Feb. 12, 1946. F. J. RODE 2,394,636

PROGRESSIVE DRAWING PRESS

Filed Aug. 3, 1942 3 Sheets-Sheet 1

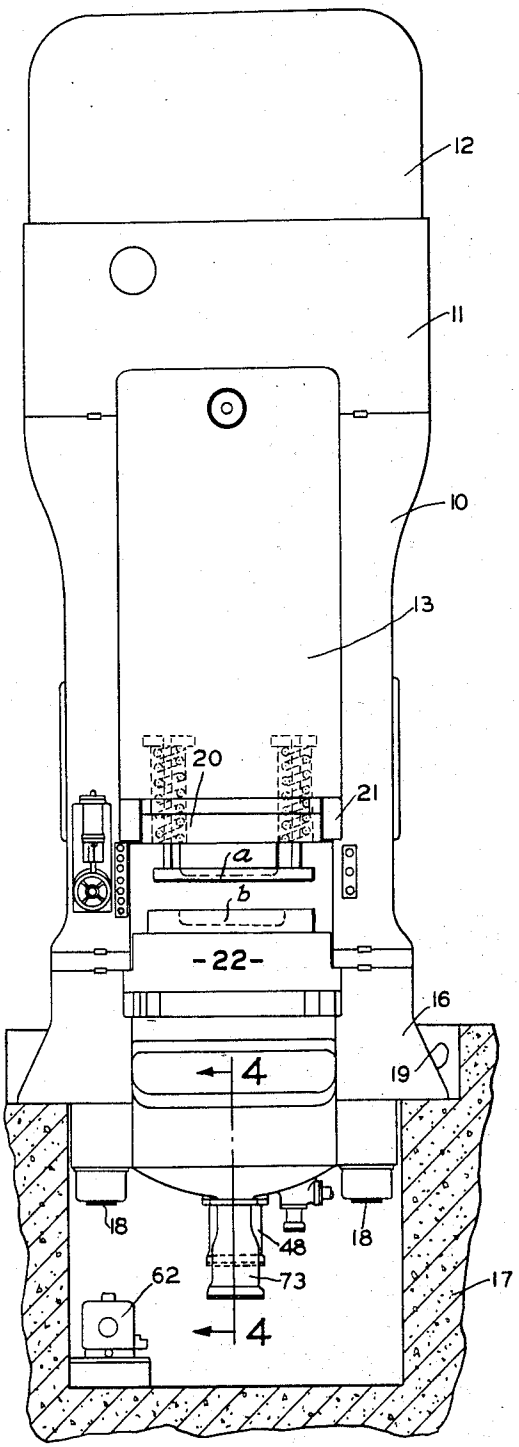


FIG. 1.

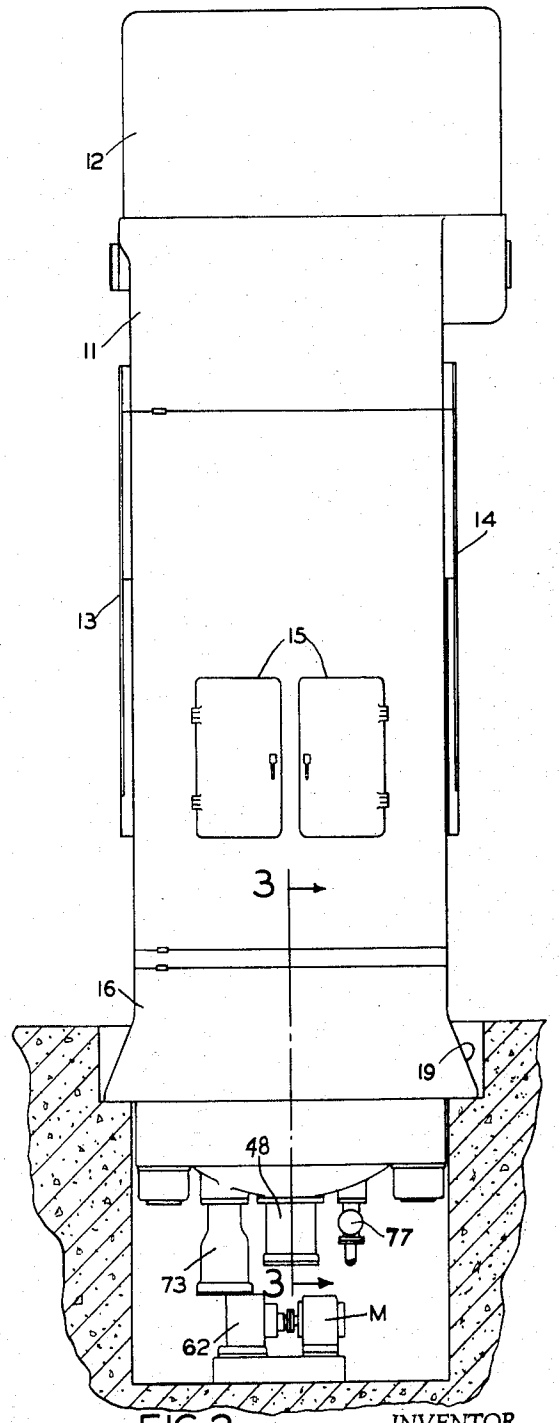


FIG. 2.

