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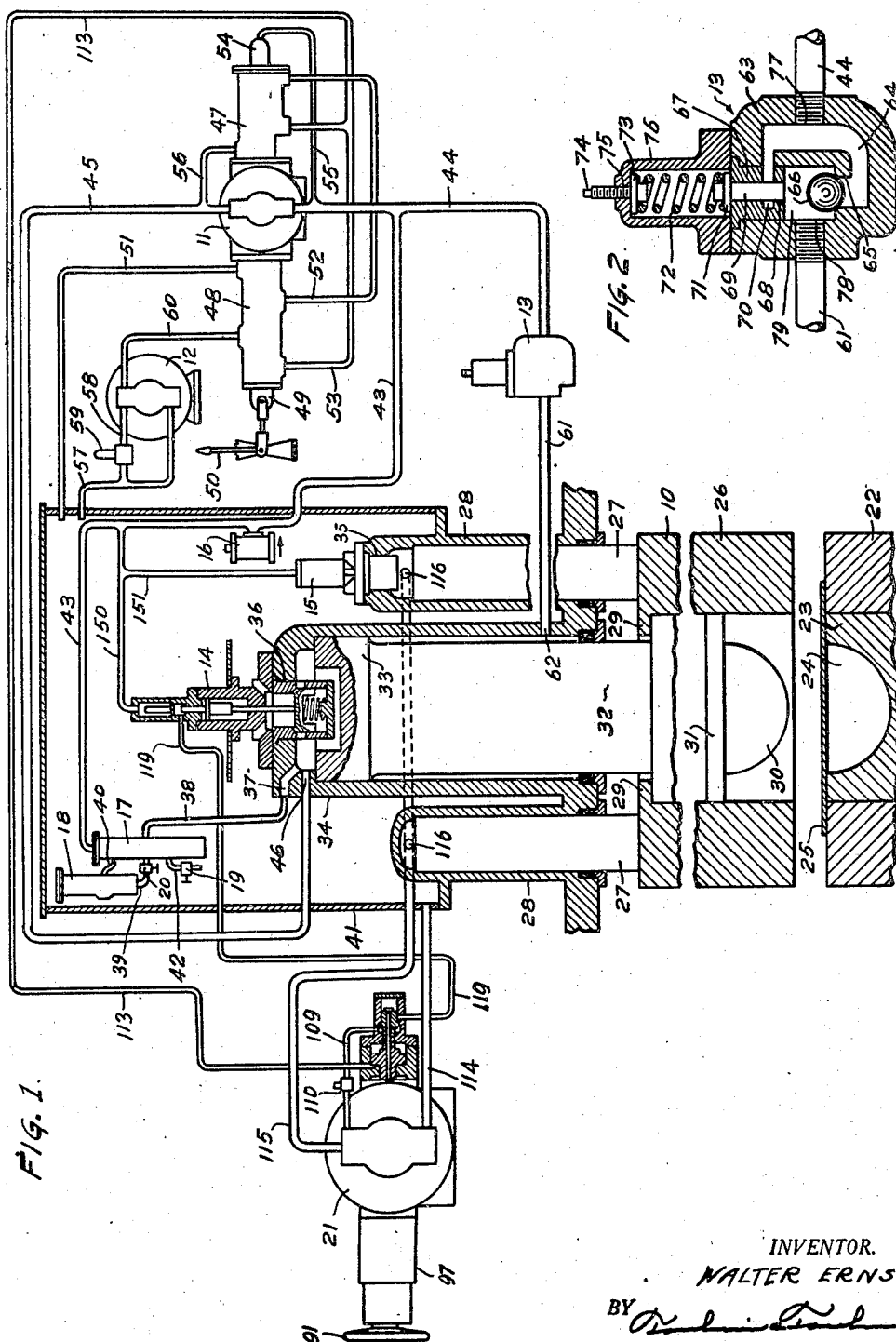
W. ERNST

2,193,248

SURGE VALVE

Original Filed May 27, 1936

2 Sheets-Sheet 1



INVENTOR.

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FIG. 3.

