Feb. 7, 1939. W. ERNST 2,146,535

DOUBLE-ACTION METAL-DRAWING PRESS

Filed July 22, 1935

FIG. 1.

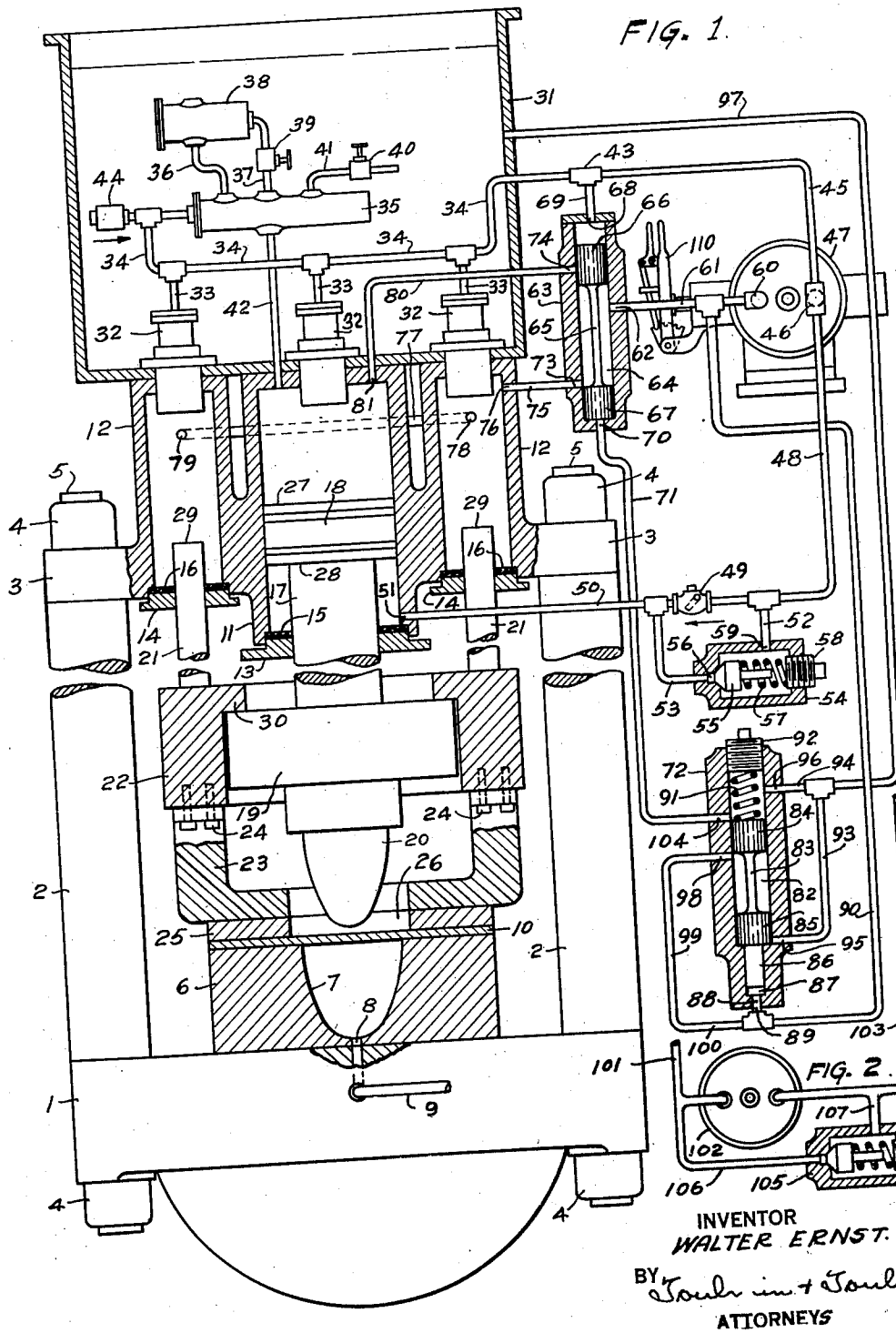


FIG. 2.