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Filed Aug. 3, 1942 3 Sheets-Sheet 2

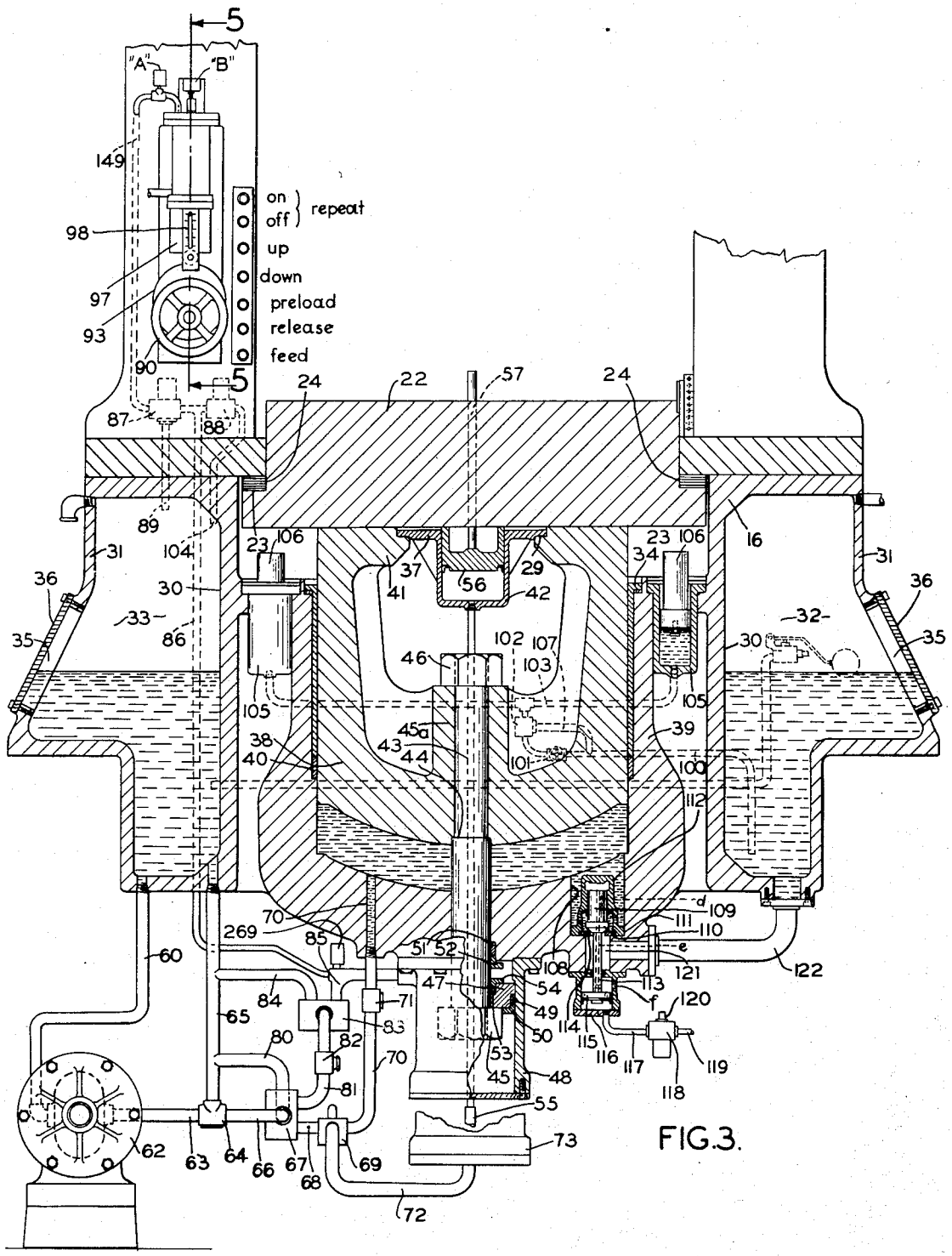


FIG.3.

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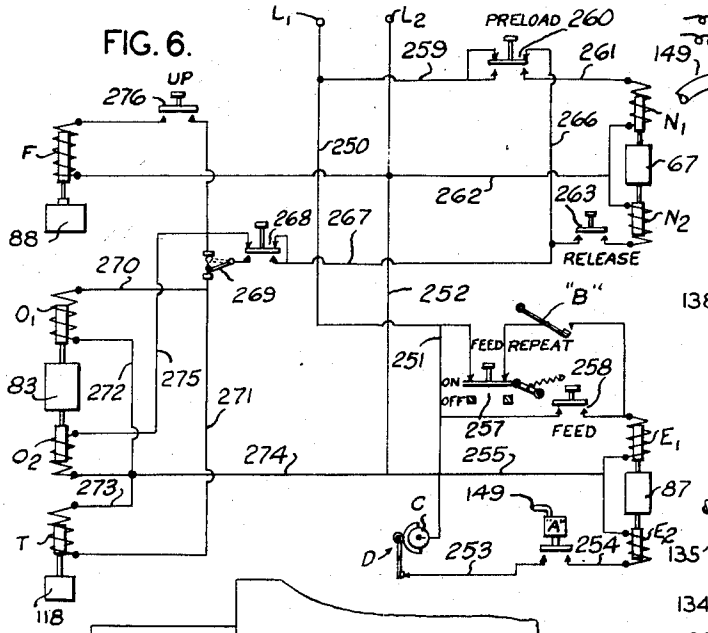
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Feb. 12, 1946. F. J. RODE 2,394,636

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Filed Aug. 3, 1942 3 Sheets-Sheet 3

FIG. 6.



