

March 16, 1943.

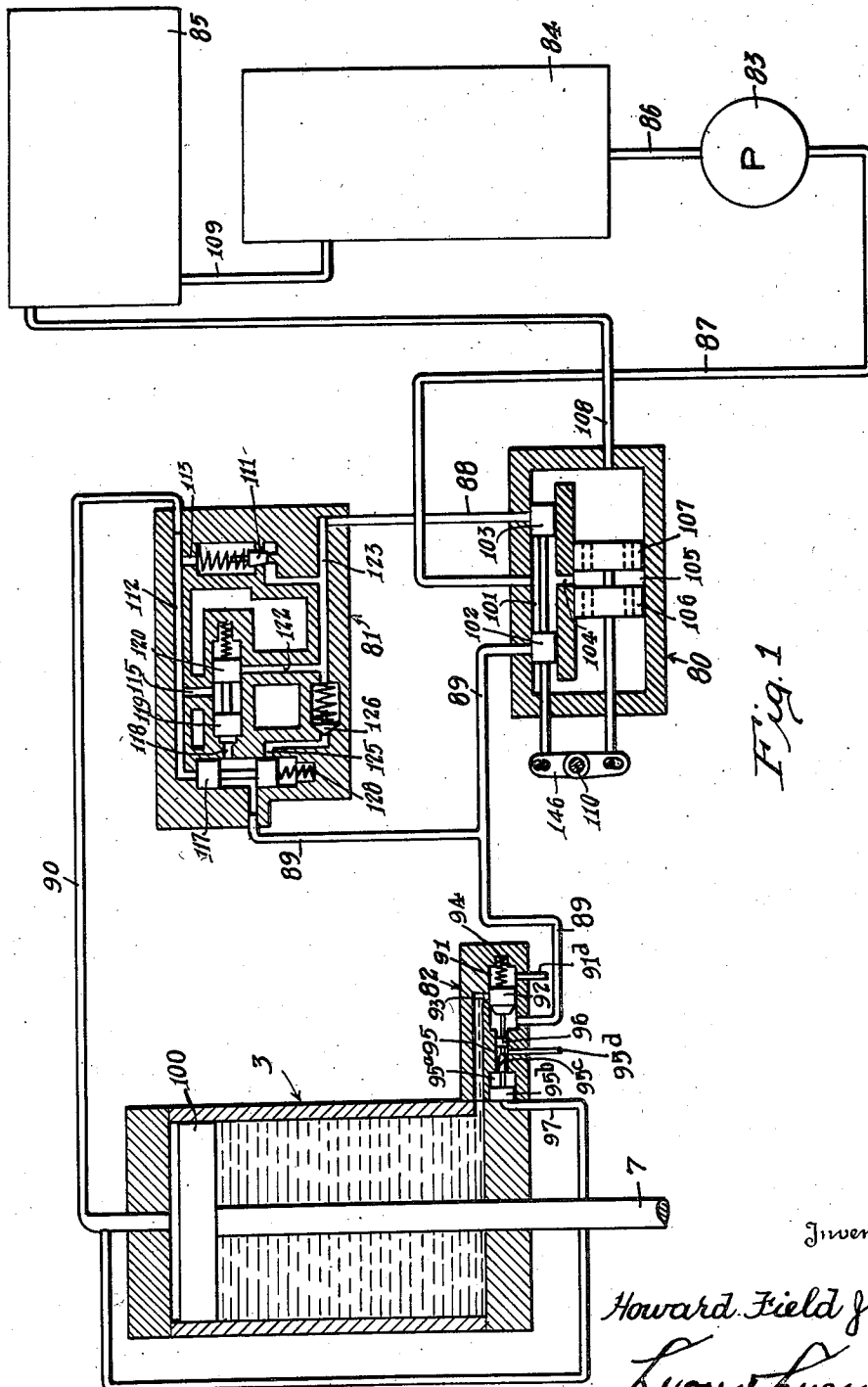
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2,314,082

