11 is placed in communication with the pipe line 6 by means of the port 50, the valve chamber 37, and the port 41.

At one end of the piston valve 38 there is provided a rod 51 extending through the valve chamber 37 and beyond the valve casing 36, the rod 51 sliding in a bore 52 provided with a suitable packing gland 53. At the outer end of the rod 51 there is provided a collar 54 rigidly attached to said rod by a pin or other suitable attaching means.

The valve casing 36 is provided with chambers 55, 55 communicating with the pipe line

56, 56 by means of the ports 57, 57. The pipe lines 56, 56 communicate at all times with the pipe line 6 so that, for a purpose hereinafter described, the same fluid pressure is caused to exist in the chambers 55, 55 as in the pipe line 6.

Adapted to slide in the packing glands 58 in the valve casing 36, and projecting into the chambers 55, are the plungers 59, 59, said plungers sliding in bearings 60 in a bracket 61 bolted to a flange 62 on the valve casing 36. A cross bar 63 is attached to the plungers 59, 59 by means of nuts 64, 64.

Slidably mounted on the plungers 59 and the rod 51 is a cross head 65 equipped with suitable bushings 66. The plungers 59 are provided with collars 67 adapted to abut the cross head 65 and to thereby move said cross head to the right in the plane of the drawings when said plungers are caused to be moved to the right in a manner hereinafter described.

A spring loaded compressible link 68 is loosely pivoted at one end to the cross head 65 and at its other end to a pin 69 on the bracket 61, while a second and similar link 70 is loosely pivoted at one end to the cross head 65 and at the other end is fixed to a rock shaft 71 journaled in the bracket 61. It is to be noted that the links 68 and 70, and the cross-head 65, which in effect is also a link, comprise a spring loaded toggle, so that when the plungers 59 move to the right, forcing the cross head 65 ahead of them, the center of the cross head 65 will eventually reach a point just to the right of a line connecting the centers of the pivot pins 69 and the rock shaft 71, at which time the toggle will quickly snap to its extreme position, whereby the cross head 65 will strike the collar 54 on the rod 51 and moves said rod, and the piston valve 38 to the right. By rocking the shaft 71 in a counter clockwise direction by means hereinafter described, the toggle will be caused to move in the opposite direction, finally snapping to the left and causing the cross head 65 to abut a shoulder 72 on the rod 51, thereby shifting the piston valve 38 to the left.

Mounted in a boss 73 on the bracket 61 and extending longitudinally of the rod 51 is a stem 74 provided at its inner end with a shoulder 75 abutting a shoulder 76 in the boss 73, a clamping nut 77 being threaded to the stem 74 and serving to hold the shoulder 75 against the shoulder 76, thereby locking the stem 74 to the boss 73. A set screw 78 in the boss 73 prevents the stem 74 from turning relative to said boss. In the inner end of the stem 74 there is provided a recess 79 permitting the rod 51 and the collar 54 to move to the right, the bottom of said recess limiting the movement of said rod and nut in that direction.

Slidably mounted on a reduced portion 80 of the stem 74 is a collar 81 which is urged

against a shoulder 82 on said stem by means of a coil spring 83. A hand wheel 84 is threaded on the outer end of the stem 74 and is adapted to vary the expansive force of said spring. A spring seat 85 and a thrust bearing 86 are interposed between the hand wheel and the spring to facilitate the turning of said hand wheel, and a nut 87 prevents the hand wheel from being accidentally removed from the stem 74.

