March 5, 1940. T. F. STACY 2,192,778

DRAWING PRESS

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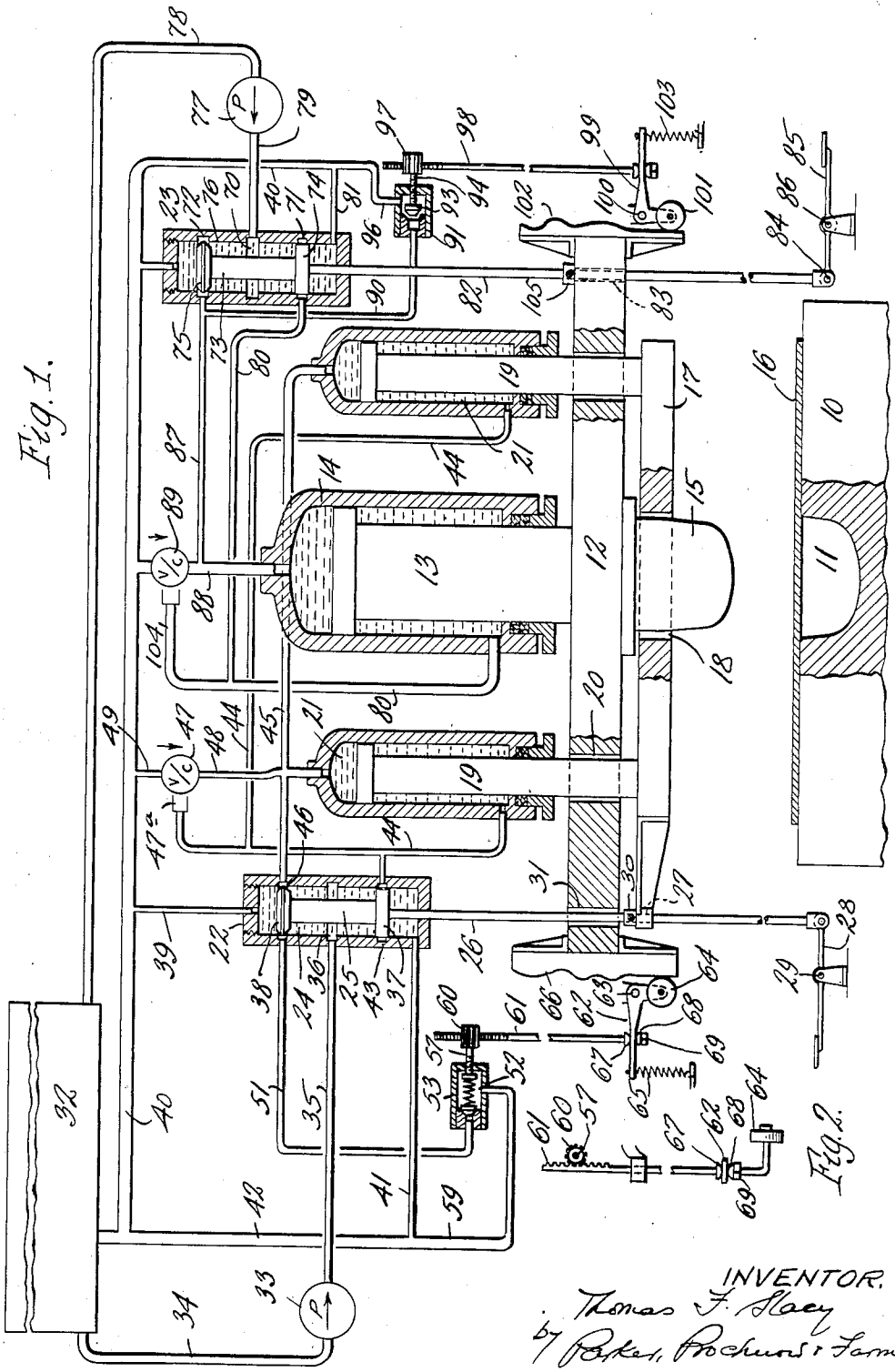


Fig. 1.

Fig. 2.

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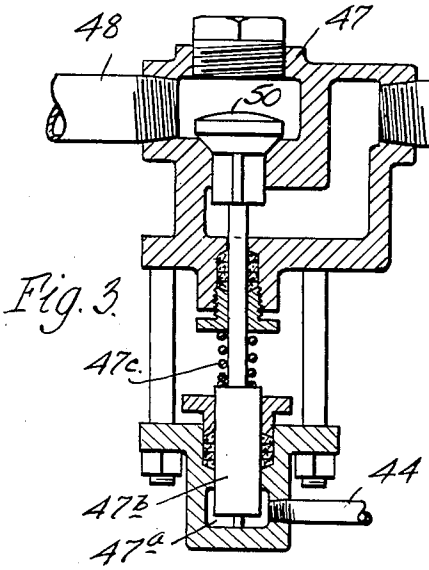


Fig. 3.

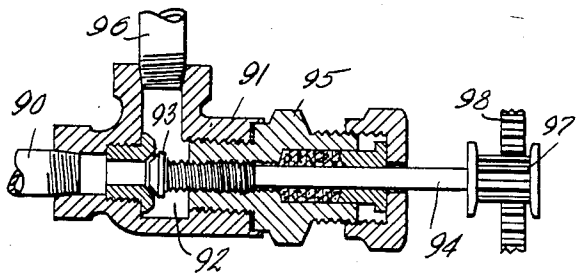


Fig. 4.

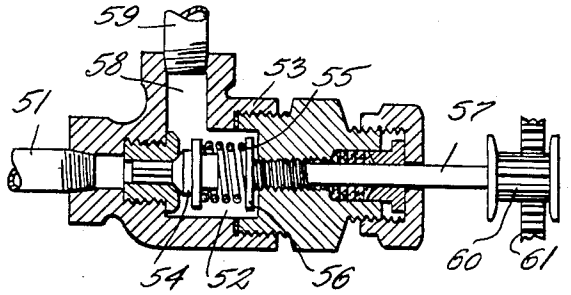


Fig. 5.

Fig. 6.

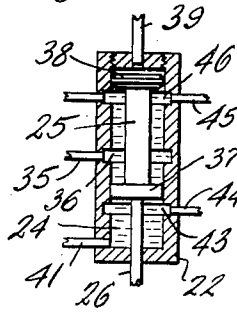


Fig. 7.

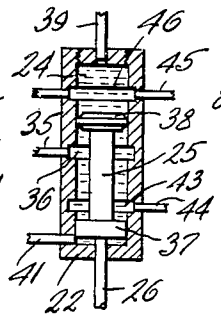


Fig. 8.

