This invention relates to hydraulic presses of the type employed for forming or drawing work pieces or blanks into desired shapes, and it is particularly applicable to the forming and drawing of large plates and extruded shapes.

A press of the type to which the invention relates in particular is provided with a die arranged in a stationary position, a movable die carried by at least one main hydraulic motor and adapted to cooperate with a stationary die to form or draw a work piece or blank into a desired shape, and a draw ring carried by a plurality of hydraulic clamping motors and adapted to press a marginal portion of the blank against a stationary abutment such as marginal portion of the stationary die. The movable die and the ram of the main motor are ordinarily advanced at high speed until the die is close to or engages the the blank, the clamping motors are energized and cause the ram to clamp the blank against the abutment, then the main motor is energized and slowly advances the movable die to force the blank into or over the stationary die to perform the forming or drawing operation, and then the movable die and the draw ring are retracted, thereby completing a cycle of operation. During the forming or drawing operation, a predetermined pressure is maintained in each clamping motor which necessitates wasting power.

The present invention has as an object to provide a press of the above character which will operate at high speed and will exert large pressing forces with a minimum loss of power.

Another object is to provide a press that is positive and precise in operation.

Other objects and advantages will appear from the description hereinafter given of a press in which the invention is embodied.

According to the invention in its general aspect and as ordinarily embodied in a downward acting press, the movable die and the draw ring are rapidly advanced by gravity until the ring is about to engage the blank; then liquid from a large pump energizes the clamping motors and causes them to press the draw ring against the blank, the large pump continues to deliver liquid to the clamping motors until pump pressure exceeds a predetermined value and then the pressure in the clamping motors is maintained by a small pump and the liquid discharged by the large pump is directed to the main motor and causes it to advance the movable die to perform the drawing or forming operation.

The invention is exemplified by the press shown schematically in the accompanying drawings in which the views are as follows:

- Fig. 1 is a diagrammatic view showing the hydraulic circuit and such parts of the press as are necessary for an explanation of the operation of the press.
- Fig. 2 is a diagram of the electric circuit of the press.
- Fig. 3 is a view showing a surge valve in a position different from that shown in Fig. 1.
- Figs. 4, 5, 6 and 7 are views showing other valves in positions different from those shown in Fig. 1.

For the purpose of illustration, the invention has been shown embodied in a downward acting press the platen and draw ring of which are rapidly traversed toward the work by gravity but it is to be understood that the invention may be readily embodied in a horizontal or upward acting press of a press the platen and draw ring of which are rapidly traversed by auxiliary motors and that the terms used herein to denote direction are explanatory only and not limiting.

As shown, the press has a lower stationary bed fixed to the press frame which, since it is of conventional construction and forms no part of the present invention, has not been illustrated but it is to be understood that the platen and the draw ring are suitably guided by the frame and that all stationary parts are fixed to and supported by the frame.

Bed 1 carries a stationary lower die 2 which has a flat marginal portion to provide an abutment for supporting a work piece or blank 3 and which cooperates with an upper die 4 to form or draw blank 3 into a desired shape.

Upper die 4 is carried by a platen 5 which is connected to a ram 8 fitted in a stationary power cylinder 7 and which is also connected to the rods 8 and 8* of two pistons 9 and 9* fitted, respectively, in stationary pullback cylinders 10 and 10*.

Platen 5 has a peripheral flange or a plurality of flanges if fixed to or formed integral therewith and extending beneath a peripheral flange or a plurality of flanges extending inward from and fixed to or formed integral with a draw ring 13 which extends around platen 5 directly above the marginal portion of lower die 2.

Draw ring 13 is adapted to be pressed against blank 3 by a plurality of clamping motors the rams 14 and 14* of which are fastened to ring 13 and extend, respectively, into stationary cylinders 15 and 15*.

25 The press chosen for illustration is ordinarily provided with auxiliary clamping motors which are divided into pairs and each pair is controlled by a valve 16 having a valve
plunger 17 arranged in its casing 18 to control communication between an admission port 19 and two distributing ports 20 and 20* formed therein. Since the clamping motors are identical both as to structure and function and are controlled by identical valves, only one pair of motors has been shown.

The press is powered by a large capacity pump 25 which is reversible and a much smaller capacity pump 26 which draws liquid from a surge tank 27 and discharges into a channel 28. Pump 26 is of the type that will deliver liquid at its maximum adjusted rate until the pressure created by it reaches a predetermined maximum and then it will automatically reduce its displacement until it is delivering just sufficient liquid to maintain that maximum pressure constant.