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Patented Feb. 7, 1939

2,146,535

UNITED STATES PATENT OFFICE

2,146,535

DOUBLE-ACTION METAL-DRAWING PRESS

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Application July 22, 1935, Serial No. 32,480

16 Claims. (Cl. 113—45)

This invention relates to hydraulic presses and circuits for actuating them, and in particular, to metal-drawing presses adapted to form articles of various shapes from metal blanks while these blanks are clamped in position by devices associated with the press.

One object of this invention is to provide a hydraulic double-acting press having a pressing plunger and a clamping plunger, arranged to move independently of one another in one direction but interconnected in another direction, the two plungers being arranged to be operated in sequence.

Another object is to provide a hydraulic double-acting press having a pressing plunger and a clamping plunger, wherein the clamping plunger is operated initially and directly from a pump, through a shiftable valve, the flow of the pump being then redirected by the shifting of this valve to the main or pressing plunger, which thereupon continues its stroke and completes the pressing or drawing of the article from the blank. This is in contrast to the manner previously adopted of operating the clamping plungers indirectly and simultaneously by fluid displaced from beneath the main pressing plunger, the excess above a predetermined pressure being discharged through a relief valve, with consequent heating and loss of power because the use of the fluid beneath the main piston to build up pressure on the blank holder required force which must be deducted from the available pressing force.

Another object is to provide a press of the type described above, wherein the pull-back side of the pressing plunger is given a smaller area than the top area of the clamping plunger so that a rapid pull-back or retraction of the plunger is obtained, means being provided to discharge the excess of oil arising from the unequal areas involved.

Another object is to provide a press of the type described, wherein an actuation of the press is entirely automatic, without need for adjustments upon the part of the operator other than the reversal of the pump after the drawing operation has been completed.

Another object is to provide a hydraulic circuit including a press having a pressing plunger and a clamping plunger, the circuit having a pump and valve system arranged to discharge the flow of the pump first against the clamping plunger until a predetermined clamping pressure is reached, after which the discharge of the pump is shifted and applied to the main pressing plunger, whereupon the pressing or drawing operation is completed.

Another object is to provide such a press, wherein the valve for shifting the discharge of the pump from the clamping plunger to the pressing plunger is operated by the pressure fluid directed thereto from a separate hydraulic device, the latter being supplied with pressure fluid either from the main pump or from an auxiliary source of pressure fluid.

In the drawing:

Figure 1 shows a preferred embodiment of the press and circuit of my invention, this drawing being a front elevation, partly in section and somewhat diagrammatic.

Figure 2 shows the additional apparatus in a modification of the circuit shown in Figure 1, illustrating the use of an auxiliary pump for supplying the fluid utilized by the fluid control valve in actuating the fluid distributing valve.

Referring to the drawing in detail, the hydraulic press shown as embodying my invention, consists of a base 1, which is connected by the tie rods 2 to a top member 3, these being secured upon the tie rods 2 by nuts 4, threaded upon the threaded portions 5 thereof. Mounted upon the base 1 is a die 6, having a recess or forming portion 7, of the shape necessary for producing the particular article which it is desired to make. The forming portion 7 is provided with a port 8 communicating with a pipe 9, the latter being arranged to provide compressed air for ejecting the finished article after the drawing operations have taken place. The metal blank 10 is shown in position upon the die 6 before any of the operations have taken place.

Mounted upon the top member 3 of the press is a main drawing cylinder 11 and a pair of clamping cylinders 12. The mouth of the main drawing cylinder 11 is closed by a gland 13, arranged to compress a packing 15, whereas the mouths of the clamping cylinders 12 are provided with similar glands 14, arranged to compress packings 16. These packings prevent the escape of fluid from the clamping cylinders and drawing cylinder.

Arranged to reciprocate in the main cylinder 11 is the main piston rod 17, having a piston head 18, the piston rod 17 passing through the aperture in the gland 13 and packing 15. To the lower end of the piston rod 17 is attached a platen 19 having a die member 20 secured thereto. The die member 20 corresponds in configuration to the forming portion 7 of the die member 6, but is of opposite shape so that the

two portions 7 and 20 cooperate to form the finished article between them from the metal blank 10.

