HYDRAULIC LOCKING CYLINDERS

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ABSTRACT OF THE DISCLOSURE

According to the disclosure a press having a ram and a pressure pad movable between first and second positions is provided with improved means for controlling the movement of the pressure pad from the second to the first positions. The improved means disclosed include a hydraulic cylinder having an elongated cylindrical bore filled with hydraulic fluid and having a piston movably positioned in the bore and dividing it into first and second chambers. A fluid line communicates the first and second chambers and includes flow regulating means permitting free flow in a direction from the first to the second chamber and an adjustable rate of flow from the second to the first chamber. Means interconnect the piston and the pressure pad so that as the pressure pad moves to the first position the piston is moved to contract the volume of the first chamber and force fluid through the line from the second to the first chamber and, as the pressure pad moves to the second position the piston is moved to contract the volume of the second chamber and force fluid through the line to the first chamber. Additionally, the line is provided with valve means operable in response to opening and closing of the press for blocking flow through the line for predetermined periods as the press moves from a closed position to an open position.

In the past, the hold down cylinders have been controlled in response to movement of the press ram by complicated air operated systems. Generally these air operated control systems included a plurality of air lines, air control solenoid valves, air pressure regulators, and air lubricators. As a consequence, the systems were complicated and bulky and took up space which could otherwise have been utilized for other press auxiliary apparatus. Further, the locking cylinders themselves were complicated and required complex piping and fluid reservoirs.

The present invention overcomes these problems by the provision of a highly simplified cushion lock cylinder arrangement. The arrangement eliminates the need for any auxiliary air control systems and decreases the overall size and cost of the cushion lock cylinder and its control systems.

In accordance with the present invention a press having a ram and a pressure pad movable between first and second positions is provided with improved means for controlling the movement of the pressure pad from the second to the first positions. These improved means include a hydraulic cylinder having an elongated cylindrical bore filled with hydraulic fluid and having a piston movably positioned in the bore and dividing it into first and second chambers. A fluid line communicates the first and second chambers and includes flow regulating means permitting free flow in a direction from the first to the second chamber and an adjustable rate of flow from the second to the first chamber. Means interconnect the piston and the pressure pad so that as the pressure pad moves to the first position the piston is moved to contract the volume of the first chamber and force fluid through the line from the second to the first chamber and, as the pressure pad moves to the second position the piston is moved to contract the volume of the second chamber and force fluid through the line to the first chamber. Additionally, the line is provided with valve means operable in response to opening and closing of the press for blocking flow through the line for predetermined periods as the press moves from a closed position to an open position.

Because only a single valve needs to be used for controlling the operation of the hydraulic lock cylinder the system is greatly simplified and the control valve can be a simple normally closed electric solenoid valve controlled by a limit switch operated by the press crankshaft. Further, because only a single flow line and control valve control the functioning of the locking cylinder, the cost of construction is greatly reduced.

Accordingly, a primary object of the present invention is to provide a highly simplified hydraulic cushion lock cylinder arrangement.

A further object of the present invention is the provision of a cushion lock cylinder which does not require complicated air control or operating systems.

A still further object is the provision of a hydraulic lock cylinder arrangement which allows all functions of the cylinder to be controlled by a single valve.

These and other objects and advantages of the invention will become obvious from the following description used to illustrate preferred embodiments of the present invention when read in conjunction with the accompanying drawings wherein:

FIGURE 1 is a cross-sectional view, somewhat diagrammatic, of a press equipped with a hydraulic cushion lock cylinder formed in accordance with the present invention;

FIGURE 2 is a cross-sectional view, similar to FIGURE 1, showing a second embodiment of a cushion lock cylinder formed in accordance with the present invention; and,
FIGURES 3 and 4 are diagrammatic views showing the press in various stages of its operational cycle.

Referring now to the drawings wherein the showings are for the purpose of illustrating preferred embodiments of the invention only and not for the purpose of limiting same, FIGURE 1 shows the overall arrangement of a conventional double-acting forming press A provided with a preferred embodiment of a hydraulic cushion lock cylinder formed in accordance with the present invention. As shown, the press includes a ram and blank holder assembly 10, a lower die assembly 12 and a pneumatic die cushion 14.

The precise details of construction of the press are not important to the present invention and could be of any conventional type. However, as shown, the ram and blank holder assembly 10 includes a reciprocated ram 18 which is driven in timed relationship with a blank holder 20. As is customary, blank holder 20 is driven downwardly ahead of ram 18 and arranged to hold the workpiece between it and a subjacent die holder 22 while the press is closed and the ram 18 is reciprocated downwardly to form the workpiece. Subsequently, the press is opened and the ram and die holders moved upwardly and the formed workpiece removed from the lower die assembly 12.

As shown, the lower die assembly 12 includes a lower die holder 22 which is mounted on the press bolster 24 supported from the press bed or frame 26. Positioned within the die holder in a conventional manner is a lower die 28 and a die pad 30. Die pad 30 is arranged for vertical reciprocation in the die holder 22. As shown, pressure pins 34 extend downwardly from the bottom of die pad 30 through the press bolster 24 into engagement with a pressure pad 32. Pressure pad 32 is maintained under an upward bias by a conventional die cushion 14. The die cushion functions to provide a controlled resistance to downward movement of the die pad and to move the die pad upwardly to strip the formed workpiece from the dies following opening of the press and movement of the workholder and ram toward their upper position.