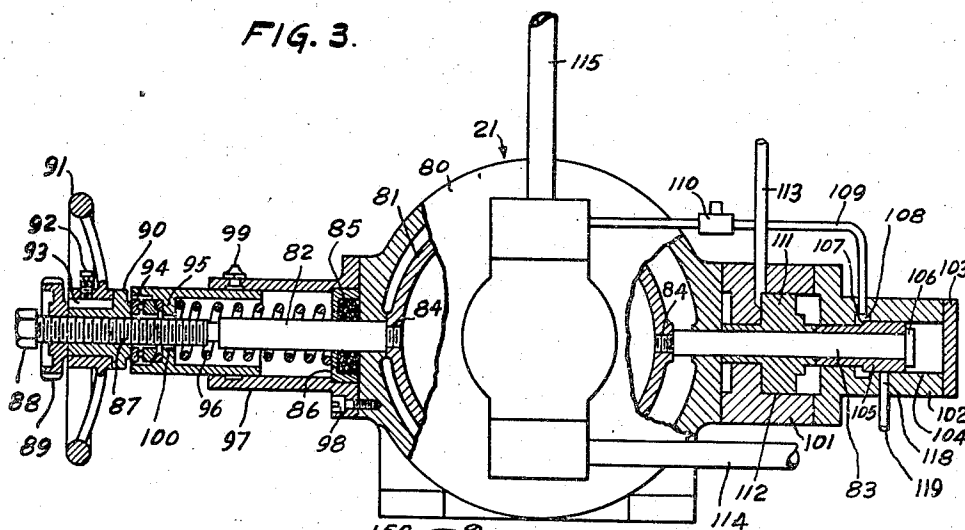
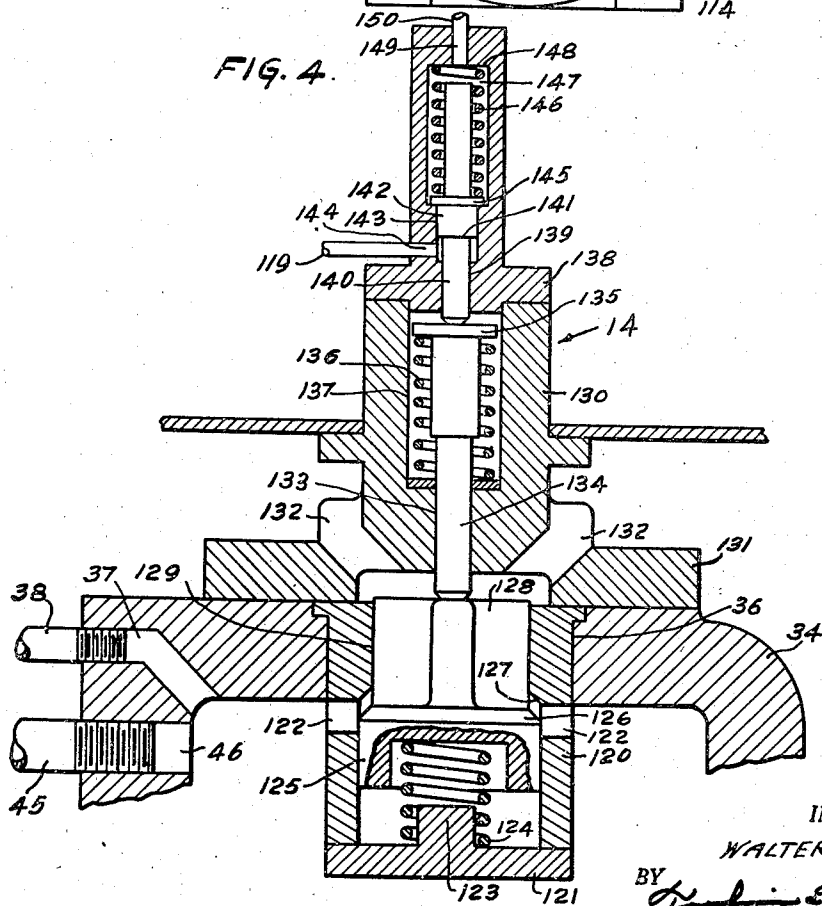


FIG. 4.



