May 19, 1942. W. ERNST 2,283,356

METHOD OF DRAWING

Original Filed March 27, 1939 2 Sheets-Sheet 1

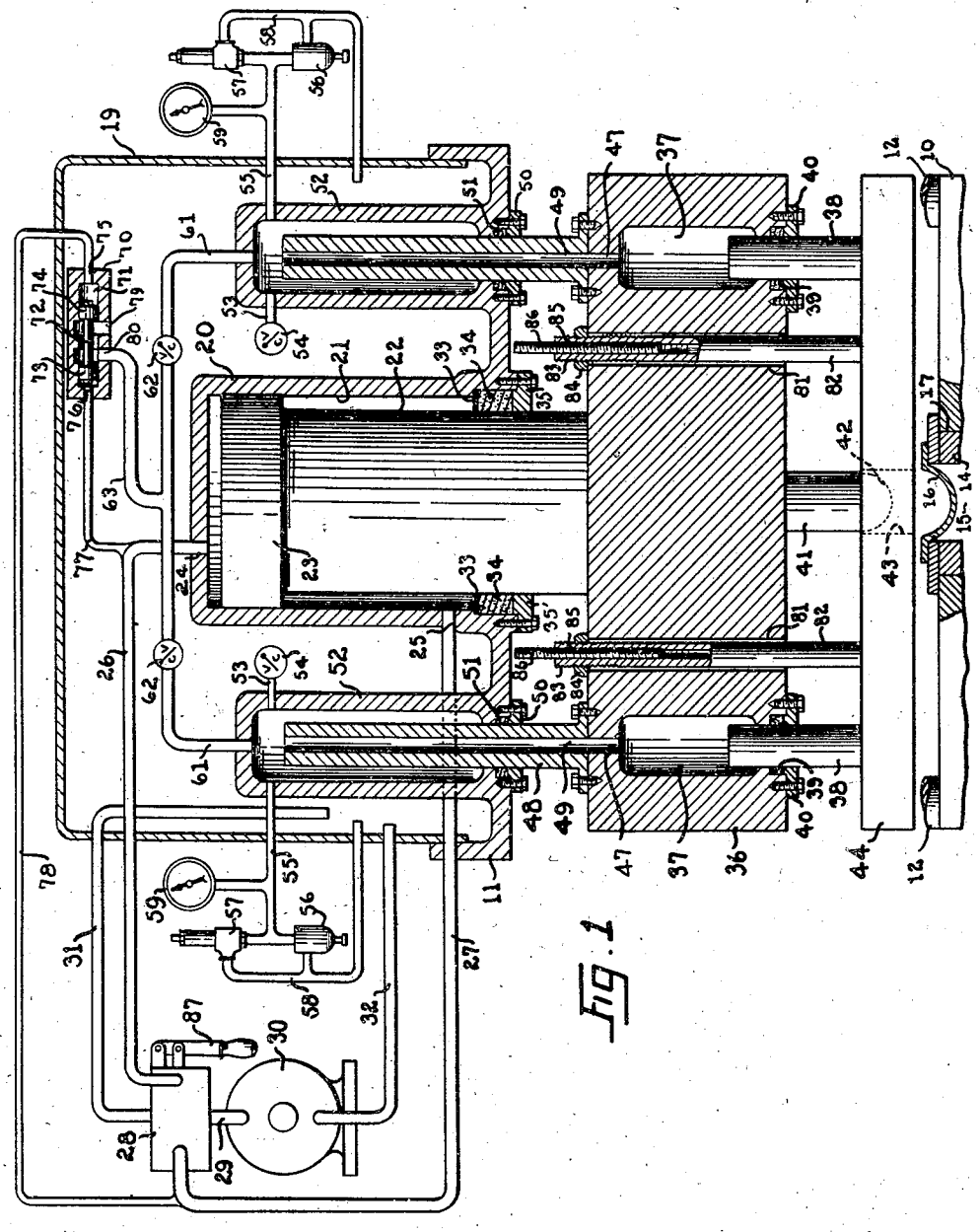


Fig. 1

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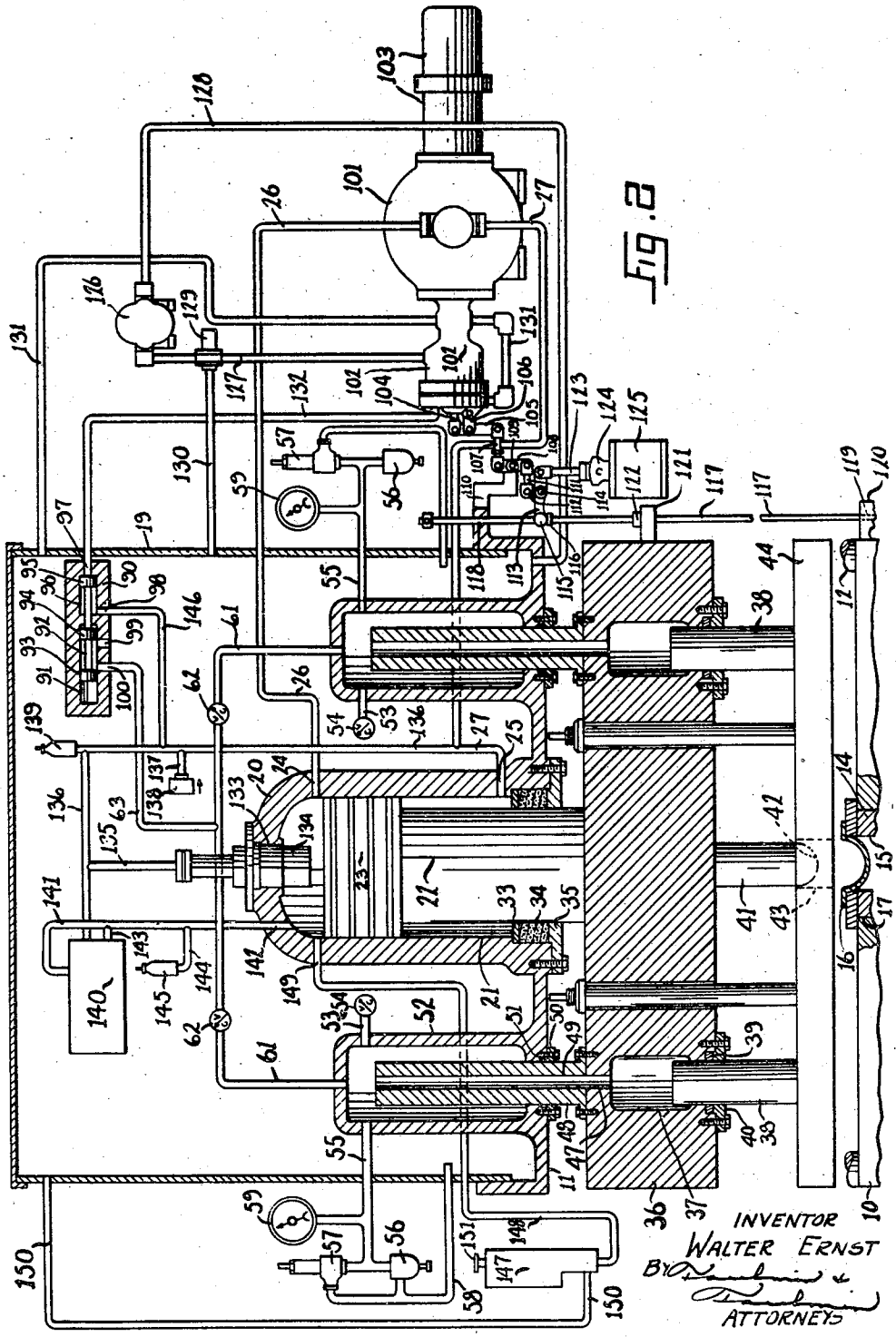


Fig. 2

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UNITED STATES PATENT OFFICE

2,283,356

METHOD OF DRAWING

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Original application March 27, 1939, Serial No. 264,311. Divided and this application August 28, 1939, Serial No. 292,271

3 Claims. (Cl. 113—45)

This invention relates to presses, and in particular, to hydraulic presses having clamping mechanism associated with drawing mechanism.

