

R. E. DAVIS
HYDRAULIC DRAW PRESS
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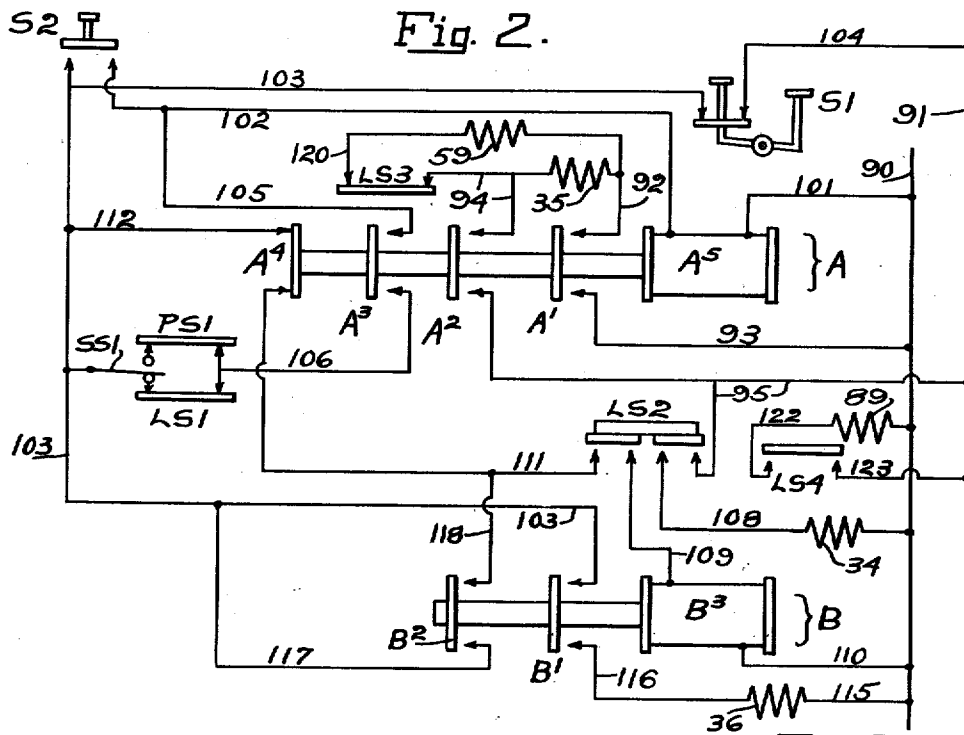
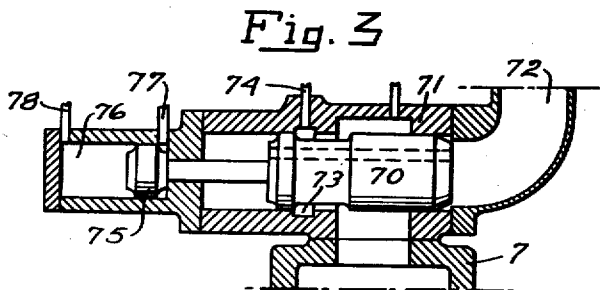
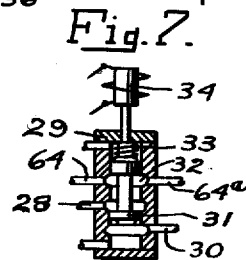
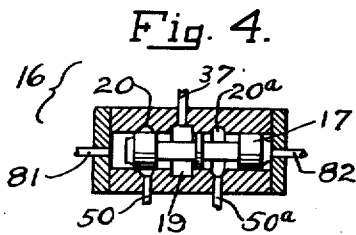
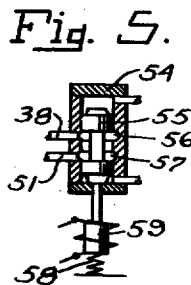
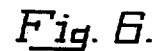
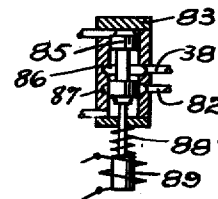
R. E. DAVIS

2,380,153

HYDRAULIC DRAW PRESS

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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

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HYDRAULIC DRAW PRESS

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Application April 30, 1941, Serial No. 391,057

12 Claims. (Cl. 113—45)

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 adapted to presses of large capacity.

