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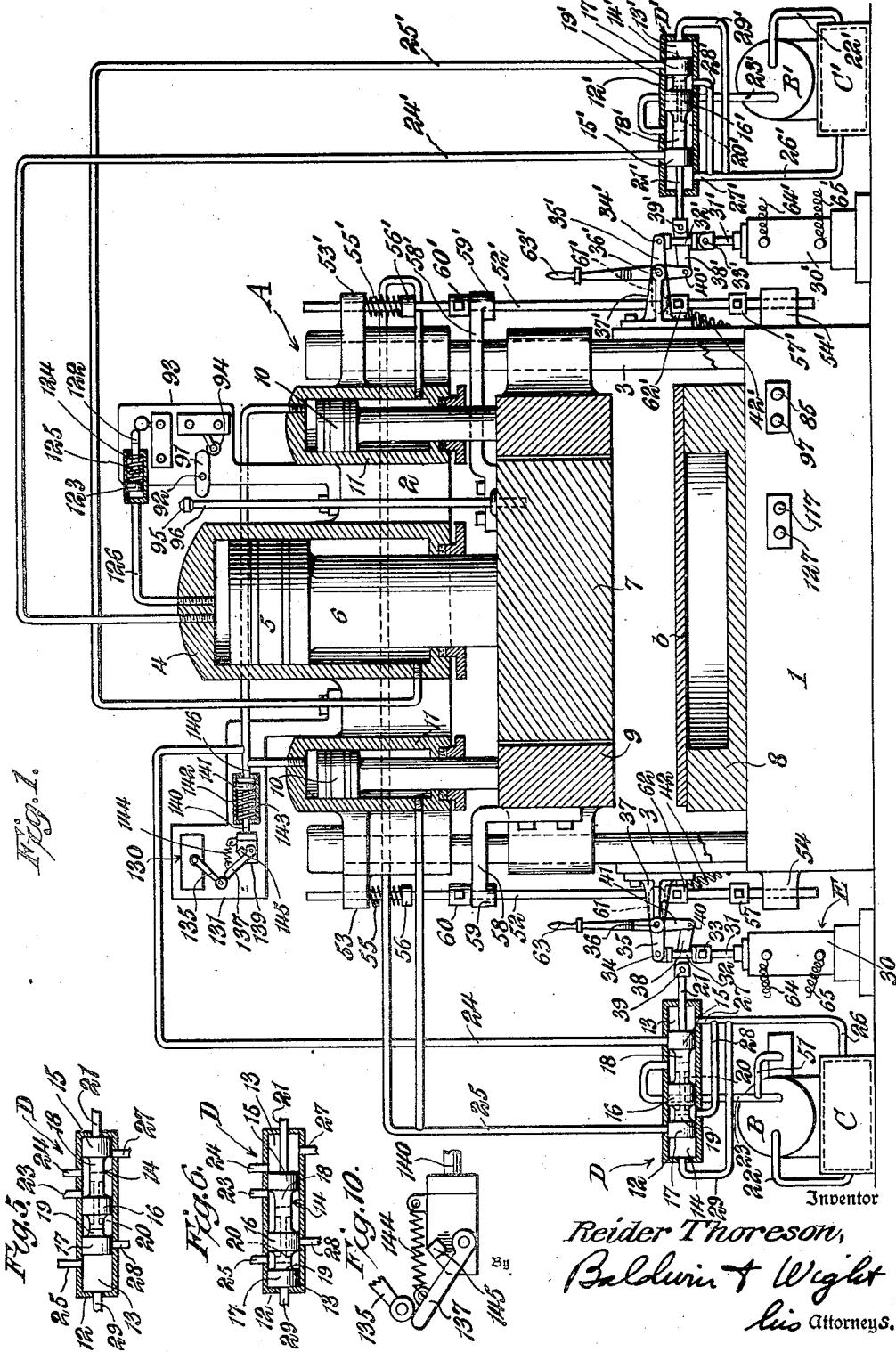
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DRAWING PRESS OR THE LIKE

Filed Nov. 18, 1931.

3 Sheets-Sheet 1



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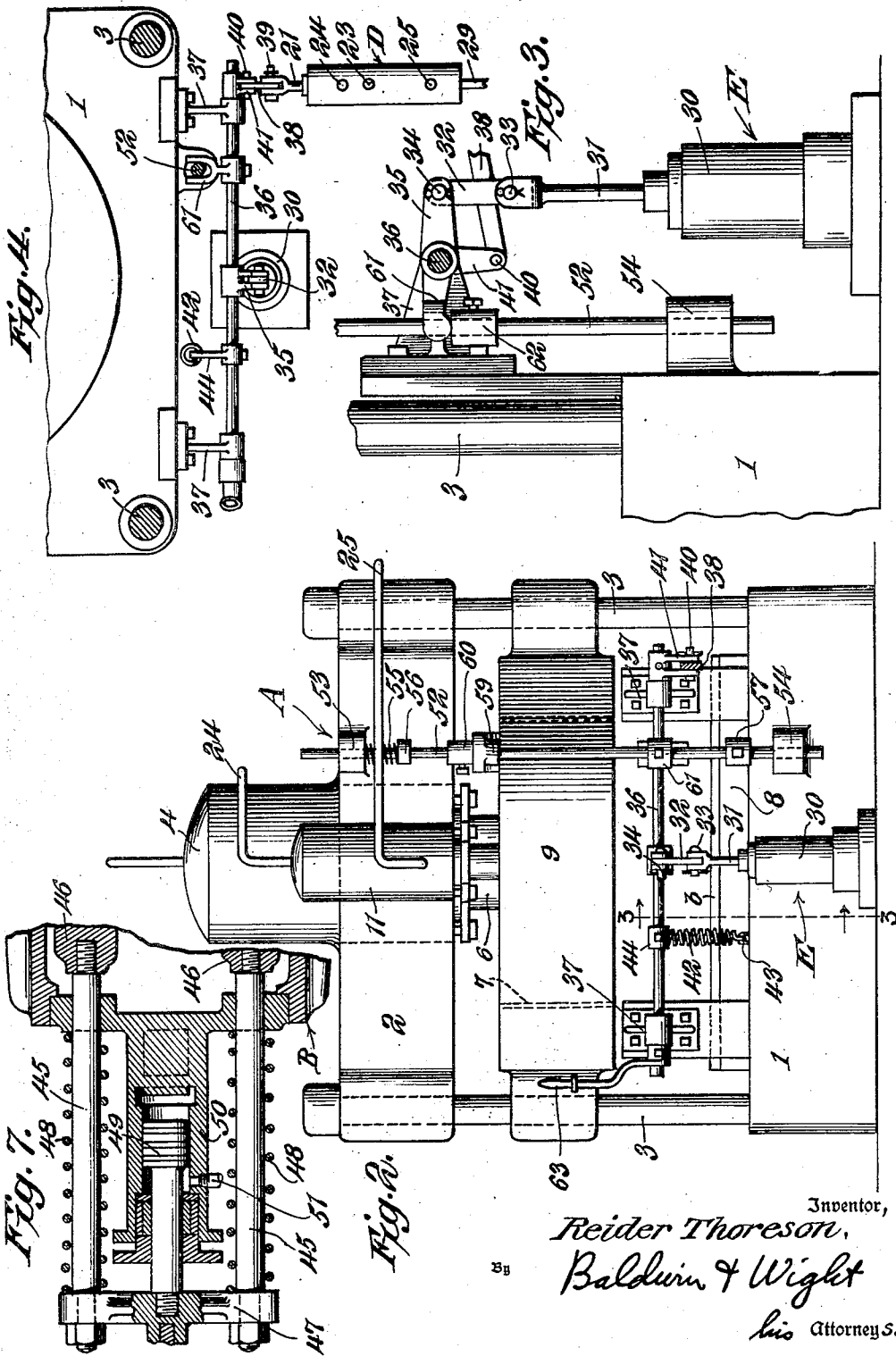
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DRAWING PRESS OR THE LIKE