One object of this invention is to provide a hydraulic press having a drawing plunger and a clamping plunger, means being provided for releasing the pressure from the clamping plunger during the retraction stroke of the drawing plunger, together with means for preventing the release of this pressure during the drawing stroke.

Another object is to provide a hydraulic press having a drawing plunger and a clamping plunger, together with means responsive to the reversal of pressure fluid for retracting the drawing plunger in order to release the pressure in the clamping plunger.

Another object is to provide a hydraulic press having a drawing plunger and a clamping plunger, together with a valve shifted in response to the reversal of the drawing plunger by pressure fluid supplied for retracting the latter so that the valve for releasing the pressure from the clamping plunger is automatically actuated by the pressure condition existing in the drawing plunger circuit without the necessity for the provision of linkages or other mechanism interconnecting the drawing plunger with the valve.

Another object is to provide a method of producing drawn articles, residing in clamping the article at its periphery by hydraulically operated means while performing the drawing operation, and thereafter releasing the pressure from the hydraulic clamping means in response to the reception of pressure for reversing the drawing operation.

This application is a division of my application Serial No. 264,311, filed March 27, 1939, which has resulted in Patent No. 2,252,881, Aug. 19, 1941.

In the drawings:

Figure 1 is a diagrammatic view, partly in section, showing the working elements of a hydraulic drawing press circuit according to one embodiment of this invention, wherein a reversing valve controls the distribution of fluid to the drawing plunger.

Figure 2 is a diagrammatic view of a modification of the circuit shown in Figure 1, wherein a reversible pump is employed for reversely distributing pressure fluid to the drawing plunger to advance and retract the latter.

General arrangement

In general, the drawing press of this invention consists of a drawing plunger and a plurality of clamping plungers having relief valves associated therewith for release of the pressure fluid therein at predetermined pressures, thereby enabling a predetermined clamping pressure to be exerted on the blank. The relief valves may be set at different loadings so as to provide different clamping pressures at different points upon the blank. Check valves are employed to prevent the interflow of fluid between the various clamping cylinders, thereby preventing equalization of clamping pressures. The hydraulic circuit also includes a two-way valve connected to the clamping cylinders, and operated in response to the admission of pressure fluid into the retraction circuit of the drawing plunger. By this arrangement it is impossible to release the clamping pressure until the retraction stroke of the drawing plunger has been started.

Hitherto, the provision of a platen-operated valve for releasing the pressure from the clamping cylinders has required complex mechanism, such as linkages actuated by the platen for shifting the valve. This, in turn, has required an individual adjustment of this mechanism to be made every time the dies are changed, and has always created the danger of erroneous adjustment whereby the valve would not be operated at all, or would be operated at the wrong position.

According to the present invention, however, the platen-operated mechanism for shifting the valve is entirely eliminated, and instead the valve is shifted by pressure fluid applied thereto when pressure fluid is admitted into the retraction circuit of the drawing plunger. This construction simplifies the external appearance of the press, results in economy of manufacture, avoids the possibility of maladjustment and saves the time hitherto required for adjusting the platen-operated mechanism to suit various dies. According to the present invention also the clamping pressure releasing valve is preferably mounted inside the oil reservoir so that leakage is of no consequence.

Press circuit employing pump with reversing valve

Referring to the drawings in detail, Figure 1 shows diagrammatically a hydraulic metal drawing press having a base member 10 connected to a top member 11 by tie rods 12, the latter being cut off for simplicity of showing. Mounted in the base member 10 is a drawing die 14 having a die cavity 15 for receiving the blank 16. The die 14 is received within a bore 17 in the

base member 10. The drawing press of the present invention may utilize either flat blanks or blanks which have already been subjected to one or more drawing operations. In Figures 1 and 2 the blank 16 is illustrated as having been previously subjected to one drawing operation and in position for another drawing operation, which will elongate it and cause it to be drawn downwardly into the die cavity 15.