In order to avoid unnecessary loss of power, channel 28 is normally connected through a bypass valve 29 to a drain channel 30 which discharges into surge tank 27. Valve 28 has a valve plunger 31 fitted in its casing to control communication between channels 28 and 30 and between channel 28 and a port 29 to which all of the clamping cylinders 10 and 10* are connected. As will presently be explained. Plunger 31 is normally held by a spring 33 in the position shown in Fig. 1 and it is adapted to be shifted by a socket 34 to the position shown in Fig. 7.

Pump 25 has been shown being a standard Oligeer DX pump which is well known and in extensive use. Since such a pump is shown and described in application Patent No. 2,269,778, it is deemed sufficient to state herein that it is controlled by two solenoids 35 and 36, that its displacement and delivery will be reduced to zero when both solenoids are deenergized, that it will deliver liquid into one and have liquid returned to it through the other of two branched channels 31 and 32 when one or other of the two solenoids is energized, and that any deficiency or excess in the liquid returned to the pump 25 is compensated by liquid drawn from or discharged into surge tank 27.

Communication between pump 25 and tank 27 is controlled by a differential valve 39 arranged in a bore 40 which communicates at or near its center with tank 27 through a check valve 41 and a low pressure resistance valve 42. Branches of channel 28 and 30 communicate at opposite sides of its center and are connected, respectively, by channels 43 and 44 to opposite ends of bore 40.

The arrangement is such that, when the pressure is higher one than the other of channels 37 and 38, liquid will flow from the high pressure channel through channel 43 or 44 to the end of bore 40 and shift differential valve 39 in a direction to cause it to block the end of the high pressure channel and uncover the end of the low pressure channel so that liquid cannot escape from the high pressure channel into tank 27 but liquid may be discharged from the low pressure channel into tank 27 through resistance valve 42, or pump 25 may draw liquid from tank 27 through check valve 41.

Pump 25 is employed to control the speed of platen 5 and draw ring 13 during gravitational descent thereof, to supply liquid to the clamping motors at the end of the gravitational descent to enable them to force ring 13 against blank 3, to supply liquid to main motor 6—7 to enable it to perform the pressing operation, and to supply liquid to the pull back motors to cause them to raise platen 5 and ring 13.

In order that pump 25 may energize the clamping motors, channel 37 is connected to port 19 in valve 18 and ports 20 and 20* thereof are connected by channels 80 and 80* to cylinders 15 and 15* respectively.

In order that pump 25 may control the rapid traverse descent of platen 5 and in order that it may supply liquid to the pull back motors to cause them to raise platen 5, a channel 81 has one of its ends connected to the lower ends of both of cylinders 10 and 10* and its other end connected to channel 30 through a check valve 65, a resistance valve 66 and a blocking valve 64 which when open bypasses valves 62 and 63. Blocking valve 64 has a valve member or plunger 65 arranged in its casing to control communication between two annular grooves or ports 66 and 67 which are formed therein and have channels 82 and 81 connected thereto respectively, a spring 83 for urging plunger 65 to the position shown in Fig. 1 and normally keeping valve 64 closed, and a solenoid 85 for moving plunger 65 to the position shown in Fig. 5 to open valve 64.

The arrangement is such that, when pump 25 is adjusted to discharge liquid into channel 37, the liquid may flow freely through check valve 62 or through blocking valve 64 if it is open and then flow through channel 81 to the lower ends of cylinders 10 and 10* and cause pistons 9 and 9* to raise platen 5 and draw ring 13.

When pump 25 is idle, valve 64 is closed and platen 5 and draw ring 13 are supported in their upper positions by liquid which is trapped in the lower ends of cylinders 10 and 10* for the reason that the pressure required to open resistance valve 66 is higher than the pressure required to enable pistons 9 and 9* to support the weight of platen 5 and draw ring 13.

When pump 25 is adjusted to discharge liquid into channel 37, valve 64 is open, and pump 25 will draw liquid through channel 80, valve 84 and channel 81 from cylinders 10 and 10* and permit platen 5 and draw ring 13 to descend by gravity at a rapid traverse rate. That is, pump 25 will meter the outflow from cylinders 10 and 10* and thereby govern the rate at which platen 5 and ring 13 descend.

Platen 5 and ring 13 will descend at rapid traverse rate until ring 13 is about to engage blank 3 and 34 communicate at opposite sides of its center and are connected, respectively, by channels 43 and 44 to opposite ends of bore 40. During this time, pump 25 has been delivering liquid through channel 37, valve 18 and channels 80 and 80* to all of the clamping cylinders 15 and 15* but the total volume supplied to cylinders 10 and 10* is insufficient to keep them filled. However, sufficient additional liquid to keep cylinders 10 and 10* filled is supplied thereto from tank 27 as will presently be explained.