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 blank, the clamping motors are energized and cause the ring 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 that 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 to 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 rapid traversed toward the work by gravity but it is to be understood that the invention may as readily be embodied in a horizontal or upward acting press or a press the platen and draw ring of which are rapid 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 1 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 6 fitted in a stationary power cylinder 7 and which is also connected to the rods 8 and 8^a of two pistons 9 and 9^a fitted, respectively, in stationary pullback cylinders 10 and 10^a.

Platen 5 has a peripheral flange or a plurality of flanges 11 fixed to or formed integral therewith and extending beneath a peripheral flange or a plurality of flanges 12 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^a of which are fastened to ring 13 and extend, respectively, into stationary cylinders 15 and 15^a. The press chosen for illustration is ordinarily provided with at least six 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^a 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 29 has a valve plunger 31 fitted in its casing to control communication between channels 28 and 30 and between channel 28 and a port 32 to which all of the clamping cylinders 15 and 15^a 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 solenoid 34 to the position shown in Fig. 7.

Pump 25 has been shown as being a standard Oilgear 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 37 and 38 when one or the other of the two solenoids is energized, and that any deficiency or excess in the liquid returned to the pump 25 is compensated for 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 channels 37 and 38 communicate with bore 40 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 in one than in 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 enable 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 16 and ports 20 and 20^a thereof are connected by channels 50 and 50^a to cylinders 15 and 15^a 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 51 has one of its ends connected to the lower ends of both of cylinders 10 and 10^a and its other end connected to channel 38 through a check valve 52, a resistance valve 53 and a blocking valve 54 which when open bypasses valves 52 and 53. Blocking valve 54 has a valve member or plunger 55 arranged in its casing to control communication between two annular grooves or ports 56 and 57 which are formed therein and have channels 38 and 51 connected thereto respectively, a spring 58 for urging plunger 55 to the position shown in Fig. 1 and normally keeping valve 54 closed, and a solenoid 59 for moving plunger 55 to the position shown in Fig. 5 to open valve 54.

The arrangement is such that, when pump 25 is adjusted to discharge liquid into channel 38, the liquid may flow freely through check valve 52 or through blocking valve 54 if it is open and then flow through channel 51 to the lower ends of cylinders 10 and 10^a and cause pistons 9 and 9^a to raise platen 5 and draw ring 13.

When pump 25 is idle, valve 54 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^a for the reason that the pressure required to open resistance valve 53 is higher than the pressure required to enable pistons 9 and 9^a to support the weight of platen 5 and draw ring 13.

When pump 25 is adjusted to discharge liquid into channel 37, valve 54 is open and pump 25 will draw liquid through channel 38, valve 54 and channel 51 from cylinders 10 and 10^a 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^a 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 then valve 54 is closed which will momentarily arrest downward movement of platen 5 and draw ring 13 for the reason that liquid can then escape from cylinders 10 and 10^a only through resistance valve 53.

During this time, pump 25 has been delivering liquid through channel 37, valve 16 and channels 50 and 50^a to all of the clamping cylinders 15 and 15^a but the total volume supplied to cylinders 15 and 15^a is insufficient to keep them filled. However, sufficient additional liquid to keep cylinders 15 and 15^a filled is supplied thereto from tank 27 as will presently be explained.

As soon as valve 54 closes and arrests the gravitational descent of ring 13, the liquid delivered by pump 25 to cylinders 15 and 15^a will create pressure therein and cause rams 15 and 15^a to move ring 13 downward against blank 3 and will then create sufficient additional pressure to cause the output of pump 25 to be diverted to cylinder 7 as will presently be explained.

Pump 26 is provided for the purpose of maintaining pressure in clamping cylinders 15 and 15^a after pressure has been created therein by pump 25.

In order that the pressure in each clamping

cylinder 15 or 15^a 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 4—15 is provided with a unit consisting of two oppositely opening resistance valves 60 and 61 which may be simultaneously adjusted to vary the resistance thereof inversely to 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 bypass 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 63 into channel 50 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, the corresponding parts of the unit for cylinder 15^a being indicated by corresponding reference numerals with the exponent "a" 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 60^a 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^a is so adjusted that the drop in pressure thereacross 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 to open at about 2210#. Then, if the pressure in cylinder 15 should be too low when bypass valve 29 is opened, liquid from pump 26 would flow through channel 28, valve 29 and channel 64 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 therefrom until the pressure therein was reduced to 2210#.