HYDRAULIC PRESS

Filed Dec. 22, 1939

4 Sheets-Sheet 1



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4 Sheets-Sheet 2

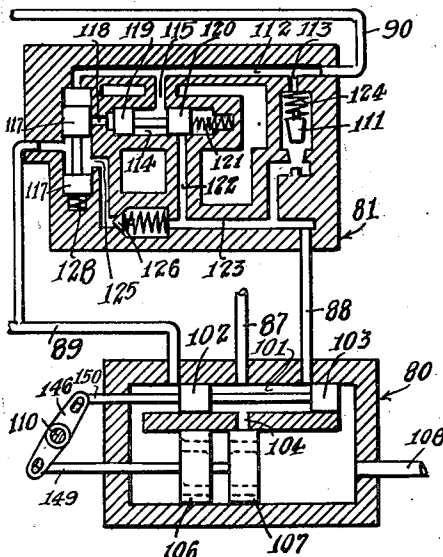


Fig. 2

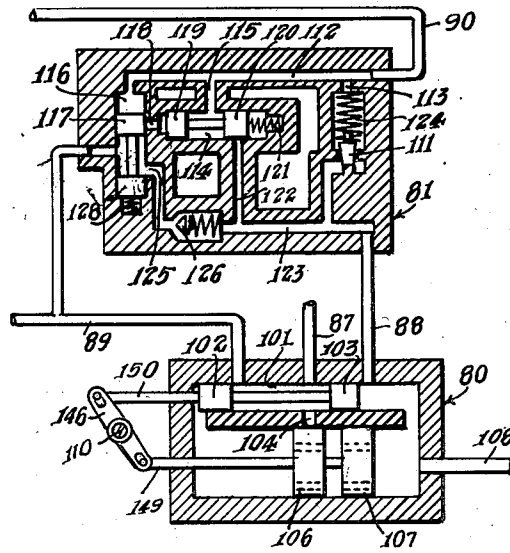


Fig. 3

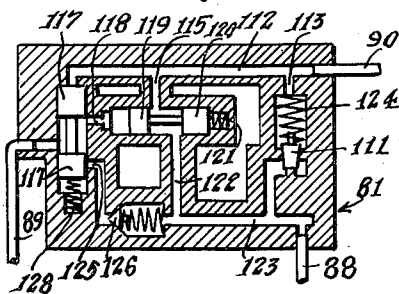


Fig. 4