As soon as valve 64 closes and arrests the gravitational descent of ring 13, the liquid delivered by pump 25 to cylinders 10 and 10* will create pressure therein and cause rams 16 and 16* to move ring 13 downward against blank 3 and will then cause sufficient additional pressure to cause the output of pump 25 to be diverted to cylinder 7 as will presently be explained.

Pump 25 is provided for the purpose of maintaining pressure in clamping cylinders 15 and 15* after pressure has been created therein by pump 25.

In order that the pressure in each clamping
cylinder 15 or 15* may be adjusted independently of the pressure in any other clamping cylinder, each clamping motor is provided with a separate pressure regulating unit. As shown, motor 14-15 is provided with a unit consisting of two oppositely opening resistance valves 50 and 51 which may be simultaneously adjusted to vary the resistance of corresponding valves 50, 51 and each other by rotating and adjusting screw 62 but the sum of the resistances of the two valves remains constant and the pressure required to open both valves simultaneously is greater than the maximum pressure that pump 26 can create.

Resistance valve 60 has its inlet connected to cylinder 15, as by being connected to channel 50, and its outlet connected to tank 27 by a channel 63. Resistance valve 61 has its inlet connected by a channel 64 to port 32 in by-pass valve 29 and its outlet connected to channel 50. In order that clamping cylinder 15 may be supplied with liquid from tank 27 when draw ring 13 is moved downward at rapid traverse speed, channel 63 is connected to channel 50 through a check valve 65 which permits liquid to flow from channel 50 into channel 63 but prevents flow in the opposite direction.

The pressure regulating unit for each of the other clamping cylinders is identical to and connected in the same manner as the above described unit. Consequently, a description thereof is unnecessary as the corresponding parts of the unit for cylinder 15* being denoted by corresponding reference numerals with the exponent "*" added thereto. While only two pressure regulating units have been shown connected to port 32 in bypass valve 29, it is to be understood that all of the pressure units are connected thereto.

Each resistance valve 60 or 61* is adjusted to open at a pressure slightly higher than the pressure desired in the clamping cylinder to which it is connected, and each resistance valve 61 or 61* is so adjusted that the drop in pressure thereafter is equal to the difference between the pressure desired in the clamping cylinder associated therewith and the maximum pressure created by pump 26.

For example, if a pressure of 2200# per sq. in. were desired in cylinder 15 and pump 26 were adjusted to create a maximum pressure of 2500# per sq. in., resistance valve 61 would be adjusted to close at 300# and resistance valve 60 would be adjusted at about 2210#. Then, if the pressure in cylinder 15 should be too low when bypass valve 29 is opened, liquid from pump 25 would flow through channel 29, valve 26, and channel 54 to resistance valve 61 and open it and then flow therethrough and through channel 50 to cylinder 15 until the pressure therein reached 2200# at which time valve 61 would close. If the pressure in cylinder 15 should become too high for any reason, valve 60 would open and permit liquid to escape therethrough until the pressure therein was reduced to 2120#.

Since the drop in pressure across each resistance valve 61 or 61* is equal to the difference between the pressure created by pump 26 and the pressure in the clamping cylinder 15 or 15* associated with that valve, the pressure in each clamping cylinder is independent of the pressure in any other clamping cylinder.

During gravitational descent of platen 5 ram cylinder 1 is kept filled with liquid supplied thereto from tank 27 under the control of a surge valve 70 which is arranged in a valve casing 71 connected to cylinder 7. Valve 10 controls communication between cylinder 1 and a channel 72 which connects one end of casing 71 to tank 27, and between cylinder 1 and a port 73 which is connected to channel 71 by channel 74.

Surge valve 70 is adapted to be shifted to one or the other of its two positions by a piston 75 which is fitted in a cylinder 76 and provided with a position sensitive section which is connected to casing 71. Cylinder 76 has its inner end connected by a channel 78 to channel 71 and its outer end connected by a channel 76 to channel 74 through a check valve 79 and a resistance valve 80 which are connected in parallel and open in opposite directions.

In order that cylinders 15 and 15* may be disconnected from pump 25 after pressure has been created therein and before pump 25 delivers liquid to ram cylinder 7, valve 16 has its left end connected by a channel 81 to channel 16 intermediate the ends thereof and, in order that pressure may be maintained in cylinders 15 and 15* until after ram 6 has stripped die 4 from the article into which blank 3 was formed, valve 16 has its right end connected by a channel 82 to channel 83 through a hold-down valve 84 and a check valve 85.

Valve 83 has a plunger 85 arranged in its casing to control communication between two ports 86 and 87 to which channels 88 and 89 are connected respectively. Plunger 85 is urged to the position shown in Fig. 1 by a spring 88 and it is adapted to be shifted by a solenoid 89 to the position shown in Fig. 6.