Since the drop in pressure across each resistance valve 61 or 61^a is equal to the difference between the pressure created by pump 26 and the pressure in the clamping cylinder 15 or 15^a 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 7 is kept filled with liquid supplied thereto from tank 27 under the control of a surge valve 10 which is arranged in a valve casing 11 connected to cylinder 7. Valve 10 controls com-

munication between cylinder 7 and a channel 72 which connects one end of casing 11 to tank 27, and between cylinder 7 and a port 73 which is connected to channel 37 by channel 74.

Surge valve 10 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 connected to casing 11. Cylinder 76 has its inner end connected to channel 38 by a channel 77 and its outer end connected by a channel 78 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^a 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 78 intermediate the ends thereof and, in order that pressure may be maintained in cylinders 15 and 15^a 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 38 through a hold-down valve 83 and a check valve 84.

Valve 83 has a plunger 85 arranged in its casing to control communication between two ports 86 and 87 to which channels 38 and 82 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 10 is in the position shown in Fig. 1 and liquid flows freely from tank 27 through channel 72 and surge valve casing 11 to ram cylinder 7 and from tank 27 through channels 63 and 63^a, check valves 65 and 65^a and channels 50 and 50^a to cylinders 15 and 15^a to keep cylinders 7, 15 and 15^a filled with liquid.

When draw ring 13 meets the work, pump 25 creates pressure in cylinders 15 and 15^a until the pressure becomes high enough to open resistance valve 80 and then liquid will flow through channels 37 and 74 and resistance valve 80 into channel 78. Since the force required to move surge valve 10 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^a, and plunger 17 will eject liquid from the right end of valve 16 through channel 82 and check valve 84 into channel 38. 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 75 to shift surge valve 10 to the position shown in Fig. 3, liquid being expelled by piston 75 from the right end of cylinder 76 through channel 77 into channel 38.

Moving surge valve 10 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 37 and 74 and surge valve casing 11 to cylinder 7 and cause ram 6 to move platen 5 downward.

When pump 25 is reversed, plunger 85 of blocking valve 83 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 77 to cylinder 76 and cause piston 75 to shift surge valve 10 to the position

shown in Fig. 1 to open cylinder 7 to channel 72 and to block the end of channel 74. Piston 75 will eject liquid from cylinder 76 through channel 78, check valve 79 and channel 74 into channel 31.

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 A⁴ 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 92 to one terminal of switch A¹ the other terminal of which is connected by a conductor 93 to power conductor 90. The other end of the winding of solenoid 35 is connected by a conductor 94 to one terminal of switch A² 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 PSI which opens when the pressure in ram cylinder 7 reaches a predetermined maximum. As shown, pressure switch PSI is subjected to the pressure in cylinder 7 as by 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 PSI 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 starting switch S2 by a conductor 102. The other terminal of switch S2 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 PSI. The other terminals of switches PSI and LS1 are adapted to be connected to conductor 103 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 to which conductor 95 is connected, a second contact 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 A⁴ 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 B¹ the other terminal of which has conductor 103 connected thereto. Switch B² 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 59 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 59 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 LS3 the other terminal of which has conductor 94 connected thereto.

Solenoid 89 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 89 has one end of its winding 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 29 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 10^a by valve 54 being closed.

To start a cycle of operation, switch S2 is closed to establish a circuit (91—104—S1—103—S2—102—A⁵—101—90) to energize magnet A⁵ which will close switches A¹, A² and A³ and open switch A⁴.

If selector switch SS1 is adjusted to connect limit switch LS1 in circuit as shown, closing switch A³ establishes a circuit (91—104—S1—103—SS1—LS1—106—A³—105—102—A⁵—101—90) to keep magnet A⁵ energized and switches A¹, A² and A³ closed and switch A⁴ open.

Closing switches A¹ and A² establishes a circuit (90—93—A¹—92—35—94—A²—95—91) to energize solenoid 35 which will adjust pump 25 to

cause it to draw liquid from channel 38 and discharge it into channel 37.