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UNITED STATES PATENT OFFICE

2,193,248

SURGE VALVE

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Original application May 27, 1936, Serial No.
82,087. Divided and this application February
25, 1937, Serial No. 127,799

3 Claims. (Cl. 137—153)

This invention relates to hydraulic presses and control circuits therefor.

One object of this invention is to provide a special valve for use with a hydraulic press having a clamping plunger and a drawing plunger with a control circuit including this special valve arranged to prevent the building up of pressure in the main cylinder until the clamping plunger has engaged the work-piece.

Another object is to provide a special valve for such a press and circuit, wherein this special valve is arranged to prevent the main plunger from starting the drawing operation until the clamping plunger has engaged the work-piece with a sufficient pressure.

Another object is to provide a surge valve for such a press and circuit, wherein this surge valve is provided with forcible opening and closing means arranged to permit the main plunger to carry out the drawing operation as soon as a predetermined pressure has been built up in the clamping plunger cylinder by the engagement of the clamping plunger with the work-piece.

Another object is to provide a surge valve having a disabling device for temporarily and selectively holding the valve inoperative.

Another object is to provide a special surge valve for use with a double-acting drawing press having a drawing plunger and clamping plunger, with a hydraulic circuit and devices arranged to permit the gravitational descent of the clamping plunger and drawing plunger in exact unison with one another; this special surge valve being arranged to delay the application of pressure to the drawing plunger until the pressure has been built up to a predetermined amount in the clamping plunger cylinder, whereupon the drawing plunger is permitted to carry out its drawing operation; this special surge valve being also arranged to release the pressure in the drawing plunger cylinder in response to the reversal of the main plunger.

This application is a division of my application filed May 27, 1936, Serial No. 82,087.

In the drawings:

Figure 1 is a diagrammatic view, partly in section, of a hydraulic drawing press and circuit, in connection with which the surge valve of the present invention may be used.

Figure 2 is a central vertical section through the combination relief and check valve employed in the circuit of Figure 1.

Figure 3 is an elevation, partly in section, of the hydraulic pump used in the circuit of Figure 1, showing the servomotor control arrangement

for bringing about its reversal in response to the application of pressure fluid from an outside source.

Figure 4 is an enlarged sectional view of the main cylinder surge valve of this invention, as shown in Figure 1.

Hydraulic press and circuit generally

Referring to the drawings in detail, Figure 1 shows, for purposes of illustration, a circuit containing a hydraulic drawing press and associated control devices with which the surge valve of this invention may be used. The circuit as a whole contains a number of individual units which may be generally designated before being described in detail. The press 10 is operated by a main pump 11, which in turn, is supplied with servomotor fluid from a servomotor pump 12, and discharges fluid into the return side of the press 10 by way of the combination relief and check valve 13. The press 10 is also provided with a main surge valve 14, of a special construction according to the present invention, and having means incorporated therewith for holding the surge valve temporarily inoperative. The press 10 is provided with clamping cylinders having a surge valve 15 opening into the surge tank of the press 10. The surge valve 15 is opened by pressure fluid from the push-back side of the main plunger, and is of a type described in the Ernst patent, No. 1,892,568, of December 27, 1932.

The surge tank of the press 10 also contains a check valve 16, a pressure release valve 17 which is arranged to control direct communication between the main cylinder and the surge tank, and a by-pass valve 18, each of these valves being provided with choke valves 19 and 20, respectively. The details of the valves 17, 18, 19 and 20 form no part of the present invention, but are fully disclosed in the Ernst patent, No. 1,956,758, dated May 1, 1934. The purpose of the main cylinder release and by-pass valve arrangement 17, 18 is to release pressure from the main cylinder prior to the opening of the surge valve and by-pass the return of the pump discharge to the surge tank during the release of this fluid, in the manner described in the Ernst patent, No. 1,956,758. The circuit of Figure 1 also contains an auxiliary or clamping pump 21, arranged to provide pressure fluid for operating the clamping cylinders of the press. This clamping pump 21 is provided with a special servomotor control arrangement described in detail below.