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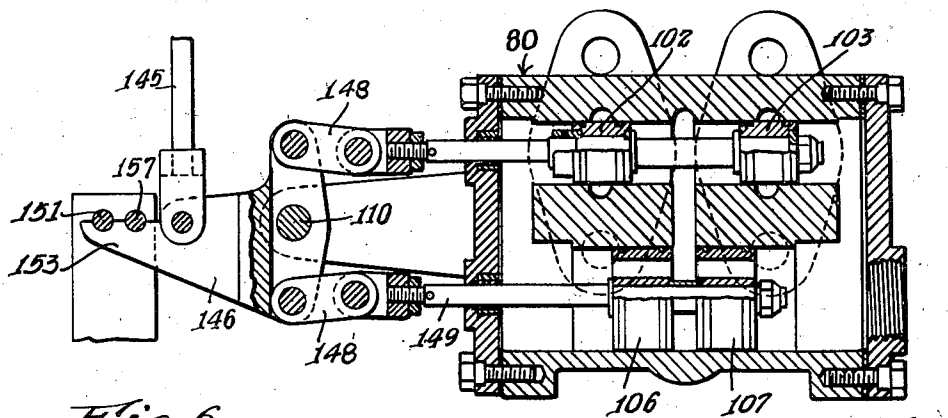
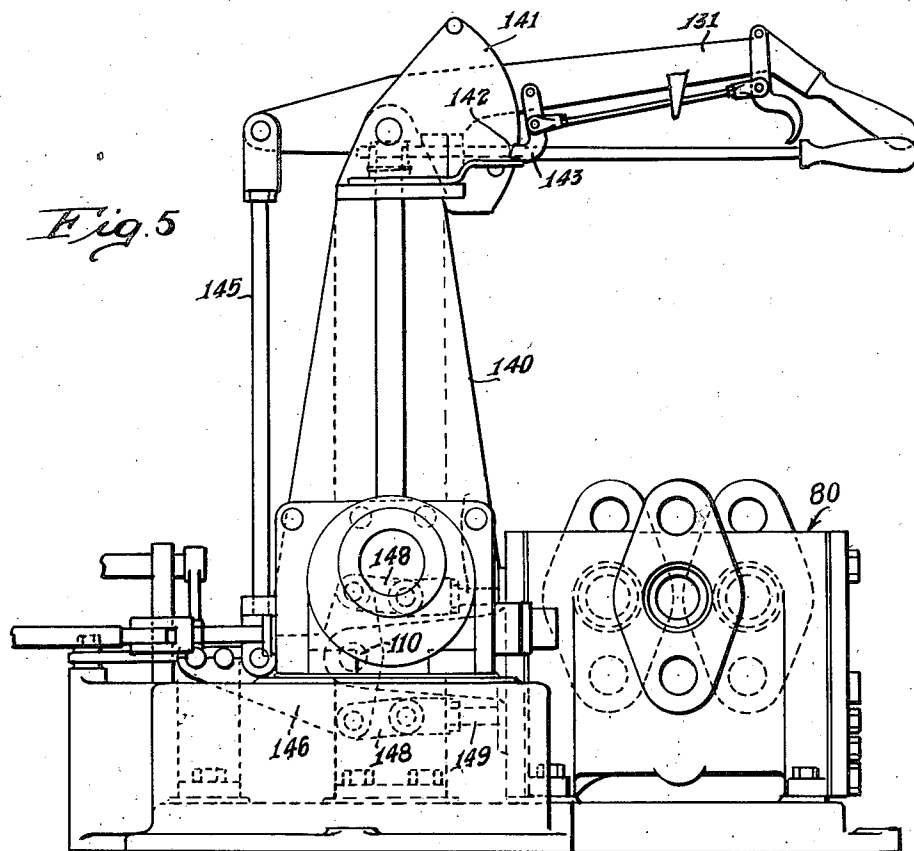
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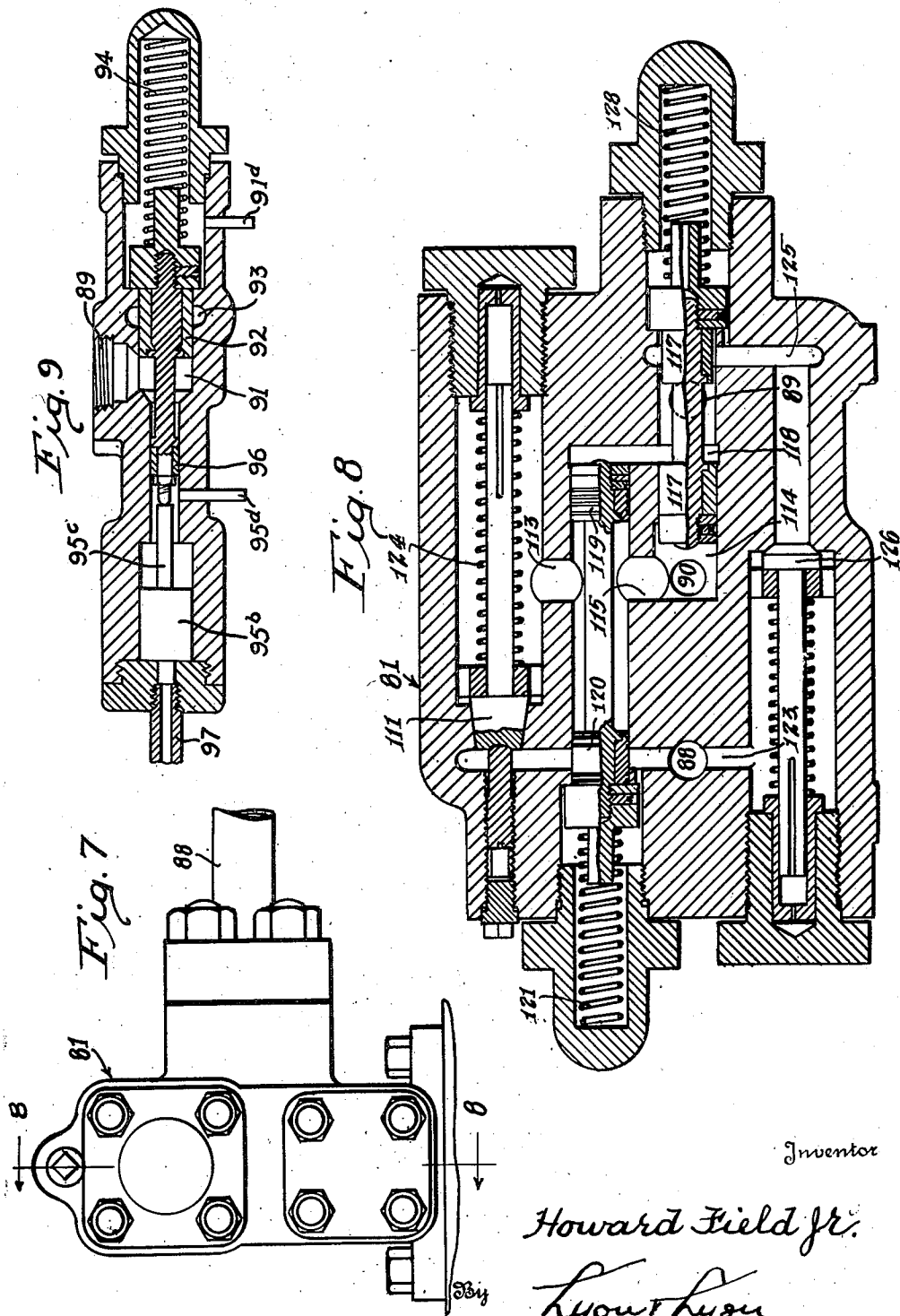
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UNITED STATES PATENT OFFICE