The arrangement is such that, when platen 5 and draw ring 13 descend by gravity, surge valve 70 is in the position shown in Fig. 1 and liquid flows freely from tank 27 through channel 72 and surge valve casing 71 to ram cylinder 7 and from tank 27 through channels 63 and 65, check valves 66 and 67 and channels 50 and 60 to cylinders 15 and 15* filled with liquid.

When draw ring 13 meets the work, pump 25 creates pressure in cylinders 15 and 15* until the pressure becomes high enough to open resistance valve 60 and then liquid will flow through channels 71 and 74 and resistance valve 80 into channel 78. Since the force required to move surge valve 70 is greater than the force required to move plunger 17 of valve 16, the liquid will first flow from channel 78 through channel 81 to the left end of valve 16 and shift its plunger 17 to the position shown in Fig. 4 to block communication between pump 25 and cylinders 15 and 15*, and plunger 17 will eject liquid from the right end of valve 16 through channel 82 and check valve 85 into channel 83. As soon as plunger 17 is shifted, pressure will rise enough to enable the liquid in channel 78 to enter cylinder 76 and cause piston 15 to shift surge valve 70 to the position shown in Fig. 3, liquid being expelled by piston 15 from the right end of cylinder 76 through channel 71 into channel 38.

Moving surge valve 70 to the position shown in Fig. 3 blocks communication between cylinder 7 and channel 72 and opens communication between cylinder 7 and port 73 so that liquid from pump 25 may flow through channels 71 and 74 and surge valve casing 71 to cylinder 7 and cause ram 6 to move platen 5 downward.

When pump 25 is reversed, plunger 85 of blocking valve 85 is in the position shown in Fig. 6 so that the liquid discharged by pump 25 cannot shift plunger 17 of valve 16 but will flow through channels 38 and 71 to cylinder 16 and cause piston 15 to shift surge valve 70 to the position.
shown in Fig. 1 to open cylinder 7 to channel 12 and to block the end of channel 74. Piston 15 will eject liquid from cylinder 16 through channel 76, check valve 19 and channel 14 into channel 37.

The electric circuit

An electric circuit which may be employed for controlling the press is shown in Fig. 2 in which the numerals 90 and 91 represent two sides of a power line from which current for energizing the several solenoids is supplied thereto under the control of various switches.

As shown, solenoids 35 and 36 which control pump 25 are controlled, respectively, by two magnetic switches or contactors A and B. Contactor A includes three normally open switches A1, A2 and A3, a normally closed switch A4 and a magnet A5 which when energized will open switch A1 and close switches A1, A2 and A3. Contactor B includes two normally open switches B1 and B2 and a magnet B3 which when energized will close switches B1 and B2.

Solenoid 35 has one end of its winding connected by a conductor 52 to one terminal of switch A1 while the other terminal of which is connected by a conductor 53 to power conductor 90. The other end of the winding of solenoid 35 is connected by a conductor 94 to one terminal of switch B1, the other terminal of which is connected by a conductor 95 to power conductor 91. Contactor A is controlled by a normally closed stop switch S1, a normally open starting switch S2 and either by a normally closed limit switch LS1 which is opened when platen 5 reaches a given point in its down stroke, or a normally closed pressure responsive switch PS1 which opens when the pressure in ram cylinder 7 reaches a predetermined maximum. As shown, pressure switch PS1 is subjected to the pressure in cylinder 7 as being connected thereto through surge valve casing 71 and limit switch LS1 is arranged in a stationary position and an arm 96 on platen 5 has an actuator 97 so located thereon that it will open switch LS1 when platen 5 reaches a given point in its down stroke, such as when die 4 has completed its operation upon blank 3. While for the purpose of illustration pressure switch PS1 has been shown connected directly to surge valve casing 71 so that it is subjected to the full pressure created in cylinder 7, in practice a low pressure switch is employed and connected to surge valve casing 71 through a high pressure resistance valve, so that the switch is subjected to only a low pressure, and a check valve is provided to permit liquid to escape from the pressure switch when the pressure in ram cylinder 7 drops to a low value.

The winding of magnet A5 has one end thereof connected to power conductor 90 by a conductor 101 and the other end thereof to one terminal of switching switch S5 by a conductor 102. The other terminal of switch S5 is connected by a conductor 103 to one terminal of stop switch S1 the other terminal of which is connected to conductor 91 by a conductor 104. Conductor 102 is connected by a conductor 105 to one terminal of switch A3 the other terminal of which is connected by a conductor 106 to one terminal of limit switch LS1 and to one terminal of pressure switch PS1. The other terminals of switches PS1 and LS1 are adapted to be connected to conductor 105 by a selector switch which may be adjusted to connect either of these switches into the circuit, and to simultaneously cut the other switch out of circuit.