Press construction

The hydraulic press 10 shown diagrammatically in Figure 1 is provided with a clamping block 22 having a die 23, with a recess 24 into which the work-piece 25 is to be drawn by the action of the press. The clamping block 22 is mounted upon the bed of the press (not shown) and is arranged to receive the outer portions of the work-piece 25, clamped thereagainst by the clamping slide 26. The clamping slide 26 is operated by the clamping plungers 27 adapted to reciprocate in clamping cylinders 28. The clamping slide 26, at points adjacent the junctions therewith of the clamping plungers 27, is provided with projecting portions 29 adapted to be engaged by the main platen of the press upon the upward stroke thereof, as will subsequently appear. Arranged to cooperate with the die 23 and adapted to fit into the recess 24 thereof is a punch 30 attached to the main platen 31, which in turn, is secured to the main or drawing plunger 32. The drawing plunger 32 is of a double-acting type, with a piston head 33, and reciprocates within the main cylinder 34.

One of the clamping cylinders 28 is provided with an aperture 35 in the head thereof, adapted to receive the surge valve 15 previously mentioned. Similarly, the main cylinder 34 is provided with an aperture 36 for receiving the main surge valve 14, also previously mentioned. The main cylinder 34 is further provided with a port 37 leading, by way of the line 38, to the main cylinder release valve 17, from which the line 39 leads through the choke valve 20 to the by-pass valve 18. The line 40 also interconnects the main cylinder release valve 17 and the by-pass valve 18. The main cylinder release valve 17 discharges directly into the surge tank 41 of the press 10 by way of the line 42, containing the choke valve 19. The line 43 leads from the main cylinder release valve 17 to the return line 44 of the main pump 11. The check valve 16 is installed at an intermediate point along the line 43 and within the surge tank 41 in order to permit fluid to be drawn therethrough into the line 43 when the latter is under suction. The internal arrangement and operation of the circuit comprising the port 37, the line 38, the main cylinder release valve 17, the by-pass 18, the line 43 and the check valve 16 will be found fully disclosed in the above-mentioned Ernest Patent No. 1,956,758, of May 1, 1934.

Main pump and associated circuit

The main pump 11 is provided with a pressing line 45 opposite the return line 44, and receives pressure fluid from the pump 11 while the main plunger 32 is performing a drawing operation. The line 45 enters the main cylinder 34 through the port 46. The main pump 11 is provided with a servomotor cylinder 47 containing a servopiston (not shown) for shifting the shift ring of the pump 11 to vary or reverse the discharge thereof. The servomotor 47 is controlled manually by a servomotor valve 48, containing a valve plunger 49 operated by a hand lever 50. The servomotor valve 48 is connected to the surge tank 41 by means of the pipe line 51. The servomotor 47 and servomotor valve 48 are interconnected by means of the pipe lines 52 and 53, respectively. The servomotor 47 is also automatically operated on the return stroke by a pilot piston within a pilot cylinder 54, through the pilot line 55 running to the return line 44 of the main pump 11; and on the pressing stroke by a differential pilot

piston (not shown) by way of the line 56, leading therefrom to the pressing line 45.

Fluid for operating the servomotor 47 is supplied from the surge tank 41 by the servomotor pump 12, connected thereto by the suction line 57, connected to the suction side of the pump 12. The pressure side of the pump 12 is connected to the suction line 57 by means of the by-pass line 58, containing the pressure relief valve 59, and is also connected to the servomotor valve 48 by means of the pressure line 60. When the servomotor valve 48 is moved into such a position that the pressure line 60 is blocked, the discharge of the pump 12 passes through the pressure relief valve 59 to the suction line 57, and is accordingly by-passed until the line 60 is again opened by shifting the manual control lever 50. The details of the servomotor valve 48 and the servomotor 47 form no part of the present invention, and will be found fully disclosed in the Ernst Patent, No. 2,038,272, dated April 21, 1936.