Referring to Figure 1, there is shown a vertically disposed operating rod 88, slidably mounted in lugs 89 and 90 on the stationary table C and the press head D respectively, the downward movement of said rod being limited by a collar 91 adjustably fixed to the rod. The operating rod 88 is constantly urged to its lowermost position by gravity and also by means of a coil spring 92 mounted on said rod between the lug 90 and a collar 93 also on said rod. A boss 94 on the platen is arranged to slide freely on the operating rod 88. Adjustably attached to the rod 88 is a collar 95 which is adapted to be engaged by the boss 94 when the platen has reached a predetermined point in its upward travel, the rod 88 being thereby lifted. At the lower end of the operating rod is a collar 96, held in adjusted position by means of nuts 97. Located above the collar 96 is a rocker arm 98 having an arcuate projection 99 adapted to be engaged by the collar 96, said rocker arm having one of its ends fixed to the shaft 71 and its other end pivoted to a coupling link 100. Rigidly attached to the coupling link 100 is a rod 101 adapted to slide in a hollow coupling 102, the latter being pivotally connected at 103 to a manually operable control lever 104. A tensioned coil spring 105 interposed between the press base B and the shorter arm of the bell crank lever tends to cause a lug 106 on said handle to abut a lug 107 on the base B, thereby normally maintaining the bell crank lever in the position shown in the drawings.

As clearly shown in Figure 6, there is rigidly attached to the upper end of the rod 101 a collar 108 which is adapted to slide within the hollow coupling 102 and to abut the inwardly extending flange 109, thereby limiting the downward movement of the rod 101 relative to the coupling 102. It is apparent that although the control lever 104 may be swung to the left and the rod 101 thereby elevated, an upward movement of the rod 101 will not cause the control lever to be moved. Thus, when the rod 101 is caused to perform a reciprocatory motion during constant operation of the press in a manner hereinafter described, there will be no danger of the control lever swinging outwardly and striking the operator.

In Figures 1, 2 and 7 there is shown a mechanism for controlling the rate of discharge of the pump. This mechanism is pro-

vided with a vertically disposed and longitudinally adjustable operating rod 110, slidably mounted in lugs 111 and 112 on the stationary table C and the press head D respectively. The downward movement of said rod is limited by collars 113 and 114 fixedly attached to the rod. The operating rod 110 is constantly urged to its lowermost position by gravity and by means of a coil spring 115 mounted on said rod and interposed between the lug 112 and a collar 116 on the rod. A boss 117 on the platen is arranged to slide freely on the operating rod 110. Adjustably attached to the rod 110 is a collar 118 which is adapted to be engaged by the boss 117 when the platen has reached a predetermined point in its upward travel, the rod 110 being thereby lifted.

Rigidly attached to the base B directly below the lug 111 is a bracket 119 to which a bell crank lever 120 is pivoted as at 121. A link 122 is pivoted to the operating rod 110 at 123 and to the bell crank lever 120 at 124.

A link 125 disposed at right angles to the operating rod 110 is pivotally connected to the bell crank lever at 126. A lever 127, pivotally mounted at 128 on a bracket 129 carried by the pump, has one of its ends pivotally connected at 130 to the link 125. The other end of the lever 127 is provided with rounded head 131 which is engaged by a cross head 132 on the pump 1, whereby a clockwise movement of the lever 127 will cause the pump cross head to be pushed towards the center of the pump, thus decreasing the discharge of the pump in a manner well known to those skilled in the art. As stated above, pumps of this type are provided with a spring for returning the cross head to a position permitting full discharge of the pump when the externally applied force, such as the pressure exerted on the cross head by the lever 127, is removed. In the pump shown, two springs 133 are interposed between the cross head 132 and the pump casing, these springs serving to constantly urge the cross head outwardly. A piston 134 connected to the cross head is slidably mounted in a cylinder 135 carried by the pump casing and a pipe 136 provides constant communication between the discharge pipe 4 and the outer end of the cylinder, so that, when the pressure in the pipe 4 rises to a predetermined extent, the cross head will be moved inwardly against the urge of the springs 133, thus reducing the rate of displacement by the pump.

Operation

If it is desired that the press operate under full automatic control, the collar 95 is adjusted in a position on the operating rod permitting said collar to be engaged by the boss 94 at the proper point in the up stroke of

the platen, and the motor driving the pump then started.