Contactor B is controlled in part by switch A4 and in part by a normally open limit switch LS2 which also controls solenoid 34 and closes as soon as platen 5 starts downward. As shown, limit switch LS2 is opened at the end of the up stroke by an actuator 107 carried by draw ring 13. Limit switch LS2 has one contact which is connected by a conductor 108 to one end of the winding of solenoid 34 the other end of which is connected to conductor 90, a third contact connected by a conductor 109 to one end of the winding of magnet B3 the other end of which is connected to conductor 90 by a conductor 110, and a fourth contact connected by a conductor 111 to one terminal of switch A3 the other terminal of which is connected to conductor 103 by a conductor 112 so that when switches A4 and LS2 are closed, magnet B3 and solenoid 34 will be energized.

Solenoid 36 has one end of its winding connected to conductor 90 by a conductor 115 and the other end thereof connected by a conductor 116 to one terminal of switch B3 the other terminal of which has conductor 103 connected thereto. Switch B3 has one of its terminals connected to conductor 103 by a conductor 117 and its other terminal connected to conductor 111 by a conductor 118.

Solenoid 55 is controlled in part by contactor A and in part by a normally closed limit switch LS3 which is opened just before draw ring 13 engages blank 3. As shown, limit switch LS3 is arranged in a stationary position and operated by an actuator 119 carried by draw ring 13. Solenoid 55 has one end of its winding connected to conductor 92 and the other end thereof connected by a conductor 120 to one terminal of limit switch LS4 the other terminal of which has conductor 94 connected thereto.

Solenoid 99 is controlled by a normally closed limit switch LS4 which is opened when platen 5 approaches the end of its up stroke. As shown, limit switch LS4 is arranged in a stationary position and operated by an actuator 121 carried by arm 96 on platen 5. Solenoid 99 has one of its terminals connected to conductor 90 and the other end thereof connected by a conductor 122 to one terminal of limit switch LS4 the other terminal of which is connected to conductor 91 by a conductor 123.

Operation

With the parts in the positions shown and pumps 25 and 26 running, pump 25 is at zero stroke so that no liquid is delivered thereby, pump 26 is discharging freely through valve 25 into tank 27, and platen 5 and draw ring 13 are being held in their upper positions by the liquid trapped in the lower ends of pull back cylinders 10 and 10a by valve 54 being closed.

To start a cycle of operation, switch S2 is closed to establish a circuit (91—104—S5—102—A3—101—90) to energize magnet A3 which will close switches A1, A2, and A3 and open switch A4.

If selector switch S3 is adjusted to connect limit switch LS1 in circuit as shown, closing switch A3 establishes a circuit (91—104—S5—102—S1—105—91—103—S5—LS1—106A—105—102—A3—90) to keep magnet A3 energized and switches A1, A2 and A3 closed and switch A4 open.

Closing switches A3 and A4 establishes a circuit (90—51—A3—102—35—54—A3—51—51) to energize solenoid 35 which will adjust pump 25 to
cause it to draw liquid from channel 38 and discharge it into channel 57.

Closing switches A1 and A2 also establishes a circuit (90—23—A1—92—63—126—LS3—92—
A2—95—91) to energize solenoid 93 which will shift plunger 95 of valve 94 to the position shown in Fig. 4 to bypass resistance valve 93.

Platen 9, drawing plunger 13 and the parts connected thereto will then descend by gravity and pistons 9 and 14 will expel liquid from cylinders 15 and 16 through channel 61, valve 64 and channel 65 to the intake of pump 25. The pressure created by the weight of the plated parts and associated parts extends through channel 64 and holds differential valve 92 in its right hand position so that the liquid discharged from cylinders 15 and 16 must pass through pump 25 which meters the flow and thereby permits platen 9 and ring 13 to descend at a rapid but controlled rate.

As platen 9 and ring 13 move downward, actuates 107 and 121 will move out of engagement with limit switches LS2 and LS4 and permit them to close. Closing limit switch LS4 establishes a circuit (90—99—122—LS4—125—91) to energize solenoid 93 which will shift plunger 95 of valve 94 to the position shown in Fig. 6 so that valve 16 will not be operated when pump 25 is reversed as will presently be explained.