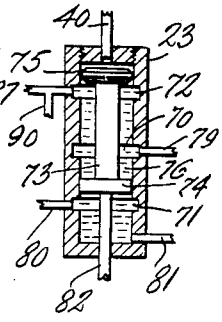
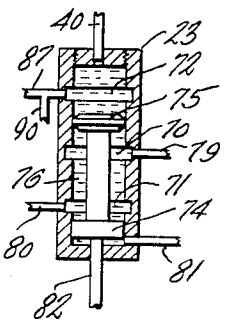


Fig. 9.



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Filed Nov. 5, 1935 3 Sheets-Sheet 3

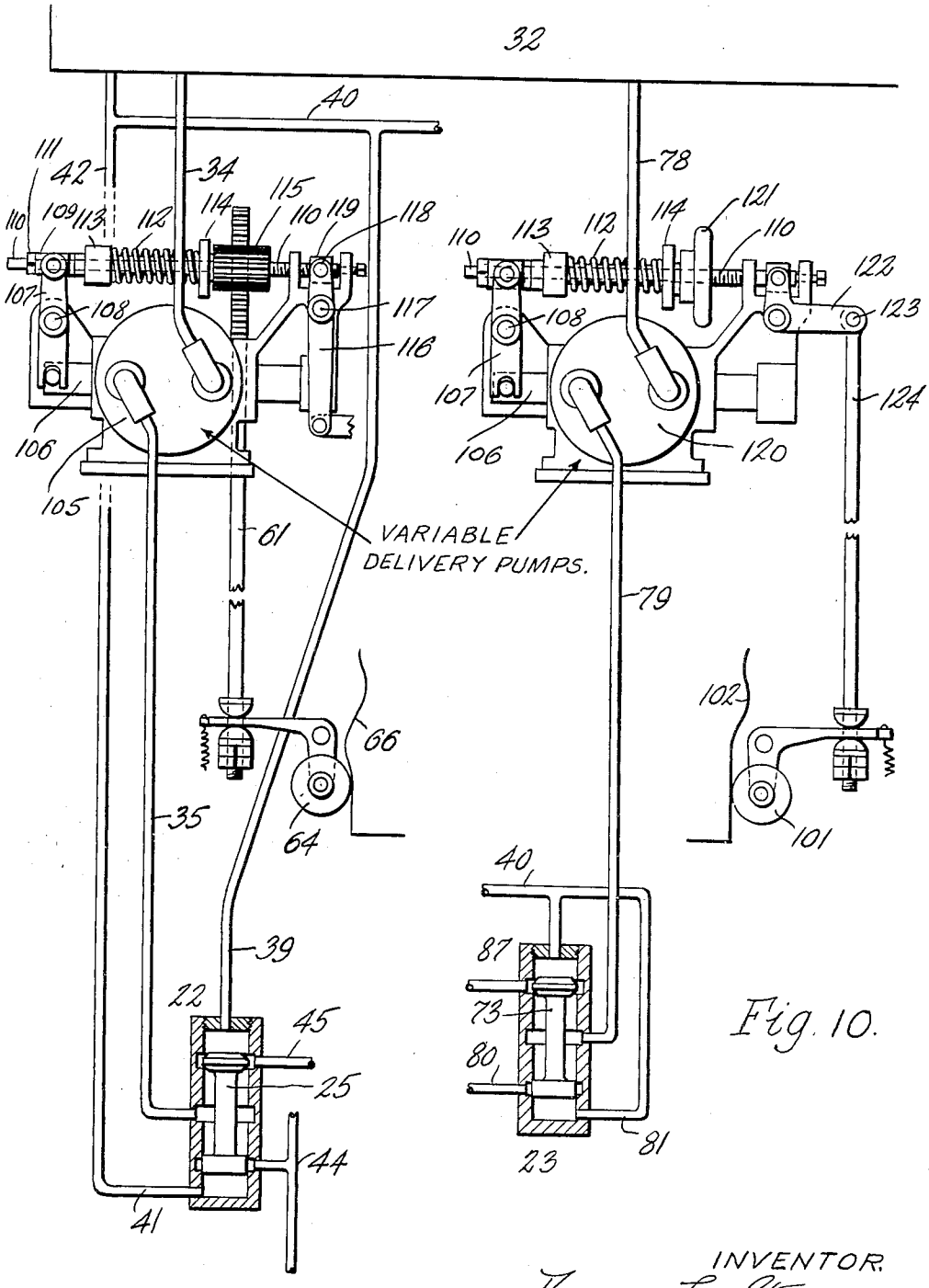


Fig. 10.

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2,192,778

UNITED STATES PATENT OFFICE

2,192,778

DRAWING PRESS

Thomas F. Stacy, Piqua, Ohio, assignor to The French Oil Mill Machinery Co., Piqua, Ohio

Application November 5, 1935, Serial No. 48,382

19 Claims. (Cl. 113—45)

This invention relates to metal drawing presses in which a blank sheet of metal is drawn and deformed into a desired form or configuration. In the drawing of sheet metal from blanks, when deep draws are made, a certain point is sometimes reached at which the metal will tear or rupture. If the speed of drawing is too great, there is further danger of tearing of the metal blank.

An object of the invention is to provide an improved method of drawing metal from blanks, with which exceptionally deep draws will be possible; and with which losses from tearing and rupturing of the metal blanks will be reduced.

Another object of the invention is to provide improved means for controlling and varying the pressure on a metal blank during the drawing operation.

Another object of the invention is to provide an improved metal drawing press and control means therefor, with which deeper draws may be made with a minimum of loss from tearing and rupturing of the blanks in the drawing operation; with which the speed of the draw need not be objectionably lessened; and which will be relatively simple, dependable, easily controlled, compact and inexpensive.

A further object is to provide improved means for controlling the speed of travel of a platen in accordance with a predetermined plan.

Various other objects and advantages will appear from the following description of an embodiment of the invention, and the novel features will be particularly pointed out hereinafter in connection with the appended claims.

In the accompanying drawings:

Fig. 1 is a diagram of a drawing apparatus and control system constructed in accordance with this invention;

Fig. 2 is an elevation of part of the control mechanism for one of the parts;

Fig. 3 is a transverse sectional elevation through a pilot operated check valve, two of which are employed in the system shown in Fig. 1;

Fig. 4 is a sectional elevation through a control valve which may be used in the system of Fig. 1 for controlling the rate of travel of the main ram;

Fig. 5 is a sectional elevation through another control valve which may be used for maintaining a sustained pressure on the blank holding ring in the system of Fig. 1;

Figs. 6 and 7 are sectional elevations of a control valve used in the system of Fig. 1 for controlling the activity of the auxiliary blank holding rams;

Figs. 8 and 9 are similar elevations of valve mechanism used in the system of Fig. 1 for controlling the activity of the main ram, and

Fig. 10 is a diagram similar to Fig. 1 but illustrating some modifications in the system.