Assuming that this adjustment of the collar 95 has been made, that the motor driving the pump has been started, and that the reciprocating platen F is travelling downward, the various parts comprising the automatic control mechanism will be in the positions shown in the drawings, and their operation will be as follows:

The pump 1 is set to deliver its full discharge of fluid under pressure through the pipe line 4 into the reversing valve 5, the fluid then passing through the port 43, the valve chamber 37, the port 41 and the pipe line 6 and into the booster cylinders 7, the fluid pressure thereby exerted in said booster cylinders causing the platen to move downwardly. During this part of the down stroke of the platen, fluid from the surge tank 2 will flow through the port 14, the valve chamber 13 and the port 16 into the main cylinder 15. It is to be noted that during the down stroke of the platen, the fluid which entered the push back cylinders 10 during the preceding up stroke must escape from said cylinders, this being accomplished by means of the pipe line 9, the port 42, the valve chamber 37, the passage 47, the port 50, and the pipe line 11 which pipe line discharges said fluid into the surge tank 2.

When the platen encounters resistance to its downward movement, the fluid pressure in the pipe lines 4 and 6 will build up until it reaches a predetermined value at which time said pressure, acting on the tail rod 18 of the surge shifting valve 8, will cause the piston valve 17 to be moved to the left from the position shown in the drawings, thereby expelling the fluid contained in the chamber 22 through the ports 28^a and 28 of the check valve 26. It is to be noted that by varying the pressure exerted on the ball 29 by the spring 30, the fluid pressure in the pipe line 6 necessary to move the piston valve to the left may be varied at will.

After the piston valve 17 has been moved to the left as described above, the valve chamber 13 will be shut off from communication with the port 14 by the righthand end portion of said valve, and, at the same time said valve chamber 13 will be placed in communication with the pipe line 6 by means of the passage 20 and the bore 19, which bore has been vacated by the tail rod 18. The main cylinder 15 now receives the fluid under pressure from the valve chamber 13 through the port 16. The platen, now being forced downwardly by the combined action of the main and booster cylinders, continues said downward movement until the pressure building up on the circuit acts through the pipe 136 and on the piston 134 to move the pump cross head inwardly against the pressure of the cross head springs, thus decreasing the rate of

discharge from said pump and preventing the occurrence of shocks or water hammer which might otherwise take place when the flow of fluid under pressure is reversed to start the platen on its upward movement.

As has been heretofore stated, the chambers 55 are always in communication with the pipe line 6 by means of the ports 57 and the pipe line 56, so that as the fluid pressure builds up in the main and booster cylinders, the pressure will increase correspondingly in said chambers, until a predetermined pressure has been reached, at which time the plungers 59 will be forced to the right. This movement of the plungers 59 will cause the cross bar 63 to slide on the stem 74; and the collars 67 to abut the cross head 65 and thereby move said cross head to the right against the force exerted by the spring loaded, compressible links 68 and 70. When the vertical center line of the cross head 65 has reached a point just a little to the left of a plane containing the centers of the pin 69 and the rock shaft 71, the cross bar 63 will abut the collar 81, the plungers 59 being thereby held against further movement to the right until the fluid pressure in the chambers 55 has further built up. When said pressure has further built up to a predetermined value, the force exerted by the plungers 59 and the cross bar 63 on the collar 81 will cause said collar to slide to the right against the pressure of the spring 83, thus allowing the plungers 59 to move further to the right, until the cross head 65 has passed the plane containing the pin 69 and the rock shaft 71, at which time the spring loaded, compressible links 68 and 70 will cause the toggle to snap quickly to the right, the cross head 65 striking the collar 54 on the rod 51 moving said rod, and the piston valve 38 to the right.

It is to be noted that by turning the hand wheel 84 and thus varying the tension of the spring 83, the amount of pressure which must build up the main and booster cylinders before the valve 5 is reversed may be varied at will.

As has been described above, when the piston valve 38 has been moved to the right, the pipe line 4 will communicate with the pipe line 9, and the pipe line 6 with the pipe line 11. In this position of the valve, the discharge of the pump is directed through the pipe lines 4 and 9 into the push back cylinders 10 and the chamber 25 in the surge shifting valve 8. The fluid pressure in the chamber 25 acts on the tail rod 21 causing the piston valve 17 to be moved to the right, in other words, to the position shown in Fig. 3. While the piston valve is moving to the right, fluid from the surge tank 2 will enter the chamber 22 through the check valve 32 as hereinbefore described. The fluid under pressure in the push back cylinders 10 then causes the platen to move upwards, the fluid contained

in the main cylinder 15 being expelled therefrom into the surge tank 2 through the port 16, the valve chamber 13 and the port 14, and the fluid in the booster cylinders 7 being expelled through the pipe line 6, the reversing valve 5, and the pipe line 11 into the surge tank 2. It is to be noted that since the pressure in the pipe line 4 is less at this time than it was at the time the platen met resistance to its downward travel, the spring on the pump cross head will return said cross head to the position permitting maximum discharge by the pump, thereby causing the platen to be rapidly returned to its uppermost position.

