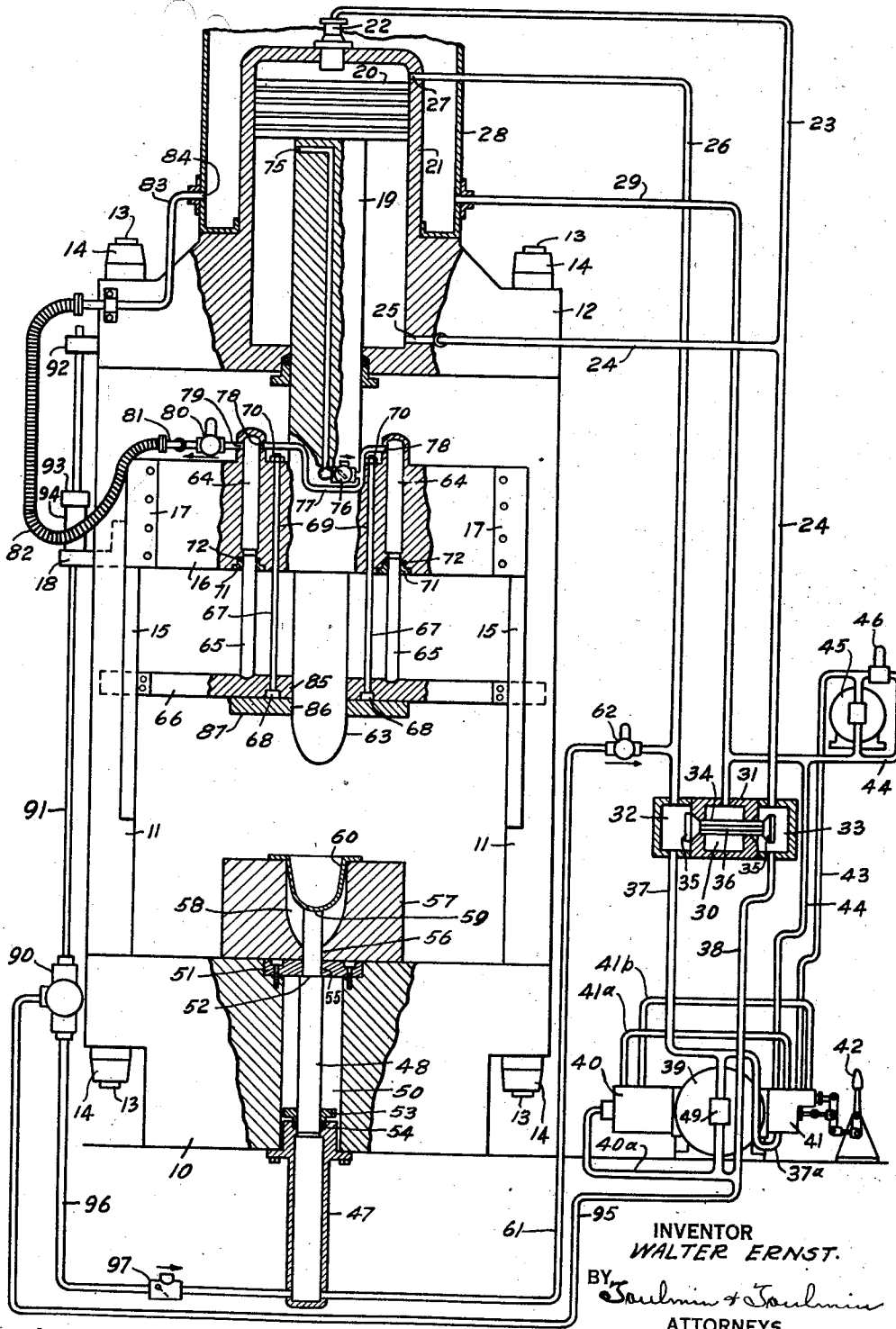


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TRIPLE-ACTION DRAWING PRESS  
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## UNITED STATES PATENT OFFICE

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## TRIPLE-ACTION DRAWING PRESS

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13 Claims. (Cl. 113—45)

This invention relates to hydraulic presses, and in particular, to drawing presses.

One object of this invention is to provide a triple-action drawing press having clamping and drawing devices, together with a movable support for the article being drawn, this support being arranged to provide a movable rest for the drawing device so as to prevent the latter from pushing its way through the article during the drawing operation.

Another object is to provide a drawing press having a supporting plunger which enters the drawing die and provides support for the end of the blank being drawn, the end of the plunger being preferably of a shape conforming to the shape of the bottom of the drawing die.