The actual construction of die cushion 14 is not important to the present invention and could be of any conventional type. The particular die cushion shown is of the pneumatic type and includes a body portion 36 which forms a vertical, upwardly open, cylinder. Body portion 36 is connected to the underside of the press frame 26 by a plurality of vertically extending studs 38 and nuts 40. A piston member 42 is positioned in the cylinder and arranged to provide a sealed chamber 44. Air under pressure is admitted to chamber 44 through a line 46 and functions to maintain a continual upward bias on piston 42.

The operation of the structure as thus far described is as follows:

1. With the press in the open position shown in FIGURE 1, a workpiece is positioned between the ram and the blank holder assembly 10 and the lower die assembly 12;
2. The blank holder 20 is then actuated downwardly to grip the workpiece;
3. With the workpiece firmly gripped, the ram is driven downwardly forcing the workpiece into the lower die causing it to be drawn into a generally cup shaped form; and
4. Subsequent to the forming the ram and blank holder are retracted and the workpiece stripped from the die.

During the third step (i.e. the downward movement of the ram to the position shown in FIGURE 3), die pad 30 is maintained under a continual upward bias by the die cushion 14 acting through pressure pad 32 and pressure rods 34. As is apparent, when the press is opened and the ram and blank holder moved to the upper position the bias of the die cushion 14 forces the die pad 30 upwardly to perform the fourth step (i.e. strip the formed workpiece from the die and move it to a position where it can be removed).

In order to prevent the pressure pad from moving upward simultaneously with the upward movement of the ram and striking the bottom of the formed workpiece before the blank holder has been released, means are provided for locking the pressure pad in the lower position and controlling its rate of ascent after the press has opened. Generally, as previously noted, these locking devices have comprised hydraulic flinders provided with complicated air control systems. In accordance with the present invention, an improved and simplified hydraulic locking cylinder arrangement is provided. Although many arrangements of the invention are possible, a preferred arrangement is shown in FIGURE 1.

As shown in FIGURE 1, a hydraulic locking cylinder 16 is provided which includes a cylinder 50 having a central cylindrical bore 52 formed therein. The upper end of the bore is closed by a plate 53 connected to the underside of the air cushion cylinder 36. A piston 54 is positioned within bore 52 and provided with a plurality of piston rings 55 functioning to divide the bore into first and second sealed chambers 56 and 58. A piston rod 55 is connected to the piston and extends upwardly through a sealed opening 57 formed in plate 53. The upper end of piston rod 55 is connected at 59 to the die cushion piston 42. Chambers 56 and 58 are completely filled with hydraulic fluid and are interconnected by a fluid line 60. As is apparent, when the press is closed and ram 18 actuated downwardly, piston 54 is moved into the second chamber 58 reducing its volume and forcing fluid through line 60 into the second chamber 56. Conversely, upward movement of the pressure pad under the influence of die cushion 14 causes the piston to be pulled upwardly into the first chamber 56 reducing its volume and forcing fluid through line 60 to the second chamber 58.

The rate of fluid flow through line 60 is controlled by fluid regulating means comprising a check valve 66 and a needle valve 68 positioned in parallel in line 60. Check valve 66 is arranged so as to permit free flow of fluid in the direction from chamber 58 to chamber 56. Additionally, a check valve 66 built into piston 54 permits fluid to flow from chamber 58 to chamber 56 during downward movement of the piston. Consequently, the piston can move downward relatively freely. However, since check valves 66 are closed when the ram is in the reverse direction during the opening stroke of the press fluid from chamber 56 must all flow through needle valve 68. In this manner, by regulating the setting of needle valve 68 the rate of fluid flow out of chamber 56, and, consequently, the rate of rise of the pressure pad and die pad can be closely regulated.

In order to completely block flow through line 60 to prevent any upward movement of the piston and the die pad until a predetermined point in the opening cycle, a solenoid operated valve 70 controlled in response to the position of the press is provided. As shown, valve 70 is a conventional solenoid valve of the normally closed type (i.e. so long as the solenoid coil is energized the valve is in the open position).

A variety of means could be utilized for controlling the energization and de-energization of the solenoid valve 70 in accordance with the movements of the press; however, according to the preferred embodiment the means utilized comprise a switch 73 controlled by a cam 74 driven by a press crankshaft. Cam 74 is arranged so as to maintain switch 73 closed and the valve energized in all portions of the press cycle except for a predetermined period of time following the start of upward movement of the ram 18 and blank holder 20. Consequently, with valve 70 in the closed position the piston and pressure pad are locked in the lowermost position thus preventing the die pad 30 from rising. However, when the press has been opened
the desired amount, the cam again closes switch 73 energizing valve 70 to its open position to permit a controlled rate of flow through line 69 and needle valve 68 to chamber 58. The piston and pressure pad can then move upward under the influence of die cushion 14 to drive the die pressure pad upwardly and strip the formed workpiece from the die.