When the platen reaches a predetermined point on its upward travel the boss 117 carried by said platen will strike the collar 118 on the operating rod 110, thereby lifting said rod and causing the lever 127 to be swung in a clockwise direction by means of the link 122, the bell crank lever 120, and the link 125. By this movement of the lever 127, the head 131 of said lever forces the cross head 132 of the pump inwardly against the force of the pump cross head spring, thereby reducing the rate of discharge from the pump preparatory to a reversal of direction of travel of the press platen for the purpose stated above.

When the platen has proceeded a little farther on its upward travel, and has reached a predetermined point the boss 94 carried by said platen will strike the collar 95 on the operating rod 88, lifting said operating rod, whereby the collar 96 contacts with the arcuate projection 99 on the rocker arm 98, causing said rocker arm to be swung upwardly, thus turning the rock shaft 71 in a clockwise direction as viewed in Fig. 1 and in a counter clockwise direction as viewed in Fig. 5. This turning of the shaft 71 causes the compressible link 70 which is fixed to the rock shaft to be swung to the left, whereby the cross head 65 will be also swung to the left, during which movement the cross head will strike the collars 67 on the plungers 59, and the shoulder 72 on the rod 51, thereby returning the plungers to their inner position and the piston valve 38 to the position shown in Figures 4 and 5. In this position of the piston valve 38, the pipe line 4 communicates with the pipe line 6, whereby the platen will start another downward stroke. The platen will in this way continue to reciprocate until the motor driving the pump is shut off, whereupon the press will, of course, cease operating.

If it is desired to operate the press semi-automatically, or in other words in such a way that the platen will perform one pressing operation and then return to its uppermost position and stop, the collar 95 on the operating rod 88 is loosened and moved up into a position in which it will not be engaged by the boss 94. Assuming that the platen is on its downward stroke, the completion of said

downward stroke and the start of the upward stroke will be executed in the same manner as that described above. When the boss 117 strikes the collar 118 on the upward stroke of the platen, the rod 110 will be lifted and the pump cross head 132 moved inwardly in the manner already described, until said cross head has reached a point at which the discharge of the pump is zero, the platen then coming to rest.

To cause the platen to perform another pressing operation, the manually operable control lever 104 is swung to the left from the position shown in Figure 1, thereby raising the rod 101, swinging the lever 98 upwardly and turning the rock shaft 71 in a clockwise direction as viewed in Figure 1 and in a counter clockwise direction as viewed in Figure 5. The piston valve 38 is thereby moved to the left in the manner described above, and the pipe line 4 will then communicate with the pipe line 6, and the pipe line 9 with the pipe line 11. It may be noted that though the valves 5 and 8 are now in a position to allow fluid under pressure to produce a downward movement of the platen, the pump is at this time delivering no fluid under pressure to produce such a downward stroke. However, since the main cylinder 15 communicates with the surge tank 2 by means of the port 16, the chamber 13 and the port 14, the push back cylinder 10 with the surge tank by means of the pipe line 9, the valve 5, and the pipe line 11, and the booster cylinders 7 with the surge tank by means of the pipe line 6, the valve 5, the pipe line 4, the pump 1 and the pipe line 3, there is no fluid pressure tending to hold the platen up. The weight of the platen itself will therefore cause said platen to coast downwardly until the operating rod 110 has been lowered and the pump cross head 132 thereby allowed to be moved outwardly by the cross head spring, whereupon the pump will start to discharge and the operation will proceed in the manner already described.