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HYDRAULIC PRESS

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5 Claims. (Cl. 60—52)

This invention relates to hydraulic presses, and particularly to presses for the forming of relatively thin sheet metal parts, such as are employed, for example, in the fabrication of aeroplanes.

It is now a common practice in pressing thin sheet metal parts to employ a male die on the bed of the press and a rubber matrix in the platen which presses the sheet metal about the male die, thereby avoiding the necessity of a rigid female die. Such a system requires extremely high pressures exceeding those commonly utilized with mating male and female dies. Furthermore, a great amount of energy is stored in the compressed rubber, which energy is capable of throwing the platen up with dangerous force and speed, if the closing force on the press is suddenly removed.

The present invention relates particularly to a hydraulic system for large presses of the type described, and has as a broad object to provide automatic safety features that prevent the enormous forces involved from getting out of control and causing injury either to the press itself or to the person operating it.

Another object is to provide a control that is simple to operate and at the same time automatically insures smooth movement of the press.

The foregoing objects, together with other more specific objects and features of the invention will become apparent from the detailed description to follow of a particular embodiment of the invention.

In the drawings:

Figure 1 is a schematic view of the hydraulic system of a press in accordance with the invention; the view showing the ram in the upper position and the control valve in the neutral or holding position.

Figure 2 is a schematic view of the ram control valve and cracking valve corresponding to the showing of these parts in Figure 1, but showing the valves in position for downward movement of the press.

Figure 3 is a schematic view, similar to Figure 2, but showing the valves in position for moving the press upwardly at the beginning of the upward movement.