Closing limit switch LS2 establishes a circuit (90—
94—118—LS2—96—91) to energize solenoid 94 which will shift plunger 91 of valve 92 to the position shown in Fig. 7 and then the liquid discharged by pump 25 will flow through channel 59, valve 58, channels 54 and 55, resistance valves 61 and 61a and channels 66 and 68 to cylinders 15 and 16. At the same time the liquid discharged by pump 25 is flowing through channel 37, valve 15 and channels 80 and 50a to cylinders 15 and 16 but the liquid discharged by both pumps is insufficient to keep cylinders 15 and 16 filled during the rapid traverse descent of platen 9 and ring 13. However, additional liquid flows from tank 27 through channels 63 and 53a, check valves 55 and 55a and channels 50 and 50a to cylinders 15 and 16 to keep them filled, ram cylinder 17 being kept filled with liquid which flows thereto from tank 27 through channel 72 and surge valve casing 71 as previously explained.

Platen 9 and ring 13 will continue downward at rapid traverse speed until just before ring 13 engages blank 3 and then actuates 107 and 121 open limit switch LS2 to deenergize solenoid 94 which permits spring 98 to close valve 94 so that the liquid expelled from cylinders 15 and 16 by pistons 9 and 14 must pass through resistance valve 93. Since the pressure required to open valve 93 is greater than the pressure required to enable pistons 9 and 14 to support platen 9, closing valve 94 causes the rapid downward movement of platen 9 to be checked.

Pump 25 will then tend to discharge through resistance valve 42 which will cause pressure to rise, extend through channel 43 and shift differential valve 39 toward the left to block communication between channel 37 and tank 27 so that the entire output of pump 25 will enter clamping cylinders 15 and 16 and cause rams 14 and 14a to move ring 13 and platen 9 downward at reduced speed.

Platen 9 and platen 5 will continue downward at reduced speed until ring 13 engages blank 3 and pump 25 will continue to deliver liquid to the clamping cylinders until the pressure therein becomes high enough to cause resistance valve 93 to open and permit liquid to flow therethrough into channel 70. This liquid will first flow through channels 70 and 81 to valve 15 and shift its plunger 17 to the position shown in Fig. 4 and then the liquid will flow to cylinder 16 and cause piston 75 to shift surge valve 15 to the position shown in Fig. 3.

Valve plunger 17 when shifted blocks communication between channel 37 and channels 50 and 50a so that no more liquid can be delivered from pump 25 to cylinders 15 and 16 but pump 25 continues to deliver liquid thereto and to maintain in each clamping cylinder a pressure which is determined by the adjustment of the resistance valve unit connected thereto and which is independent of the pressure in any other clamping cylinder. If the pressure in any clamping cylinders is too low, liquid from pump 25 will flow through channel 28, valve 25 and channel 66 or 66a, resistance valve 61 or 61a and channel 68 or 68a to that cylinder and increase the pressure therein to a value equal to the difference between the pressure created by pump 25 and the drop in pressure across the resistance valve 61 or 61a connected to that cylinder. If the pressure in any clamping cylinder is too high, liquid will escape therethrough from channel 60 or 60a, resistance valve 60 or 60a and channel 66 or 66a into tank 27 until the pressure in that cylinder has been reduced to the value determined by the adjustment of resistance valve 60 or 60a.

Surge valve 70 when shifted blocks communication between ram cylinder 7 and tank 27 and opens communication between cylinder 7 and channel 74 so that, since valve 15 is now blocking any communication between channel 37 and channels 50 and 50a, all of the liquid discharged by pump 25 will flow through channels 37 and 74 and surge valve casing 71 to cylinder 7 and cause ram 6 to move platen 9 downward at slow speed and force die 6 into die 2 to form or draw blank 3 into a desired shape.

Ram 6 will continue downward at slow speed until the forming or drawing operation is completed at which time actuator 97 opens limit switch LS1. If selector switch SS1 is in the position shown, opening switch LS1 will break the circuit through magnet A2. If selector switch SS1 is adjusted to connect pressure switch PS1 into the circuit, pump 25 will continue to deliver liquid to ram cylinder 7 until the pressure therein becomes high enough to cause pressure switch PS1 to open and break the circuit through magnet A1. In either case, magnet A2 is deenergized and permits switches A1, A2 and A3 to open and switch A1 to close.

Opening switch A2 prevents magnet A2 from being energized and again closing switches A1, A2 and A3 when limit switch LS1 or pressure switch PS1 closes. Opening switches A1 and A2 deenergizes solenoid 36 which causes pump 25 to be adjusted to zero displacement.

In practice, operation of limit switch LS1 or pressure switch PS1 causes the displacement of pump 25 to be reduced to zero and a valve to be shifted to reduce the pressure in ram cylinder 7 to a given value and then a pressure responsive switch operates to energize solenoid 36 so that the pressure in cylinder 7 is reduced before reversing takes place, as described in Patent No. 2,357,848. But, since reducing the pressure in the ram cylinder before reversing takes place forms no part of the present invention, the press has been shown provided with simplified electric and hydraulic circuits and the electric circuit so arranged that closing switch A1 establishes a circuit.