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This invention relates to drawing presses and more particularly to hydraulic drawing presses including cooperating dies, one of which is attached to a stationary table fixed to the press frame and the other of which is carried by a ram mounted on the press frame for reciprocatory movements towards and away from the stationary die, and in which there is provided a hydraulically operated blank-holder for clamping the work against the stationary die and thus holding the work in proper position relative to the dies during the drawing operation.

When shaping metal into various forms by the drawing process, it is customary to employ a pair of dies, one being fixed to a stationary part of a press and the other being carried by the press ram and adapted to move towards and away from the fixed die so that the movable die cooperates with the fixed die and shapes or draws to the desired form a blank placed on the fixed die. When the drawing operation requires what is known as a "deep draw," there is a tendency for the blank to wrinkle. In order to overcome this tendency, various devices known as "blank holders" have been used to yieldingly clamp the blank against one of the dies. Some of these previously used blank holders have been operated by mechanical means including links and toggles, others by spring loaded devices, and still others by air or hydraulic pressure loaded pistons or rams. It is obvious that regardless of whether the blank-holder be operated by mechanical toggles or the like, or by fluid pressure devices, it is important that the blank-holder be brought into its holding position before the movable die starts to perform the drawing operation. At the same time, it is important that after the blank-holder has moved into engagement with and exerted the desired pressure upon the blank, no time be lost in bringing the movable die into action to effect the drawing operation.

Accordingly, an object of the present invention is to provide control mechanism for a press of the general character referred to adapted to automatically start operation of the movable die as soon as the blank-holder

has been brought to exert the desired pressure on the blank, the arrangement being such that the movable die will not begin to move until the required pressure is exerted by the blank-holder, irrespective of the thickness of the blank or the position of the blank-holder.

Another object is to provide control mechanism for such a press adapted, upon the operation of one control device, to automatically effect movement of the blank-holder into blank engaging position, to then automatically effect a drawing stroke of the movable die, to then automatically effect a return stroke of said die, to then automatically effect a return stroke of the blank-holder, and to then bring the movable die and the blank-holder to rest in retracted positions. A further object is to provide control mechanism adapted to automatically effect various steps of the aforementioned sequence of operations. Other objects will become apparent from a reading of the following detailed description, the appended claims, and the accompanying drawings, in which:

Figure 1 is a front view of a press and control mechanism embodying the invention some parts being shown in elevation and some in section;

Figure 2 is a side view of the press shown in Figure 1;

Figure 3 is a fragmentary vertical sectional view taken on the line 3—3 of Figure 2;

Figure 4 is a fragmentary top plan view of certain of the parts shown in Figure 3;

Figures 5 and 6 are vertical sectional views of a control valve, showing a piston valve element thereof in different positions;

Figure 7 is a fragmentary horizontal sectional view of a pump control device, drawn on an enlarged scale;

Figures 8 and 9 are respectively diagrammatic showings of electrical control circuits for a drawing ram and a blank-holder; and

Figure 10 is a detail view of a pressure operated switch mechanism.

The invention may be embodied in various kinds of drawing presses or the like, but for the purpose of illustration is shown as being embodied in a hydraulic drawing press A of the downward pressure type having a base

1 and a head 2 connected to the base by means of strain rods 3. Carried by the press head is a cylinder 4 in which a double-acting drawing ram 5 is mounted for reciprocatory movements, the ram being formed with an extension 6 to the lower end of which is connected a movable die 7 adapted to cooperate with a fixed die 8 mounted on the base 1 for the purpose of drawing a blank *b*.

In order to yieldably hold the blank against the fixed die 8 during the drawing operation, a blank-holder 9 is guided on the strain rods and is adapted to be moved into and out of engagement with the blank by means of double-acting blank-holder rams 10—10 respectively mounted in blank-holder cylinders 11—11. In operation, when it is desired to draw a blank *b*, positioned as indicated in Figure 1, the rams 10 are first caused to move the blank-holder 9 into engagement with the blank so as to exert the desired pressure thereon. The movable die 7 is then moved downwardly into engagement with the blank to shape or draw the latter. After the shaping of the blank has been completed, the movable die 7 is withdrawn from the die 8, the blank-holder still exerting pressure upon the blank. After the movable die has been returned to its Figure 1 position, the blank-holder is moved upwardly to its upper position.

In the illustrative embodiment of the invention separate hydraulic circuits are employed for reciprocating the drawing ram and the blank-holder rams. The hydraulic circuit for effecting operation of the blank-holder ram includes a variable discharge pump B, a tank C, a blank-holder ram control valve D, and suitable piping forming a hydraulic circuit with the blank-holder cylinders 11, the pump, the tank, and the valve.

The valve D includes a casing 12 formed with a valve chamber 13, and a piston valve 14 mounted for sliding movements within the casing. The piston valve comprises spaced heads 15, 16 and 17, a valve stem 18 interposed between and connecting the heads 15 and 16, and a stem 19 interposed between and connecting the heads 16 and 17. A passage 20 formed within the piston valve provides constant communication between the space defined by the valve casing and the heads 15 and 16 and the space defined by the valve casing and the heads 16 and 17. A valve rod 21 extends from the head 15 through the adjacent end of the casing 12 for connection to valve actuating means to be later described.

The piping connecting the reversing valve, the tank, and the pump to complete the reversible flow circuit includes a pump intake or suction pipe 22 respectively communicating at its opposite ends with the pump and the tank, a discharge pipe 23 communicating at one end with the pump and at its other end with the valve chamber 13, adjacent to the center thereof, a pipe 24 which connects the

top ends of the blank-holder cylinders with the valve chamber at a point between the pipe 23 and the right hand end of the valve as viewed in Figures 1, 5 and 6, a pipe 25 which connects the bottom ends of the blank-holder cylinders with the valve chamber adjacent the left hand end thereof, an exhaust pipe 26 connected to the tank C and exhaust branches 27, 28, and 29 respectively, communicating with the valve chamber, as shown in Figures 1, 5 and 6.

Thus far only the press and associated hydraulic circuit have been described and no means have been described for actuating the valve D to control the movements of the blank-holder 9. In order to assist in the understanding of the detailed description of the control means which is to follow, the operation of the blank-holder will be briefly set forth without reference to any particular means for shifting the valve.