The clamping cylinders 12 are provided with clamping pistons 21 passing through the apertures in the glands 14 and packings 16, and secured to a tie member 22, which serves to interconnect their lower ends. Secured to the tie member 22 is a clamping member 23, as by the bolts 24. Beneath the clamping member 23 is arranged a blank holder 25, the latter resting upon the metal blank 10 from which the article is formed. An aperture 26 in the blank holder 25 permits the passage of the die member 20 therethrough.

The main piston head 18 is of the double-acting type, having a working face 27 and a pull-back face 28, the latter being of annular shape and constituting the space beneath the piston head 18 and surrounding the piston rod 17. Similarly, the clamping pistons 21 are provided with working faces 29. In my invention, by the arrangement subsequently to be described, the annular pull-back area 28 may be made substantially smaller than the combined areas of the working faces 29 of the clamping pistons 21. Previously, it has been considered necessary to make the annular area 28 equal to the combined areas of the working faces of the clamping pistons 21, plus an additional area sufficient to sustain the weight of the moving parts so as to raise them against gravity. This construction, however, caused a slow action of the parts, whereas in my present construction the comparatively small annular area of the pull-back portion 28 in its reciprocation has a correspondingly smaller piston displacement volume. This condition, therefore, enables a very rapid withdrawal or pull-back of the main platen, because a given quantity of pressure fluid will retract the main piston farther than the clamping piston in the same period of time. The main platen 19 and the tie member 22 move downwardly in an independent manner, although substantially simultaneously. On the upward or retraction stroke, however, the main platen engages the tie member in the shouldered portions 30, raising the tie member and with it the clamping pistons 21.

Mounted on top of the main pressing cylinder 11 and clamping cylinders 12 is the surge tank 31, within which are surge valves 32 providing intercommunication between the surge tank and the tops of the cylinders 11 and 12. These surge valves 32 are of the type disclosed in my prior patent, No. 1,892,568, issued December 27, 1932, and the details thereof form no part of the present invention. These surge valves 32 are arranged to permit fluid to be drawn into the top portions of the cylinders 11 and 12 during the downward stroke of the plungers 18 and 21 when the latter descend by gravity, thereby providing a prefilling of these cylinders and enabling a more rapid descent of the plungers than is enabled by the use of the pump.

The surge valves 32, however, are also arranged to be actuated so as to permit the discharge of fluid into the surge tank upon the return strokes of the plungers 18 and 21, this being accomplished by mechanism disclosed in the above-mentioned patent and actuated by pressure fluid passing into the surge valves 32 along the lines 33. The lines 33 are connected to the pipe 34, which in turn, is connected at its left-hand end through a T-coupling to the pressure release valve 35. The latter is connected by pipes 36 and 37 to the by-pass valve 38. A choke valve 39 serves to restrict the flow of fluid through the pipe 37 from the pressure release valve 35, whereas a similar choke valve 40 on the pipe 41 discharges fluid directly into the surge tank 31 from the pressure release valve 35. The details of the pressure release valve 35, the by-pass valve 38, and their adjacent valves and pipes, form no part of the present invention, but a full disclosure thereof is found in my prior patent, No. 1,956,758, issued May 1, 1934. The purpose of these valves is to assist in the releasing of the fluid pressure in the main cylinder prior to the opening of the surge valve on the return stroke of the press, and also to by-pass the return of the pump discharge to the surge tank 31 through the by-pass valve 38 during the release of the pressure fluid through the release valve 35.

The pipe 42 leads from the main cylinder 11 to the pressure release valve 35, and serves to convey the pressure fluid from the former, through the latter, into the surge tank 31. This apparatus increases the rapidity of performance of the press upon its return stroke.

The pipe 34 at its left-hand end leads into a T-coupling to which is connected the check valve 44. The latter opens in a direction to withdrawn fluid from the surge tank 31 into the pipe 34. The right-hand end of the pipe 34 is connected to the T-connection 43, from which runs the pipe 45 to the port connection 46 of the pump 47. Continuing onward from the port connection 46 is the pipe 48, leading to the check valve 49, and thence through the line 50 to the port 51 in the main pressing cylinder 11 below the plunger 18 thereof. The check valve 49 opens in a direction away from the pump 47 and toward the main pressing cylinder 11.