While one method of carrying out my invention has been herein described, it is of course to be understood that the details of structure and arrangements of parts may be variously changed and modified without departing from the spirit and scope of my invention.

Although I have illustrated a press provided with a platen especially adapted for performing compressing operations, it is to be understood that the invention described herein may be embodied in presses used for punching, forging, shearing, or other like purposes and that the term "platen" is intended to cover any tool, die, or other appliance with which a press embodying my invention might be provided. Other modifications in construction and arrangement of

parts may be also made without departing from the scope of my invention.

I claim as my invention:

1. The combination with a hydraulic press including a table and reciprocatory platen movable towards and from said table, of a pump dischargeable in one direction only, means forming with the press and the pump a hydraulic circuit, a reversing valve in the circuit and responsive to the pressure therein to reverse the travel of the platen at the end of one stroke thereof, and a mechanical connection interposed between said reversing valve and said platen and being adapted to be engaged by the platen when the latter approaches the end of travel in the opposite direction to reverse said valve independently of pressure in the circuit.

2. The combination with a hydraulic press including a table and reciprocatory platen movable towards and from said table, of a variable displacement pump dischargeable in one direction only, valve means forming with the press and the pump a hydraulic circuit, means connected to said pump and being operatively connected in the circuit for reversing the direction of fluid travel in the circuit to reciprocate the platen, and means responsive to the fluid pressure in said circuit for decreasing the rate of displacement by the pump prior to operation of said valve means when the platen approaches the limit of one of its reciprocatory movements.

3. The combination with a hydraulic press including a table and a reciprocatory platen movable towards and from said table, of a variable displacement pump dischargeable in one direction only, means forming with the press and the pump a hydraulic circuit, valve means operatively connected in the circuit for reversing the direction of fluid travel in the circuit to reciprocate the platen, and means connected to said pump and operated by the platen prior to the operation of said valve means to decrease the rate of displacement by the pump when the platen approaches the limit of one of its reciprocatory movements.

4. The combination with a hydraulic press including a table and a reciprocatory platen movable towards and from said table, of a variable displacement pump dischargeable in one direction only, means forming with the press and the pump a hydraulic circuit, valve means operatively connected in the circuit for reversing the direction of fluid travel in the circuit to reciprocate the platen, means connected to said pump and being responsive to the fluid pressure in said circuit to decrease the rate of displacement by the pump prior to the operation of said valve means when the platen approaches the limit of its pressing stroke, and means connected to said pump and operated by the platen to decrease the rate of displacement by the pump prior to operation of said valve means

when the platen approaches the end of the opposite stroke.

5. The combination with a hydraulic press including a table, a reciprocatory platen movable towards and from said table, main, booster, and push back cylinders, and a surge tank, of a pump adapted to discharge in one direction only, means forming with the press, the main, booster, and push back cylinders, the pump, and the surge tank a hydraulic circuit, controlling means operatively connected with the circuit for reciprocating the platen and including a reversible valve responsive to the pressure in said circuit to reverse the travel of the platen at the end of one stroke thereof, and a mechanical connection interposed between said reversing valve and said platen and being adapted to be engaged by the platen when the latter approaches the end of travel in the opposite direction to reverse said valve independently of pressure in the circuit.

6. The combination with a hydraulic press including a table, a reciprocatory platen movable towards and from said table, main, booster, and push back cylinders, and a surge tank, of a pump adapted to discharge in one direction only, means forming with the press, the main, booster, and push back cylinders, the pump, and the surge tank a hydraulic circuit, controlling means operatively connected with the circuit for reciprocating the platen and including a reversible valve responsive to the pressure in said circuit to reverse the travel of the platen at the end of one stroke thereof, a mechanical connection interposed between said reversing valve and said platen and being adapted to be engaged by the platen when the latter approaches the end of travel in the opposite direction to reverse said valve independently of pressure in the circuit, and means responsive to the fluid pressure in said circuit adapted to decrease the rate of discharge of the pump when the platen approaches the limit of one of its reciprocatory movements.