Assuming that the parts are in the relative positions shown in Figures 1 and 2, the pump will receive fluid through the suction pipe 22 and will discharge fluid under pressure through the pipe line 23 into that part of the valve chamber 13 then included between the valve heads 15 and 16. This fluid will then pass through the passage 20 in the piston valve to the space between the valve heads 16 and 17 and thence to tank C by means of the branch exhaust pipe 28 and the exhaust pipe 26, the pump discharge being thus by-passed so as to produce no movement of the press platen. When the piston valve 14 is moved to its extreme right hand position (the position shown in Figure 5), discharge from the pump will flow through the discharge pipe 23 into that part of the valve chamber then included between the heads 15 and 16 and thence through the pipe 24 to the upper ends of the blank-holder cylinders. At this time the lower ends of the cylinders will communicate with the tank C by means of the pipe 25, that part of the valve chamber then included between the head 17 and the left hand end of the valve casing, the exhaust branch 29, and the exhaust pipe 26. Fluid under pressure will then move the blank-holder downwardly, this downward movement of the blank-holder and consequently of the rams 10 forcing from the lower ends of the cylinders 11 the fluid which remained therein after the termination of the preceding return stroke. When the working stroke has been completed, the valve 14 will be moved to its extreme left hand position (the position shown in Figure 6), at which time the pump will deliver fluid under pressure to the lower ends of the blank-holder cylinders by means of the discharge line 23, that part of the valve chamber then included between the heads 15 and 16, the passage 20 in the piston valve 17, that part of the valve chamber then included between the heads 16 and 17, and the pipe 25. Fluid under pres-

sure thus delivered to the push-back cylinders will cause the blank-holder to move upwardly which will result in expelling from the top ends of the cylinders 11 the fluid remaining therein at the completion of the preceding working stroke, this fluid passing back to the tank through the pipe 24, that part of the valve chamber included between the head 15 and right hand end of the valve casing, the exhaust branch 27, and the exhaust pipe 26. When the blank-holder has been thus returned to its uppermost position, the valve 14 may be moved either to its Figure 5 position to start another working stroke, or to its Figure 1 position to bring the blank-holder to rest.

For moving the valve 14 from either its Figure 1 or its Figure 6 position to its Figure 5 position to effect a working stroke of the blank-holder, I have provided electrical valve-actuating means generally designated E and comprising a solenoid 30 having a plunger 31 connected to the valve rod 21 through the medium of a link 32 pivoted at its lower end to the plunger 31 as at 33 and pivoted at its upper end as at 34 to a forked crank arm 35 secured to a rock shaft 36 journaled in brackets 37 on the side frame of the press, and a link 38 pivoted at one of its ends as at 39 to the valve rod 21 and pivoted at its other end as at 40 to a forked crank arm 41 also secured to the shaft 36. When the solenoid is energized in a manner to be hereinafter described, the plunger 31 will be drawn downwardly which, through the link 32 and the crank arm 35, will rock the shaft 36 in a counter-clockwise direction. This rocking of the shaft will swing the arm 41 in a counter-clockwise direction, as viewed in Figure 1, and will move the valve rod 21 and the valve 14 to the right to their Figure 5 positions, thus initiating a downward stroke. It will be observed that the solenoid 30 and the valve D together constitute electrically actuated flow-controlling means. Any other suitable form of electrical device having a movable element connected to the valve rod 21 may be used instead of the solenoid 30.

For constantly urging the valve 20 to its extreme left hand or Figure 6 position, there is provided a spring 42 interposed between a lug 43 on the press frame and an arm 44 secured to the shaft 36, this spring tending to rotate the shaft 36 in a clockwise direction, and to move the valve 14 to its Figure 6 position.

During operation of the press when the blank-holder engages the blank, it is necessary that the blank-holder be maintained stationary while exerting pressure in the blank during the drawing operation. For this reason, it is necessary to discontinue the flow of fluid to the upper ends of the cylinders 11. This may be accomplished by any well-known means, such as a by-pass valve, but in the pres-

ent instance the pump B is of the well-known radial variable discharge type including rods 45 extending through the pump casing and being connected at their inner ends to shiftable eccentric rings 46 and being connected together at their outer ends by means of a cross-head 47. The cross-head 47 is urged outwardly by means of springs 48—48 interposed between the cross-head and the pump casing, the springs thus tending to maintain the shiftable rings 46 in a position for effecting maximum discharge of the pump. A piston 49 is connected to the cross-head and is mounted for sliding movements within a cylinder 50 carried by the pump casing. A pipe 51 provides constant communication between the outer end of the cylinder and the pump discharge pipe 23, so that when the desired blank-holder pressure has built up in the cylinders 11—11 and the pipe 23, this pressure acting upon the piston 49 will move the latter, the cross-head 47 and the rods 45 inwardly against the urge of the springs 47, thereby placing the pump substantially on neutral so as to prevent further discharge therefrom but at the same time to maintain the blank-holder pressure.

In accordance with the invention, control means is provided for energizing the solenoid 30 to move the valve 14 to its Figure 5 position so as to cause the blank-holder to perform a working stroke, for subsequently automatically deenergizing the solenoid when the drawing ram has completed a drawing stroke and has reached a predetermined position during a return stroke so as to permit the spring 42 to move the valve 14 to its Figure 6 position, thus effecting a return stroke of the blank-holder; and for finally and automatically moving the valve 14 to its Figure 1 position when the blank-holder approaches the end of its return stroke to thereby bring the blank-holder to rest in its upper position. This control means includes a rod 52 mounted for vertical sliding movements in lugs 53 and 54 on the press head and base respectively, the rod 52 being urged downwardly by means of a spring 55 interposed between the lug 53 and a collar 56 secured to the rod, and being limited in its downward movement by a collar 57 secured to the rod and adapted to engage the lug 54. Mounted on the blank-holder is an arm 58 having at its outer end a boss 59 through which the rod 52 extends and with respect to which the rod is freely slidable. During upward movement of the blank-holder, the boss 59 is adapted to engage a collar 60 secured to the rod in adjusted position. After this engagement of the boss 59 with the collar 60, further movement of the blank-holder will raise the rod, and will move the valve 14 toward its Figure 6 position through medium of a forked arm 61 secured to the shaft 36 and engageable by a collar 62 secured to the rod 52. When the rod is lifted

the collar 62 will engage the arm 61 and will rock the latter in a clockwise direction as viewed in Figure 3, thus moving the valve 14 from its Figure 6 position to the left. As the blank-holder approaches its uppermost position, the valve 14 will, by means of the mechanism just described, be caused to gradually approach its Figure 1 position. During this movement of the valve, the head 16 will gradually uncover the exhaust branch pipe 28 so that the by-pass to the tank will be gradually opened. At the same time the head 17 will gradually cover the end of the pipe 25. The return motion of the blank-holder will cease as soon as the throttled exhaust opening between the valve chamber and the exhaust branch 28 is enlarged to such a degree that the pump pressure has dropped to a value required to balance the weight of the movable press elements. At this time a state of balance will exist in the circuit and the pump will supply fluid at a pressure just sufficient to hold the movable press parts in their upper position against the attraction of gravity. Although, when the blank-holder is automatically brought to rest in its upper position, the valve 14 will not be moved all the way from the Figure 6 to the Figure 1 position, it is obvious that in the position to which the valve will be moved in actual practice flow of fluid under pressure is effectively cut off from both the upper and lower ends of the cylinders 11. A manually operable lever 63 secured to the shaft 36 provides for manual control of the press whenever desired.