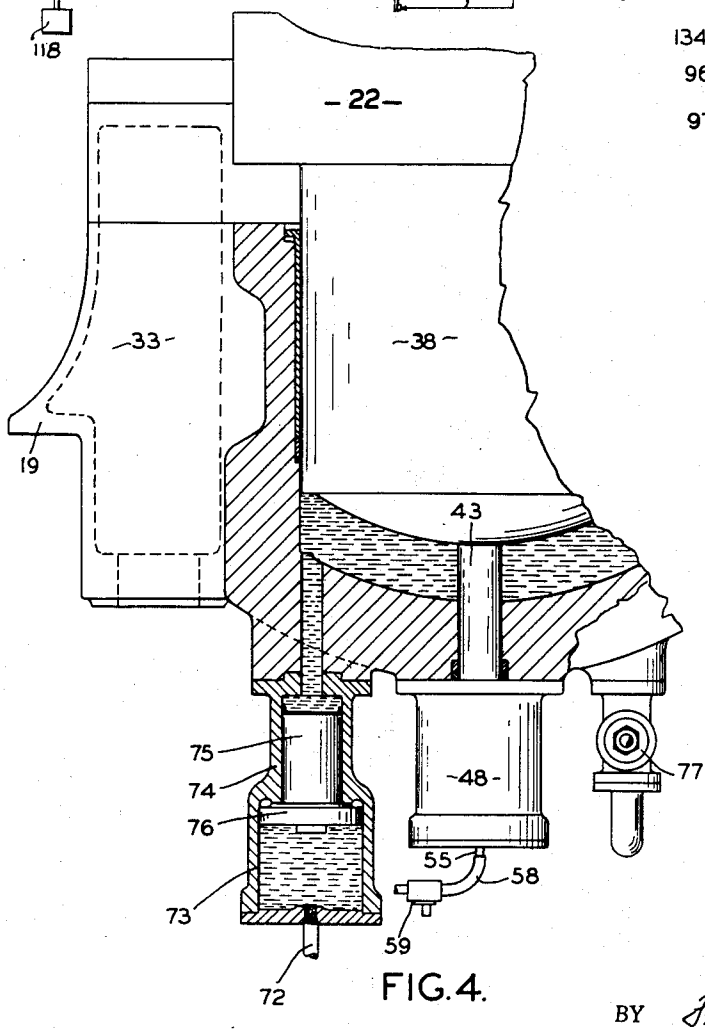


FIG. 4.

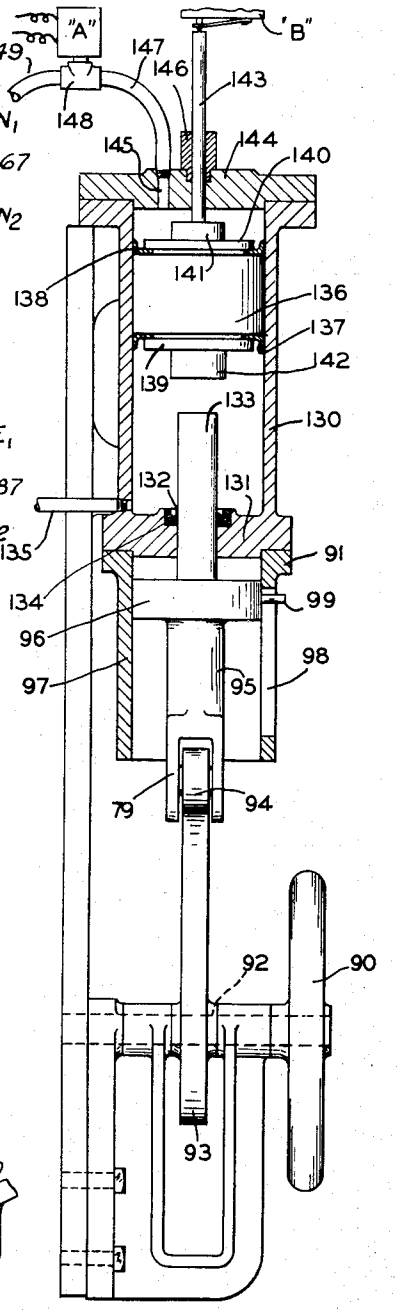


FIG. 5.

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Patented Feb. 12, 1946 2,394,636

UNITED STATES PATENT OFFICE

2,394,636

PROGRESSIVE DRAWING PRESS

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Application August 3, 1942, Serial No. 453,362

20 Claims. (Cl. 113—45)

This invention relates to improvements in metal working machines, more particularly to machines of the type in which a ram carrying the upper die is mounted for reciprocating movement in the upper part of a press, while the lower die is located on a bed in the lower part of said press, and in which the cooperating dies for the working of the metal are moved to progressively closer relative positions as the work proceeds.