7. The combination with a hydraulic press including a table, a reciprocatory platen movable towards and from said table, main, booster, and push back cylinders, and a surge tank, of a pump adapted to discharge in one direction only, means forming with the press, the main, booster, and push back cylinders, the pump, and the surge tank a hydraulic circuit, controlling means operatively connected with the circuit for reciprocating the platen and including a reversible valve responsive to the pressure in said circuit to reverse the travel of the platen at the end of one stroke thereof, a mechanical connection interposed between said reversing valve and said platen and being adapted to be engaged by the platen when the latter approaches the end of travel in the opposite direction to reverse said valve independently of pressure in the circuit, and

means controlled by the platen to decrease the rate of discharge of the pump when the platen approaches the limit of one of its reciprocatory movements.

8. The combination with a hydraulic press including a table, a reciprocatory platen movable towards and from said table, main, booster, and push back cylinders, and a surge tank, of a pump adapted to discharge in one direction only, means forming with the press, the main, booster, and push back cylinders, the pump, and the surge tank a hydraulic circuit, controlling means operatively connected with the circuit for reciprocating the platen and including a reversible valve responsive to the pressure in said circuit to reverse the travel of the platen at the end of one stroke thereof, a mechanical connection interposed between said reversing valve and said platen and being adapted to be engaged by the platen when the latter approaches the end of travel in the opposite direction to reverse said valve independently of pressure in the circuit, means responsive to the fluid pressure in said circuit to decrease the rate of discharge of the pump when the platen approaches the limit of its pressing stroke, and means controlled by the platen to decrease the rate of discharge of the pump when the platen approaches the end of the opposite stroke.

9. The combination with a hydraulic press including a table, a reciprocatory platen movable towards and from said table, main, booster, and push back cylinders, and a surge tank, of a pump adapted to discharge in one direction only, means forming with the press, the main, booster, and push back cylinders, the pump, and the surge tank a hydraulic circuit, controlling means operatively connected with the circuit for reciprocating the platen and including a reversible valve responsive to the pressure in said circuit to reverse the travel of the platen at the end of one stroke thereof, a mechanical connection interposed between said reversing valve and said platen and being adapted to be engaged by the platen when the latter approaches the end of travel in the opposite direction to reverse said valve independently of pressure in the circuit, and a surge shifting valve connected in said circuit and responsive to the pressure therein for placing the main cylinder in communication with the surge tank during each stroke of the platen.

10. The combination with a hydraulic press including a table, a reciprocatory platen movable towards and from said table, main, booster, and push back cylinders, and a surge tank, of a pump adapted to discharge in one direction only, means forming with the press, the main, booster, and push back cylinders, the pump, and the surge tank a hydraulic circuit, controlling means operatively connected with the circuit for reciprocating the platen and including a reversible valve re-

sponsive to the pressure in said circuit to reverse the travel of the platen at the end of one stroke thereof, a mechanical connection interposed between said reversing valve and said platen and being adapted to be engaged by the platen when the latter approaches the end of travel in the opposite direction to reverse said valve independently of pressure in the circuit, means responsive to the fluid pressure in said circuit to decrease the rate of discharge of the pump when the platen approaches the limit of its pressing stroke, means controlled by the platen to decrease the rate of discharge of the pump when the platen approaches the end of the opposite stroke, and a surge shifting valve connected in said circuit and responsive to the pressure therein for placing the main cylinder in communication with the surge tank during each stroke of the platen.

11. The combination with a hydraulic press including a main pressing cylinder, a booster cylinder, a table, and a reciprocatory platen movable towards and from the table of a pump, dischargeable in one direction only, means forming with the press and the pump a hydraulic circuit, means operatively connected with the circuit for reversing the direction of fluid travel therein, a surge tank operatively connected in said circuit, and a surge shifting valve including a valve casing having a passage normally in open communication with the main cylinder and with the surge tank, a valve movably mounted in the casing and responsive to fluid pressure for moving said valve to open said passage, a chamber in said casing located at one side of said valve, a check valve for admitting fluid from the surge tank to said chamber, an adjustable valve for permitting the egress of fluid from said chamber into said tank, the valve casing having a second chamber, and a tail rod on said valve extending into the second chamber, said rod being responsive to fluid pressure in said chamber to move the valve to close said passage.