Figure 4 is a schematic view of the cracking valve showing the condition of the valve during upward movement of the press through the upper portion of its stroke.

Figure 5 is a front elevation of the main control valve mechanism, of which the present invention forms a part.

Figure 6 is a vertical sectional view through the main control valve for the ram.

Figure 7 is an end elevation of a cracking valve for the ram.

Figure 8 is a vertical section through the cracking valve taken substantially on the line 8—8 of Figure 7.

Figure 9 is a longitudinal section through a safety control valve for the ram.

Hydraulic system for the ram

Referring to Fig. 1, there is shown a hydraulic system for actuating the head (not shown) of a press, which head is attached to a piston rod 7 of a ram piston 100 positioned in the ram cylinder 3 of the press. Although the details of the press platen are not shown, it is to be understood that the hydraulic system herein to be described is of particular usefulness in connection with the type of press employing a compressible rubber platen for forming sheet metal around the male dies. The hydraulic system comprises, in addition to the cylinder 3 previously mentioned, a main control valve 80, a cracking valve 81 which is automatic in its operation, a safety stop valve 82 which is likewise automatic in its operation, a pump 83, a reservoir 84, a cooling device 85 and piping interconnecting these various elements in proper relation. Thus fluid is delivered from the reservoir 84 through a pipe 86 to the pump 83 and thence through a pipe 87 to the main control valve 80, from which it may flow to the cracking valve either through a pipe 88 or a pipe 89, depending upon the position of the valve 80. Fluid can flow between the cracking valve 81 and the upper end of the cylinder 3 through a pipe 90 and between the main valve 80, the cracking valve 81 and the lower end of the cylinder 3 through the pipe 89. Fluid flow between the pipe 89 and the lower end of the cylinder 3 can only occur through the safety valve 82.

The valve 82 will open in response to pressure in either line 89 or 90 but is always closed when no pressure exists in either of these lines. Thus the valve comprises a cylinder 91 in which a piston 92 is reciprocable between a left position, as shown in Fig. 1, in which it covers a port 93 leading to the lower end of the ram cylinder 3 and a right position in which it is displaced to the right of the port 93 permitting communication of this port through the cylinder 91 with the pipe 89. The valve piston 92 is normally urged into the left position shown in Fig. 1 by a spring 94. At its left end the cylinder 91 communicates

with a smaller cylinder 95 containing a piston 96 connected to the piston 92. The left end of the cylinder 95 communicates with a larger cylinder 95a, which is connected, by a pipe 97, with the upper end of the ram cylinder 3.

A piston 95b is fitted in cylinder 95a and has a short rod 95c extending therefrom and adapted to contact the piston 96. The right end of cylinder 91 and the interconnected ends of cylinder 95 and 95a are vented through ducts 91d and 95d, respectively.

When no pressure exists in either pipe 89 or pipe 90, the spring 94 controls the piston 92 and holds it in position to close the port 93, so that fluid cannot escape from the underside of the ram piston 100 and the piston is prevented from moving down in response to its own weight and the weight of the press parts connected thereto through the piston rod 7. However, if sufficient pressure is developed in either the pipe 89 or the pipe 97, force is exerted on the left end of piston 92 or the left end of piston 95b to move the pistons to the right, uncovering the port 93 and permitting fluid to flow to or from the lower end of the ram cylinder 3 under the control of valves 80 and 81.

The construction and operation of the control valve 80 and the cracking valve 81 will now be described. Under normal operation the pump 83 runs continuously and when the control valve 80 is in neutral position, as shown in Fig. 1, fluid is circulated from the pump 83 through the pipe 87 into a cylinder 101 in valve 80 between two valve pistons 102 and 103, respectively. This fluid flows directly through the cylinder 101 and out through a port 104 into a cylinder 105 between two valve pistons 106 and 107 therein. Both of these pistons 106 and 107 have openings longitudinally therethrough so that fluid flowing through the port 104 can escape through the piston 107 and thence through a return pipe 108 back to the cooling device 85 and thence through a pipe 109 to the reservoir 84 from which it can again flow to the pump 83.