Arranged to form a bridge connection around the check valve 49 are the lines 52 and 53, leading respectively toward and away from the relief valve 54. The relief valve 54 is provided with a plunger 55, arranged to close the port 56 and urged in that direction by the coil spring 57, the tension of which is changed by moving the screw plug 58. Thus fluid coming into the port 56, along the lines 50 and 53 can, if of sufficient pressure, overcome the resistance of the coil spring 57, force back the valve plunger 55 and pass outward through the port 59, leading into the pipe 52, and thence along the pipe 48 to the pump 47.

From the remaining port connection 60 of the pump 47 the line 61 leads to the middle port 62 of the fluid distributing valve, generally designated 63, and having a longitudinal bore 64 within which is reciprocably mounted a valve stem 65, having spaced heads 66 and 67. From the port 68, in one end of the valve 63, the line 69 leads to the line 34. From the port 70 into the opposite end of the valve 63 the line 71 leads to the control valve, generally designated 72, in a manner described below.

The fluid distributing valve contains a pair of spaced side ports 73 and 74, respectively. The port 73 opens into the line 75, leading to the port 76 in the right-hand clamping cylinder 12. Communication between the right-hand and left-hand clamping cylinders 12 is established by the pipe 77 interconnecting the ports 78 and 79, respectively, in the clamping cylinders 12. From the other side port 74, of the fluid distributing valve 63, the line 80 leads to the port 81 in the main pressing cylinder 11.

The control valve 72 is provided with a bore 82, within which reciprocates a valve stem 83 having

spaced heads 84 and 85 mounted thereon. Attached to the opposite side of the valve head 85 is the pilot plunger 86, the latter being reciprocably mounted in the pilot bore 87 of the valve. To the port 88 of the pilot bore 87 run pipelines 89 and 90, and a connection with the pipeline 61 runs from the pump 47 to the fluid distributing valve 63. The valve stem 83, with its heads 84 and 85, is urged in one direction by the coil spring 91, the tension of which is adjusted by turning the threaded plug 92. The lines 93 and 94, leading from the ports 95 and 96 in the valve bore 82, connect to the line 97 running back to the surge tank 31, and provided means of disposing of any fluid which leaks past the valve heads or plungers into the space behind them.

The side port 98 is supplied with pressure fluid through the line 99, in any suitable manner, either by a connection to the main pump 47, along the line 100, or else through the dotted connection 101 to the auxiliary pump 102, from which the suction line 103 runs back to the surge tank 31. The remaining side port 104 of the control valve 72 is connected to the line 71, running to the end port 70 in the fluid distributing valve 63.

The pump 47 may be of any suitable type, preferably of a reversible type. It will be understood, however, that a reversing valve may be employed to reverse the direction of flow of the fluid from the pump 47 in place of using a reversible pump, without departing from the spirit of my invention.

In the operation of the circuit of my invention, the metal blank 10 is placed upon the lower die member 6. The pump 47 is started and the main plunger 18 and clamping plungers 21 are then allowed to descend by gravity, their respective cylinders 11 and 12 being prefilled from the surge tank 31 through the surge valves 32. This arrangement causes the plungers 18 and 21 to descend more rapidly than if the pump alone were used to force them downward. The valve 54 prevents the main plunger 18 from moving ahead of the blank holder 25.

Meanwhile, the pump 47 has been discharging pressure fluid into the line 61 and the central chamber of the fluid distributing valve 63. The fluid passes outward through the port 73, to the line 75, through the port 76 into the right-hand clamping cylinder 12, whence it proceeds through the port 78 and along the line 77, through the port 79 into the left-hand clamping cylinder 12. This pressure causes the clamping plungers 21 to move downward, carrying with them the main plunger 18 by reason of their interengagement at the shouldered portions 30 on the tie member 22.

As soon as the blank holder 25 has made contact with the blank 10, the resistance encountered causes pressure to be built up in the clamping cylinders 12 and in the lines leading through the fluid distributing valve 63 to the connection 60 of the pump 47, this pressure being conveyed along the lines 90 and 89, through the port 88 into the pilot bore 87. This pressure acts against the pilot plunger 86 in such a manner as to force the valve stem 83 and its spaced heads 84 and 85 upward. Pressure fluid is then discharged either from the connection 100 of the line 99 to the line 90, leading to the main pump 47, or else to the connection 101 leading to the auxiliary pump 102.