Another object is to provide a triple-action drawing press having a drawing plunger, a clamping plunger and a supporting plunger adapted to support a portion of the article being drawn so as to prevent the drawing plunger from piercing the article, this supporting plunger being yieldable a sufficient amount to permit the drawing action to take place, yet not to such an extent that such piercing will occur.

Another object is to provide a drawing press of the type described immediately above, wherein the supporting plunger is received within a hydraulic cylinder connected to the main cylinder so that the pressure with which the supporting plunger will resist the drawing operation is proportional to the pressure exerted by the drawing plunger itself, this hydraulic cylinder preferably having a pressure relief valve associated therewith for regulating the pressure at which the supporting plunger yields before the advance of the drawing plunger.

Another object is to provide a triple-action drawing press having a hydraulic main cylinder and ram for operating a drawing plunger, hydraulic clamping cylinders and rams for operating the clamping member, and a hydraulic supporting plunger for supporting a portion of the article being drawn during the drawing operation, the clamping plungers being hydraulically connected to the push-back side of the press so as to be operated by the fluid expelled therefrom during the advance of the main plunger, the clamping plungers preferably having a pressure relief valve associated therewith for releasing the clamping pressure when a predetermined pressure is being exerted.

In the drawing:

The single figure shows a front elevation, partly in section, of a triple-action hydraulic

drawing press and a hydraulic circuit in the diagrammatic form, according to this invention.

Referring to the drawing in detail, the figure shows a hydraulic press having a base 10, which is connected by uprights 11 to a top member 12. The connection is maintained by means of strain rods 13, extending through the uprights 11 and having nuts 14 threaded upon the ends thereof. Arranged to reciprocate vertically while guided on gibbed ways 15 is a platen 16, having guide plates 17 associated therewith. The platen 16 is also provided with an extension arm 18 adapted to operate a valve, in a manner subsequently to be described. The platen 16 is secured to one end of a main plunger 19, the head 20 of which reciprocates within the main cylinder 21 associated with the top member 12 of the press.

Mounted in the main cylinder 21 is a surge valve 22 for admitting the pressure fluid into the main cylinder during the gravitational descent of the platen. The details of this surge valve 22 form no part of the present invention, and are disclosed in United States patent to Walter Ernst No. 1,892,568, issued December 27, 1932. The surge valve 22 is operated to be opened upon the return stroke of the main plunger 19 by means of a pressure line 23 connected to the push-back line 24 of the press, which communicates with the port 25 opening into the push-back space beneath the main plunger head 20. The space above the latter is served by means of the pressing line 26 communicating with the port 27. A surge tank 28 surrounds the main cylinder 21, and provides fluid, such as oil, for the operation of the press, either through the surge valve 22 or through the line 29 extending to the middle chamber 30 of a make-up valve 31, the left and right end chambers 32 and 33 of which are connected to the pressing line 26 and push-back line 24, respectively.

The make-up valve 31 is of a conventional type, whose details form no part of the present invention, and contains a valve member 34 having heads 35 joined by a fluted body portion 36. The purpose of the make-up valve 31 is to take care of the need for fluid in any part of the circuit over that available from the various cylinders themselves. This valve operates automatically to provide such fluid, in a manner well known to those skilled in the art.

The opposite end chambers 32 and 33 are connected, respectively, to the pressing line 37 and the push-back line 38 of a hydraulic pump 39. This pump is preferably of the reversible variable delivery type, with a servo-motor 40 contain-

ing a piston (not shown) for moving the shift ring of the pump to vary and reverse the delivery of the pump. The servo-motor 40 is controlled manually by a control valve 41 connected thereto by the lines 41a and 41b and operated by the hand lever 42, and automatically by the line 40a running to the push-back line 38 of the pump 39. Fluid for operating the servo-motor 40 is provided through the lines 43 and 44 leading to the pressure and suction sides, respectively, of the low pressure pump 45, the line 44 being likewise connected to the line 29 leading from the make-up valve 31 to the surge tank 28. A pressure relief valve 46 by-passes the discharge of the pump 45 into the lines 44 and 29 when the valve 41 closes off the line 43. The details of this control arrangement are disclosed in the patent to Walter Ernst No. 1,861,116, issued May 31, 1932.