It will be observed, therefore, that with the control valve 80 in neutral position, as shown in Fig. 1, fluid from the pump 83 circulates freely through the valve 80 to the return pipe 108 and no pressure is developed in the system. At the same time the pipes 88 and 89 are closed by the valve pistons 103 and 102, respectively, so that no pressure fluid is applied to either pipe 89 or 90 and the safety valve 82 remains closed, preventing downward movement of the ram piston 100.

It may be mentioned at this point that the function of the cracking valve 81 is to control the initial upward movement of the ram piston 100, following a pressing operation. The necessity of this valve arises from the fact that the press employs a rubber matrix as the female die element, which matrix is highly compressed during each final downward movement of the press. As a result of the compression of the rubber, enormous energy is stored therein, tending to move the piston 100 upwardly and if the fluid in cylinder 3 above the piston 100 were permitted to escape rapidly, the expansion of the rubber matrix in the press would cause the piston to rebound with great velocity and force. Such rebound is controlled by the cracking valve 81 which permits only slow escape from the upper end of the cylinder 3 through the pipe 90 until the energy stored in the compressed rubber matrix has been dissipated.

Let it be assumed, now, that the press is to be lowered, which operation is caused to be performed by rotating a control lever 146 about a shaft 110 on the valve 80 clockwise into the position shown in Fig. 2. This moves the piston 107 against the port 104, stopping free circulation of pressure fluid from pipe 87 to the return pipe 108. At the same time the pistons 102 and 103 are moved to the right, clear of the ports of pipes 89 and 88, respectively, so that pipe 88 is communicated with the supply pipe 87 and pipe 89 is communicated (through the passages in the pistons 106 and 107) with the return pipe 108.

Pressure fluid, therefore, flows from pipe 87 into pipe 88, into the cracking valve 81 where it flows upwardly past the spring-actuated valve element 111, and through pipe 90 to the upper end of the ram cylinder 3. Pressure is therefore built up in the pipe 90 and in the pipe 97 (Fig. 1) which pressure acting upon the left end of the piston 96 in the safety valve 82 moves the piston 92 clear of the port 93, permitting communication of the lower end of the ram cylinder 3 with the pipe 89. The application of the fluid under pressure through the pipe 89 to the upper end of the cylinder 3 moves the ram piston 100 downward, expelling the fluid below the piston through the pipe 89 (Fig. 2) and through the openings in the pistons 106 and 107 of the control valve 80 to the return pipe 108. As the press closes with the ram piston 100 near the lower end of its stroke, the full pressure of fluid developed by the pump 83 is applied to the upper end of the piston and is maintained so long as the control lever 146 is maintained in clockwise position, as shown in Fig. 2.

When it is desired to restore the press to open position, the control lever 146 is rotated in counterclockwise direction from the position shown in Fig. 2 into the position shown in Fig. 3. This connects the fluid supply pipe 87 through the cylinder 101 to the pipe 89 and connects the pipe 88 with the return pipe 108.

Fluid now flows freely from supply pipe 87 through the pipe 89, through the cylinder 101 in the cracking valve 81, out through an open port 125 in that cylinder, and past a check valve 126 and through a passage 123 to the pipe 88, which is connected through valve 80 to the return pipe 108. Therefore no pressure is developed in the line 89.

At this time of course the piston 100 is being urged upwardly by the force of the compressed rubber matrix in the press, but it can move upwardly only as fluid is discharged from the upper end of cylinder 3 through the pipe 90, and (Fig. 3), the only path for escape of fluid from the pipe 90 to the return pipe 108 is through the cracking valve 81, which now functions to perform its intended purpose of limiting the rate of escape of fluid from the pipe 90 to the pipe 88 and thence through the control valve 80 to the return pipe 108.