While many features of the invention may be applied to presses of various types, including mechanical, crank and hydraulic presses, or combinations of them, the improved system is shown, by way of example, as utilized in connection with a hydraulic press having upon its base a relatively fixed die element 10 with a suitable die cavity or recess 11 in its upper face. Supported above the base, as usual in hydraulic presses, is a platen 12 which is guided in the usual manner for reciprocation toward and from the base which mounts the die element 10. This platen 12 is operated in both directions by a piston 13 projecting into a main cylinder 14 and forming therewith a double acting main ram, by which the platen 12 is reciprocated in opposite directions. The platen 12 removably mounts a die element 15 which cooperates with the die cavity 11 to draw and deform a metal blank 16 into a desired configuration or shape.

The blank 16 is placed on the die element 10 across the cavity 11, and while it is confined in that position, the cooperating die element 15, during the downward travel of the platen 12, will draw and deform the blank until it conforms to the shape of the cavity 11. During the drawing operation it is desirable that the periphery of the blank be held under a sustained pressure in order to prevent wrinkling of the blank while being drawn. For this purpose a blank holding ring or member 17 is disposed beneath the platen 12 and is provided with an aperture or opening 18 through which the die element 15 projects. The ring or member 17 is supported by a plurality of pistons 19, which extend upwardly therefrom through apertures 20 in the platen 12, and into auxiliary cylinders 21 so as to form with the cylinders 21, double acting rams that support and reciprocate the blank holding ring or member 17.

When the pistons 19 are lowered or forced downwardly, the member or ring 17 will engage with the blank 16 and confine it against the die element 10 with a sustained pressure. The details of such drawing presses are well known in the art, and in themselves form no part of the invention, and while the blank holding means may be employed equally well with a mechanical

or any other type of drawing press, the means for controlling the pressure of the blank holding ring on the blank is particularly adaptable for use in connection with a hydraulic press in which the drawing platen is reciprocated by hydraulic rather than mechanical means.

The activity of the auxiliary ram pistons 19 is controlled by a valve 22 illustrated in Figs. 1, 6 and 7, and the activity of the main ram piston 13 is controlled by a valve 23 which is similar in construction to the valve 22. The valve 22 is provided with a valve chamber 24 in which a spool-shaped valve element 25 reciprocates, and reciprocation of the element 25 is obtained by a valve stem 26 extending from the element 25 downwardly through the bottom end of the casing of valve 22, and downwardly through a passage 27 provided in a lateral extension of the blank holding ring or member 17. The lower end of the stem 26 is pivotally connected to one end of a control lever 28, which is pivoted at 29 on a suitable part of the press frame. Intermediate of its ends and above the ring 17, the stem 26 carries a collar 30 which is shiftable along the stem 26 into different, desired, adjusted positions in any of which positions it may be secured in any suitable manner such as by a set screw.

In the particular illustrated example, the stem 26 also extends loosely through an aperture 31 in the platen 12. The neutral or intermediate position of the valve element 25 is shown in Fig. 1, and the other operative positions are shown in Figs. 6 and 7, the element 25 being shiftable into the different positions by the control lever 28 and the collar 30. The liquid for the actuation of the auxiliary rams that control the blank holding ring 17 may be obtained from any suitable source such as a tank 32 of any desired size, and preferably, although not essentially, the liquid in tank 32 is maintained under a pressure such as under a pneumatic pressure, or by the use of an accumulator, not shown. Various means for maintaining the liquid in the tank 32 under such pressure are well known and are omitted in the interest of clarity.

A unidirectional, continuously operating pump 33 is connected at its intake side by a pipe 34 to one portion of the tank 32, and at its outlet side is connected by a pipe 35 to a port 36 in the valve chamber 24 approximately midway between its ends and between the flanges 37 and 38 of the spool-shaped valve element 25. One end of the chamber 24 is connected by pipes 39 and 40 to another part of the tank 32, and the opposite end of the chamber 24 is similarly connected by pipes 41 and 42 to the pipe 40 which leads to the tank 32.

When the valve element 25 is in a neutral or intermediate position, such as shown in Fig. 1, the flange 37 of one end of the spool, bridges and closes an annular port 43 in the side wall of the chamber 24, and this port 43 is connected by a branched pipe 44 to the lower or pull back ends of the auxiliary cylinders 21, that is to the ends of the cylinders 21 which are beneath the head of the piston 19. Any number of the cylinders 21 may be employed, but only two are shown for the sake of simplicity.

The opposite ends of the cylinders 21, that is, the upper ends which extend across the entire end areas of the heads of the pistons 19, are connected by a pipe 45 with a port 46 which is aligned with the other flange 38 of the spool of the valve element 25, when the latter is in this intermediate or neutral position shown in Fig. 1. The flange 38, however, instead of bridging and closing the port 46, when aligned therewith, in the manner that the flange 37 closes the port 43, is bevelled or chamfered off on opposite sides of its peripheral edge so that when this flange 37 is aligned with this port 46, as shown in Fig. 1, liquid in the chamber 24 may pass around the flange 38 as well as through the port 46 which, for convenience, is made annular.

When the valve element 25 is shifted into the position shown in Fig. 6, that is, when it is moved upwardly from the neutral position, such as occurs when the free end of the control lever 28 is depressed, the intermediate port 36 will be connected through the central annular space surrounding the valve element with the upper port 46, and at the same time the flange 37 has uncovered the port 43 so that communication is established between pipe 41 leading to the lower end of the chamber 24 and the port 43. When the valve element 25 is in this upper position shown in Fig. 6, any liquid trapped in the auxiliary cylinders 21 below the heads of the piston, may escape through the pipe 44, port 43, the lower end of chamber 24 and pipes 41 and 42, back to the tank 32. At the same time the pump 33 is withdrawing liquid from the tank 32 through the pipe 34 and delivering it through the pipe 35, port 36, central portion of the valve chamber 24, port 46 and the pipe 45 to the upper ends of the auxiliary cylinders 21.

The pistons 19 are now free to descend and the liquid delivered from the pump into the upper ends of the cylinders 21 will urge the pistons 19 downwardly. Until resistance is encountered, however, by the ring 17, its weight will tend to pull the pistons 19 downwardly, and in order to expedite this movement, a prefill check valve 47 is connected at one side through a pipe 48 to the pipe 45, and at its other side by a pipe 49 to the pipe 40. One type of such a check valve is shown in Fig. 3. The free check valve element 50 provided in this valve 47, opens freely to pass fluid from the pipe 49 to the pipe 48 and automatically closes to prevent reverse flow. Thus as the pistons 19 start downwardly to place the blank holding ring 17 on the blank 16, the operating liquid will flow from the tank 32 through pipes 40 and 49 to the valve 47, will open the check valve 50 and pass through the pipes 48 and 45 to the free ends of the cylinders 21 to fill the space created by descending pistons 19. When the auxiliary pistons 19 are to be raised, it is desirable to open the valve 47 and allow the liquid displaced from the upper ends of the cylinders 21 by the pistons 19 to return easily and rapidly to the tank 32. For this purpose a pilot cylinder 47*a* (Fig. 3), operates a piston 47*b* against the action of a helical compression spring 47*c* to lift the valve element 50 forcibly. A branch of the pipe 44 is connected to the pilot cylinder 47*a*. Hence, whenever operating liquid is supplied to the lower ends of the cylinders 21 to lift the pistons 19, the same operating liquid pressure is applied to the pilot device to lift valve element 50 and allow free return of liquid from the upper ends of cylinders 21 to tank 32, without passage of all of the displaced liquid through the valve 22.