12. The combination with a hydraulic press including a table, a reciprocatory platen movable towards and from said table, main, booster, and push back cylinders, and a surge tank, of a pump adapted to discharge in one direction only, means forming with the press, the main, booster, and push back cylinders, the pump, and the surge tank a hydraulic circuit, controlling means operatively connected with the circuit, and a reversing valve comprising a valve casing, a chamber in said casing, a plurality of ports in said casing communicating with said circuit, a valve movably mounted in said chamber and cooperating with said ports to reverse the direction of fluid travel in the circuit, and a toggle cooperating with said valve to quickly shift said valve to either extreme position.

13. The combination with a hydraulic

press including a table, a reciprocatory platen movable towards and from said table, main, booster, and push back cylinders, and a surge tank, of a pump adapted to discharge in one direction only, means forming with the press, the main, booster, and push back cylinders, the pump, and the surge tank a hydraulic circuit, controlling means operatively connected with the circuit, and a reversing valve comprising a valve casing, a chamber in said casing, a plurality of ports in said casing communicating with said circuit, a valve movably mounted in said chamber and cooperating with said ports to reverse the direction of fluid travel in the circuit, a toggle cooperating with said valve to quickly shift said valve to either extreme position, a second chamber in said valve casing, a plunger projecting into said second chamber, and responsive to the pressure therein to move said toggle in one direction, and means controlled by the platen adapted to move said toggle in the opposite direction.

14. The combination with a hydraulic press including a table, a reciprocatory platen movable towards and from said table, main, booster, and push back cylinders, and a surge tank, of a pump adapted to discharge in one direction only, means forming with the press, the main, booster, and push back cylinders, the pump, and the surge tank a hydraulic circuit, and a reversing valve, comprising a valve casing, a chamber in said casing, a valve slidable therein, a rod attached to said valve, a plunger slidable in said casing parallel to said rod and responsive to fluid pressure, a cross head slidable on said rod and said plunger, compressible links pivoted to said casing on opposite sides of the cross head and to said cross head, a collar on said plunger for engagement with said cross head for moving the cross head in one direction, and shoulders on said rod for engagement with said cross head for moving the valve in both directions.

15. The combination with a hydraulic press including a table, a reciprocatory platen movable towards and from said table, main, booster, and push back cylinders, and a surge tank, of a pump adapted to discharge in one direction only, means forming with the press, the main, booster, and push back cylinders, the pump, and the surge tank a hydraulic circuit, and a reversing valve, comprising a valve casing, a chamber in said casing, a valve slidable therein, a rod attached to said valve, a plunger slidable in said casing parallel to said rod and responsive to fluid pressure, a cross head slidable on said rod and said plunger, compressible links pivoted to said casing on opposite sides of the cross head and to said cross head, a collar on said plunger for engagement with said cross head for moving the cross head in one direction, shoulders on said rod for engagement with said

cross head for moving the valve in both directions, and adjustable means opposing the movement of said plunger, whereby the pressure exerted by the platen may be varied.

16. The combination with a hydraulic press including a table and a reciprocatory platen movable towards and from said table, of a pump dischargeable in one direction only, means forming with the press and the pump a hydraulic circuit, a reversing valve in the circuit and responsive to the pressure therein to reverse the travel of the platen, a toggle cooperating with said valve to quickly shift the same, a rod movable longitudinally by the platen, and a rocker arm cooperating with said rod and with said toggle to move the latter.

17. The combination with a hydraulic press including a table and a reciprocatory platen movable towards and from said table, of a pump dischargeable in one direction only, means forming with the press and the pump a hydraulic circuit, a reversing valve in the circuit and responsive to the pressure therein to reverse the travel of the platen, a toggle cooperating with said valve to quickly shift the same, a rod movable longitudinally by the platen, a rocker arm cooperating with said rod and with said toggle to move the latter, and a manually operable lever cooperating with said rocker arm to move said toggle and adapted to remain stationary when the rocker arm is moved by the operating rod.

In testimony whereof, I have hereunto subscribed my name.

WALTER ERNST.