This pressure fluid discharges through the port 98 in the middle chamber of the control valve 82, and passes outward through the port 104, along the line 71 and through the port 70, into the lower end chamber of the fluid distributing valve 63. This pressure forces the valve head 67 upward, cutting off the connection of the clamping cylinders 12 to the valve 63 by way of the port 73, and enabling the pressure fluid received along the line 61 from the pump 47, to be discharged through the port 74 of the valve 63, the line 80 and the port 81, into the main pressing cylinder 11 above the pressing plunger 18. The pressure fluid thus received forces the main plunger downward and completes the drawing operation upon the metal blank 10 by forcing the upper die member 20 into the forming portion 7 of the lower die member 6, with the metal blank 10 therebetween. Meanwhile, the pressure fluid operating the clamping plungers 21 has been entrapped within the clamping cylinders 12.

At the same time, the fluid forced out of the space beneath the pressing plunger 18 passes outward through the port 51 in the main cylinder 11, through the pipes 50 and 53, and the port 56 of the relief valve 54 acts against the relief valve plunger 55 in such a manner as to force it backward and permit the fluid to escape through the port 59 and the lines 52 and 48, leading back to the port connection 46 of the pump 47. During these operations the surge valves 32 automatically remain closed by reason of the pressure exerted upon them, permitting no discharge of the fluid in the upper parts of the cylinders 11 and 12 into the surge tank 31.

When the drawing or pressing operations have been completed, the direction of flow of the pressure fluid from the pump 47 is reversed, as by shifting the control lever 110, whereupon the pump 47 now discharges into the lines 45 and 48. The fluid discharged through the line 48 passes through the check valve 49, along the line 50, through the port 51 into the space beneath the main pressing plunger 18, forcing the latter upward and retracting the main platen 19 and the upper die member 20. The same action causes the clamping plungers to be retracted through the shouldered connection 30 of their tie member 22 with the platen 19.

The pressure fluid in the line 45 flows downward through the branch line 69 and the upper end port 68, into the upper end chamber of the fluid distributing valve 63. This pressure fluid acts against the valve head 66, forcing it downward and closing the connection through the port 74 to the line 80. This same action opens the connection from the clamping cylinders 12, through the port 76, the line 75 and port 73, into the middle chamber of the fluid distributing valve 63, thence through the port 62 and line 61, into the connection 60 of the pump 47, this connection 60 in the reversed position of the pump being a suction connection.

Meanwhile, the fluid in the upper portions of the cylinders 11 and 12 is permitted to pass back into the surge tank 31 through the surge valves 32, the latter being operated to accomplish this by the pressure fluid reaching them along the lines 45 and 33 from the pump 47. This manner of operation of these surge valves 32 is disclosed in my prior patent, No. 1,892,568, previously referred to.

With the pump 47 in its reversed position, lines 90 and 89, leading from the line 61, are caused to become suction lines, releasing the pressure against the pilot plunger 86 of the control valve 72. This allows the valve stem 83, with its heads 84 and 85, to move downward, closing the connection between the ports 98 and 104 and pre-

venting pressure fluid from flowing along the line 71 into the lower end chamber of the fluid distributing valve 63. The fluid escaping from the latter, however, passes through the upper end chamber of the control valve 72, through the opposite port 96 and line 94 thereof, along the line 97 to the surge tank 31.

The discharge of the fluid from the auxiliary pump 102, if such be used, may be by-passed by a suitable by-pass or relief valve 105, forming a bridge through the lines 106 and 107 between the opposite ports of the pump 102. Alternatively, a pump of the variable delivery type may be used as an auxiliary pump 102, this pump having a servo-piston which, at a predetermined pressure, shifts the shift ring of the pump to its neutral position, and causes the discharge from the pump to cease. This mechanism is well known to those skilled in the art, and forms no part of the present invention.

During the return stroke more oil is displaced from the space above the main plunger 18 than is forced into the annular space beneath it, because of the volume occupied by the piston rod 17. This excess oil is returned to the surge tank 31 through the surge valve 32, in the manner previously described. A make-up check valve 44 is provided in the line 34 to supply the pump with oil on the downward or pressure stroke. During the downward stroke of the main plunger 18 the relief valve 54 prevents "coasting" of the platen 19 and die member 20 at the moment the clamping member 23 and blank holder 25 engage the workpiece or blank 10.