When the blank holding ring 17 engages with the blank 16, resistance is immediately offered to further downward travel of the pistons 19, whereupon the pressure in the upper ends of the cylinders 21 immediately builds up because of the continued delivery thereto of the operating liquid from the pump 33, and this increased pressure

tends to cause a reverse flow through the valve 47. The valve 47 thereupon automatically closes through the seating of its valve element 50, and thereafter continued delivery of the operating liquid from the pump 33 to the upper ends of the cylinders 21 will cause the building up of a high pressure on the pistons 19 acting in a downward direction, which pressure is transmitted to the blank holding ring 17 and thus to the periphery of the blank 16.

It is desirable to maintain a sustained pressure on the ring 17 in this holding position, and this is accomplished in accordance with this invention by means in addition to the pump 33. For this purpose the port 46 is also connected by a pipe 51 through a valve seat to the valve chamber 52 of a pressure relief valve 53. This pressure relief valve, shown particularly in Fig. 5, has a free valve element 54 which is urged into closed position against its seat by a spring 55 which is compressed between the valve element 54 and a pressure head 56 also disposed in the chamber 52. The pressure head 56 is mounted on a stem 57 which has threaded engagement with the casing of valve 53, so that when this stem or rod 57 is turned or rotated, it will be shifted endwise in the chamber 52 in a direction depending upon the direction of rotation of the stem. The pressure of the spring 55 on the valve element 54 will thus be varied by rotation of the stem or rod 57.

An outlet 58 of the chamber 52 is connected by a pipe 59 to the pipe 42, so that when the pressure in the pipe 51, which is at all times in communication with the upper ends of the auxiliary cylinders 21, becomes sufficient to overcome the pressure of the spring 55 on the valve element 54, the valve element 54 will open and liquid will pass through pipes 59 and 42 back to the tank 32. As soon as the excess pressure falls the spring 55 will again close the valve element 54, and hence the pressure in the upper ends of the cylinders 21 and thus on the blank holding ring 17 will be sustained, and will be directly proportional to the pressure of the spring 55 on the valve element 54. Thus the pressure on the ring 17 may be varied by rotating the stem or rod 57 in one direction or the other, depending upon whether an increase or decrease in the pressure of the ring 17 on the blank 16 is desired.

In order to vary the pressure on the spring 55 and thus the pressure of the ring 17 on the blank 16, the outwardly extending end of the rod or stem 57 is provided with a pinion 60 which meshes with the teeth of a rack bar 61. The bar 61 is rockably connected at its lower end to one arm of the bell crank lever 62, pivoted at 63, and mounts upon its other arm a cam follower or roller 64. A spring 65 urges the bell crank lever 62 yieldingly in a direction to force the cam follower 64 against a cam surface 66 which is carried by the platen 12.

As the platen 12 moves toward the die element 10, the undulations of the cam surface 66 cause a rocking of the bell crank lever 62, reciprocation of the rack bar 61, and rotation of the pinion 60 and of the stem or rod 57, to change the pressure on the blank holding ring 17 in accordance with a predetermined plan under the control of the platen 12. Thus while the ring 17 remains clamped against the blank 16 under a sustained hydraulic pressure, the travel of the platen in a downward direction will cause a variation in this sustained pressure in accordance with a predetermined plan.

The connection between the rack bar 61 and the bell crank lever 62 is one which causes the rack bar to reciprocate vertically in both directions upon rocking of the bell crank lever 62. For example, the rack bar may have a shoulder or collar 67 provided thereon at a short distance from the lower end of the bar and engaging with one side of the bell crank arm, and the bar, after passing loosely through an aperture or slot in the arm of the bell crank lever 62, carries a washer 68 and a nut 69. The collar 67 and the washer 68 have semi-spherical or convex arcuate surfaces abutting opposite faces of the bell crank lever 62, so that the rack bar may rock laterally somewhat at its connection to the bell crank 62.

The valve 23 is similar in construction to the valve 22, and is provided with a central annular port 70 and intermediate ports 71 and 72. The valve element 73 is of spool shape, similar to the valve element 25 of valve 22, and has the flange 74 at one end, which corresponds to the flange 47 of valve 22, of such thickness that when in its neutral position shown in Fig. 1, it will bridge and close the port 71. The other flange 75, which corresponds to the flange 38 of valve 22, is bevelled or chamfered on both faces at its periphery for a similar purpose, so that when the valve element 73 is in a neutral or intermediate position, such as shown in Fig. 1, in which the flange 74 closes the port 71, the chamfered flange 75 will be aligned with the port 72. Liquid may thus pass from the port 70 around the flange 75 at the port 72, through the upper end of the valve chamber 76, and thence through the pipe 40 to the tank 32.

A unidirectional, continuously operating pump 77 is connected at its intake side by a pipe 78 to a portion of the tank 32 at a point spaced from the connection of the pipe 40 to the tank. The output or delivery side of the pump 77 is connected by a pipe 79 to the port 70, so that when the valve element 73 is in the neutral position shown in Fig. 1, the liquid delivered by the pump 79 will flow around the periphery of flange 75 and back through the pipe 40 to the tank, thus circulating idly through the valve chamber 76. The port 71 is connected by a pipe 80 to the lower end of the main cylinder 14, and thus liquid trapped in the cylinder 14, below the head thereof, cannot escape through the port 71, which holds the platen 12 in raised position.

Pipe 40 is also connected by a branch pipe 81 to the lower end of the chamber 76, for a purpose which will appear presently. The valve element 73 is reciprocated endwise in the chamber 76 by means of a valve rod 82 which extends downwardly through the lower end of the chamber 76, passes through an aperture 83 in the platen 12, and at its lower end is pivotally connected by a pin 84 to one end of a control lever 85, which in turn is pivoted at 86 to a suitable support.

When a downward movement of the platen is desired the operator pushes the free end of the control lever 85 downwardly, which elevates the rod 82 and through it shifts the valve element 73 from the neutral intermediate position shown in Fig. 1 to the upper position shown in Fig. 3. When this occurs the flange 74 uncovers the port 71 and positively prevents communication between the ports 70 and 71. Communication is, however, established between the pipes 80 and 81 so that the fluid trapped in the lower end of the main ram cylinder 14 may escape through the pipe 80, the port 71, the chamber 76, and pipes 81 and 40 back to the tank 32.