Associated with the top member 11 of the press is a surge tank 19 or oil reservoir for containing the working fluid by which the press is actuated. Also associated with the top member 11 is a main cylinder or drawing cylinder 20, having a bore 21 reciprocably receiving the double-acting main plunger or drawing plunger 22 having a piston head 23 thereon. The cylinder 20 is provided with upper and lower ports 24 and 25 on opposite sides of the piston head 23, and adapted by means of pipes 26 and 27 to supply pressure fluid to advance or retract the drawing plunger 22. The delivery of pressure fluid to the main cylinder 20 and the exhaustion of fluid therefrom are controlled by a four-way valve 28. This valve 28 is of any suitable type known to those skilled in the art, and its details form no part of the present invention.

Leading to the four-way valve 28 is a pressure line 29, connected at its opposite end to a hydraulic pump 30. An exhaust line 31 leads from the four-way valve 28 to the interior of the surge tank 19. The pump 30 is also provided with a suction line 32, likewise leading into the interior of the surge tank 19 for supplying fluid to the pump. The main or drawing cylinder 20 is provided, near its lower end, with a packing ring 33 having a packing 34 associated therewith and adapted to be compressed by a gland 35 in such a manner as to prevent leakage around the drawing plunger 22.

Mounted upon the lower end of the drawing plunger 22 is a platen 36 containing clamping cylinders 37, having clamping plungers 38 reciprocable therein. Each clamping cylinder 37 is provided with a packing 39 surrounding the clamping plunger 38, and compressed by a gland 40 for the prevention of leakage. Mounted upon the platen 36 is a drawing die member or punch 41, cooperating with the drawing die 14 and having a nose portion 42 approximately corresponding to the die cavity 15. The punch 41 is adapted to pass through an aperture 43 in a clamping member 44, the latter being secured to the outer ends of the clamping plungers 38.

The clamping cylinders 37 are provided with passages 47 connected to the bores 49 of tubular plungers 48, mounted upon the upper side of the platen 36. The hollow plungers 48 pass through glands 50 and packings 51, into cylinders 52 arranged on the press top member 11 and within the surge tank 19. From each cylinder 52 the line 53 leads through the check valve 54 to the interior of the surge tank 19. Each check valve 54 opens in the direction of the cylinder 52 so that the latter may draw in fluid upon the descent of the hollow plungers 48. The check valves 54, however, close and prevent the discharge of fluid upon the ascent of the plungers 48.

From each cylinder 52 a T-shaped line 55 leads also to a safety valve 56 and a pressure relief valve 57. The safety valve 56 is merely provided as an additional safety feature in the event of a jamming or other failure of the relief valve 57. The safety valve 56, however, is set to release pressure at a higher pressure than the relief valve 57, hence, does not become operative unless the relief valve 57 fails to release fluid in response to the accumulation of a dangerous pressure within the corresponding clamping cylinder 37. Each clamping cylinder 37 is provided with its own pressure relief valve 57 and safety valve 56 so that a different pressure release point may be provided for each clamping cylinder 37, if desired. This, in turn, enables different clamping pressures to be exerted upon different portions of the periphery of the blank 16, a feature which is useful in certain classes of drawing work.

The valves 56 and 57 both discharge into the discharge line 58, leading to the interior of the surge tank 19. A pressure gauge 59 is connected to each line 55 to indicate pressure existing in the associated clamping cylinder 37. Extending from each clamping cylinder 52 is a line 61 having therein a check valve 62, opening in a direction away from its associated clamping cylinder 52 and toward a common line 63 connected thereto. The line 63 leads to a two-way valve 70, having a cylindrical bore 71 containing a valve member 72 with valve heads 73 and 74. The opposite ends of the cylinder bore 71 are provided with ports 75 and 76. A branch line 77 leads from the line 26 to the port 76, whereas a branch line 78 leads from the line 27 to the port 75. The cylinder bore 71 likewise contains a discharge port 79, opening directly into the interior of the surge tank 19, and an additional port 80 to which the line 63 is connected. The end portions of the valve bore 71 immediately adjacent the ports 75 and 76 serve as pilot chambers or valve-actuating chambers for shifting the valve member 72 in response to the reception of pressure fluid either along the line 78 or 77 from the line 27 or 26, respectively.