In some cases, where the reversing valve is necessarily heavy because of the high pressures handled, the force required to move the valve may be greater than that available from the solenoid 30 and the spring 42. In such cases the reversing valve may be actuated by means of an auxiliary hydraulic pilot circuit including a "servo motor" for effecting the application of pressure to suitable pistons or plungers for moving the main valve to each of its three positions. Devices of this kind are well known in the art and need not be here further referred to.

The solenoid 30 is adapted to be connected to a suitable source of electrical power by means of power lines 64 and 65, and a two-pole normally open main switch F which includes switch arms 66 and 67 adapted to be closed upon switch points 68 and 69 to close the circuit through and to energize the solenoid. The arms 66 and 67 of the main switch are fixed to but insulated from a rotatable shaft 70 urged in the direction of the arrow *x* in Figure 9 by means of a spring 71 connected to an arm 72 on the shaft, the switch arms 66 and 67 being thereby normally maintained out of contact with the points 68 and 69. The shaft 70 is adapted to be rotated in the direction of the arrow *y* and the main switch consequently adapted to be closed by

electric means comprising a pilot electric circuit connected across the lines 64 and 65 and including two parallel circuit branches 73 and 74, a circuit portion 75 common to both of the branches and connecting one end of each to the line 65, and a conductor 76 also common to both of the branches and being adapted to connect one end of each to the line 64.

Interposed in series in the circuit portion 75 is a manually operable cut-out switch 77 and a holding coil 78, the latter when energized being adapted to attract an arm 79 fixed to the shaft 70 as at 80 and to thus rotate the shaft to close the main switch and to energize the solenoid. When the holding coil 78 is energized the arm 79 will be swung in the direction of the arrow *y* (see Figure 9), at which time a normally open contactor switch G will be closed, the switch G comprising a contactor bridge piece 81 on the lower end of the arm 79 adapted to bridge two contact points 82 and 83, thus connecting the circuit branch 73 with the conductor 76 and completing the pilot circuit through the branch 73. The shaft 70 and the arm 79 are urged to their Figure 9 positions by the spring 71.

The circuit branch 73 includes a conductor 84 connected to the circuit portion 75, a normally closed emergency reverse push button switch 85, a conductor 86, a normally closed switch 87, and a conductor 88. The switch 87 includes a switch arm 89, spring urged to its closed position, and an operating arm 90 mounted in fixed relation to the switch arm 89. This switch is adapted to be operated to open position by means of a lever 91 pivoted as at 92 to a bracket 93 on the press head (see Figure 1). One end of the lever 91 overlies a roller 94 on the operating arm 90 of the switch and the other arm of the lever is disposed in the path of travel of a head 95 on the upper end of a rod 96 secured to the movable die 7. When the die 7 moves upwardly, the head 95 will engage the lever 91 and rock it so as to open the switch 87, thereby breaking the pilot circuit through the branch 73.

The circuit branch 74 includes the conductor 84, a normally open manually operable starter switch 97 preferably of the push-button variety, and a conductor 98 connected to the common conductor 76. Assuming that all of the circuit branches are open as shown in Figure 9 and that it is desired to momentarily manually energize the holding coil 78 to close the main switch and to close the bridge piece 81 upon the points 82 and 83, the push-button switch 97 is pressed, thus closing the pilot circuit through the common circuit portion 75, the conductor 84, the switch 97, the conductor 98, and the conductor 76. As soon as the holding coil is thus energized the pilot circuit will be closed through the circuit branch 73 in the manner described above

and subsequent opening of the push-button switch 97 will not act to deenergize the holding coil 78 or to open the main switch. Thus, when the holding coil 78 has been once energized and the bridge piece 81 closed upon the contact points 82 and 83, the pilot circuit will be closed through the conductor 76, the circuit branch 73, and the common circuit portion 75, thereby maintaining the coil 78 energized and maintaining the bridge piece 81 closed upon the points 82 and 83 until either the switch 85 or the switch 87 is opened.

In operation, when it is desired to initiate a downward stroke of the blank-holder 9 the push-button switch 97 is momentarily closed. This will close the pilot circuit through the common circuit branch 75, the conductor 84, the circuit branch 74 and the conductor 76, thereby energizing the holding coil 78, closing the switch F and energizing the solenoid 30 so as to effect movement of the valve 14 to its Figure 5 position. As previously described, when the valve is in this position, the pump will deliver fluid to the upper ends of the cylinders 11 and the blank-holder will be moved downwardly. When the pilot circuit is energized in the manner just described, the bridge piece 81 is closed across the contacts 82, and 83, thus closing the pilot circuit through the circuit branch 73. Therefore, when the push-button switch 97 is opened the pilot circuit will still be closed through the circuit branch 73 and the solenoid will be maintained energized. After the blank-holder has engaged the work, the drawing ram 5 will be caused to perform a drawing and a returning stroke in a manner to be described later. As the drawing ram approaches the end of its return stroke, the head 95 on the rod 96 will engage the lever 91 and rock it in a clockwise direction as viewed in Figure 1, thereby opening the switch 87 breaking the pilot circuit and deenergizing the holding coil 78. This permits the spring 71 to open the switch F and to thereby deenergize the solenoid 30 permitting the spring 42 to move the valve 14 to its Figure 6 position and to thereby effect a return stroke of the blank-holder. As the blank-holder approaches its uppermost position, the rod 52 will be lifted and the valve 14 returned to its Figure 1 or neutral position in the manner already described.

The hydraulic circuit for effecting operation of the drawing ram 5 and movable die 7 includes a pump B', a tank C', a drawing ram control valve D' and suitable piping forming a hydraulic circuit with the drawing cylinder 4, the pump, the tank and the valve. The valve D' and the connecting piping of this circuit are, in the illustrative showing, the same in arrangement and mode of operation as the corresponding circuit parts of the blank-holder circuit already described in detail, and it is therefore believed unnecessary

to describe the drawing circuit in detail. It is believed sufficient to state that the several parts of the drawing ram circuit are designated in the drawings by primed reference characters corresponding to the un-primed reference characters designating similar parts of the blank-holder circuit. With the exception of the electrical circuit and associated switches, the control mechanism for the drawing ram is likewise the same as that for the blank-holder already described. Therefore, similar reference characters designate corresponding parts in the two mechanisms except that the reference characters applied to the parts of the drawing ram control mechanism are primed.

In accordance with the invention, control means are provided for automatically effecting a drawing stroke of the ram 5 as soon as the desired blank-holder pressure has been attained for automatically effecting a return stroke of the ram 5 when the desired drawing pressure has been reached and for automatically bringing the ram 5 to rest when it has reached a predetermined position during its return stroke. The control mechanism herein shown by way of example comprises the electric circuit and associated switches illustrated in Figure 8 of the drawings. The solenoid 30' is adapted to be connected to the power lines 64 and 65 by means of a two-pole normally opened main switch H which includes switch arms 99 and 100 adapted to be closed upon switch points 101 and 102 to close the circuit through and to energize the solenoid. The arms 99 and 100 of the switch G are fixed to but insulated from a rotatable shaft 103 urged in the direction of the arrow α' in Figure 8 by means of a spring 104 connected to an arm 105 on the shaft, the switch arms being thereby normally maintained out of contact with the points 101 and 102. The shaft 103 is adapted to be rotated in the direction of the arrow γ' and the main switch consequently adapted to be closed by electric means comprising a pilot electric circuit connected across the lines 64 and 65 and including three parallel circuit branches 106, 107 and 108, a circuit portion 109 common to all of the branches and connecting one end of each to the line 65, and a conductor 110 also common to all of the branches and being adapted to connect one end of each to the line 64.