At the same time the flange 75 moves above the port 72 and the liquid delivered by the pump 77 instead of passing upwardly and around the flange 75 to the pipe 40 will be compelled to pass through the port 72, and thence by means of pipes 87 and 86 to the upper end of the main cylinder 14. The movement of operating fluid into the upper end of the cylinder 14 and the weight of the platen 12 will cause the platen to descend as rapidly as fluid can enter the upper end of the cylinder 14.

In order that the speed of the platen 12 may be rapid until the drawing operation starts, the pipe 88 is connected through a prefill check valve 89 to the pipe 40 and thus to the tank 32. This valve 89 is identical with, except usually larger than, the valve 47 shown in Fig. 3 and it opens freely in a direction to pass fluid from the pipe 40 to the pipe 88 and the main cylinder 14, so that as the descent of the platen creates a suction in the upper end of the cylinder 14, operating liquid may flow from the tank 32 through the pipe 40, the valve 89 and pipe 88 into the upper end of the cylinder 14, thus supplementing the liquid delivered by the pump 77 to the upper end of the cylinder 14.

When the die 15 carried by the platen 12 engages with the blank 16, pressure resistance to further movement of the platen 12 is set up, and since the pump 77 continues to deliver liquid to the upper end of the cylinder 14, the pressure on the upper end of the piston 13 will build up, whereupon the liquid in the cylinder 14 will tend to flow outwardly through the pipe 88 and valve 89 to the pipe 40, but thereupon the valve 89 closes automatically, so that the pressure on the upper end of the piston 13 builds up in response to the continued delivery of liquid to the upper end of the cylinder 14 from the pump 77.

It is desirable to vary the speed of downward travel of the platen during the drawing operation on the blank 16, and the means for varying this speed in accordance with a predetermined plan will next be described. The pipe 90 connects the pipe 87, leading from the port 72, to one end of a bypass valve 91 which is shown diagrammatically in Fig. 1 and in greater detail in Fig. 4. In the chamber 92 of the valve 91 is a valve element 93 which is mounted on the end of a stem or rod 94. The rod 94 has threaded engagement with the inner end of a sleeve 95 that closes one end of the chamber 92. Thus as the stem 94 is rotated, it will be threaded into and out of the chamber 92 to various extents, so as to shift the valve element 93 toward or from its valve seat in the chamber 92, depending upon the direction of rotation of the stem 94.

A pipe 96 connects the chamber 92 to the pipe 40, from which it will be observed that a portion of the liquid delivered by the pump 77 to the pipe 87 may pass through the pipe 90 and the valve 91 back to the pipe 40, thus completing an idle circuit through the pump for a portion of the liquid. The proportion of the liquid which is bypassed through the valve 91 in this manner will vary with the setting of the valve element 93, and this setting may be varied by rotating the stem or rod 94 in one direction or the other, depending upon whether an increase or decrease in the amount of bypass is desired. The outer end of the stem or rod 94 is provided with a pinion 97 which meshes with the teeth of a rack bar 98. This rack bar depends from the pinion 97 and at its lower end is rockably connected to one arm of a bell crank lever 99, such as in the manner explained for the connection of the rack bar 61 to the bell crank lever 62.

The bell crank lever 99 is pivoted at 100, and its other arm carries an offset cam roller or follower 101 which engages with and rolls upon a cam surface 102 carried by the platen 12. A spring 103 that is connected to the horizontal arm of the bell crank 99, urges the latter in a direction to press the roller 101 against the undulating cam surface 102 at all times. The cam surface 102 extends or undulates in the direction of the travel of the platen, and thus as the platen 12 descends, the cam surface 102 thereof will cause a rocking of the bell crank 99 and through the resulting reciprocation of the rack bar 98, the pinion 97 and stem 94 will be turned in one direction or the other to increase or decrease the amount of liquid bypassed. When more liquid is bypassed, the speed of travel of the platen 12 will be decreased, and vice versa.

Thus the platen 12 in its movement controls its own speed during the drawing stroke, and by selecting the undulations of the cam surface 102, the speed of travel of the platen 12 may be decreased at those points or zones in the drawing operation, where there is danger of tearing or rupturing of the blank, with the result that deeper draws may be successfully made. By selecting the character of the cam surface 66, the pressure of the blank holding ring 17 on the periphery of the blank 16 may be decreased to the extent desired in the proper zone of the platen travel to allow more slippage of the blank 16 at the critical zones, which in some cases may be at the same time that the speed of the platen 12 is decreased. Any other control of the pressure of the blank holding ring on the blank or in the speed of the platen may be obtained merely by proper selection of the shapes of the cams 66 and 102.

At the end of a drawing operation the operator elevates the upper end of the control lever 85, which pulls the valve rod 82 downwardly and moves the valve element 73 from the position shown in Fig. 8 to the position shown in Fig. 9. When this occurs the flange 75 will cut off communication between the ports 70 and 72, thus interrupting delivery from the pump 77 to the upper end of the main cylinder 14, and the flange 74 will move concomitantly to a position between the port 71 and the outlet pipe 81, so that escape of further liquid from the lower end of the cylinder 14 will be prevented. The central port 70 is now connected to the port 71, and thus the liquid delivered by the pump 77 to the valve chamber 76 will now pass through the port 71 to the pipe 80, and thence to the lower end of the cylinder 14, so as to exert a lifting pressure on the piston 13. The flange 75 has moved from a position in which it interrupted communication between the port 72 and the pipe 40, so that the liquid previously delivered to the upper end of the cylinder 14 may now pass through the pipes 86 and 87, the port 72 and the pipe 40 back to the tank 32. The pressure in the upper end of the cylinder 14 thus immediately falls and permits an upward movement of the piston 13.

In order to expedite the upward movement of the platen 12, provision is made for forcibly opening the check valve of the prefill valve 89. For this purpose a branch pipe 104 leads from the pipe 80 to the pilot cylinder of the prefill valve 89 so as to forcibly open the check valve element 50 thereof in the manner hereinbefore explained in connection with the opening of the prefill valve 47.

As the platen 12 moves upwardly and approaches its upper limit of movement, it will engage with a collar 105 provided on the valve rod 82, so that further upward movement of the platen 12 will elevate the rod 82 and shift the valve element 73 from the position shown in Fig. 9 to the neutral or idle position shown in Fig. 1. When the valve element 73 moves back into this neutral position, the flange 74 again bridges the port 71 and thus disconnects the pump 77 from the pipe 80, and also prevents escape of liquid from the pipe 80, thus locking the main piston 13 in its elevated position. The flange 75 at the same time opens communication from the port 70 to the port 72 and the pipe 40, thus conducting the liquid delivered by the pump 77 back to the tank 32. This idle circulation of liquid through the pump 77 will continue and the piston 13 will be effectively held in its elevated position. The collar 105 is mounted on the rod 82 for adjustment endwise along it, and it may be secured in different adjusted positions in any suitable manner such as by a set screw which is carried by the collar and is engageable with the rod 82.