The platen 36 is provided with bores 81 adapted to receive rods 82, the lower ends of which are secured to the clamping platen 44 and the upper ends of which are externally threaded, as at 83, and provided with nuts 84 threaded thereon. The upper ends of the rods 82 are likewise provided with internal threaded bores 85, carrying the threaded rods 86. This construction provides means for stripping the workpiece from the punch 41 when the rods 86 encounter the press top member 11 upon the return stroke of the main plunger 22. The construction permits this ejection or knock-out point to be accurately adjusted for each different type of workpiece.

Operation

In the operation of the circuit shown in Figure 1 the pump 30 is placed in operation, and the valve 28 is shifted by means of its operating lever 87 so that pressure fluid is admitted to the line 26, and thence to the upper part of the main cylinder 20 above the piston head 23. At the same time fluid is exhausted from beneath the piston head 23, through the line 27, and is discharged through the valve 28 to the line 31, and thence into the surge tank 19. When this occurs pressure fluid likewise passes through the line 77 and port 76, into the left-hand end of the cylinder bore 71, any fluid in the right-hand end of the cylinder bore 71 being discharged through the port 75 and line 78 by way of the valve 28 and line 31, into the surge tank 19.

Under the influence of the pressure in the line 77, the valve member 72 is pushed to the right so that the valve head 73 comes to rest between the ports 80 and 79. Under these conditions liquid is trapped in the left-hand end of the cyl-

inder bore 71, and cannot escape through the port 79. Ordinarily, a surge valve is provided in the top of the main cylinder 20 to admit fluid freely upon the downward stroke of the drawing plunger 22, thereby accelerating the gravitational descent of the platen 36. This surge valve is omitted for simplicity of disclosure, and its use is well known to those skilled in the art.

As the main plunger 22 moves downwardly it carries with it the platen 36 and the clamping assembly, which includes the clamping platen 44, the clamping plungers 38 and the tubular plungers 48. The suction thereby created in the cylinders 52 opens the check valves 54 and causes fluid to be drawn from the surge tank 19, into the cylinders 52. When the clamping member or clamping platen 44 has descended to a point where it engages the workpiece 16 it halts. The platen 36, however, continues to advance and moves the punch 41 into engagement with the workpiece 16. By reason of the relative motion thus created between the halted clamping plungers 38 and the moving clamping cylinders 37, fluid is displaced by the plungers 38 from the cylinders 37. The displaced fluid passes through the bores 49, into the cylinders 52. As the cross sectional area of the clamping plungers 38 is greater than the cross sectional area of the tubular plungers 48, however, more fluid is discharged from the clamping cylinders 37 into the cylinders 52 than there is room for. This results in pressure being built up in the cylinders 37 and 52, and this pressure acts against the heads of the plungers 48 and 38 to force the clamping member or clamping platen 44 firmly into engagement with the periphery of the workpiece 16.

When pressure in this clamping system exceeds the setting of the relief valves 57, the latter open and permit the excess fluid to be discharged through the lines 58, into the surge tank 19. The check valves 54 prevent the escape of fluid through the lines 53, and the closed position of the valve 70 prevents the discharge of fluid from the line 63 since the valve head 73 now stands between the ports 80 and 79. Consequently, the clamping platen 44 grips the periphery of the workpiece or blank 16 while the punch 41 is urged downwardly by the main platen 36, thereby performing the drawing operation upon the workpiece 16. When the required operation has been completed, the valve lever 87 is manipulated to shift the four-way valve 28 so that pressure fluid is discharged from the pump 30, into the line 27 leading to the retraction side of the main plunger 22. At the same time the space above the piston head 23 is open to exhaust through the line 26, the four-way valve 28 and the exhaust line 31 leading to the surge tank 19. Under these conditions the main plunger 22 and main platen 36 move upward.