It will be observed from an inspection of Fig. 3 that the pipe 90 communicates with a passage 112 which connects with the upper end of the passage 113 leading to the valve element 111 and also communicates with a valve cylinder 114 through a port 115 and with the upper end of a cylinder 116. The pressure fluid in the pipe 90 acts against the upper end of a piston 117 in the cylinder 116, holding the latter in lowermost position, in which piston 117 closes a port 118 leading to the left end of cylinder 114. This

prevents application of pressure fluid to the left end of cylinder 114 and pistons 119 and 120 in cylinder 114 are maintained in leftmost position by a spring 121. In this position of pistons 119 and 120 the latter piston closes a port 122 leading to the passage 123 and pipe 88. It will be apparent, therefore, that fluid cannot escape from pipe 90 through either port 115 or through the cylinder 116. The only escape is through the passage 113 past the valve element 111 and through the passage 123 into the pipe 88. The flow of fluid downwardly past the valve element 111 aids a spring 124 in keeping the element in lowermost position, in which it almost, but not quite, closes the passage 113 and fluid slowly flows out through the pipe 90 into the pipe 88 and to the return pipe 108, permitting the ram piston 100 to slowly rise in response to the reactive force of the rubber matrix in the press.

During this stage of operation, the piston 117 is maintained in lower position by the pressure of the fluid in pipe 90 and passage 112, in which position pipe 89 is communicated through cylinder 116 and the port 125 thereof with the check valve 126, as previously described.

During this initial upward movement of the ram piston 100 the pressure of the fluid in pipe 90 applied through the pipe 97—(Fig. 1) to the left end of the piston 96 of the safety valve 82 holds the valve in open position, in which pipe 89 is in communication with the ram cylinder 3. However, as previously indicated, the fluid supplied to pipe 89 is being bypassed through the cracking valve 81 so that the only force acting to move the ram piston 100 upwardly is the reactive force of the rubber in the press. This reactive force of the rubber in the press is gradually reduced as the rubber expands to its normal size with the upward movement of the piston; the force tending to lift the piston decreases, and the pressure of the fluid in the upper end of the cylinder 3 and in the pipe 90 diminishes to a value insufficient to maintain the piston 117 (Fig. 3) in lower position against the reactive force of a spring 128 bearing against the lower end of the piston. Therefore piston 117 is moved into uppermost position, as shown in Fig. 4, in which the lower end of piston 117 closes off port 125 and the upper end of the piston is clear of the port 118. Closure of the port 125 stops the free circulation of fluid from pipe 89 past the check valve 126 back to pipe 88 so that the pressure rises in pipe 89. At the same time pipe 89 is connected through port 118 with the left end of cylinder 114, moving the pistons 119 and 120 therein to the right against the force of the spring 121 and interconnecting the port 115 with the port 122. This provides a free connection through passage 112 and cylinder 114 to the passage 123 and pipe 88 so that fluid in the upper end of the ram cylinder 3 may be freely evacuated during the remainder of the upward stroke of the ram piston.

Referring now to Fig. 1, the closure of the return path from pipe 89 causes pressure to be developed in the pipe 89, which pressure, acting upon the safety valve 82, opens the latter to communicate pipe 89 with the lower end of the ram cylinder 3. Pressure fluid is therefore supplied to the ram cylinder to lift the piston 100 to the upper end of its stroke, whereupon the operator moves the control shaft 110 into neutral position, as shown in Fig. 1, completing a cycle of operations.

Structural details of the system

The control lever 146 (Fig. 1) of the ram control valve 80 is manually actuated by means of a lever so arranged as to move in the same direction as the press element which it controls.

Thus referring to the elevation view of Fig. 5, the ram control valve 80 is actuated by a lever 131 movable vertically. Downward movement of lever 131 causes the press platen to move downwardly, and upward movement of lever 131 causes the press platen to move upwardly. This greatly reduces the possibility of the operator becoming confused in his manipulation of the control lever 131.