When the platen 12 starts upwardly the blank holding ring 17 will continue to hold the blank 16 against the die element 10, so as to strip the formed blank from the die element 15, and after that occurs the operator elevates the free end of the control lever 28 which shifts the valve element 25 from the position shown in Fig. 6 to the position shown in Fig. 7. When this occurs, the intermediate port 36 to which the pump 33 delivers operating liquid will be connected with the port 43, and thus the liquid from the pump will be delivered through the pipe 44 to the lower ends of the auxiliary cylinders 21. At this time the flange 38 is disposed between the ports 36 and 46 and shuts off communication between them, but places the port 46 in communication with the pipes 39 and 40.

The liquid in the upper ends of the auxiliary cylinders 21 may then pass through the pipe 45, through the port 46, and pipes 39 and 40 back to the tank 32, and thus as the liquid is delivered under pressure to the lower ends of the auxiliary cylinders 21, the auxiliary pistons 19 will be elevated and thus will elevate the blank holding ring or element 17 and release the blank 16.

The pressure of the liquid from the pump 33 is transmitted through the pipe 44 to the pilot cylinder 47*a*, and will force the pilot piston 47*b* upwardly against the action of the spring 47*c*. This forcibly opens or lifts the check valve element 50, so as to allow the liquid to pass directly from the upper ends of the auxiliary cylinders 21 to the pipe 40 and back to the tank. After the blank holding ring 17 has been elevated, the formed blank 16 may then be ejected from the die recess 11 in any suitable manner which is common in the art, such as by a spring ejector or air or hydraulic mechanism, not shown, and which in itself forms no part of this invention.

As the ring 17 approaches its upper limit of movement it engages the collar 30, shifts the valve stem or rod 26 upwardly, and thus returns the valve element 25 from the Fig. 7 position to the Fig. 1 position which is the idle or neutral position occupied when the press is idle. At this time the pump 33 circulates liquid idly through the valve 22 and pipes 39 and 40 back to the tank 32, and the pistons 19 are held in their upper positions by the liquid trapped in the lower portions of the auxiliary cylinders 21, due to the bridging of the port 43 by the flange 37 of the valve element 25.

The operation of the press and system will be clear from the foregoing description, but may be briefly summarized as follows:

Assuming that the parts are in the idle position shown in Fig. 1, let it be assumed that a blank 16 has been placed on the die element 10 across the die recess 11. The operator then depresses the free end of the control lever 28, which elevates the valve element 25 and initiates a downward movement of the auxiliary pistons 19 and ring 17. At the start of this downward movement of ring 17, the pressure on the pipe 44 is released, and thus the pressure on the pilot piston 47*b* is decreased, whereupon the spring 47*c* forces the pilot piston 47*b* downwardly to release the check valve element 50, and permit it to close. When the ring 17 engages with the blank 16, the pressure then built up in the upper ends of cylinders 21 causes the prefill valve 47 to close, and the continued delivery of liquid from the pump 33 to the upper ends of the auxiliary cylinders 21 will build up a sustained pressure upon the blank holding ring 17, until the pressure is sufficient to overcome the force of spring 55, whereupon the valve element 54 opens sufficiently to maintain the pressure at that determined by the setting of the pressure head 56.

When the blank holding ring has progressed far enough so that it will engage and hold the blank 16 before the platen 12 can carry the die element 15 into engagement with the blank, the operator depresses the free end of the control lever 35, which elevates the valve element 73 from the Fig. 1 position to the Fig. 8 position, and initiates a downward movement of platen 12. The downward movement of the platen 12 will be controlled at intervals in its descent as to speed by the cam surface 102 and the bypass valve 91, the latter being set into different degrees of opening by successive changes in the character of the surface 102 as the platen 12 descends. At the same time the pressure on the blank holding ring will vary in accordance with the successive positions of the platen 12 under the control of the cam surface 66.

At the end of the drawing operation, the operator elevates the free end of the control lever 35 and initiates an upward travel of the platen 12 that is terminated automatically by engagement of the platen with the collar 105, through which the rod 82 is elevated to return the valve element 73 to the neutral position shown in Fig. 1. The upward movement of the blank holding ring 17 is initiated after the platen 12 has started upwardly, by tilting upwardly the free end of the control lever 28, and the upward movement of the ring 17 is terminated when it engages the collar 30 and elevates the rod 26 sufficiently to return the valve element 25 to the neutral position shown in Fig. 1.

The shape and configuration of the cam surfaces 66 and 102 will vary with different dies employed, because the slippage and speed of travel must be varied at just the critical points in the drawing operation. These critical points will vary with different types of blanks being drawn and different dies that are used, and must be determined for each different die or blank employed.

In Fig. 10 a slight modification of the controls of the pressure on the blank and of the travel of the platen have been illustrated with so much of the remainder of the press and system as is necessary to show the relation of the modified parts to the other parts. In this modification of

Fig. 10, the pressure opened valve 53 and the pipes 51 and 59 shown in Fig. 1 are omitted, and the pump 33 is replaced by a pump 105 which is of the variable delivery reversible type, but continuously operating. Such pumps are well known in the art and by way of example, one of this general type is illustrated in U. S. patent to Landenberger et al. #1,863,448 issued June 14, 1932. The pump at its intake side is connected by the pipe 34 to the tank or source 32 of operating liquid, and its output side is connected by the pipe 35 to the valve 22, as in Fig. 1.

The pump 105 is adjustable in order to vary its delivery or to reverse its delivery by means of a yoke 106 which is shifted in alternate directions by a lever 107 pivoted at 108. The lever 107 is pivoted to a block 109 which is mounted on a rod 110 to slide in a direction endwise thereon. A nut or collar 111 is provided on an end of the rod 110 so as to limit movement of the rod 110 through the block 109 in one direction, and a helical spring 112, disposed on the rod 110 and acting against a washer or collar 113 that is slidably mounted on the rod 110, forces the block 109 yieldingly against the nut or collar 111. Pressure is provided on the spring 112 by a washer 114 which is slidable on the rod 110 and abuts endwise against a pinion 115 that is threaded on the rod 110. Thus, by rotating the pinion 115, it will be threaded along the rod 110 so as to further compress or release the spring 112, and thus vary the pressure with which the lever 107 is held against the collar or nut 111.

A lever 116, pivotally mounted at 117, is pivoted at one end by a pin 118 to a block 119 that is also threaded or fixed on the rod 110, so that the rod 110 may be forcibly operated in alternate directions to change the direction of delivery of the pump, or the rate of delivery, in a manner which is well known in the variable delivery reversible type of pumps. The pressure in the pipe 35, which is the output side of the pump as connected, is operable upon the lever 107 through a small ram, not shown, but which is common in this type of pump, in a manner to rock the lever 107 clockwise in Fig. 10, against the action of the spring 112, while the rod 110 remains in set position. Thus, when the pressure in pipe 35 equals or exceeds a predetermined pressure, determined by the pressure of spring 112, the lever 107 will be rocked clockwise in Fig. 10 against the action of spring 112 so as to shift the yoke 106 in a direction to set the pump for neutral delivery position.