I desire to comprehend within my invention such modifications as may be embraced within my claims and the scope of my invention.

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

1. In combination, a pressing cylinder, a pressing plunger therein, a clamping cylinder, a clamping plunger therein, a source of pressure fluid, a valve arranged in one position to direct pressure fluid into the clamping cylinder and in another position to direct pressure fluid into the pressing cylinder, and means responsive to the attainment of a predetermined pressure in one of said cylinders for shifting said valve from one position to the other position.

2. In combination, a pressing cylinder, a pressing plunger therein, a clamping cylinder, a clamping plunger therein, a source of pressure fluid, a valve arranged in one position to direct pressure fluid in to the clamping cylinder and in another position to direct pressure fluid into the pressing cylinder, and means responsive to the attainment of a predetermined pressure in said clamping cylinder to shift said valve to direct pressure fluid into said pressing cylinder.

3. In combination, a pressing cylinder, a double-acting pressing plunger therein, a clamping cylinder, a clamping plunger therein, a source of pressure fluid, a valve arranged in one position to direct the pressure fluid into the clamping cylinder and in another position to direct pressure fluid into the pressing cylinder, automatically operative means for shifting said valve from initially directing pressure fluid into said clamping cylinder to subsequently directing pressure fluid into said pressing cylinder, and valve means arranged to release the fluid on the opposite side of said pressing plunger during the working stroke thereof.

4. In combination, a pressing cylinder, a pressing plunger therein, a clamping cylinder, a clamping plunger therein, a source of pressure fluid, a single distributing valve arranged in a first position to direct the discharge of fluid from said source into said clamping cylinder only and in a second position to direct pressure fluid into said pressing cylinder, and means responsive to the attainment of a predetermined pressure in said clamping cylinder to shift said valve and thereafter direct pressure fluid into said pressing cylinder.

5. In combination, a pressing cylinder, a double-acting pressing plunger therein, a clamping cylinder, a clamping plunger therein, a source of pressure fluid, a valve arranged in one position to direct the pressure fluid into the clamping cylinder and in another position to direct pressure fluid into the pressing cylinder, means responsive to the attainment of a predetermined pressure in said clamping cylinder to shift said valve from said first-mentioned position to said last-mentioned position, means to reverse the direction of flow from said source to said cylinders, and means responsive to said reversal to shift said valve to release the fluid from said clamping cylinder.

6. In combination, a pressing cylinder, a pressing plunger therein, a clamping cylinder, a clamping plunger therein, a source of pressure fluid, a valve arranged in one position to effect the discharge of pressure fluid from said source into said clamping cylinder, and means responsive to the attainment of a predetermined pressure in said clamping cylinder to shift said valve and direct said pressure fluid into said pressing cylinder.

7. In combination, a pressing cylinder, a pressing plunger therein, a clamping cylinder, a clamping plunger therein, a source of pressure fluid, a valve arranged in one position to effect the discharge of pressure fluid from said source into said clamping cylinder, means responsive to the attainment of a predetermined pressure in said clamping cylinder to shift said valve and direct said pressure fluid into said pressing cylinder, and means responsive to the shifting of said valve to entrap the pressure fluid within said clamping cylinder and to supply pressure fluid to said pressing cylinder.

8. In combination, a pressing cylinder, a pressing plunger therein, a clamping cylinder, a clamping plunger therein, a source of pressure fluid, a valve arranged in one position to effect the discharge of pressure fluid from said source into said clamping cylinder, hydraulic means responsive to the attainment of a predetermined pressure in said clamping cylinder for shifting said valve into a position for directing said pressure fluid into said pressing cylinder, and a control valve arranged to control the admission of pressure fluid to said hydraulic shifting means.

9. In combination, a pressing cylinder, a pressing plunger therein having piston areas associated therewith for advancing and retracting said pressing plunger, a clamping cylinder, a clamping plunger therein, a source of pressure fluid having associated therewith means for selectively delivering pressure fluid to said piston areas for advancing and retracting said pressing plunger, a distributing valve connected to said source of pressure fluid, said valve having associated therewith hydraulic means for shifting said valve from a first position for normally directing pressure fluid into said clamping cylinder to a second position for directing pressure fluid into said pressing cylinder, and a control valve having associated therewith means responsive to the attainment of

a predetermined pressure in said clamping cylinder for shifting said control valve to deliver pressure fluid to said hydraulic shifting means, whereby to shift said distributing valve from said first position to said second position.