The admission of pressure fluid to the retraction line 27 also admits pressure fluid to the line 78, this fluid entering the port 75 at the right-hand end of the cylinder bore 71 in the valve 70, and shifts the valve member 72 to the left into the position shown in Figure 1. As the tubular plungers 48 move upwardly, therefore, the fluid displaced from the cylinders 52 escapes through the lines 61, the check valves 62, the line 63, the port 80, the valve bore 71 and the port 79, into the surge tank 19. This enables the tubular plungers 48 to be freely retracted along with the main plunger 22 and main platen 36. In the arrangement of Figure 1, therefore, the valve 70 is automatically shifted to permit the escape of fluid from the cylinders 52 the instant that pressure fluid is admitted to the retraction side of the main plunger 22. There is thus no necessity for any leakage or any attention on the part of the operator for shifting the valve 70 to permit the escape of this fluid.

Modified drawing press circuit employing reversible pump

The modified arrangement shown in Figure 2 is similar to the arrangement shown in Figure 1, as regards the general construction of the press itself, and likewise is provided with similar relief and safety valves 57 and 56 for the cylinders 52. The common line 63, however, is connected to a valve 90, of a slightly different construction from the two-way valve 70 of Figure 1, but serving essentially the same purpose. The valve 90 is provided with a valve bore 91, containing a valve member 92 having heads 93 and 94. The valve member 92 carries a third valve head 95, reciprocable in an independent bore 96, having ports 97 and 98 at the opposite ends thereof. The valve bore 91 is provided with ports 99 and 100, similar in arrangement and purpose to the ports 79 and 80 of the valve 70 in Figure 1. The line 63 is connected, in Figure 2, to the port 100 and the port 99 opens directly into the interior of the surge tank 19.

In the circuit of Figure 2 the pressure fluid is supplied selectively to the line 27 or 26 from a reversible variable delivery pump 101. The latter is provided with a flow-control member or shift ring (not shown), familiar to those skilled in the art, and shifted to and fro by a servomotor 102 in order to vary the direction and amount of the fluid delivered from the pump 101. Mounted on the opposite side of the pump 101 from the servomotor 102 is a safety centering device 103 for shifting the flow-control member of the pump 101 to its neutral position in the event of a power failure to the motor driving the pump 101. The details of the servomotor 102 and safety centering device 103 form no part of the present invention, and are disclosed in the copending application of Walter Ernst, Ser. No. 170,250, filed October 21, 1937.

The servomotor 102 contains a servopiston connected to the pump flow-control member, and actuated in opposite directions in response to the shifting of the servomotor control valve member 104. The latter is pivotally connected to a lever 105 mounted upon a floating link 106, and pivotally connected at its opposite end to a link 107, which is pivotally connected to a lever 108 mounted upon a fixed fulcrum 109, secured to a bracket 110 mounted upon the press head 11, or any stationary part of the press. The lower end of the lever 108 is pivotally connected to a link 111, the opposite end of which is pivotally connected to an arm 112 operatively connected to a rocker arm 113. The rocker arm 113 is pivotally mounted upon a fulcrum 114, supported upon the press head 11, or any other stationary part of the press. One end of the rocker arm 113 is provided with a rounded yoke portion 115 engaging a collar 116 upon the press control rod 117. The latter is reciprocably supported upon the press, such as in the bore 118 on the press head 11, and by the bore 119 in the bracket 120 secured to the press bed 10.