Combination relief and check valve

The return line 44 from the main pump 11 leads to the combination relief and check valve 13, beyond which the line 61 leads to the port 62, discharging into the return side of the main cylinder 34. The valve 13 consists of a casing 63 having a chamber 64 with a port 65 closed by a ball 66. Opposite the port 65 is a plug 67 containing a bore 68, in which reciprocates the valve plunger 69. A portion 70 of the chamber 64 intersects the bore 68. The plunger 69 is provided with an enlarged portion 71 engaged by a coil spring 72, the opposite end of which engages the collar 73, acted upon by the adjusting screw 74 mounted in the threaded bore 75 of the valve cap 76. The latter is mounted upon the valve casing 63. The pipe line 44 opens into the chamber 64 by way of the port 77, whereas the pipe line 61 leads outwardly from the port 78 in the chamber 79 containing the ball 66.

Accordingly, fluid may pass freely from the main pump 11, along the line 44, through the valve 13 and the line 61, into the return side of the main cylinder 34 by merely displacing the ball 66 from its position closing the port 65. Fluid proceeding in the opposite direction, however, cannot pass freely, but forces the ball 66 against the port 65 to close this port. Pressure is built up in the chamber 79 containing the ball 66 until this pressure is sufficient to force the plunger 69 upwardly against the urge of the coil spring 72, whereupon the entrapped fluid is released through the bore 68 into the extension 70 of the chamber 64, and thence escapes through the line 44. The detailed operation of the combination relief and check valve 13 is described below.

Auxiliary or clamping pump

The auxiliary pump or clamping pump 21 serves to supply pressure fluid to the clamping cylinders 28 for the operation of the clamping plungers 27 for moving the clamping slide 26, and is shown in detail in Figure 3. This pump consists of a casing 80 containing a shift ring 81 for varying the eccentricity of the secondary rotor of the pump relatively to the cylinder barrel or primary rotor, in a manner well known to those skilled in the art. By thus shifting the shift ring 81 the delivery of the pump 21 is varied or reversed. The shift ring 81 is mounted upon the rods 82 and 83, secured within the diametrically opposite threaded bores 84.

The rod 82 passes through the antileakage packing 85 and the retaining cap 86 therefor, and is threaded upon its outer end, as at 87, to receive the nut 88 and the stop nut 89. Also threaded upon the threaded portion 87 is a sleeve 90, to which is secured the hand wheel 91, as by the set screw 92 and key 93. The sleeve 90 engages the ball thrust bearing 94, the opposite side of which engages a sleeve 95 arranged to compress a coil spring 96 when the hand wheel 91 and threaded sleeve 90 are rotated to move along the threaded portion 87 of the rod 82. The opposite end of the coil spring 96 engages the retaining cap 86, and the sleeve 95 is guided by the tubular extension 97 secured to the pump casing 80 by means of the set screws 98. A lubricating coupling 99 serves to admit oil to lubricate the connection between the sleeve 95 and its tubular guide portion 97. The sleeve 95 is not threaded upon the threaded portion 87, but is provided with a bore 100, which is spaced apart from the threaded portion 87.

To the opposite side of the pump 21 is secured a tubular portion 101, through which passes the rod 83, and which is closed by a cap 102 having an end plate 103. The cap 102 contains a bore 104, within which reciprocates a piston head 105 which is mounted upon the rod 83 and retained in position by the head 106 thereof. The piston head 105 is provided with an annular shoulder 107 lying within the annular chamber 108, from which the line 109 leads, through the choke valve 110 to the pressure side of the auxiliary pump 21. Also mounted upon the rod 83 is a piston head 111, adapted to reciprocate within the bore 112 of the tubular member 101.

The line 113 leads from the bore 112 on the left-hand side of the piston head 111 to the servomotor line 53 interconnecting the servomotor valve 48 with the servomotor 47 of the main pump 11. The line 53 supplies pressure fluid from the servomotor pump 12 to the servomotor 47 to reverse the main pump and cause it to deliver pressure fluid through the return line 44 to the return side of the main cylinder 34. When this is done it will be obvious that pressure fluid will also flow through the line 113 into the bore 112, and act upon the piston head 111 forcing it to the right (Figure 3), and causing it to engage the piston head 105 and force the rod 83 and shift ring 81 of the pump 21 to the right, in a manner subsequently to be described in connection with the operation of the circuit as a whole.