Closing switches A¹ and A² also establishes a circuit (90—93—A¹—92—59—120—LS2—84—A²—95—91) to energize solenoid 59 which will shift plunger 55 of valve 54 to the position shown in Fig. 5 to bypass resistance valve 53.

Platen 5, draw ring 13 and the parts connected thereto will then descend by gravity and pistons 9 and 9^a will expel liquid from cylinders 10 and 10^a through channel 51, valve 54 and channel 38 to the intake of pump 25. The pressure created by the weight of the platen and associated parts extends through channel 44 and holds differential valve 39 in its right hand position so that the liquid discharged from cylinders 10 and 10^a must pass through pump 25 which meters the flow and thereby permits platen 5 and ring 13 to descend at a rapid but controlled rate.

As platen 5 and ring 13 move downward, actuators 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—89—122—LS4—123—91) to energize solenoid 89 which will shift plunger 85 of valve 83 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 switch LS2 establishes a circuit (90—34—102—LS2—95—91) to energize solenoid 34 which will shift plunger 31 of valve 29 to the position shown in Fig. 7 and then the liquid discharged by pump 25 will flow through channel 28, valve 29, channels 64 and 64^a, resistance valves 61 and 61^a and channels 50 and 50^a to cylinders 15 and 15^a. At the same time the liquid discharged by pump 25 is flowing through channel 37, valve 16 and channels 50 and 50^a to cylinders 15 and 15^a but the liquid discharged by both pumps is insufficient to keep cylinders 15 and 15^a filled during the rapid traverse descent of platen 5 and ring 13. However, additional liquid flows from tank 27 through channels 63 and 63^a, check valves 65 and 65^a and channels 50 and 50^a to cylinders 15 and 15^a to keep them filled, ram cylinder 7 being kept filled with liquid which flows thereto from tank 27 through channel 72 and surge valve casing 71 as previously explained.

Platen 5 and ring 13 will continue downward at rapid traverse speed until just before ring 13 engages blank 3 and then actuator 119 opens limit switch LS3 to deenergize solenoid 59 which permits spring 58 to close valve 54 so that the liquid expelled from cylinders 10 and 10^a by pistons 9 and 9^a must pass through resistance valve 53. Since the pressure required to open valve 53 is greater than the pressure required to enable pistons 9 and 9^a to support platen 5, closing valve 54 causes the rapid downward movement of platen 5 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 15^a and cause rams 14 and 14^a to move ring 13 and platen 5 downward at reduced speed.

Ring 13 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 80 to open and permit liquid to flow therethrough

into channel 78. This liquid will first flow through channels 78 and 81 to valve 16 and shift its plunger 17 to the position shown in Fig. 4 and then the liquid will flow to cylinder 76 and cause piston 75 to shift surge valve 70 to the position shown in Fig. 3.

Valve plunger 17 when shifted blocks communication between channel 37 and channels 50 and 50^a so that no more liquid can be delivered from pump 25 to cylinders 15 and 15^a 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 29 and channel 64 or 64^a, resistance valve 61 or 61^a and channel 50 or 50^a 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 61^a connected to that cylinder. If the pressure in any clamping cylinder is too high, liquid will escape therefrom through channel 50 or 50^a, resistance valve 60 or 60^a and channel 63 or 63^a into tank 27 until the pressure in that cylinder has been reduced to the value determined by the adjustment of resistance valve 60 or 60^a.

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 16 is now blocking communication between channel 37 and channels 50 and 50^a, 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 5 downward at slow speed and force die 4 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 A⁵. 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 A⁵. In either case, magnet A⁵ is deenergized and permits switches A¹, A² and A³ to open and switch A⁴ to close.

Opening switch A³ prevents magnet A⁵ 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 35 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 reversal takes place, as described in Patent No. 2,337,848 but, since reducing the pressure in the ram cylinder before reversal 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 A⁴ establishes a circuit

(91-104-S1-103-112-A¹-111-LS2-109-B³-110-90) to energize magnet B³ which will close switches B¹ and B².

Closing switch B² establishes a circuit (91-104-S1-103-117-B²-118-111-LS2-109-B³-110-90) to keep magnet B³ energized and switches B¹ and B² closed. Closing switch B¹ establishes a circuit (91-104-S1-103-B¹-116-36-115-90) to energize solenoid 36 which will cause pump 25 to be adjusted to deliver liquid into channel 38.