The platen 36 carries a platen arm 121 engageable with an adjustable collar 122 upon the control rod 117. The opposite end of the rocker arm 113 from the yoke portion 115 is pivotally

connected to a rod 123, leading to the armature 124 of a solenoid 125. The energization of the solenoid 125, acting through the above-mentioned linkage, pushes the servomotor control valve member 104 to the right, whereas a spring within the servomotor 102 urges it to the left when the solenoid 125 is deenergized. When the platen 36 reaches its retracted position, the arm 121 lifts the control rod 117, and the collar 116 thereon shifts the rocker arm 113 in such a manner as to move the servomotor control valve member 104 to the right into its neutral position, thereby placing the flow-control member of the pump 101 in its neutral position, and reducing the delivery of the pump 101 to zero. This halts the platen 36 in its retracted position.

The motor which drives the variable delivery pump 101 also drives a pilot pump 126, preferably from the same shaft. The pilot pump 126 delivers pressure fluid through the line 127 to the servomotor 102, thereby operating the servomotor, and withdraws fluid from the surge tank 19 by way of the suction line 128. The line 127 thus serves as a pilot pressure line, and contains a relief valve 129 having a discharge line 130 discharging into the surge tank 19. The servomotor 102 is also provided with an exhaust line 131, similarly discharging into the surge tank 19. A pressure line 132 leads from the servomotor 102 to the end port 97 of the bore 96 within the valve 90. The main cylinder 20 is provided with a bore 133 in the head thereof, and serves to receive a surge valve 134 connected by the line 135 to the line 136, which in turn, is connected to the line 27 leading to the retraction side of the main plunger 22. The surge valve 134 is of the type disclosed in the patent to Walter Ernst, No. 1,892,568, issued December 27, 1932.

The line 136 is provided with a branch line 137 having a check valve 138, opening toward the line 136. The line 136 is additionally provided with a pressure relief valve 139, and is connected at its end to a main cylinder release and by-pass valve 140, having a line 141 leading to the port 142 in the head of the main cylinder 20. A branch line 143 likewise leads from the valve 140 to the line 141, and a second branch line 144 terminates in a pressure relief valve 145. The details of the main cylinder release and by-pass valve 140 form no part of the present invention, and are disclosed in the patent to Walter Ernst, No. 1,956,758, issued May 1, 1934. Running from the line 136 is a branch line 146 leading to the port 98 in the valve 90.

In order to provide a variable pressure control to alter the energization of the solenoid 125 and to automatically reverse the main plunger 22 at the attainment of a predetermined pressure during its working stroke, there is provided a tonnage control device 147 having a line 148 connected to the port 149 in the head of the main cylinder 20, and likewise having an exhaust line 150 connected to the interior of the surge tank 19. The tonnage control device 147 consists of a spring-loaded hydraulic plunger reciprocable in a chamber connected to the line 148, and movable to actuate an electric switch in circuit with the solenoid 125 when the pressure in the line 148 overcomes the force of the loading spring, at which time the plunger uncovers a port leading to the line 150, and the excess pressure fluid discharges into the line 150. The loading of the spring within the tonnage control device 147 is regulated by the hand wheel 151 so as to vary the pressure at which the switch therein becomes operative to alter the energization of the solenoid 125. The tonnage control device 147 is therefore, in principle, a pressure-responsive electric switch, and its details are well known to those skilled in the art and form no part of the present invention.

Operation of modified press circuit

In the operation of the modified press circuit shown in Figure 2, the pumps 101 and 126 are started in operation, preferably by energization of the solenoid 125, or manually by shifting the press control rod 117 downwardly by a hand lever (not shown). The resulting motion of the servomotor control valve member 104 shifts the flow-control member or shift ring of the pump 101 so as to place the latter upon stroke to discharge pressure fluid into the line 26 while withdrawing pressure fluid from the line 27. The main plunger 22 descends, as described in connection with Figure 1, and its gravitational descent is accelerated by the free admission of fluid from the surge tank 19, through the surge valve 134, into the upper end of the main cylinder 20.