The auxiliary pump 21 is supplied with fluid from the surge tank 41 by way of the suction line 114, and discharges pressure fluid from its pressure side through the pressure line 115 and the ports 116, into the clamping cylinders 28 above the clamping plungers 27. From the bore 104 the port 118 opens into the line 119, which leads to the main surge valve 14 to render the latter operative or inoperative, in the manner described below.

Main surge valve

The main surge valve 14 of the present invention (Figure 4) consists of a tubular casing 120 mounted in the bore 36 in the head of the main cylinder 34 and containing an end cap 121. The tubular casing 120 is provided with outlet ports 122 leading from the interior into the chamber formed by the main cylinder 34 above the main piston head 33. The end cap 121 is provided with a projection 123, serving as a seat for the coil

spring 124, the opposite end of which urges upwardly the surge valve member 125. The latter is provided with a beveled portion 126 adapted to engage a valve seat 127 in the casing 120, and is also provided with fluted portions 128 along its upper extent so as to permit fluid to pass through the passageway 129, by way of the fluted portions 128, between the valve seat 127 and the beveled portion 126, through the ports 122 into the main cylinder, and vice versa, when the main surge valve 14 is open.

Mounted above the tubular casing 120 is a cylindrical casing 130 having a flanged portion 131 resting upon the outer wall of the main cylinder 34, and provided with passageways 132 leading from the surge tank into the interior of the valve (Figure 4). The cylindrical casing 130 is provided with a bore 133, within which the valve-operating rod 134 is reciprocally mounted. The rod 134 is provided with a head 135, urged in an upward direction by the coil spring 136 contained within the counter-bore 137. The upper portion of the counter-bore 137 is closed by a cap 138 having a bore 139 within which reciprocates a piston rod 140, having an annular shoulder 141 formed by a piston head 142.

The piston head 142 reciprocates within a bore 143, access to which is gained through the port 144 leading to the pipe line 119. Above the piston head 142 is an annular enlargement 145, urged downwardly by the coil spring 146 within the chamber 147. The opposite end of the coil spring 146 engages the end wall 148 containing the port 149 opening into the pipe line 150. The latter leads to the pipe line 43, and is joined at an intermediate point by the pipe line 151 leading thereto from the surge valve 15. When the main pump 11 is set to discharge pressure fluid into the return side of the main cylinder 34, as will subsequently appear, pressure fluid likewise passes along the lines 150 and 151 to operate the surge valves 14 and 15.

Operation

In the operation of the press and circuit shown in Figure 1, a work-piece 25, in the form of a metal blank, is placed upon the clamping block 22 immediately above the die 23. The main pump 11 and auxiliary pump 21 are then started in operation, and the hand lever 50 is set at such a position that pressure fluid is delivered from the servomotor pump 12, through the servomotor valve 48 and the line 52, into the servomotor cylinder 47 to operate the servo-piston to shift the shift ring of the main pump 11 to a forward delivery position. The main pump 11 then draws fluid through the port 62 on the return side of the main cylinder 34 by way of the line 61, the combination relief and check valve 13 and the line 44, and discharges it under pressure through the line 45 leading to the pressing side of the main cylinder 34 above the main piston head 33. Meanwhile, the auxiliary pump 21 withdraws fluid through the suction line 114, and discharges it through the pressure line 115, through the ports 116 into the space above the clamping plungers 27.

The weight of the clamping slide, the clamping plungers 27, the main platen 31 and the main plunger 32 causes these parts to descend under the influence of gravity, opening the surge valves 14 and 15 and permitting fluid to pass directly from the surge tank 41 into the clamping cylinders 28 and main cylinder 34. In the main surge valve 14 this fluid passes through the passage-

ways 132, the fluted portions 128, the space between the valve seat 127 and beveled portion 126 and the ports 122 into the main cylinder 34, the suction created therein drawing the surge valve member 125 downwardly against the urge of the coil spring 124 (Figure 4). The interior arrangement of the surge valve 15 and its action in this respect are similar to the arrangement of the lower portion of the main surge valve shown in Figure 4. In this way the descent of the clamping plungers 27 and main plunger 32 is brought about more rapidly than would be possible by the use of pressure fluid discharged from the main pump 11 and auxiliary pump 21 without the action of the surge valves 14 and 15.