More particularly, the invention relates to mechanism for raising the die carrying bolster intermittently by predetermined increments whereby stage forming, shaping, forging or drawing operations can be effected upon a workpiece. One of the main objects of the invention is to provide means for controlling the movement of said bolster in a reliable and accurate manner when the machine is being utilized for step by step working of the metal. These means comprise a combined hydraulic and pneumatic system operated by electric controls.

Another object of the invention is to build the machine in a way that all the equipment, including an electric motor, a pump driven by the same and oil reservoirs for the liquid, which is recycled through the system of the pump, will be confined within the machine frame and the pit in which the base of the machine is embedded. This construction not only adds to the streamlined appearance of the machine, but results in the saving of space and prevents the parts from exposure to dust, atmosphere and other damaging influences, thereby decreasing the wear and adding to the life of the machine.

Another object of the machine is to provide knockout means in a machine of the type disclosed for expelling a workpiece when it has gone through the final operating step. Yet another object of the invention is the provision of means for building up a high pressure for the finishing step of the metal working process.

Other improvements will be apparent from the following detailed description and the annexed drawings.

In the accompanying drawings—

Fig. 1 is a front view of the machine with the pipe system removed;

Fig. 2 is a side view of the machine;

Fig. 3 is a section on lines 3—3 of Fig. 2 on an enlarged scale with some parts being broken away;

Fig. 4 is a similar section on lines 4—4 of Fig. 1;

Fig. 5 shows, on a still larger scale, the feed control mechanism of the machine in section along lines 5—5 of Fig. 3; and

Fig. 6 is a wiring diagram showing the electrical connections for controlling the valves of the hydraulic and pneumatic system.

Frequently it is desired to form, draw, forge or shape a piece of work in stages or steps whereby a dwell or time period is afforded for the crystalline structure of the metal to become adjusted to a preceding metal stressing before a succeeding force application to the metal being worked takes place. This is true, for example, in the forming, shaping or drawing of work pieces which are made out of the lighter alloy metals and which, if completely formed, drawn or shaped in one stroke, would develop fissues or other defects. The present invention is directed to presses adaptable to such metal working and embodies, as one of the salient operating features, a bolster actuating mechanism which effects a step by step or stage feeding of the bolster, with die mechanism thereon, vertically upward toward the cooperating die mechanism carried on the ram of the press.

Referring more particularly to Figs. 1 and 2 of the drawings, 10 is a frame of the press supporting a crown 11 in which the mechanism for reciprocating the ram is mounted. This may preferably be a crank driven press mechanism of known construction, which does not form a part of the invention and has, therefore, not been shown in the drawings.

A top portion 12 covers the crown and forms a casing for such parts of the drive mechanism as extend beyond the crown. A front plate 13 and a rear plate 14 serve for covering the machinery between the uprights of the frame, to which access is provided by doors 15.

The frame is supported by a hollow bed or base 16, which is shaped with outwardly flaring legs 19, that provide a support for the press against the walls of a concrete pit 17. The base structure at the same time provides space for the accommodation of two oil tanks 32 and 33, the purpose of which is more fully stated hereafter. Within the pit a motor M, a pump 62 and two cylinders 48 and 73, comprising part of the bolster operating mechanism, are disposed so as to be protected in the way above described.

Tierods 18 extend through the entire height of the uprights up to the crown and secure the parts together to form the complete frame. A ram 20 carrying an upper die *a* is mounted for reciprocating movement between guideways 21 so as to

cooperate with a lower die b, supported by a vertically movable bolster 22.

The mechanism for raising the bolster in increments and the hydraulic system which operates said mechanism are shown in Figs. 3 and 5. This mechanism is such that the bolster may be raised and lowered as desired and also is automatically operable to raise the bolster a predetermined amount during each cycle of operation of the press until the work is completely formed. At the last step or stage of work formation, the bolster becomes set or conditioned for the exertion of a considerably increased pressure upon the work piece in opposition to the ram action of the press.

Referring more particularly to Fig. 3, the movable bolster 22 consists of a casting having shoulder portions 23 with shims 24 stacked thereon for adjustment or final determination of the upper limit of movement of the bolster with respect to the press bed and thus indirectly with respect to the ram 20 and any die mechanism carried thereby. As shown in this figure, the bolster is in the uppermost position with the shims 24 acting as a stop for the bolster.

The two tanks 32 and 33 are accommodated between the inner wall 30 and the outer wall 31 of base 16. Tank 32 is an accumulator connected to an air pressure line (not shown) by which the tank is held under a constant pressure of about 50 pounds per square inch. Tank 33 contains oil under atmospheric pressure and is a storage tank. Both tanks are fitted with openings 35 for purposes of filling, cleaning and the like; the openings are ordinarily closed by lids 36. A float switch is provided in tank 32 in order to return oil from this tank to storage tank 33.

The bolster 22 is operated by a hydraulically operated piston 38 slidingly mounted in a cylinder 39, hereinafter called the main cylinder and which can comprise part of the bed formation of the press. A packing 40 is interposed between piston and cylinder and held in place by a retainer 34.