Arranged within the base 10 of the press is a hydraulic cylinder 47, within which reciprocates the supporting plunger 48 of the press. The cylinder 47, near its upper end, is flanged to enter a bore 50 in the base 10 of the press, the upper portion of which is closed by a plate 51, serving as a stop for shoulders 52 upon the supporting plunger 48 so as to limit the motion thereof. Leakage from the supporting plunger cylinder 47 is prevented by means of the gland 53, arranged to compress the packing 54 around the plunger. The upper part of the supporting plunger 48 passes through an aperture 55 in the plate 51, and through a corresponding aperture 56 in the drawing die 57, and enters the drawing die recess 58. The upper end 59 of the supporting plunger 48 is shaped to conform with the bottom of the drawing die recess 58, and serves to support the blank or work-piece 60 during the drawing operation. The supporting plunger cylinder 47 is connected by the line 61, containing the pressure relief valve 62, to the pressing line 26.

Arranged to enter the drawing die recess 58 and having a shape corresponding thereto is the drawing plunger 63, attached to and depending from the platen 16. The platen 16 is provided with clamping cylinder bores 64 forming clamping cylinders, within which reciprocate the clamping plungers 65. The latter are connected at their lower ends to the clamping member 66, which reciprocates vertically and which is suspended from the main platen 16 by means of the tie bolts 67 having their heads countersunk, as at 68, into the clamping member 66, and their opposite ends extending loosely through the bores 69 and held in position by the nuts 70 upon the upper ends thereof. Leakage around the clamping plungers 65 is prevented by means of the glands 71 arranged to compress packings 72.

Fluid is supplied to the clamping cylinders 64 from the push-back space beneath the main plunger head 20 by means of the line 75, the opposite end of which terminates in the check valve 76. The line 77 is connected to the opposite side of the check valve 76 and joins the latter with the ports 78 in the clamping cylinders 64. The port 79 in one of the clamping cylinders 64 is connected to a pressure relief valve 80, and thence by the line 81 and flexible connection 82 to the line 83, entering the port 84 of the surge tank 28. The flexible connection 82, for convenience, is shown as a flexible pipe, but it will be understood that any other suitable arrangement for maintaining a connection between the clamping cylinders 64 and the surge tank 28 may be used. Similarly, the line 75 is shown as a passageway through the main plunger 19, but it is

likewise understood that any other suitable form of connection may be used. For example, instead of the flexible connection 82 and the drilled passage 75, tubular telescoping plungers or pivotally connected devices might be used to transmit the fluid during the motion of the platen. The lower end of the drawing plunger 63 passes through an aperture 85 in the clamping member 66, and likewise through an aperture 86 in a contact member 87 secured to the clamping member 66.

Mounted upon the side of the press is a valve 90, of any suitable type, and arranged to be operated by a valve rod 91 supported at its upper end by the projection 92, upon the top member 12 of the press. Mounted upon the valve rod 91 and adjustable therealong is a collar 93, below which is a spring-urged cushion 94 for receiving the impact of the platen arm 18 as the platen moves upwardly. When the platen arm 18 engages the spring cushion 94 and moves the valve rod 91 upwardly, the valve 90 is opened and permits fluid to pass from the push-back line 38 of the pump 39, through the line 95, the valve 90, the line 96 and the check valve 97 into the supporting plunger cylinder 47. In this manner the opening of the valve 90 serves to admit pressure fluid to the supporting plunger cylinder 47 so as to cause the supporting plunger 48 to be actuated as a "knock-out" plunger to expel the work-piece 60.

#### Operation

In starting the operation of the press to perform a pressing stroke, the main plunger 19 is allowed to descend by gravity and the pump 39 is started in operation. As the main plunger 19 descends, the suction created in the main cylinder 21, above the head 20, draws in fluid from the surge tank 28 through the surge valve 22, thereby speeding the descent of the platen 16 over the speed which would occur in the event that the pump 39 alone was operating.

The platen 16 and the clamping member 66 continue to descend until the contact member 87 engages the blank or work-piece 60. The drawing plunger 63, however, continues to descend, and as it encounters resistance in drawing the work, a pressure is built up in the main cylinder 21 by the operation of the pump 41. By reason of the motion of the clamping cylinders 64 relatively to the now stationary clamping plungers 65, pressure is built up within the latter, and prevented from escaping by the closing of the check valve 76. The pressure thus developed by intensification within the clamping plunger cylinders 64 causes the clamping plungers 65 to grip the work-piece with a pressure which is limited by the setting of the pressure relief valve 80. Accordingly, the work-piece 60 will be clamped with a constant pressure throughout the drawing valve 80 and the lines 81, 82 and 83 into the surge tank 28.