At the same time, when the pilot pump 126 delivers pressure fluid to the servomotor 102 to place the pump 101 upon stroke to deliver pressure fluid into the line 26 and advance the main plunger 22, pilot pressure fluid also passes out of the servomotor 102, through the line 132, into the end chamber 96 of the valve 90, acting against the vave head 95 and shifting it to the left. This action shifts the valve head 94 into a position between the ports 100 and 99, and blocks the escape of fluid from the line 63, through the valve 90. Since the pilot pressure fluid remains at practically constant pressure, it can be depended upon to hold the valve 90 in its closed position during the power or working stroke of the main plunger 22. The valve 90 in Figure 2 is operated by pilot pressure in this manner rather than connected to the line 26 leading to the upper end of the main cylinder 20, as is the valve 70 in Figure 1, because the main plunger 22 descends under the influence of gravity with the aid of the surge valve 134, and hence, pressure sufficient to operate the valve 90 may not accumulate until after the workpiece 16 has been engaged by the clamping member 44. Thus, the valve might be closed too late to prevent loss of pressure from the cylinders 52 and 37. After the clamping member 44 engages the workpiece 16, the operation of the clamping apparatus 38, 37, 48, 52, etc., is as described in connection with the circuit of Figure 1.

When the drawing operation has proceeded to a point where the tonnage control device 147 deenergizes the solenoid 125 to reverse the delivery of the pump 101, the latter then discharges pressure fluid into the retraction line 27 and withdraws fluid from the advancing line 26. The main plunger 22 then rises, but a portion of the pressure passes through the lines 136 and 146, into the left-hand end of the valve bore 96. This pressure forces the valve head 95 and the valve member 92 to the right, into the position shown in Figure 2. At this time the line 132 is connected to the servomotor exhaust line 131, and releases any fluid in the right-hand end of the valve bore 96. The consequent shifting of the valve head 94 to the position shown in Figure 2 opens communication between the ports 99 and 100, and permits fluid to escape from the cylinders 52 and 37 of the clamping circuit analogous to the manner described in connection with Figure

1. The clamping platen 44 is, therefore, permitted to be retracted along with the main plate 36 and main plunger 22.

When the platen 35 nears the end of its retraction stroke, the collar 122 on the control rod 117 is lifted by the platen arm 121, shifting the servomotor control valve member 104 to its neutral position, and placing the flow-control member of the variable delivery pump 101 in its neutral or zero delivery position. This brings the platen 36 to a halt at the top of its retraction stroke.

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 method of drawing workpieces in presses having a drawing cylinder for operation of a drawing die, and a clamping cylinder, which comprises the step of admitting pressure fluid into the drawing cylinder and concommitantly therewith applying pressure fluid independent of said first-named pressure fluid for closing the escape of fluid from the clamping cylinder, clamping the work piece hydraulically while performing the drawing operation, and relieving the hydraulic pressure by permitting the escape of fluid from the clamping cylinders instantly in response to the application of hydraulic pressure to reverse the drawing operation and retract the drawing die.

2. A method of drawing workpieces in presses having a drawing die and a clamping cylinder, which includes the steps of (*a*) closing an outlet from and thus preventing the escape of fluid from the clamping cylinder and simultaneously subjecting said die and clamping cylinder to hydraulic pressure to initiate the advancing or drawing movement thereof, (*b*) clamping the work piece hydraulically while performing the drawing operation, and (*c*) reversing said hydraulic pressure on said die at the end of the drawing operation to initiate the retraction of said die, and simultaneously therewith applying said last mentioned pressure instantly to open the outlet from and thus release the fluid entrapped in said clamping cylinder.

3. A method of drawing workpieces in presses having a drawing die and a clamping cylinder, which includes the steps of (*a*) closing the outlet from and thus preventing the escape of fluid from the clamping cylinder while simultaneously subjecting said die and clamping cylinder to hydraulic pressure to initiate the advancing or drawing movement thereof, (*b*) clamping the work piece hydraulically while performing the drawing operation, (*c*) reversing said hydraulic pressure on said die at the end of the drawing operation to initiate the retraction of said die, and simultaneously therewith causing said last named pressure instantly to release the fluid entrapped in said clamping cylinder, and (*d*) thereafter stripping the work piece from the drawing die at a position between its end positions.

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