The piston rod of piston 38 is designated by 43; it is a hollow rod which is mounted for sliding movement in the bottom wall of cylinder 39, with a packing 51 held by a packing nut 52 interposed for sealing the parts. The top of rod 43 is secured to a central boss 45a of piston 38 between a shoulder 44 and a nut 46. The bottom end of the rod carries a nut 45 which supports a stepped annular piston member 47 rigidly secured to the rod and slidably received in a cylinder 48, hereinafter called the bolster locking or arresting piston and cylinder. Between the cylinder wall and piston 47 a packing 49 is held by a retainer 50 and another packing 53 is held by packing nut 54 between member 47 and rod 43.

The space between the top of the arresting cylinder 48 and piston member 47 is filled with oil, which prevents the piston 38 and thereby the bolster 22 from being raised except in a predetermined manner as hereafter provided. This cylinder and piston, therefore, function after the manner of a locking cylinder. As shown, piston 38 may comprise a head 41 which is partly hollow and accommodates another cylinder 42 within its confines, which is called the knockout cylinder, since it serves for removing a finished work piece from the dies carried on the bolster 22. The knockout cylinder has wide laterally extending flanges 37 supported by shoulders 29 on the piston head 41. Within cylinder 42 a piston 56 is slidingly received, which carries the knockout rod 57. A tube 55, connecting with an air line 58 extends through the hollow center of rod 43 and leads up to knockout cylinder 42, serving as an air conduit for that cylinder. As shown in Fig. 4, a hand operated valve 59 is arranged in line 58. This valve has an exhaust port (not shown). Piston 56 and its rod 57 are thus operated pneumatically whenever finished articles are to be removed from the dies.

As already mentioned, the lifting mechanism, which effects the raising of the bolster, is operated hydraulically and the system of pipes and valves for operation of the device will now be described. From tank 33 a pipe 60 leads to a pump 62 and from there pipe 63 connects to a pump relief valve 64. One line 65 branches off from valve 64 and returns to the storage tank 33, while another line 66 leads on to a four-way valve 67 operated by two solenoids, N_1 and N_2 (Fig. 6). From valve 67 a pipe 68 leads through operating valve 69 over line 70 into the cylinder 39, whereas another branch, 72, leads to a booster cylinder 73, the purpose of which will be described below.

From valve 67 one pipe 80 connects with line 65 leading back to tank 33, whereas another branch 81 connects over a check valve 82 to a valve 83 which is another solenoid controlled valve, the solenoid being O_1, O_2 in Fig. 6. Valve 83 has one branch pipe 84 connecting to return pipe 65 and another pipe, 85, which connects to bolster arresting cylinder 48 and is used for filling this cylinder before the operation of the machine is started. From pipe 85 a pipe line 86 leads up to another part of the system, containing the feed control proper; the cylinder 48 is connected to pipe line 86 during the operation of the machine.

For adjusting bolster 22 or determining its down position before the machine is started, a manually controlled mechanism is provided which comprises two cylinders 105 with pistons 106 slidable therein, capable of limiting the downward travel of bolster 22 and of raising the same against the shims when no work piece is in the dies. A pipe line 103 connects these cylinders through valves 102 and 101 to a pipe 100 leading into the pressure tank 32. In case valve 101 is open and bolster 22 is lowered while being supported by pistons 106, the oil in cylinders 105 will act as a cushion to limit the down travel of the bolster to the extent desired. A return pipe 107 is arranged between valve 102, which is an overload relief valve and line 100.

It will be seen that the bolster mechanism is subjected to and supported by hydraulic pressure during all of the time work is being done by the ram and the bolster is moved upwardly as desired by such hydraulic pressure. The bolster is lowered by gravity or can be forced down mechanically by the ram as desired, all of which will hereafter appear.

To fill the main cylinder 39 with oil at the beginning of an operation, a valve mechanism is arranged in a pocket 108 formed in the bottom wall of the main cylinder. This valve mechanism functions by reason of a check valve 110 formed on the end of a piston 109 valve 110 is normally maintained in open position by the back pressure on the oil in reservoir 32 which causes oil to flow, insofar as volume permits, into the cylinder 39. Thus, in normal operation the pressure within the main cylinder 39 will not fall below the pressure within the reesrvoir 32. The pressure in tank 32 tends to raise the bolster mechanism during any period the valve 110 is open, but the locking mechanism limits the time and amount of such raising.

On the other hand, by reason of the one-way action of the valve 110, the pressure can be built up in the cylinder 39 by the pump through line 70; at the end of the bolster feed, still higher pressure may be exerted by booster piston 75; during that time the valve 110 will be closed.

As shown, the check valve 110 is operatively disposed within a housing 112 fitted within the said pocket 108. The housing has a narrow upper portion, in which piston 109 is slidingly received, and a wider lower portion, the latter forming a valve chamber; an outwardly extending flange 111 of the housing forms a bottom at the end of the pocket 108. Several radial openings in the lower part of the housing 112 allow the free passage of oil from the tank 32, through line 122, passageway 121 and between the cone-shaped valve 110 and its seat 114 into the interior of the main cylinder 39.

Secured to valve 109—110 is a hollow piston rod 113 connected to a conduit *d* which extends through the valve 110 and piston 109 and communicates with the top portion of cylinder 112 where an air chamber is formed.