Interposed in series in the circuit portion 109 is a manually operable cut-out switch 111 and a holding coil 112, the latter when energized being adapted to attract an arm 113 fixed to the shaft 103 and to thus rotate the latter to close the main switch and to energize the solenoid 30'. When the holding coil 112 is energized, the arm 113 will be swung in the direction of the arrow γ' , at which time a normally opened contactor switch I will be closed. The switch I com-

prises a contactor bridge piece 113^a on the lower end of the arm 113 adapted to bridge two contact points 114 and 115, thus connecting the circuit branch 106 with the conductor 110 and completing the pilot circuit through the branch 106.

The circuit branch 106 includes a conductor 116 connected to the common circuit portion 109, a normally closed emergency reverse push-button switch 117, a conductor 118, a normally closed pressure responsive switch 119, and a conductor 120 connected to the contact point 115. The switch 119 includes a switch arm 120^a spring urged to its closed position and an operating arm 121 mounted in fixed relation to the arm 120^a.

This switch is adapted to be opened by means of a rod 122 carried by a piston 123 mounted for sliding movements in a cylinder 124 mounted on the bracket 93. The piston 123 and rod 122 are urged to the left as viewed in Figures 1 and 8 by means of a spring 125 interposed between the piston and the right hand end of the cylinder. The chamber within the cylinder is in constant communication with the upper end of the cylinder 4 through the medium of a pipe 126 so that the unit pressure within the cylinder 124 will always be equal to that in the upper end of the drawing cylinder 4. The compression of the spring 125 is such that the piston 123 will remain in its extreme left hand position, as shown in Figure 1, until a desired predetermined drawing pressure has built up in the cylinder 4 and in the cylinder 124 during a drawing stroke, at which time the piston 123 and the rod 122 will be moved to the right against the action of the spring, the rod at this time engaging the operating arm 121 of the switch 119 and moving it to rock the switch arm 120^a to open position. This opening of the switch serves to break the pilot circuit through the circuit branch 106, thereby deenergizing the coil 112 and effecting opening of the switch H to deenergize the solenoid 30'. This permits the valve 14' to be moved to a position to effect a return stroke of the ram 5.

The circuit branch 107 includes the conductor 116, a manually operable push-button starter switch 127 and a conductor 128. If it is desired to effect a downward stroke of the ram 5 independently of blank-holder movement, the switch 127 is manually closed for a moment. This will effect closing of the pilot circuit through the circuit branch 107, thereby energizing the holding coil 112, closing the main switch H to energize the solenoid 30' and also closing the bridge piece 113^a across the contacts 114 and 115. When the starter switch 127 is opened, the pilot circuit will still be closed through the circuit branch 106 which is now connected to the contactor 110 by means of the closed switch I.

In accordance with the invention, means are provided for closing the pilot circuit au-

tomatically upon the attainment of a predetermined blank-holder pressure. To this end the circuit branch 108 comprises a conductor 129 connected to the common circuit portion 109, a normally opened switch 130 mounted on a bracket 131 on the press head and a conductor 132 connected to the conductor 128 of the circuit branch 107. The switch 130 includes a switch arm 133 normally spring-urged against a stop 134 and an operating arm 135 connected in fixed relation to the switch arm 133 and having at its lower end a roller 136. This roller is adapted to be engaged by an arm 137 pivoted as at 138 to a head 139 on a rod 140 carried by a piston 141 mounted for sliding movements in a cylinder 142 mounted on the bracket 131. The rod 140 and piston 141 are urged to the right as viewed in Figure 1 by means of a spring 143 so that in the normal position of the rod 140 and arm 137 the latter is disposed to the right of and out of contact with the roller 136. The arm 137 is urged in a clockwise direction by means of a spring 144 interposed between the outer end of the arm and the head 139, and movement of the arm under the influence of the spring is limited by means of a stop 145 on the head 139. A pipe 146 provides constant communication between the chamber within the cylinder 142 and the pipe 24, thereby maintaining equal unit pressures within the cylinder 142 and the upper ends of the blank-holder cylinders 11. In operation, when the blank-holder has engaged the work and the required blank-holder pressure has built up in the upper ends of the cylinders 11 and consequently in the cylinder 142, the piston 141 will be moved to the left against the urge of the spring 143, thereby causing the arm 137 to engage the roller 136 and to rock the switch arm 133 to its closed position. The arm 137 will continue to move to the left past the roller 136 so that the engagement of the arm with the roller is only momentary and the switch will consequently be closed only momentarily. However, this momentary closing of the switch effects closing of the pilot circuit through the circuit branch 108 whereby the holding coil 112 is energized, the switch H is closed, the solenoid 30' is energized to move the valve 14 to effect a drawing stroke of the main ram, and the contactor switch I is closed. Closing of the contactor switch will effect closing of the pilot circuit through the circuit branch 106 so that when the switch 130 is opened after the arm 137 has passed beyond the roller 136, the pilot circuit will remain closed until the switch 119 is opened in the manner already described.

When the pressure in the top ends of the cylinders 11 and in the cylinder 142 drops, the spring 143 will move the piston 141 to the right to its Figure 1 position. During this movement, the upper face of the arm 137 will engage the operation arm roller 136 as

shown in Figure 10, and since the operating arm 135 is held against movement by the stop 134, the arm 137 will be cammed downwardly so as to pass under the roller without effecting movement thereof.

Operation

In order that the sequence of operations of the illustrated embodiment of the invention be readily understood, a complete operating cycle of the press will be briefly reviewed.

It will be assumed that the various parts are in the positions shown in the several figures of the drawings with the exception of Figures 5, 6 and 10, and that a blank *b* has been placed on the stationary die. As previously described, with the valves 14 and 14' in the positions shown in Figure 1, the discharge from both pumps will be returned to their respective tanks and no movement of the drawing ram 5 or of the blank-holder lines 10 will take place.