As is apparent, there is a volume difference between chambers 56 and 58 (i.e., as piston 54 moves downwardly more fluid is forced from chamber 58 than can be received in chamber 56 because of the presence of piston rod 55). For this reason, the FIGURE 1 embodiment is provided with a fluid reservoir tank 80 connected with chamber 58 through a pair of lines 76 and 78. Flow of fluid through lines 76 and 78 is controlled by a pair of check valves 82 and 84, respectively. Check valve 82 is arranged to permit fluid flow in a direction from the chamber 59 to the reservoir 80; while check valve 84 allows fluid flow only from reservoir 80 to chamber 58. Preferably, check valve 82 is maintained under a bias so that it opens only when the fluid pressure within chamber 58 rises to, for example, a pressure of approximately 20 psi. Check valve 84, however, is preferably biased so as to be free to open at a much lower pressure, for example, 5 psi.

Consequently, during downward movement of the piston 54 the excess fluid from chamber 58 is forced through check valve 82 into reservoir 80. Conversely, on upward movement of the piston the excess fluid required to fill chamber 58 is withdrawn through check valve 84 from reservoir 80.

As is apparent from the foregoing description, the locking cylinder arrangement provided is extremely simple in construction and greatly simplified relative to the prior art constructions. An even more simplified arrangement is shown in FIGURE 2.

The embodiment shown in FIGURE 2 eliminates the need for a fluid reservoir as required by the FIGURE 1 embodiment. The FIGURE 2 embodiment is shown on a press which is identical in construction to that described with reference to FIGURE 1. Accordingly, all elements of FIGURE 2 which are identical to those previously described with reference to FIGURE 1 are illustrated with the same reference numerals differentiated by the addition of a prime (') suffix and, accordingly, all descriptions of the counterpart FIGURE 1 elements are to be considered as applicable to the FIGURE 2 elements unless otherwise noted.

The hydraulic locking cylinder arrangement of FIGURE 2 comprises a cylinder forming member 90 having a longitudinally extending bore 92 formed therethrough. The lower end of the bore is closed by a plate 91 connected to the cylinder 90 such as by screws 93. The upper end of the cylinder is closed by a plate 95 which is in turn connected to the bottom of die cushion cylinder 36'. Positioned within the bore 92 and dividing it into a first chamber 96 and a second chamber 98 is a piston 94. A piston rod 100 extends up through plate 95 into engagement with cylinder 42' in the same manner described with reference to piston rod 55 of the FIGURE 1 embodiment. Extending downwardly from the lower side of piston 94 is a piston rod 101 which extends completely through chamber 98 and exits through plate 91. A seal 102 is provided around rod 101 to completely seal chamber 98.

As is apparent, because piston rod 101 extends through chamber 98 the volumetric change taking place in chamber 96 and 98 during reciprocation of piston 94 are identical but of opposite sign (i.e., one chamber increases in volume at the same rate the other decreases). Consequently, it is not necessary to provide a reservoir tank as required by the FIGURE 1 embodiment. In this manner, the locking cylinder is further simplified.

The invention has been described in great detail sufficient to enable one of ordinary skill in the press art to make and use the same. Obviously modifications and alterations of the preferred embodiments will occur to others upon a reading and understanding of the specification and it is my intention to include all such modifications and alterations part of my invention insofar as they come within the scope of the appended claims.

Having thus described my invention, I claim:

1. In a press having a die pressure pad movable from a first position to a second position in response to closing of the press, a die cushion movable with the pressure pad to provide a predetermined resistance to movement of the pressure pad from the first to the second position and to move the pad from the second to the first position upon subsequent opening of the press, the improvement comprising: improved means for controlling the movement of said pressure pad from said second to said first position, said improved means including: a hydraulic cylinder having an elongated cylindrical bore filled with hydraulic fluid, a piston sealingly positioned in said bore and dividing said bore into first and second chambers; a fluid line communicating said first and second chambers and including flow regulating means permitting free flow in a direction from said first to said second chambers and an adjustable rate of flow from said second to said first chambers; means interconnecting said piston and said pressure pad so that as said pressure pad moves to said first position said piston is moved to contract the volume of said second chamber and force fluid through said line from said second to said first chamber and, as said pressure pad moves to said second position said piston is moved to contract the volume of said first chamber and force fluid through said line from said first to said second chamber; and, valve means in said line operable in response to opening and closing of the press for blocking flow through said line for a predetermined period as said press moves from a closed position to an open position.

2. The improvement as defined in claim 1 wherein fluid reservoir means are connected to said second chamber and provided with means permitting flow from said second chamber to said reservoir upon a predetermined rise of pressure in said second chamber.

3. The improvement as defined in claim 1 including means movable with said piston and producing a volumetric change in said second chamber equivalent to that produced in said first chamber.

4. The improvement as defined in claim 1 wherein said flow regulating means include a check valve and an adjustable orifice positioned in parallel in said line.

5. The improvement as defined in claim 1 including a check valve means carried by said piston and permitting flow from said second chamber to said first chamber in response to movement of said piston into said first chamber.

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