The press disclosed herein may be modified in various ways without departing from the scope of the invention which is hereby claimed as follows:

1. In a hydraulic press having a main motor for forcing a die against a work piece, a clamping motor for forcing a clamping member against said work piece and auxiliary motor means for retracting said die, the combination of a main pump for energizing said main motor, an auxiliary pump for energizing said clamping motor, and means for directing the output of both pumps to said auxiliary motor means for retracting said die, and means responsive to said pressure reaching a given value for diverting the output of said main pump only to said main motor means for diverting the output of said main pump to said auxiliary motor means for retracting said die, and means responsive to said pressure reaching a given value for connecting said auxiliary pump and said clamping motors to discharge.

2. In a hydraulic press having a main motor for forcing a die against a work piece and a plurality of clamping motors for forcing a clamping member against said work piece, the combination of a large capacity high pressure main pump for energizing said main motor, a constant pressure auxiliary pump for energizing said auxiliary motors, means for directing the output of both pumps to said clamping motors to create pressure therein, means responsive to said pressure reaching a given value for diverting the output of said main pump to said auxiliary motor means for retracting said die and means connecting between said auxiliary pump and said auxiliary motor means for diverting the output of said auxiliary motor means to said auxiliary clamp motor to discharge.

3. In a hydraulic press having a main motor for forcing a die against a work piece, a clamping motor for forcing a clamping member against said work piece and a surge tank, the combination of a large capacity high pressure main pump for energizing said main motor, an auxiliary pump for energizing said clamping motor, and means for directing the output of both pumps to said clamping motor, means for causing said die and said member to advance toward said work piece at rapid traverse speed, means for directing liquid from said tank to said motors during rapid traverse advance of said die and said member, means responsive to said die and said member reaching a given point for checking said rapid traverse advance and thereby causing said pumps to create pressure in said clamping motor, and means responsive to said pressure reaching a given value for blocking communication between said motors and said tank and for diverting the output of said main pump only to said main motor.

4. In a hydraulic press having a main motor for forcing a die against a work piece, a plurality 2,380,153
of clamping motors for forcing a clamping member against said work piece and a surge tank, the combination of a large capacity high pressure main pump for energizing said main motor, a constant pressure auxiliary pump for energizing said clamping motors, means for directing the output of both pumps to said clamping motors, means for causing said die and said member to advance toward said work piece at rapid traverse speed, means for directing liquid from said tank to said motors during rapid traverse advance of said die and said member, means responsive to said die and said member reaching a given point for checking said rapid traverse advance and thereby causing said pumps to create pressure in said clamping motors, means responsive to said pressure reaching a given value for blocking communication between said working chamber and said tank and for diverting the output of main pump to said working chamber, and means connected between said auxiliary pump and each clamping motor for enabling said auxiliary pump to maintain in that motor a pressure independent of the pressure in any other motor.

5. In a downward acting hydraulic press having main motor means for forcing a die against a work piece and retracting it therefrom and including a working chamber and a return chamber, a clamping motor for forcing a clamping member against said work piece and a surge tank, the combination of a large capacity high pressure main pump for energizing said main motor means, an auxiliary pump for energizing said clamping motor, means for directing the output of both pumps to said clamping motor, a resistance valve connected to said return chamber to resist the discharge of liquid therefrom and having sufficient resistance to prevent gravitational descent of said die and said member, valve means for bypassing said resistance valve, means for opening said valve means to bypass liquid around said resistance valve and thereby permit free advance of said die at rapid traverse speed, means for directing liquid from said tank to said working chamber during rapid traverse advance of said die, means responsive to said die reaching a given point for closing said bypass valve means to cause said pumps to create pressure in said clamping motor, and means responsive to said pressure reaching a given value for blocking communication between said working chamber and said tank and for diverting the output of main pump only to said working chamber.

6. In a downward acting hydraulic press having main motor means for forcing a die against a work piece and retracting it therefrom and including a working chamber and a return chamber, a plurality of clamping motors for forcing a clamping member against said work piece and a surge tank, the combination of a large capacity high pressure main pump for energizing said main motor means, a constant pressure auxiliary pump for energizing said clamping motors, means for directing the output of both pumps to said clamping motors, a resistance valve connected to said return chamber to resist the discharge of liquid therefrom and having sufficient resistance to prevent gravitational descent of said die, valve means for bypassing said resistance valve, means for opening said valve means to bypass liquid around said resistance valve and thereby permit free advance of said die at rapid traverse speed, means for directing liquid from said tank to said working chamber during rapid traverse advance of said die, means responsive to said die reaching a given point for closing said bypass valve means to cause said pumps to create pressure in said clamping motor, and means responsive to said pressure reaching a given value for blocking communication between said working chamber and said tank and for diverting the output of main pump to said working chamber, and means connected between said auxiliary pump and each clamping motor for enabling said auxiliary pump to main-
tain in that motor a pressure independent of the pressure in any other motor.