To start operation of the press, the starter switch 97 of the pilot circuit shown in Figure 9 is momentarily closed. This will close the pilot circuit through the circuit branch 74 thereby closing the switch F, energizing the solenoid 30 to move the valve 14 to its Figure 5 position, and closing the contactor switch G whereby the pilot circuit will be maintained closed through the circuit branch 73. With the valve 14 in its Figure 5 position, fluid from the pump B will be delivered through the pipe 24 to the upper ends of the blank-holder cylinders 11, thereby moving the rams 10 and blank-holder 9 downwardly until the latter engages the blank *b*. When the desired pressure has been attained in the blank-holder cylinders, the piston 49 will move the pump control rods 45 inwardly to prevent further delivery of fluid to the upper ends of the cylinders 11. When this desired blank-holder pressure has built up, the piston 141, shown in Figure 1 will be moved to the left to bring the arm 137 into engagement with the roller 136, thereby momentarily closing the switch 130. This completes the pilot circuit shown in Figure 8 through the circuit branch 108, thereby closing the switch H, energizing the solenoid 30' to move the valve 14' to a position to direct fluid from the pump B' to the upper end of the cylinder 4, and closing the switch I whereby the pilot circuit of Figure 8 is maintained closed through the circuit branch 106. The drawing ram 5 will then be moved downwardly to bring the movable die 7 into engagement with the blank to effect the drawing operation. When the desired drawing pressure has been reached in the upper end of the cylinder 4, this pressure acting on the piston 123 will move the latter and the rod 122 to the right as viewed in Figures 1 and 8, thereby opening the switch 119 and breaking the pilot

circuit through the branch 106. This will permit the spring 104 to open the switch H, thereby deenergizing the solenoid 30' and permitting the spring 42' to move the valve 14' to a position effecting delivery of fluid from the pump B' to the lower end of the cylinder 4, thus producing the upward or return stroke of the ram 5 and die 7.

When the die 7 approaches the limit of its upward travel, the head 75 on the rod 96 carried by the die will engage the lever 91 and will rock the latter in a clockwise direction so as to open the switch 87 in the circuit branch 73 of the pilot circuit, shown in Figure 9. This will permit the spring 71 to open the switch F and to deenergize the solenoid 30 so that the spring 42 will be permitted to move the valve 14 to its Figure 6 position. This will effect delivery of pressure fluid from the pump B to the lower ends of the cylinders 11 to thereby produce the upward or return movement of the rams 10 and blank-holder 9.

After the head 95 has operated the lever 91 and switch 87 in the manner just described, the ram 5 and die 7 will continue upward movement until the boss 49 carried by the die engages the collar 60', thereby raising the rod 52' to bring the collar 62' into engagement with the forked arm 61', thereby rocking the shaft 36' in a direction to move the valve 14' to its Figure 1 position in which position the valve will divert the fluid flowing from the pump B' and return it to the tank C'.

Similarly, when the blank-holder approaches the end of its upward movement, the boss 59 will engage the collar 60, thereby raising the rod 52 to bring the collar 62 into engagement with the forked arm 61, thereby rocking the shaft 36 in a direction to move the valve 14 to its Figure 1 position in which position the valve will divert the fluid flowing from the pump B and return it to the tank C.

Although the form of press and associated circuits and control means illustrated are considered practical embodiments of the invention, it will be understood that various changes may be made in the arrangement shown without departing from the scope of the invention as defined in the appended claims.

I claim:

1. The combination with a drawing press having a drawing ram and a blank-holder ram mounted for movements independently of the drawing ram; of means for applying fluid pressure to said rams; and control mechanism including means responsive to pressure acting on said blank-holder ram for automatically effecting application of pressure upon said drawing ram.
2. The combination with a drawing press having a drawing ram and a blank-holder ram mounted for movements independently

of the drawing ram; of means for applying fluid pressure to said rams; and control mechanism associated with said fluid pressure applying means including manually operated means for effecting application of pressure to said blank-holder ram, and means responsive to the pressure acting on said blank-holder ram for automatically effecting application of pressure upon said drawing ram.

3. The combination with a drawing press having a double-acting drawing ram and a blank-holder ram mounted for movements independently of the drawing ram; of means for applying fluid pressure to said rams; and control mechanism associated with said fluid pressure applying means including means for effecting application of pressure to said blank-holder ram to move the latter towards the work, means for automatically effecting application of pressure to one side of said drawing ram to move the latter on a drawing stroke, and means responsive to pressure built up on said drawing ram for effecting application of pressure on the other side thereof to move said drawing ram on a return stroke.

4. The combination with a drawing press having a double-acting drawing ram and a blank-holder ram mounted for movements independently of the drawing ram; of means for applying fluid pressure to said rams; and control mechanism associated with said fluid pressure applying means including means for effecting application of pressure to said blank-holder ram to move the latter towards the work, means for automatically effecting application of pressure to one side of said drawing ram to move the latter on a drawing stroke, means responsive to pressure built up on said drawing ram for effecting application of pressure on the other side thereof to move said drawing ram on a return stroke, and means adapted to be operated by said drawing ram when the latter has reached a predetermined position during a return stroke for stopping further application of pressure thereto to thereby bring said ram to rest.

5. The combination with a drawing press having a double-acting drawing ram and a blank-holder ram mounted for movements independently of the drawing ram; of means for applying fluid pressure to said rams; and control mechanism associated with said fluid pressure applying means including means for effecting application of pressure to said blank-holder ram to move the latter towards the work, means responsive to the blank-holder pressure for automatically effecting application of pressure to one side of said drawing ram to move the latter on a drawing stroke, and means responsive to pressure built up on said drawing ram for effecting application of pressure on the other side thereof to move said drawing ram on a return stroke.

6. The combination with a drawing press

having a double-acting drawing ram and a double-acting blank-holder ram mounted for movements independently of the drawing ram; of means for applying fluid pressure to said rams; and control mechanism associated with said fluid pressure applying means including means for effecting application of pressure to one side of said blank-holder ram to move the latter towards the work, means for automatically effecting application of pressure to one side of said drawing ram to move the latter on a drawing stroke, means responsive to pressure built up on said drawing ram for effecting application of pressure on the other side thereof to move said drawing ram on a return stroke, and means adapted to be operated by said drawing ram when the latter reaches a predetermined position during a return stroke for effecting application of pressure to the other side of said blank-holder ram to move the latter away from the work.

7. The combination with a drawing press having a double-acting drawing ram and a double-acting blank-holder ram mounted for movements independently of the drawing ram; of means for applying fluid pressure to said rams; and control mechanism associated with said fluid pressure applying means including means for effecting application of pressure to one side of said blank-holder ram to move the latter towards the work, means for automatically effecting application of pressure to one side of said drawing ram to move the latter on a drawing stroke, means responsive to pressure built up on said drawing ram for effecting application of pressure on the other side thereof to move said drawing ram on a return stroke, means adapted to be operated by said drawing ram when the latter reaches a predetermined position during a return stroke for effecting application of pressure to the other side of said blank-holder ram to move the latter away from the work, and means adapted to be operated by the respective rams when they reach predetermined positions during their return strokes for automatically discontinuing application of pressure thereto to bring the rams to rest.

8. Control mechanism adapted to be connected to a drawing press having a fluid-operated drawing ram and a fluid-operated blank-holder ram mounted for movements independently of the drawing ram; said mechanism comprising valve means for controlling application of pressure to said rams; manually operated means connected to said valve means for operating the latter to effect application of pressure to said blank-holder ram; and means connected to said valve means and being responsive to built-up blank-holder pressure for operating said valve means to automatically effect application of pressure to said drawing ram.