If the pressure falls, the spring 112 will return the lever 107 and yoke 106 to delivery position, and the pressure in pipe 35 will be built up until it is again sufficient to overcome the pressure on spring 112. By rotating the pinion 115, one may therefore determine the pressure which will be maintained automatically in the pipe 35, and this pressure may be varied merely by rotating the pinion 115 in one direction or the other, depending upon whether an increase or decrease of pressure is desired. The pinion 115 meshes with the rack bar 61 corresponding to the rack bar 61 of Fig. 1, and thus, as the platen 12 moves downwardly the cam surface 66 will operate the rack bar 61 to change the pressure on the spring 112 in accordance with a predetermined plan and controlled by the travel of the platen, thereby determining the pressure on the blank during the drawing operation, which pressure varies with the different positions of the platen in accordance with a predetermined plan. The lever 116 is operated merely to change the maximum rate of delivery of the pump, and the reversing feature of the pump need not be utilized.

In controlling the rate of travel of the platen in the working stroke under the system as modified in Fig. 10, the valve 91 and pipes 90 and 96 of Fig. 1 may be omitted, and the pump 77 of Fig. 1 is replaced by a pump 120 of the variable delivery reversible type in Fig. 10. The reversible feature need not be utilized in the system. The intake side of the pump is connected to the pipe 78, as in Fig. 1, and the output side of pump is connected by the pipe 79 to the valve 23, also as in Fig. 1. The pump 120 is identical with the pump 105 except that instead of the pinion 115 in the control for the pump 105, I have substituted a hand wheel 121 which is threaded on the rod 110 for varying the pressure on the spring 112. The rod 110 which varies the rate of delivery of the pump is connected to a lever 122 which corresponds to the lever 116 of the pump 105 except that the lever 122 is a bell crank lever and is pivotally connected by a pin 123 to one end of a link 124 which corresponds to the rack bar 98 of Fig. 1. Thus, as the platen 12 moves downwardly, the cam surface 102 thereof will act through the roller 101 and link 124 to shift the rod 110 endwise and thus change the rate of delivery of the pump which controls the speed of travel of the platen. Otherwise the system is the same as in Fig. 1.

It will be understood that the various changes in the details, materials and arrangements of parts, which have been herein described and illustrated in order to explain the nature of the invention, may be made by those skilled in the art within the principle and scope of the invention as expressed in the appended claims.

I claim as my invention:

1. In a drawing press, a fixed die holding element, a platen mounted for movement toward and from said element, means for actuating said platen toward and from said element, a blank holding member also movable toward and from said element entirely separately from the movement of said platen, hydraulic means for actuating said holding member toward and from said element and for holding it under pressure against said element, and means controlled by the platen for partially but not fully releasing the liquid pressure of said hydraulic means on said member and thus the pressure of said member against said element, automatically during a predetermined critical interval of the drawing operation during the travel of said platen towards said element, so as to allow regulated slippage of the blank during said critical interval.

2. In a drawing press, a fixed die holding element, a platen mounted for movement toward and from said element, means for actuating said platen toward and from said element, a blank holding member also movable entirely separately from said platen toward and from said element, hydraulic means for actuating said holding member separately from said platen toward and from said element and for holding it under pressure against said element, a source of actuating liquid under pressure connected to said hydraulic means to operate it, an adjustable regulator for controlling the pressure of said member against said element by controlling the admission of liquid under pressure to said means from said source, mechanism operated by said platen during its travel towards said element for adjusting said regulator to vary the pressure of said mem-

ber on said element in accordance with a predetermined plan under the control of said platen.

3. In a drawing press, a fixed die holding element, a platen mounted for movement toward and from said element, means for actuating said platen toward and from said element, a blank holding member also movable toward and from said element entirely separately from the platen, fluid actuated means for actuating said member against said element and holding it thereagainst during the travel of said platen while in contact with a blank being operated upon, a source of fluid under pressure connected to said actuated means for moving it and holding it in clamping position, and means controlled by said platen during its travel towards said element for varying the passage of actuating fluid between said source and said actuated means and thereby decreasing and increasing the pressure of said fluid actuated means on said member in accordance with a predetermined plan and dependent upon the successive positions of said platen.

4. In a drawing press, a fixed die holding element, a platen mounted for movement toward and from said element, means for actuating said platen toward and from said element, a blank holding member also movable toward and from said element, hydraulic means for actuating said holding member toward and from said element and for holding it under pressure against said element during travel of said platen, a source of fluid under pressure connected to said hydraulic means for operating said holding means in both directions, and for providing the holding pressure, a cam part and a follower part, one of said parts being mounted on the platen for travel therewith and the other part being operated thereby, and means controlled by said operated part for varying the passage of actuating liquid between said source and said hydraulic means and thereby regulating the pressure on said member in accordance with a predetermined plan dependent upon the successive positions of said platen in its travel towards said element.

5. In a drawing press, a fixed die holding element, a die-mounting platen mounted for movement toward and from said element, fluid actuated means for moving said platen toward and from said element, means controlled by said platen in its travel towards said element for selectively controlling said fluid actuated means and varying the rate of travel of said platen in accordance with a predetermined plan, a blank holding member for holding a blank against said fixed element, and means also controlled by said platen for varying the pressure of said member against said element in accordance with a predetermined plan dependent upon the successive positions of said platen.

6. In a drawing press, a fixed die carrying element, a die mounting platen mounted for movement toward and from said element, fluid actuated means for moving said platen toward and from said element, pumping means for delivering an operating fluid to said means, and means including a fluid bypass controlled by said platen in its travel towards said element for bypassing portions of the operating fluid delivered to said actuated means around said actuated means in different proportions determined by the successive positions of said platen, for varying the rate of travel of said platen towards said element in accordance with a predetermined plan dependent upon the successive positions of the platen.

7. In a drawing press, a die-mounting, fixed element, a die-mounting platen mounted for movement toward and from said element, a fluid operated device for moving said platen in alternate directions towards and from said element, a fluid circuit including a pump connected to said device for operating said platen in opposite directions, controlling means for said circuit for regulating the direction of travel of said platen, and means including a fluid bypass for said circuit from said pump past said device and operable automatically during the travel of said platen towards said element and controlled by the platen for bypassing varying proportions of the fluid delivered to said device, past said device, and thus varying the speed of travel of said platen in different successive zones of its travel in accordance with different successive positions of said platen.