When the drawing plunger 63 has descended to a point where it engages the bottom of the blank or work-piece 60, it forces the blank 60 against the end 59 of the supporting plunger 48. This action builds up a pressure inside the supporting plunger cylinder 47, and prevents the tip of the drawing plunger 63 from piercing the blank 60. This pressure will be in proportion to the main drawing pressure because the fluid discharged from the supporting plunger cylinder 47 is expelled through the pressure relief valve 62 into the main cylinder 21 by way of the pressing line 26. Accordingly, the harder the draw the tighter is the supporting force opposing the draw.

This supporting force can be modified as desired by altering the setting of the pressure relief valve 62. As the drawing proceeds, therefore, the drawing plunger 63 pushes its way downwardly, and exerts pressure on one side of the tip of the blank, the other side being supported yieldingly by the supporting plunger 48.

When the drawing plunger 63 reaches the bottom of its stroke and the work-piece is fully formed from the blank 60, the pump 39 is reversed and the push-back pressure is discharged from the connection 49 into the line 38, through the make-up valve 31 and the push-back line 24, into the push-back space beneath the main plunger head 20, and lifting the main plunger 19. This push-back pressure passes downwardly through the line 75, the check valve 76 and the line 77 into the clamping cylinders 64, causing the clamping pressure to be exerted by the clamping plungers 65 on the blank while the drawing plunger 63 is being withdrawn. In this manner the work-piece is stripped off the drawing plunger.

After the drawing plunger 63 is drawn clear of the work-piece it will raise the clamping member 66 and contact member 67 by means of the tie bolts 67. As the platen 16 continues to rise it engages the spring cushion 64 and collar 93 so that the valve rod 91 rises. This opens the valve 90 and allows pressure fluid to enter the supporting plunger cylinder 47, causing the supporting plunger 48 to act as a "knock-out" plunger and expel the work-piece.

It will be understood that the work-piece or blank 60 may be either a flat plate or a concaved member, depending upon whether the drawing operation being carried out is the first or succeeding drawing operation. For showing the general case, the work-piece or blank 60 is illustrated in the drawing as consisting of a piece upon which one drawing operation has been made and a second drawing operation is about to commence.

It will be understood that separate push-back cylinders may be used in place of a double-acting main plunger for returning the platen to its initial position. In such case the connections now made with the push-back side of the double-acting main plunger or with the push-back side of the pump 39 would be made with the push-back cylinders or the lines leading thereto.

It will be understood that I desire to comprehend within this 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. In combination, a main plunger, a platen operated thereby, a forming plunger connected thereto, a clamping plunger associated with said platen and operated by the motion thereof, a cooperative shaping die, and a supporting plunger arranged to engage the work-piece and oppose the motion of said forming plunger, means for hydraulically connecting said supporting plunger with said main plunger, whereby to oppose the motion of said forming plunger by a force proportional to the force exerted by said main plunger.

2. In combination, a main plunger, hydraulic means for operating said main plunger, a platen operated thereby, a forming plunger connected thereto, a cooperative shaping die, a supporting plunger device arranged to engage the work-piece and oppose the motion of said forming

plunger, valve means arranged to be operated to supply pressure fluid to said supporting plunger device for expelling the work-piece in response to the arrival of said platen at a predetermined point during the return stroke thereof, and means hydraulically interconnecting said main plunger and said supporting plunger, whereby to cause said supporting plunger to offer an opposing force proportional to the pressure exerted by said main plunger.

3. In combination, a main plunger, a platen operated thereby, a forming plunger connected thereto, a clamping plunger arranged on said platen to be operated by the motion thereof, a cooperative shaping die, a supporting plunger arranged to engage the work-piece and oppose the motion of said forming plunger, valve means arranged to be operated to supply pressure fluid to said supporting plunger for expelling the work-piece in response to the arrival of said platen at a predetermined point during the return stroke thereof, and means hydraulically interconnecting said main plunger and said supporting plunger.

4. In combination, a press frame having a bed, a main cylinder, a double-acting main plunger in said cylinder having forward and return sides, a platen connected to said main plunger, a clamping plunger hydraulically connected to the return side of said main plunger, a supporting plunger arranged to oppose the motion of said main plunger, means hydraulically interconnecting said main plunger with said supporting plunger, and pressure-responsive release means for releasing pressure fluid from said clamping plunger at a predetermined pressure.

5. In combination, a double-acting main plunger, hydraulic fluid-conducting means passing through said main plunger, a platen attached to said main plunger, a clamping cylinder and plunger assembly attached to said platen and connected to said fluid-conducting means, a fluid container, and means for maintaining a hydraulic connection between said clamping assembly and said fluid containers during the motion of said platen.