9. Control mechanism adapted to be con-

5 nected to a drawing press having a fluid pressure operated double-acting drawing ram and a fluid pressure operated double-acting blank-holder ram mounted for movements independently of the drawing ram; said mechanism comprising valve means for controlling the application of fluid pressure to both sides of said rams; means connected to said valve means for operating the latter to effect application of pressure to one side of said blank-holder ram to move the latter towards the work; means connected to said valve means and being responsive to built-up blank-holder pressure for automatically operating said valve means to effect application of pressure to one side of said drawing ram to produce a drawing stroke thereof; and means connected to said valve means and being responsive to built-up drawing pressure for operating said valve means to effect application of pressure to the other side of said drawing ram to produce a return stroke thereof.

10 10. Control mechanism adapted to be connected to a drawing press having a fluid pressure operated double-acting drawing ram and a fluid pressure operated double-acting blank-holder ram mounted for movements independently of the drawing ram; said mechanism comprising valve means for controlling the application of fluid pressure to both sides of said rams; means connected to said valve means for operating the latter to effect application of pressure to one side of said blank-holder ram to move the latter towards the work; means connected to said valve means and being responsive to built-up blank-holder pressure for automatically operating said valve means to effect application of pressure to one side of said drawing ram to produce a drawing stroke thereof; means connected to said valve means and being responsive to built-up drawing pressure for operating said valve means to effect application of pressure to the other side of said drawing ram to produce a return stroke thereof; and means connected to said valve means and being automatically operable by said drawing ram during a return stroke thereof for operating said valve means to effect application of pressure to the other side of said blank-holder ram to produce a return stroke of the latter.

15 11. Control mechanism adapted to be connected to a drawing press having a fluid pressure operated double-acting drawing ram and a fluid pressure operated double-acting blank-holder ram mounted for movements independently of the drawing ram; said mechanism comprising valve means for controlling the application of fluid pressure to both sides of said rams; means connected to said valve means for operating the latter to effect application of pressure to one side of said blank-holder ram to move the latter towards

the work; means connected to said valve means and being responsive to built-up blank-holder pressure for automatically operating said valve means to effect application of pressure to one side of said drawing ram to produce a drawing stroke thereof; means connected to said valve means and being responsive to built-up drawing pressure for operating said valve means to effect application of pressure to the other side of said drawing ram to produce a return stroke thereof; and means connected to said valve means and being automatically operable by said drawing ram during a return stroke thereof for operating said valve means to prevent further application of pressure to said drawing ram to thereby bring it to rest.

12. Control mechanism adapted to be connected to a drawing press having a fluid pressure operated double-acting drawing ram and a fluid pressure operated double-acting blank-holder ram mounted for movements independently of the drawing ram; said mechanism comprising valve means for controlling the application of fluid pressure to both sides of said rams; means connected to said valve means for operating the latter to effect application of pressure to one side of said blank-holder ram to move the latter towards the work; means connected to said valve means and being responsive to built-up blank-holder pressure for automatically operating said valve means to effect application of pressure to one side of said drawing ram to produce a drawing stroke thereof; means connected to said valve means and being responsive to built-up drawing pressure for operating said valve means to effect application of pressure to the other side of said drawing ram to produce a return stroke thereof; means connected to said valve means and being automatically operable by said drawing ram during a return stroke thereof for operating said valve means to effect application of pressure to the other side of said blank-holder ram to produce a return stroke of the latter; and means connected to said valve means and being automatically operable by the respective rams when they reach predetermined positions during their return strokes for automatically operating said valve means to discontinue application of pressure to said rams to thereby bring them to rest.

13. The combination with a press having two independently movable fluid pressure operated rams; of means for applying fluid pressure to said rams; and control mechanism including means responsive to pressure acting on one of said rams for automatically controlling application of pressure upon said other ram.

14. The combination with a press having two independently movable fluid pressure operated rams; of means for applying fluid

pressure to said rams; and control mechanism associated with said rams and said fluid pressure applying means including manually operable means for effecting application of pressure to one of said rams, and means responsive to the pressure acting on said ram for automatically effecting application of pressure on said other ram.

15. The combination with a press having two independently movable fluid pressure operated rams; of means for applying fluid pressure to said rams; control mechanism including means responsive to pressure acting on one of said rams for automatically controlling application of pressure upon said other ram, and means operable by said last named ram during movement thereof for controlling application of pressure upon the first named ram.

16. The combination with a press having two independently movable fluid pressure operated double-acting rams; of means for applying fluid pressure to said rams; and control mechanism associated with said rams and said fluid pressure applying means including means for effecting application of pressure to one side of one of said rams, means responsive to such pressure for automatically effecting application of pressure upon one side of said other ram, and means responsive to built-up pressure acting on said last named ram for automatically effecting application of pressure on the opposite side thereof.

17. The combination with a press having two independently movable fluid pressure operated double-acting rams; of means for applying fluid pressure to said rams; and control mechanism associated with said rams and said fluid pressure applying means including means for effecting application of pressure to one side of one of said rams, means responsive to such pressure for automatically effecting application of pressure upon one side of said other ram; means responsive to built-up pressure acting on said last named ram for automatically effecting application of pressure on the opposite side thereof, and means adapted to be operated by said last named ram during subsequent movement thereof for effecting application of pressure on the opposite side of said first ram.

18. The combination with a press having two independently movable fluid pressure operated double-acting rams; of means for applying fluid pressure to said rams; and control mechanism associated with said rams and said fluid pressure applying means including means for effecting application of pressure to one side of one of said rams, means responsive to such pressure for automatically effecting application of pressure upon one side of said other ram, means responsive to built-up pressure acting on said last named

ram for automatically effecting application of pressure on the opposite side thereof, means adapted to be operated by said last named ram during subsequent movement thereof for effecting application of pressure on the opposite side of said first ram, and means adapted to be operated by the respective rams when they reach predetermined positions during subsequent travel for automatically discontinuing application of pressure thereto to bring both rams to rest.

19. The combination with a drawing press having a drawing ram, a cooperating drawing cylinder, a blank-holder ram and a cooperating blank-holder cylinder; of a pump fed hydraulic circuit connected with said drawing cylinder; a drawing ram control valve in said circuit; a pump fed hydraulic circuit connected with said blank-holder cylinder; a blank-holder control valve in said circuit; and means connected to said drawing ram control valve and being responsive to pressure in said blank-holder circuit for automatically operating said drawing ram control valve.

20. The combination with a drawing press having a drawing ram, a cooperating drawing cylinder, a blank-holder ram and a cooperating blank-holder cylinder; of a pump fed hydraulic circuit connected with said drawing cylinder; a drawing ram control valve in said circuit; a pump fed hydraulic circuit connected with said blank-holder cylinder; a blank-holder control valve in said circuit; electrically operated means connected to said drawing ram control valve for operating the latter; a switch in circuit with said electrically operated means; and means responsive to built-up pressure in said blank-holder cylinder for automatically operating said switch.

21. The combination with a drawing press having a double-acting drawing ram, a cooperating drawing cylinder, a double-acting blank-holder ram, and a cooperating blank-holder cylinder; of a pump fed hydraulic circuit connected with said drawing cylinder for effecting application of pressure respectively on both sides of said drawing ram; a drawing ram control valve in said circuit; a pump fed hydraulic circuit connected with said blank-holder cylinder for effecting application of pressure respectively on both sides of said blank-holder ram; a blank-holder control valve in said circuit; electrically operated means connected to said drawing ram control valve and adapted when energized to operate the latter to effect application of pressure to one side of said drawing ram; a normally open switch in circuit with said electrically operated means; means responsive to built-up blank-holder pressure for automatically closing said switch; a normally closed switch also in circuit with said electrically operated means; and means responsive

to built-up drawing pressure for automatically opening said normally closed switch.