Since the liquid discharged by pump 25 cannot raise platen 5 until surge valve 70 is shifted, it first flows through channel 44 and shifts differential valve 39 to the position shown in Fig. 1, then it flows through channels 38 and 77 to cylinder 76 and causes piston 75 to shift surge valve 70 to the position shown in Fig. 1 to disconnect ram cylinder 7 from channel 74 and connect it to channel 72, and then it flows through channel 38, check valve 52 and channel 51 to cylinders 10 and 10^a and causes pistons 9 and 9^a to raise platen 5. As platen 5 moves upward, ram 6 expels liquid freely from cylinder 7 through surge valve casing 71 and channel 72 into tank 27.

Pump 26 continues to maintain the selected pressures in the clamping cylinders to enable rams 14 and 14^a to hold ring 13 firmly against the work until after platen 5 has been raised high enough to free die 4 from the work. Before flange 11 on platen 5 engages flange 12 on ring 13, actuator 121 opens limit switch LS4 to deenergize solenoid 89 which permits spring 88 to shift plunger 85 of valve 83 to the position shown in Fig. 1 and then liquid flows from channel 38 through valve 83 and channel 82 to the right end of valve 16 and shifts its plunger 17 to the position shown in Fig. 1.

After valve 16 has been shifted, the flange 11 on platen 5 engages flange 12 on ring 13 and causes ring 13 to move upward and the clamping rams to expel liquid from the clamping cylinders through channels 50 and 50^a, valve 16 and channel 37 to the intake of pump 25, the liquid in excess of pump requirements being exhausted through resistance valve 42 into tank 27.

Pressure responsive switch PS1 will close as soon as the displacement of pump 25 is reduced to zero and limit switch LS1 will close as soon as platen 5 starts upward but neither will establish a circuit at this time for the reason that switch A³ opened as soon as the active switch PS1 or LS1 was opened. Limit switch LS3 will close just after ring 13 starts upward but it will not establish a circuit for the reason that switches A¹ and A² were previously opened.

Platen 5 and ring 13 will continue upward until actuator 107 opens limit switch LS2 to deenergize solenoid 34 and magnet B³. Deenergizing solenoid 34 permits valve 29 to open and bypass pump 26. Deenergizing magnet B³ permits switches B¹ and B² to open and deenergize solenoid 36 which will cause pump 25 to be adjusted to zero stroke and the press to come to rest with the parts in the positions shown in Figs. 1 and 2 and the controls in position to start another cycle of operation when starting switch S2 is again closed, the platen and associated parts being held up by liquid trapped in cylinders 10 and 10^a by valves 52, 53 and 54. Opening limit switch LS2 also deenergizes solenoid 34 and permits valve 29 to open and bypass pump 26.

If liquid should leak from cylinders 10 and 10^a and permit the platen and associated parts to descend, switch LS2 would close as soon as ring

13 descended a very short distance. Closing switch LS2 would establish a circuit (91-104-S1-103-112-A⁴-111-LS2-109-B³-110-90) to energize magnet B³ which would close switches B¹ and B² and establish a circuit (90-104-S1-103-B¹-116-36-115-90) to energize solenoid 36 which would cause pump 25 to be adjusted to deliver liquid into channel 38 and thereby cause platen 5 and associated parts to be raised until actuator 107 again opened limit switch LS2 to deenergize magnet B³ and solenoid 36 and stop the press as previously explained.

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, means for directing the output of both pumps to said clamping motor to create pressure therein, 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 from said main motor to said auxiliary motor means to retract said die, and means responsive to said die being retracted through a limited distance 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 clamping 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 main motor, 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.

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, 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

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 motors and said tank and for diverting the output of said main pump to said main motor, 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, 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 said 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 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 said 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.

7. 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 gravitational descent of said die, means for directing liquid from said tank to said working chamber and to said clamping motor 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 cause said pumps to create pressure in said clamping motors, 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.

8. 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 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 gravitational descent of said die, means for directing liquid from said tank 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 tank and for diverting the output of said 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 motors, 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 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 tank and for diverting the output of said 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.

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 directing 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 directing 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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