The ram control lever 131 (Figs. 5 and 6), is fulcrumed on a standard 140 and cooperates with a sector 141 having a notch 142 corresponding to the neutral position of operation and cooperating with a detent 143 on the lever 131. The lever is positioned above the case of the ram control valve 80 and at its rear end is connected by a linking rod 145 with a bellcrank lever 146 which is pivotally mounted on the shaft 110 and has lower and upper extremities connected by links 148 to rods 149 and 150, respectively, which rods extend into the casing of the valve 80. The rod 150 carries the pistons 102 and 103 (Fig. 1) and the rod 149 carries the pistons 106 and 107, as also clearly shown in Fig. 6.

An actual form of construction that may be employed in the cracking valve is disclosed in Figs. 7 and 8, in which the parts bear the same reference numerals as in the schematic view of Fig. 1.

The safety valve 82, previously described with reference to the schematic view of Fig. 1, is mounted directly upon the ram cylinder and may be constructed as shown in Fig. 9, in which corresponding elements bear the same reference numerals as in Fig. 1.

It is to be understood that for the purpose of explaining the invention, the construction and operation of a particular embodiment thereof has been described in detail, but the invention is not necessarily limited to the particular construction described, except to the extent set forth in the appended claims.

I claim:

1. In combination with a hydraulic press having a ram cylinder and a piston therein movable from a first end of said cylinder to a second end thereof to close said press, a pump, fluid connections from said pump to said cylinder including a first conduit extending from said first end of said cylinder, and a second conduit extending from said second end of said cylinder, control means for selectively connecting the output of said pump to either one of said conduits and connecting the other conduit to a source of fluid for the intake of said pump, and means responsive to pressure in said one end of said cylinder for throttling the discharge of fluid from said cylinder through said first conduit while said pressure is in excess of a predetermined value, and permitting free discharge through said conduit when said pressure is below said predetermined value.

2. In combination with a hydraulic press having a ram cylinder and a piston therein movable from a first end of said cylinder to a second end thereof to close said press, a pump, fluid connections from said pump to said cylinder including a first conduit extending from said first end of said cylinder, and a second conduit ex-

tending from said second end of said cylinder, control means for selectively connecting the output of said pump to either one of said conduits and connecting the other conduit to a source of fluid for the intake of said pump, means for throttling discharge of fluid from said one end of said cylinder through said first conduit, and means jointly responsive to decrease in pressure in said one end of said cylinder and to the flow of fluid from said pump through said second conduit for providing a by-pass passage through said first conduit past said throttling means.

3. In combination with a hydraulic press having a ram cylinder and a piston therein movable from a first end of said cylinder to a second end thereof to close said press, a pump, fluid connections from said pump to said cylinder including a first conduit extending from said first end of said cylinder, and a second conduit extending from said second end of said cylinder, control means for selectively connecting the output of said pump to either one of said conduits and connecting the other conduit to a source of fluid for the intake of said pump, means responsive to pressure in said one end of said cylinder in excess of a predetermined value for throttling the discharge of fluid from said cylinder through said first conduit, and means jointly responsive to decrease in pressure in said one end of said

cylinder, and to the flow of fluid from said pump through said second conduit for providing a by-pass passage through said first conduit past said throttling means.

4. The combination as described in claim 1, said last mentioned means comprising a check-valve permitting free flow of fluid through said first conduit to said first end of said cylinder and permitting restricted flow therefrom.

5. In combination with a hydraulic press having a ram cylinder and a piston therein movable from a first end of said cylinder to a second end thereof to close said press, a pump, fluid connections from said pump to said cylinder including a first conduit extending from said first end of said cylinder, and a second conduit extending from said second end of said cylinder, control means for selectively connecting the output of said pump to either one of said conduits and the other conduit to a source of fluid for the intake of said pump, means responsive to pressure in said one end of said cylinder in excess of a predetermined value for short-circuiting fluid flow from said pump through said second conduit to said first conduit, said means including a check-valve for preventing short-circuiting flow of fluid in the reverse direction through said first conduit to said second conduit.

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