8. In a drawing press, a fixed die holding element, a platen mounted for movement toward and from said element, ram means connected to said platen for operating it toward and from said element, a source of actuating fluid, a continuously operating pump, a circuit including said source, said pump and said ram means for causing operation of said ram means in one direction or the other, a bypass forming a part of said circuit and operable to bypass a portion of said actuating fluid around said ram means while said ram means is operating the platen towards said fixed element, and means controlled by said platen in its travel towards said fixed element for operating the bypass to vary the quantity of fluid bypassed and thereby regulate the rate of advancement of said platen towards said element in accordance with intermediate successive positions of the platen.

9. In a drawing press, a fixed die holding element, a platen mounted for movement toward and from said element, ram means connected to said platen for operating it toward and from said element, a source of actuating fluid, a continuously operating pump, a circuit including said source, said pump and said ram means for causing operation of said ram means in one direction or the other, a bypass forming a part of said circuit and operable to bypass a portion of said actuating fluid being delivered by said pump to said ram means around said ram means while said ram means is operating the platen towards said fixed element, a cam part and a follower part, one of said parts being mounted on the platen for travel therewith and the other part being positioned adjacent thereto for operation from the other part during the travel of the platen, and means controlled by said other part for operating said bypass to vary the quantity of fluid bypassed and thereby control the speed of travel of the platen as determined by said cam part, during the travel of said platen towards said fixed element.

10. In a drawing press, a fixed die holding element, a platen mounted for movement toward and from said element, means for confining a blank against said fixed element, means for actuating said platen toward and from said element, means for pressing said blank confining member against said element, cam means operated by said platen in its movement toward said element for varying the speed of travel of said platen through intermediate zones of travel while in contact with said blank, and cam means also operated by said platen for concomitantly varying the pressure of said blank confining member against said element.

11. In a drawing press, a fixed die holding element, a platen mounted for movement toward and from said element, means for actuating said platen toward and from said element, a member for holding a blank against said element, a fluid circuit including fluid actuated means for pressing said blank holding member against said element, a pressure release valve included in said fluid circuit for bypassing the fluid that presses said member against said element whenever the pressure exceeds the setting of said release valve, and means controlled by said platen for varying the setting of said pressure release valve at an intermediate point in the travel of said platen toward said element while in contact with said blank.

12. In a drawing press, a fixed die holding element, a platen mounted for movement toward and from said element, means for actuating said platen toward and from said element, a member for holding a blank against said element, a fluid circuit including fluid actuated means for pressing said blank holding member against said element, a pressure opened but spring closed valve forming a part of said circuit, and opened by the fluid pressure which confines said member to said element, and means controlled by said platen for changing the pressure on said spring at an intermediate point in the travel of said platen toward said element.

13. In a drawing press or the like, a relatively fixed die holding element, a platen mounted for movement toward and from said element, a blank holding member also movable toward and from said element, means including a variable delivery pump and a fluid circuit including said pump for actuating said platen toward and from said element, means including a cam device operated by the travel of said platen for varying the delivery of said pump and thereby varying the rate of travel of said platen in accordance with a predetermined plan represented by said cam device and its relation to said platen, means including a variable delivery pump and a fluid circuit including said pump for actuating said blank holding member toward and from said element, said second pump having pressure responsive means for automatically setting it to approximately neutral delivery condition when the pressure at the delivery side of said second pump exceeds a predetermined pressure and adjustable for varying the pressure at which it sets itself to approximately neutral delivery condition, and means operable in a predetermined speed ratio to the travel of said platen and concurrently therewith for varying the pressure regulating means in a manner to vary the pressure at which said second pump will set itself to approximately neutral delivery position, in accordance with a sequence having a definite predetermined relation to the successive positions of the platen.

14. In a drawing press, a relatively fixed die holding element having an unyielding blank clamping area, a platen mounted for movement toward and from said element, hydraulic means for actuating said platen toward and from said element, a member for holding a blank against said unyielding area on said element, additional and separate hydraulic means for exerting independently of the platen travel a holding pressure on said member, and means responsive to the successive positions of the platen in its movement toward said element for partially but not fully releasing the hydraulic holding pressure of said member on said blank when said platen reaches a predetermined, critical drawing position, intermediate of the start and finish of the drawing operation.

15. In a drawing press, a relatively fixed die holding element having a clamping area rigid with the remainder of the die, a platen mounted for movement toward and from said element, means for actuating said platen toward and from said element, a member for holding a blank against said clamping area of said element, hydraulic means for exerting a holding pressure on said member independently of the platen travel, a source of liquid under pressure connected to said hydraulic means to supply the holding pressure thereto, and means including a cam device operated concurrently with said platen toward said element for decreasing and increasing the delivery of liquid from said source to said hydraulic means and hence decreasing and increasing the pressure of said holding member against said element selectively in a predetermined sequence of pressures bearing a definite timed relation to successive positions of said platen in its travel toward said fixed element.

16. In a drawing press, a relatively fixed die holding element, a platen mounted for movement toward and from said element, means for actuating said platen toward and from said element, a member for holding a blank against said element, a fluid actuated device for exerting a holding pressure on said member, means for delivering a holding fluid under pressure to said device, pressure responsive means for releasing the fluid delivered to said device when a predetermined pressure has been reached, and means responsive to the travel of said platen toward said element for adjusting said pressure responsive means in a manner to vary the quantity of fluid delivered to said device in different successive positions of said platen in its travel toward said element.

17. In a drawing press, a relatively fixed die holding element, a platen mounted for movement toward and from said element, means for actuating said platen toward and from said element, a member for holding a blank against said element, a fluid actuated device for exerting a holding pressure on said member, means for delivering a holding fluid under pressure to said device, a pressure opened valve connected to said device for releasing the fluid pressure thereon when a predetermined pressure on said member has been reached, and means responsive to the travel of said platen towards said element for adjusting the pressure at which said valve opens at a plurality of different successive positions of said platen in its travel towards said element.

18. In a drawing press, a pair of relatively movable drawing dies, a blank holding member for clamping a blank against one of said dies, fluid pressure actuated means for holding said member in blank clamping position and exerting a clamping pressure on a portion of a clamped blank independently of the relative movement of the dies, means independent of the pressure of the dies on the blank for delivering a fluid under pressure to said holding means for furnishing the holding pressure and means controlled by the relative movement of said dies during a drawing operation for increasing and decreasing the fluid pressure on said holding means in accordance with a predetermined plan determined by the relative positions of the dies.

19. In a drawing press, a pair of relatively mov-

able drawing dies, a blank holding member for clamping a blank against one of said dies, fluid pressure actuated means for holding said member in blank clamping position and exerting a clamping pressure on a portion of a clamped blank independently of the relative movement of the dies, means independent of the pressure of the dies on the blank for delivering a fluid under pressure to said holding means for furnishing the holding pressure and means controlled by the relative movement of said dies during a drawing operation for releasing fluid from and adding fluid to said holding means in accordance with a predetermined plan, whereby the holding pressure on a blank being drawn will be decreased and increased in a definite relation to the relative positions of the dies.

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