At this point, however, it is necessary that the clamping slide 26 and main platen 31 descend in unison for if the main platen 31 gets ahead of the clamping slide 26 the punch 30 will start its drawing action before the work-piece 25 has been clamped between the clamping slide 26 and the clamping block 22. This action is prevented by the operation of the combination relief and check valve 13.

To this end, the thrust of the spring 72 (Figure 2) is adjusted so that the combined weight of the main plunger assembly and clamping plunger assembly, acting upon the fluid entrapped beneath the main piston head 33, will be just sufficient to move the relief valve plunger 69 to open the valve. The clamping plunger assembly can never move ahead of the main plunger assembly because of the shoulders 29. The instant the main plunger assembly tends to move ahead of the clamping plunger assembly, however, the relief valve plunger 69 will close, because the weight of the main plunger assembly is insufficient to keep it open without the added weight of the clamping plunger assembly. For this reason also, the instant that the clamping plunger assembly engages the work-piece 25 and halts, the main plunger assembly will also halt until pressure is built up in the main cylinder 34 sufficient to open the valve plunger 69 of the valve 13. Obviously, the seating of the ball 68 will prevent fluid from passing from the chamber 73, through the port 65, into the chamber 64. (Figure 2.)

Meanwhile, the auxiliary pump 21 has been operating and discharging fluid into the clamping cylinders 28. As the clamping slide 26 comes to rest against the work-piece 25, pressure is built up by the pump 21 within the clamping cylinders 28, and this pressure is communicated, through the line 109 and the choke valve 110 (Figure 3) to the annular chamber 108, where it acts against the annular shoulder 107 upon the piston head 105, causing the piston head 105 to move to the right, overcoming the contrary urge of the coil spring 96 on the opposite side of the pump 21. The coil spring is so arranged as to urge the shift ring 81 of the pump 21 to the left, into its full forward delivery position. As the piston head 105, acting against the head 100 on the rod 83, forces the latter to the right, it moves the shift ring 81 to the right toward the neutral delivery position of the pump. At the same time the piston head 105 eventually moves beyond the port 118 and opens communication between the lines 109 and 119, permitting pressure fluid to flow through the latter into the chamber 143 of the main surge valve 14 (Figure 4), where it acts against the annular shoulder 141 to lift the piston head 142 against the urge of the coil spring 146. This lifts the piston rod 140

and permits the operating rod 134 to rise against the urge of its coil spring 136, thereby permitting the surge valve member 125, which has hitherto been forcibly held open by this means, to close by moving upwardly.

Any excess discharge of the main pump 11 into the main cylinder 34 above the piston head 33 which might have otherwise served to force the main plunger 32 to move ahead of the clamping plungers 27 has, in the meantime, been discharging through the main surge valve 14 by way of the ports 122, the fluted portions 128 and the passageways 132 into the surge tank 41 so that no excess pressure could build up within the main cylinder 34 until the clamping plungers had fully clamped the work-piece in position. The closing of the main surge valve 14, however, by the action of the fluid passing along the line 119 from the auxiliary pump 21 enables the main pump 11 to accumulate pressure within the main cylinder 34 only after a sufficient clamping pressure has been accumulated within the clamping cylinders 28. In this manner it is impossible for the main plunger 32 to get ahead of the clamping plungers 27 or to start a drawing operation before the clamping plungers 27 have fully engaged the work-piece 25.

As previously stated, the main plunger 32 could not advance further by gravity because it lacks sufficient force to open the relief valve plunger 69 in the combination relief and check valve 13, and it could not advance under pump pressure because the main surge valve 14 was kept open under the action of the piston rod 140, forced downwardly by its coil spring 146. Not until this piston rod 140 is withdrawn by the pressure fluid reaching it from the line 119 is it possible to build up pressure within the main cylinder 34 to perform the drawing stroke.

At this juncture the clamping slide 26 has come to rest, clamping the work-piece 25 between it and the clamping block 22, and the main platen 31 and punch 30 have also come to rest. By reason of the closing of the main surge valve 14, pressure now is built up within the main cylinder 34 by the main pump 11 until the punch 30 is forced downwardly against the work-piece 25, performing the drawing operation and forcing it into the recess 24 in the die 23.