10. In combination, a pressing cylinder, a reversible pressing plunger therein, a clamping cylinder, a clamping plunger therein, a reversible pump, a valve arranged in one position to discharge pressure fluid from said pump into said clamping cylinder and in another position to discharge said pressure fluid into said pressing cylinder ,and means responsive to the attainment of a predetermined pressure in said clamping cylinder to shift said valve from said first-mentioned to said last-mentioned position.

11. In combination, a pressing cylinder, a reversible pressing plunger therein, a clamping cylinder, a clamping plunger therein, a source of pressure fluid, a reversible pump, a valve arranged in one position to discharge pressure fluid from said pump into said clamping cylinder and in another position to entrap the previously discharged pressure fluid within said clamping cylinder and subsequently discharge said pressure fluid into said pressing cylinder, and means responsive to the attainment of a predetermined pressure in said clamping cylinder to shift said valve from said first-mentioned to said last-mentioned position.

12. In combination, a pressing cylinder, a reversible pressing plunger therein, a clamping cylinder, a clamping plunger therein, a source of pressure fluid, a reversible pump, a valve arranged in one position to discharge pressure fluid from said pump into said clamping cylinder and in another position to entrap the previously discharged pressure fluid within said clamping cylinder and subsequently discharge said pressure fluid into said pressing cylinder, means responsive to the attainment of a predetermined pressure in said clamping cylinder to shift said valve from said first-mentioned to said last-mentioned position, means responsive to the reversal of said pump to shift said valve to release the fluid within said clamping cylinder, and means to direct pressure fluid to the opposite side of said pressing plunger to retract said pressing plunger.

13. In combination, a pressing cylinder, a reversible pressing plunger therein, a clamping cylinder, a clamping plunger therein, a source of pressure fluid, a reversible pump, a valve arranged in one position to discharge pressure fluid from said pump into said clamping cylinder and in another position to entrap the previously discharged pressure fluid within said clamping cylinder and subsequently discharge said pressure fluid into said pressing cylinder, means responsive to the attainment of a predetermined pressure in said clamping cylinder to shift said valve from said first-mentioned to said last-mentioned position, means responsive to the reversal of said pump to shift said valve to release the fluid within said clamping cylinder, and means to direct pressure fluid to the opposite side of said pressing plunger to retract said pressing plunger, said clamping plunger and said pressing plunger having interconnecting means adapted to cause the retraction of said clamping plunger upon the retraction of said pressing plunger by the reversal of said pump.

14. In combination, a pressing cylinder, a reversible pressing plunger therein, a clamping cylinder, a clamping plunger therein, a reversible pump, a valve arranged in one position to discharge pressure fluid from said pump into said clamping cylinder and in another position to discharge said pressure fluid into said pressing cylinder, hydraulic means for shifting said valve from one position to the other, and a control valve responsive to the attainment of a predetermined pressure in said clamping cylinder to admit pressure fluid to shift said valve.

15. In combination, a pressing cylinder, a reversible pressing plunger therein, a clamping cylinder, a clamping plunger therein, a reversible pump, a valve arranged in one position to discharge pressure fluid from said pump into said clamping cylinder and in another position to discharge said pressure fluid into said pressing cylinder, hydraulic means for shifting said valve from one position to the other, a control valve responsive to the attainment of a predetermined pressure in said clamping cylinder to admit pressure fluid to shift said valve, and an auxiliary pump for supplying pressure fluid to said control valve for operating said hydraulic shifting means.

16. In combination, a pressing cylinder, a pressing plunger therein, a clamping cylinder, a clamping plunger therein, a source of pressure fluid, a valve arranged in one position to direct the pressure fluid into the clamping cylinder until a predetermined pressure is attained and in another position to direct the pressure fluid into the pressing cylinder, means to entrap the pressure fluid within the clamping cylinder during the operation of the pressing plunger, and means responsive to the attainment of a predetermined pressure in said clamping cylinder to shift said valve from said one position to said other position.

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