The bottom end of rod 113 carries a disk-shaped piston head 115 slidably received in a cylinder 116 open to the atmosphere through opening *f*. A bore in the top wall of cylinder 116 permits rod 113 to pass freely for up and down movement, but is sealed by a packing against oil leakage. The central bore or passageway *d* through the rod 113 serves to maintain the inner top portion of cylinder 112 under atmospheric pressure the communication with the atmosphere being made by means of a radial bore *e* in rod 113.

From the bottom of the cylinder a pipe 117 leads to a valve 118 having an air inlet connected to a pressure line and exhaust 119 and 120 respectively.

This mechanism serves for maintaining the valve 110 open against the pressure in the bolster cylinder 39, by admitting compressed air to cylinder 116 through pipes 117 and 119, and it is only operated when it is desired to force oil out of the bolster cylinder, i. e., when the locking piston is being forced down by pressure from oil pump 62. To permit closing of valve 110, valve 118 is connected to the exhaust 120, whereupon pressure accumulated in the cylinder 116 is released. The pressure in tank 32 will raise valve 110 when there is occasion for oil to flow into the bolster cylinder 39. As already mentioned valve 110 serves for admission of oil to main cylinder 39 from tank 32 owing to the air pressure in tank 32 when the raising of piston 38 is performed, as will be described under "Operation."

The booster mechanism mentioned above as forming part of the hydraulic system, is more fully shown in Fig. 4. The mechanism comprises a duplex piston and cylinder arrangement having two diameters. A unitary cylinder structure, in the form of cylinder 73 and a smaller cylinder 74, is attached to the bottom of main cylinder 39. A piston 75 is formed with two different diameters to fit the dual cylinder. Pressure exerted on the wide head 76 of the piston will be transmitted by the smaller end and increased in amount corresponding to the difference in surface areas. The upper cylinder portion 74 is in direct communication with main cylinder 39. The device serves for building up high pressure in the oil chamber beneath main piston 38 for the final part of the forming cycle at the time bolster 22 is in the up position. Cylinder 73 is, therefore, called an "intensifier" or booster.

An adjustable valve mechanism 77 serves as relief valve for overload in main cylinder 39 and this mechanism may be such that any desired maximum pressure may be predetermined at which oil will be released from bolster cylinder 39 while the bolster is being subjected to pressure from the ram of the press.

The feed mechanism proper is best shown in the left-hand top portion of Fig. 3 and in Fig. 5. The mechanism comprises a hand wheel 90 for adjustment of feed. By this adjustment the amount of upward movement, usually a fraction of one inch, is determined by which the bolster is raised at each feeding step. Wheel 90 is mounted on a shaft 92 which also carries a cam 93. Cam follower 94, engaging with said cam, is supported by a clevis 79, forming part of a plunger rod 95; the latter has secured thereto a plunger head 96 which is mounted to slide vertically in a cylindrically formed slideway 97. The slideway has a vertical slot 98, to both sides of which a scale is mounted and an indicating member 99 riding in said slot shows the increment for which the feed is set.

The top end of slideway 97 is flanged as at 91 and on said flange an oil measuring feed cylinder 130 is mounted in vertical alignment to slideway 97. The adjusted or predetermined amount of oil to be received by this cylinder determines the amount of the upward feed of the bolster. A bottom plate 131 in said cylinder has a central bore 132 which slidingly receives a rod 133 having an air-tight seal at 134. Rod 133 is part of head 96 and acts as a stop for a piston 136 that is forced downwardly by oil escaping under pressure from the locking cylinder 48 into the top of an oil measuring cylinder 130. The piston 136 is provided with double packing 137—138 held respectively by plates 139 and 140 respectively. Nuts 141—142 on threaded formations on the top and bottom of the piston 136, hold the plates and packing in place. Fitted by screw connection or in any other suitable way to nut 141 is a rod 143 slidingly mounted in a sleeve 146 in the top plate 144 covering cylinder 130. Rod 143 connects with a switch B, the function of which will later be described.

Near the bottom of the oil measuring cylinder 130 is an air inlet 135 for the admission of compressed air to force piston 136 up and force the measured oil out of the top of cylinder 130. A bore 145 in cover plate 144 provides an inlet for an oil line 147 connecting to a valve 148, controlled by a pressure switch A. Pipe 149 leads to valve 87 which has a connection to line 86 on the one hand, and through a pipe 89 to tank 33, on the other hand. A second valve 88, arranged at the other side of line 86, is connected to tank 33 by a pipe 104.

As shown in Fig. 1, the above described feed control device is mounted on one of the uprights of the machine frame 10.

It is apparent that the air valve 118 should be operated to have the air pressure cut off of the valve 110 when the oil measuring system associated with the locking mechanism is active, that is, when valve 87 opens to connect the locking cylinder to the measuring cylinder 130.

Wiring diagram

The wiring diagram showing the electric connections is illustrated in Fig. 6. L_1 and L_2 are the main lines carrying current from a power station. Connected in the circuit are a number of solenoids which upon energization control the hydraulic valves described above. A number of push

buttons arranged on the machine frame for actuating switches associated therewith make the necessary connections which will cause the energizing of the respective solenoids. Each push button is designated by a name in Fig. 3 and, corresponding thereto, the names appear in Fig. 6 on the parts actuated by said buttons.