9. In a downward acting hydraulic press having main motor means for forcing a die against a work piece and retracting it therefrom and including a working chamber and a return chamber, a clamping motor for forcing a clamping member against said work piece and a surge tank, the combination of a reversible main pump for energizing said main motor means, an auxiliary pump for energizing said clamping motor, means for directing the output of both pumps to said clamping motor, means for connecting said return chamber to the intake of said main pump including a resistance valve having sufficient resistance to prevent liquid from being expelled from said return chamber by the weight of said die and the parts movable therewith and valve means for bypassing said resistance valve, means for opening said valve means to bypass liquid around said resistance valve and thereby permit said die and said member to descend by gravity as fast as said main pump draws liquid from said return chamber, means for directing liquid from said tank to said working chamber during gravitational descent of said die, means responsive to said die and said member reaching a given point for closing said bypass valve means to check said gravitational descent and thereby cause said pumps to create pressure in said clamping motor, and means responsive to said pressure reaching a given value for blocking communication between said working chamber and said tank and for diverting the output of said main pump only to said working chamber.

10. In a downward acting hydraulic press having main motor means for forcing a die against a work piece and retracting it therefrom and including a working chamber and a return chamber, a plurality of clamping motors for forcing a clamping member against said work piece and a surge tank, the combination of a reversible main pump for energizing said main motor means, a constant pressure auxiliary pump for energizing said clamping motors, means for directing the output of both pumps to said clamping motor means for connecting said return chamber to the intake of said main pump including a resistance valve having sufficient resistance to prevent liquid from being expelled from said return chamber by the weight of said die and the parts movable therewith and valve means for opening said valve means to bypass liquid around said resistance valve and thereby permit said die and said member to descend by gravity as fast as said main pump draws liquid from said return chamber, means for directing liquid from said main pump to said working chamber and to said clamping motors during gravitational descent of said die, means responsive to said die and said member reaching a given point for closing said bypass valve means to check said gravitational descent and thereby cause said pumps to create pressure in said clamping motors, means responsive to said pressure reaching a given value for blocking communication between said working chamber and said main pump and for diverging the output of said main pump to said working chamber and to said clamping motors, means connected between said auxiliary pump and each clamping motor for enabling said auxiliary pump to maintain in that motor a pressure independent of the pressure in any other motor.

11. In a hydraulic press having a main motor for forcing a die against a work piece, a clamping motor for forcing a clamping member against said work piece and a surge tank, the combination of a large capacity high pressure main pump for energizing said main motor, an auxiliary pump for energizing said clamping motor, means for connecting said main motor to said main pump and to said tank selectively including an initially open surge valve adapted when open to block communication between said main motor and said main pump and to provide communication between said main motor and said tank, means for diverting the output of said auxiliary pump to said clamping motor, means including an initially open control valve for directing the output of said main pump to said clamping motor to create pressure therein, means for closing said control valve to stop delivery of liquid from said main pump to said clamping motor, and means for shifting said surge valve to direct the output of said main pump to said main motor and simultaneously block communication between said tank and said main motor, said last two means being operated in response to the pressure created by said main pump reaching a given value.

12. In a hydraulic press having a main motor for forcing a die against a work piece, a plurality of clamping motors for forcing a clamping member against said work piece and a surge tank, the combination of a large capacity high pressure main pump for energizing said main motor, a constant pressure auxiliary pump for energizing said clamping motors, means for connecting said main motor to said main pump and to said tank selectively including an initially open surge valve adapted when open to block communication between said main motor and said main pump and to provide communication between said main motor and said tank, means for diverting the output of said auxiliary pump to said clamping motors, means including an initially open control valve for directing the output of said main pump to said clamping motors to create pressure therein, means for closing said control valve to stop delivery of liquid from said main pump to said clamping motors, means for shifting said surge valve to direct the output of said main pump to said main motor and simultaneously block communication between said tank and said main motor, said last two means being operated in response to the pressure created by said main pump reaching a given value, and means connected between said auxiliary pump and each clamping motor for enabling said auxiliary pump to maintain in that motor a pressure independent of the pressure in any other motor.

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