6. In combination, a main plunger, hydraulic push-back means for said main plunger, a platen attached to said main plunger, a clamping cylinder and plunger assembly attached to said platen and movable therewith, means for maintaining a hydraulic connection between said clamping assembly and said push-back means during the motion of said platen, and a supporting plunger hydraulically connected to said main plunger and operated by pressure fluid therefrom to oppose the motion thereof.

7. In combination, a pressing plunger, a platen operated thereby, a clamping cylinder in said platen, a clamping plunger in said cylinder, means for supplying fluid to said clamping cylinder, and means responsive to the pressure built up in the clamping cylinder by the motion of said clamping plunger for cutting off said fluid-supplying means from said clamping cylinder whereby the fluid is entrapped and pressure developed by the motion of said platen relatively to said clamping plunger and caused to operate said clamping plunger to clamp the work-piece.

8. In combination, a pressing plunger, a platen operated thereby, a clamping cylinder in said platen, a clamping plunger in said cylinder, means for supplying fluid to said clamping cylinder, means responsive to the pressure built up in the clamping cylinder by the motion of said clamp-

- ing cylinder relatively to said clamping plunger for cutting off said fluid-supplying means from said clamping cylinder whereby the fluid is entrapped and pressure developed by the motion of said platen relatively to said clamping plunger and caused to operate said clamping plunger to clamp the work-piece, and a pressure release device for releasing fluid from said clamping cylinder in response to the attainment of a predetermined pressure.
9. In combination, a main cylinder, a main plunger therein, a platen operated thereby, a forming plunger connected thereto, a clamping cylinder and plunger carried by said platen and movable relatively to one another to generate pressure in response to the motion of said platen to clamp the work-piece during the forming operation, a cooperative shaping die, pressure release means associated with said clamping plunger to release fluid therefrom in response to the attainment of a predetermined clamping pressure whereby to clamp the work-piece with a predetermined force at a predetermined pressure, and fluid-conducting means connecting said clamping cylinder with said main cylinder for conducting to said clamping cylinder a portion of the fluid displaced from said main cylinder by the motion of said main plunger.
10. In combination, a main cylinder, a main plunger therein, a platen operated thereby, a forming plunger connected thereto, a clamping plunger member and a fluid-containing clamping cylinder member arranged to clamp the work-piece during the forming operation, a cooperative shaping die, one of said members being mounted on said platen and the other member being adapted to engage the work-piece, said members being movable relatively to one another to generate pressure for clamping the work-piece in response to the motion of said platen, a pressure release device associated with said clamping cylinder member whereby to clamp the work-piece with a predetermined pressure and to expel the fluid from said clamping cylinder member above said predetermined pressure, and fluid-conducting means connecting said clamping cylinder member with said main cylinder for con-

ducting to said clamping cylinder member a portion of the fluid displaced from said main cylinder by the motion of said main plunger.

11. In combination, a frame having a bed, a main cylinder, a double-acting main plunger in said main cylinder, a platen connected thereto, clamping cylinders mounted on said platen and movable therewith, said main plunger having a fluid passageway therein opening into said main cylinder and hydraulically connecting said main cylinder to said clamping cylinders whereby to supply to said clamping cylinders a portion of the fluid discharged from said main cylinder through said main plunger passageway as a result of the motion of said main plunger, clamping plungers in said clamping cylinders, and a clamping element attached to said clamping plungers.

12. In combination, a main plunger, hydraulic means for operating said main plunger, a platen operated thereby, a forming plunger connected thereto, a hollow cooperative shaping die adapted to receive said forming plunger, a supporting plunger device arranged to engage the workpiece and oppose the motion of said forming plunger, said supporting plunger device being disposed within said hollow cooperative shaping die and having the end thereof configured coextensive with the adjacent surface of said cooperative shaping die, and means hydraulically interconnecting said main plunger and said supporting plunger, whereby to cause said supporting plunger to offer an opposing force proportional to the pressure exerted by said main plunger.

13. In combination, a press frame having a bed, a platen movable in said frame, hydraulic plunger-advancing and retracting means connected to said platen for advancing and retracting said platen respectively, a clamping plunger hydraulically connected to said plunger-retracting means, a supporting plunger arranged to oppose the motion of said main plunger, means hydraulically interconnecting said main plunger with said supporting plunger, and pressure-responsive means for releasing pressure fluid from said clamping plunger at a predetermined pressure.

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