From line L_1 lines 250, 251 lead to a switch D which is timed with the crankshaft shown diagrammatically at C. For each revolution of the crankshaft switch D will be opened and closed once. From switch D a line 253 connects to a pressure switch A, which is likewise timed with the crankshaft C and operates valve 87 to open it to storage tank 33 at a predetermined time. From this switch, line 254 leads to solenoid E_2 and over lines 255 and 252 to main line L_2. With E_2 in energized state, valve 87 is in a position to allow the flow of oil from pipe 86 to pipe 149.

The four-way valve 83, which controls flow of oil to line 85 and locking cylinder 48, is operated by a two-way switch 268 actuated by button "down." This switch also controls valve 118. In the normal position, as shown in the drawings, the switch is open; valve 83 is then connected to tank-return pipe 84, valve 118 to exhaust pipe 120 and valve 110 is closed. The circuit established with switch 268 open is the following: From line L_1 over line 259, switch 260 in open position, lines 266, 267, switch 268, line 275, solenoid O_2, line 274, back to main line L_2.

When button "down" is depressed and switch 268 closed the following circuit will be established: From L_1 over 259, switch 260 in open position, lines 266 and 267, switches 268, 269, line 270, solenoid O_1, line 272 and 274, back to L_2. At the same time current will flow over branch line 271 to solenoid T, lines 273 and 274 back to L_2. Valve 118 will open air line 119 to cylinder 116 and valve 110 will be open to tank 32. Solenoid O_1 operates valve 83 so as to open it toward line 85 and allow oil to flow into cylinder 48. Valve 67 shuts off the oil to the booster cylinder 73 and line 70 and by-passes the oil from the booster cylinder, through 89 and 65 back to the storage tank 33.

In order to control the delivery of oil in line 86 from locking cylinder 48 through line 85 a switch 258 associated to button "feed" is provided, which is normally open. Closing of this switch by depressing button "feed" and energization of solenoid E_1 caused thereby, opens valve 87 permitting the passage of oil from the locking cylinder 48 to line 86. Oil is thereby free to pass through said line and valve 87 up to line 149 and from there into the feed control or measuring cylinder 130.

Two more switches, to-wit B and 257, are shunted to the electric circuit (which controls valve 87) just described. Switch B is closed each time the rod 143 on its upward stroke knocks against the spring on switch B (see Fig. 5). Switch 257 is a switch which controls automatic feed when in the "on" position, as shown in the drawings. That is to say, piston 136 in feed or measuring cylinder 130 will reciprocate and thereby, at each cycle of operation, automatically set the valves so that a measured amount of oil is permitted to escape from cylinder 48 whereby main piston 38, and simultaneously the bolster carrying the dies, is raised by the desired increment. If switch 257 is in the "off" position this automatic feed stops or does not function. Any desired number of work pieces could then be operated on in the same position of bolster 22. This, as a matter of fact, is another way to operate the machine, which will be described under "Operation."

A switch which is operated toward the end of the metal working process is switch 260 (preload). This serves to perform the final step under a raised pressure, such for example as 2500 tons. When switch 260 is closed current will flow from L_1 over line 259, through 260 to line 261, solenoid N_1, line 262 back to L_2. Solenoid N_1 operates valve 67, causing oil to flow through pipe 68 to pipe 70 and to main cylinder 39, and at the same time to the intensifier 73 through valve 69 which acts as a check valve to line 70 when the intensifier builds up to the desired pressure. Thus, by pump action oil is forced into both these cylinders in building up to a certain pressure and thereafter the booster effects the final high pressure desired in cylinder 39.

The release of pressure is brought about by closing switch 263 (release). Solenoid N_2 will be energized thereby and current will then flow from L_1, over line 259, switch 260, line 266, switch 263, N_2, line 262, back to L_2. This will cause valve 67 to open toward line 80, allowing oil to flow back to tank 33.

Finally a switch 276 (up) cooperates with switch 269, which is a pressure switch, in closing a circuit for the operation of solenoid F that controls valve 88. This valve is hand operated and when open to pipe 104 will return oil to tank 33 in case of excess pressure in the system, in which case pressure switch 269 is pivoted to the position shown in dotted lines in the drawings.

Operation

When the machine is to be adjusted for operation the bolster 22 is first placed in all down position, the pistons 106 in cylinders 105 are in abutment with the bottom of the bolster. Valve 101 is open.

After the dies have been placed in the press, the bolster is raised so as to give the correct closed position. For this purpose shims 24 are stacked on shoulders 23 until the maximum up position is determined. The operator then presses "down" button and the bolster is lowered thereby to position the dies where the metal working is to be started. Valve 101 is then closed, so that the down position of bolster 22 is fixed by the thus determined position of the members 106.

It now depends on whether it is intended to run the whole series of workpieces through, while the bolster is at a given level, then raise for an increment, pass the batch of workpieces through, raise again, and so on; or raise, step by step, for all the intended increments while one work piece is in the press, remove the same, lower the bolster to starting position, treat a second work piece from beginning to completion, and so forth.

If process number 1 is chosen, the button "feed repeat" should be in off position; in the other case it should be in the "on" position.

As mentioned above, the increments are determined by setting plunger head 96 by means of hand wheel 90 so that the indicator 99 will point to the desired fraction of an inch on the scale. If, for instance, each feed should amount to $\frac{1}{8}$ of an inch, the plunger head is set as shown in Fig. 5. The position of the head 96 determines that of stop piston 133 and, thereby, the length of the stroke of piston 136. If a larger fraction of an inch should be fed, the travel of piston 136 should be longer, stop piston 133 has consequently to be adjusted or set at a lower position.