22. The combination with a drawing press having a double-acting drawing ram, a co-operating drawing cylinder, a double-acting blank-holder ram, and a cooperating blank-holder cylinder; of a pump fed hydraulic circuit connected with said drawing cylinder for effecting application of pressure respectively on both sides of said drawing ram; a drawing ram control valve in said circuit; a pump fed hydraulic circuit connected with said blank-holder cylinder for effecting application of pressure respectively on both sides of said blank-holder ram; a blank-holder control valve in said circuit; electrically operated means connected to said drawing ram control valve and adapted when energized to operate the latter to effect application of pressure to one side of said drawing ram; a normally open switch in circuit with said electrically operated means; means responsive to built-up blank-holder pressure for automatically closing said switch; a normally closed switch also in circuit with said electrically operated means; means responsive to built-up drawing pressure for automatically opening said normally closed switch; and means connected to said drawing ram control valve for thereafter operating the latter to effect application of pressure to the other side of said drawing ram.

23. The combination with a drawing press having a double-acting drawing ram, a co-operating drawing cylinder, a double-acting blank-holder ram, and a cooperating blank-holder cylinder; of a pump fed hydraulic circuit connected with said drawing cylinder for effecting application of pressure respectively on both sides of said drawing ram; a drawing ram control valve in said circuit; a pump fed hydraulic circuit connected with said blank-holder cylinder for effecting application of pressure respectively on both sides of said blank-holder ram; a blank-holder control valve in said circuit; means for operating said drawing ram control valve to effect application of pressure respectively on both sides of said drawing ram; electrically operated means connected to said blank-holder control valve and adapted when energized to operate the latter to effect application of pressure to one side of said blank-holder ram; means for energizing said electrically operated means; a normally closed switch in circuit with said electrically operated means; and means operated by said drawing ram when the latter approaches the end of a return stroke for opening said switch.

24. The combination with a drawing press having a double-acting drawing ram, a co-operating drawing cylinder, a double-acting blank-holder ram, and a cooperating blank-holder cylinder; of a pump fed hydraulic circuit connected with said drawing cylinder

for effecting application of pressure respectively on both sides of said drawing ram; a drawing ram control valve in said circuit; a pump fed hydraulic circuit connected with said blank-holder cylinder for effecting application of pressure respectively on both sides of said blank-holder ram; a blank-holder control valve in said circuit; means for operating said drawing ram control valve to effect application of pressure respectively on both sides of said drawing ram; electrically operated means connected to said blank-holder control valve and adapted when energized to operate the latter to effect application of pressure to one side of said blank-holder ram; means for energizing said electrically operated means; a normally closed switch in circuit with said electrically operated means; means operated by said drawing ram when the latter approaches the end of a return stroke for opening said switch; and means connected to said blank-holder control valve for thereafter operating the latter to effect application of pressure to the opposite side of said blank-holder ram.

25. The combination with a drawing press having a double-acting drawing ram, a co-operating drawing cylinder, a double-acting blank-holder ram, and a cooperating blank-holder cylinder; of a pump fed hydraulic circuit connected with said drawing cylinder for effecting application of pressure respectively on both sides of said drawing ram; a drawing ram control valve in said circuit; a pump fed hydraulic circuit connected with said blank-holder cylinder for effecting application of pressure respectively on both sides of said blank-holder ram; a blank-holder control valve in said circuit; electrically operated means connected to said drawing ram control valve and adapted when energized to operate the latter to effect application of pressure to one side of said drawing ram to produce a drawing stroke; a normally open switch in circuit with said electrically operated means; means responsive to built-up blank-holder pressure for automatically closing said switch; a normally closed switch also in circuit with said electrically operated means; means responsive to built-up drawing pressure for automatically opening said normally closed switch; means connected to said drawing ram control valve for thereafter operating the latter to effect application of pressure to the opposite side of said drawing ram to produce a return stroke; electrically operated means connected to said blank-holder control valve and adapted when energized to operate the latter to effect application of pressure to one side of said blank-holder ram to produce a working stroke; means for energizing said electrically operated means; a normally closed switch in circuit with said electrically operated means; means operated by said drawing ram when the latter ap-

proaches the end of a return stroke for opening said switch; and means connected to said blank-holder control valve for thereafter operating the latter to effect application of pressure to the opposite side of said blank-holder ram to produce a return movement thereof.

26. The combination with a drawing press having a double acting drawing ram, a cooperating drawing cylinder, a double-acting blank-holder ram, and a cooperating blank-holder cylinder; of a pump fed hydraulic circuit connected with said drawing cylinder for effecting application of pressure respectively on both sides of said drawing ram; a drawing ram control valve in said circuit; a pump fed hydraulic circuit connected with said blank-holder cylinder for effecting application of pressure respectively on both sides of said blank-holder ram; a blank-holder control valve in said circuit; electrically operated means connected to said drawing ram control valve and adapted when energized to operate the latter to effect application of pressure to one side of said drawing ram to produce a drawing stroke; a normally open switch in circuit with said electrically operated means; means responsive to built-up blank-holder pressure for automatically closing said switch; a normally closed switch also in circuit with said electrically operated means; means responsive to built-up drawing pressure for automatically opening said normally closed switch; means connected to said drawing ram control valve for thereafter operating the latter to effect application of pressure to the opposite side of said drawing ram to produce a return stroke; electrically operated means connected to said blank-holder control valve and adapted when energized to operate the latter to effect application of pressure to one side of said blank-holder ram to produce a working stroke; means for energizing said electrically operated means; a normally closed switch in circuit with said electrically operated means; means operated by said drawing ram when the latter approaches the end of a return stroke for opening said switch; means connected to said blank-holder control valve for thereafter operating the latter to effect application of pressure to the opposite side of said blank-holder ram to produce a return movement thereof; and means connected to the respective valves and adapted to be operated by the respective rams when they reach predetermined positions during their return strokes for automatically operating said valves to bring the rams to rest.

27. The combination with a press having two independently movable fluid pressure operated rams; of means for applying fluid pressure to said rams; means for controlling application of pressure to one of said rams; an electrically operated valve for controlling

application of pressure to said other ram; and an electric switch responsive to pressure acting on said first ram for effecting operation of said valve.

28. The combination with a press having two independently movable fluid pressure operated rams; of means for applying fluid pressure to said rams; an electrically operated valve for controlling application of pressure on one of said rams; an electric switch responsive to the pressure acting on the other ram for effecting operation of said valve; a valve for controlling application of pressure to said second ram; and means operated by the first ram to effect operation of said last named valve.

29. In a drawing press, the combination of a stationary die support; a movable die support mounted for movements towards and away from said stationary support; a movably mounted blank-holder; and means associated with said blank-holder and operable during operation of the latter but irrespective of the position thereof for automatically effecting operation of said movable die support.

In testimony whereof, I have hereunto subscribed my name.

REIDER THORESON.