DOUBLE-ACTION METAL-DRAWING PRESS

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16 Claims.

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 shift valve and the main press, 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 of 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 the 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 tie member 20 there-through.

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 29 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 further 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. 1,822,568, 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 to 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 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 re-lease 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 25 T-coupling to which is connected the check valve 44. The latter opens in a direction to withdraw 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 30 through the pipe 31 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 from the port connection 46 into the main pressing cylinder 11 below the plunger 105 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 50. Upon the commencement of the stroke, however, the main platen engages the tie member 56 in the shouldered portions 60, raising the tie member and with it the clamping pistons 21.

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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 re- 
5 attached to the valve bore 87 of the valve. To the port 88 of the pilot bore 87 run pipelines 89 and 90, and a connection with the 
the pipeline 61 runs from the pump 47 to the fluid distributing valve 63. The valve stem 93, 
10 with its heads 84 and 85, is urged in one direction by the coil spring 81 and the tension 82 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 
15 back to the surge tank 31, and provided means of disposing of any fluid which leaks past the 
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 
20 line 102, 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 74 is connected to the line 71, running to the end 
25 port 78 in the fluid distributing valve 63. 

The pump 41 supplies fluid to the port connection 42 of the preferably of a reversible type. It will be understood, however, that a reversing valve may be 
30 employed to reverse the direction of flow of the fluid from the pump 41 in place of using a reversible 
35 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 
40 member 6. The pump 41 is started and the main 
45 plunger 16 and clamping plunger 21 are then allowed to descend by gravity, their respective cylinders 11 and 12 being pressurized from the surge 
31 through the surge valves 32. This arrangement causes the plungers 16 and 21 to descend more rapidly than if the pump alone were 
40 used to move them downward. The valve 54 prevents the main plunger 16 from moving ahead of the blank holder 25.

Meanwhile, the pump 41 has been discharging pressure fluid into the line 61 and the central 
50 chamber of the fluid distributing valve 63. The fluid passes upward through the port 11, through line 75, through the port 76 into the right-hand 
clamping cylinder 12, whence it proceeds through the port 78 and along the line 71, through the port 79 into the left-hand clamping cylinder 12. 
55 This pressure causes the clamping plungers 21 to move downward, carrying with them the main 
plunger 16 by reason of their interengagement at the 
shouledered portions 30 on the tie member 22.

As soon as the blank holder 25 has made contact with the blank 16, the resistance encountered 
60 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 96 and 93, through the port 88 into the 
line 87. This pressure acts against the pilot 
65 plunger 86 and forces 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 80, leading to the main pump 47, or else 
70 to the connection 101 leading to the auxiliary pump 102. 

This pressure discharges through the port 
75 in the middle chamber of the control valve 82, 
and passes outward through the port 104, along the line 11 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 cyl- 
inders 12 to the valve 62 by way of the port 78, and enabling the pressure fluid to discharge 
80 through the port 61 from the pump 47, to be discharged through the port 74 of the valve 63, the line 80 and the port 91, into the main pressuring cylinder 11 above the pressuring plunger 10. The pressure 
fluid thus received forces the main plunger downward and completes the drawing operation upon 
85 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 pressuring plunger 18 passes outward through the port 51 in the main cylinder 11, through the pipes 56 and 53, and the port 55 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 
20. 

The fluid discharged through the line 58 passes through the check valve 49, along the line 56, through the port 51 into the space beneath 
25 the main pressuring 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 chamber of the fluid distributing valve 63. 

105 This pressure 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 

5 connection 60 in the reversed position of the pump being a suction connection 45 and 46, and the port 55 of the 

32 over the pressure exerted upon them, permitting no discharge of the fluid in the upper parts of the cylinders 11 and 12 into the 

30 surge tank 31.

When the drawing or pressuring operations have been completed, the direction of flow of the pressure fluid from the pump 47 is reversed, as by 

the control lever 110, whereverupon the pump 41 now discharges into the lines 45 and 46. 

The fluid discharged through the line 48 passes through the check valve 49, along the line 56, through the port 51 into the space beneath the 
main pressuring 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.

Meanwhile, the fluid in the upper portions of the cylinders 11 and 12 is permitted to pass back 

through the branch line 69 and the upper end chamber of the fluid distributing valve 63. This pressure 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 

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connection 60 in the reversed position of the pump being a suction connection 45 and 46, and the port 55 of the 

32 over the pressure exerted upon them, permitting no discharge of the fluid in the upper parts of the cylinders 11 and 12 into the 

30 surge tank 31.
venting pressure fluid from flowing along the line 71 into the lower end chamber of the fluid distributing valve 83. The fluid escaping from the line 71 however, passes through the upper end chamber of the control valve 72, through the opposite port 96 and line 94 thereof, along the line 91 to the surge tank 91.

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 19.

The excess oil is returned to the surge tank 91 through the surge valve 92, 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 94 provides "coating" of the platen 19 and die member 20 at the moment the clamping member 23 and blank holder 25 engage the workpiece or blank 18.

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 said clamping cylinder to shift said valve to release the fluid from said clamping cylinder.

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 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 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 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, means to return said valve to its initial directing pressure fluid into said clamping cylinder, means to shift said valve to direct pressure fluid into said pressing cylinder, and a control valve arranged to control the admission of pressure fluid to said hydraulic shifting means.

4. In combination, a pressing cylinder, a press-
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, 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 entrapping 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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