When this operation is completed it is necessary to reverse the operation of the press and withdraw the clamping plungers and main plunger. In order to relieve the pressure in the clamping cylinders 28 before the main platen 31 picks up the clamping slide 26 by engaging the shoulders 29, the control devices associated with the auxiliary pump 21 come into play. When the hand lever 50 is shifted to throw the main pump 11 into a reverse delivery position, pressure fluid is discharged into the servomotor line 53 from the servomotor valve 48, and operates the servo-piston within the servomotor cylinder 47 to accomplish this. A part of this pressure, however, passes along the line 113, into the space to the left of the piston head 111 of the auxiliary pump 21, moving the piston head 111 to the right and causing it to shift the rod 83 and the shift ring 81 to the right. The shift ring 81 thereby moves through the neutral delivery position of the auxiliary pump 21 into the reverse position thereof, thereby immediately relieving the pressure within the clamping cylinders 28 before the main platen 31 engages the shoulders 29 of the clamping slide 26. The pressure fluid from the main pump 11 is discharged through the return

line 44, the combination relief and check valve 13 and the line 61, into the space beneath the main piston head 33, raising the main plunger 32 and retracting the main platen 31 and the clamping slide 26 simultaneously by their interengagement at the shouldered portions 29 of the clamping slide 26.

The instant the main pump 11 is reversed to retract the main plunger 32, pressure fluid passes along the lines 44, 43 and 150 and 151 to the main and clamping cylinder surge valves 14 and 15, respectively. This fluid (Figure 4) acts against the upper end of the piston rod 140 within the chamber 147, and forces it downwardly, opening the surge valve member 125 and permitting the fluid to escape from the top of the main cylinder 34 directly into the surge tank 41. At the same time the surge valve 15 will be opened by the pressure fluid reaching it along the line 151, permitting the escape of the fluid from the clamping cylinders 28 into the surge tank 41, as described in the previously mentioned Ernst Patent No. 1,892,568, of December 27, 1932.

It will be understood that I desire to comprehend within my invention such modifications as come within the scope of the claims and the invention.

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

1. A surge valve comprising a casing having a lower chamber, a middle chamber and an upper chamber, said lower chamber having a valve seat and passageways extending through said casing from opposite sides of said valve seat, a valve member reciprocable in said lower chamber, resilient means for urging said valve member into closing engagement with said valve seat, a valve operating element reciprocable in said middle chamber and engageable with said valve member, resilient means for urging said valve operating element out of engagement with said valve member, a double acting plunger reciprocable in said upper chamber and means for admitting pressure fluid to said upper chamber on opposite sides of said double acting plunger.

sure fluid to said upper chamber on opposite sides of said double acting plunger.

2. A surge valve comprising a casing having a lower chamber, a middle chamber and an upper chamber, said lower chamber having a valve seat and passageways extending through said casing from opposite sides of said valve seat, a valve member reciprocable in said lower chamber, resilient means for urging said valve member into closing engagement with said valve seat, a valve operating element reciprocable in said middle chamber and engageable with said valve member, resilient means for urging said valve operating element out of engagement with said valve member, a double acting plunger reciprocable in said upper chamber, means for admitting pressure fluid to said upper chamber on opposite sides of said double acting plunger and resilient means relatively more powerful than the previously mentioned resilient means for urging said double acting plunger downward to shift said valve operating element to move said valve member away from its seat.

3. A surge valve comprising a casing having a lower chamber, a middle chamber and an upper chamber, said lower chamber having a valve seat and passageways extending through said casing from opposite sides of said valve seat, a valve member reciprocable in said lower chamber, resilient means for urging said valve member into closing engagement with said valve seat, a valve operating element reciprocable in said middle chamber and engageable with said valve member, resilient means for urging said valve operating element out of engagement with said valve member, a double acting plunger reciprocable in said upper chamber and means for admitting pressure fluid to said upper chamber on opposite sides of said double acting plunger, said valve member, said valve operating element and said double acting plunger being reciprocable along a common axis of reciprocation.

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