Before the operation starts and while the bolster and attached piston 47 are in down position, oil from tank 33 is pumped by pump 62 through valve 83 and pipe 85 to locking cylinder 48. When in operation bolster 22 is to be raised, a measured amount of oil is allowed to flow out of the locking cylinder by pressing button "feed" which opens valve 87, whereupon the pressure in tank 32, which amounts to about 50 pounds, permits oil to pass through valve 110 into the main cylinder 39 and thereby to raise the bolster the desired amount.

The oil discharged from cylinder 48 passes over line 86 through valve 87, line 149, valve 148, into the measuring cylinder 130, where it forces piston 136 down until this piston hits against stop 133. By that time the oil pressure in cylinder 130 and line 149 will be high enough to operate pressure switch A which reverses valve 87 to a position open to line 89 leading to tank 33 so as to permit the measuring cylinder to be emptied of oil. For this purpose air under pressure is admitted to the measuring cylinder 130 through pipe 135 which pushes the piston 136 up; upward movement of the piston and of rod 143 closes switch B. This acts to reverse the position of valves and to restart the cycle. As mentioned before, switches A and B are timed also with the crankshaft controlling the reciprocation of the ram and are, therefore, adapted to operate the successive rise of the dies at the proper moment in relationship with the movement of the ram.

After the workpiece has gone through the treatment in the die as the die is raised in increments, a finishing operation may be performed on each work piece under a higher bolster sustaining pressure. For this purpose the operator pushes the button "preload," whereby the valve of the intensifier is opened to oil admission and pressure is built up to 2500 tons or more on the bolster. Under this bolster sustaining pressure the work pieces can be run through the final operation. It will be apparent that many types of work pieces can be produced without utilizing the intensifier mechanism.

After this step the release button is pressed which releases the pressure on bolster 22 and the same is returned to the original starting position.

If, during any stage of the operation, an undesired overload occurs in the bolster mechanism, valve 77 will release oil from the main cylinder and return it to tank 32. Cylinders 105 are emptied by valve 102 to that tank.

Various arrangements for maintaining the oil at or below a maximum level in tank 32 can be utilized. In Fig. 3 an ordinary float operated valve mechanism generally is indicated by dotted lines, together with a return line extending to storage tank 33. Such return is desirable since in the course of operation of the machine some oil is being moved from tank 33 to cylinder 39 through line 70, which eventually is shifted to tank 32.

Other modes of applying the principle of my invention may be employed instead of the one explained, change being made as regards the mechanism herein disclosed, provided the means stated by any of the following claims or the equivalent of such stated means be employed.

I therefore particularly point out and distinctly claim as my invention:

1. In a machine of the class described, a frame, a ram adapted to carry an upper die, means for reciprocating said ram within said frame, a bolster to receive a die for cooperation with said die in said ram, means adapted to move said ram and said bolster by increments to progressively closer relative positions between the cooperating parts as the metal working proceeds, said means including a feed control mechanism comprising an element for setting the feed increment, a stop member rigidly connected to said setting element, a cylinder-piston means for effecting the feed control in cooperation with said stop member, and means for controlling the reciprocation of said piston in timed relationship with the reciprocation of said ram.

2. In a machine of the class described, a frame, a ram adapted to carry an upper die, means for reciprocating said ram within said frame, a bolster to receive a die for cooperation with said die in said ram, means adapted to raise said bolster by increments as the metal working proceeds, said means including a feed control mechanism comprising a hand controlled element for setting the feed increment, a stop member rigidly connected to said setting element, a cylinder-piston means for effecting the feed control in cooperation with said stop member, said piston being fluid operated during its operative stroke and air operated during its return stroke, and electrical means for controlling the reciprocation of said piston in timed relationship with the reciprocation of said ram.

3. In a machine of the class described, a frame, a ram adapted to carry an upper die, means for reciprocating said ram within said frame, a bolster to receive a die for cooperation with said die in said ram, means adapted to raise said bolster by increments as the metal working proceeds, said means including a feed control mechanism comprising a hand controlled element including a cam and cam follower for setting the feed increment, a stop member rigidly connected to said setting element, a cylinder-piston means for effecting the feed control in cooperation with said stop member, means for reciprocating said piston in timed relationship with the reciprocation of said ram, said means including valve mechanism controlling the delivery of oil into said cylinder to act on said piston during its operative stroke and the admission of air at the opposite side of said piston for acting on the same during the return stroke.

4. In a machine of the class described comprising a reciprocating ram adapted to carry an upper die, a workpiece holder to receive a die for cooperation with said die in said ram, means to raise said workpiece holder by increments in combination, means including a cylinder and a piston for locking said workpiece holder against being raised, control means for intermittently relieving said locking means, said control means comprising a double acting piston adapted to advance under oil pressure and recede under pneumatic pressure, and electrically operated valve means permitting the admission of oil to said control means.

5. In a machine of the class described comprising a reciprocating ram adapted to carry an upper die, a bolster to receive a die for cooperation with said die in said ram, and hydraulic means to raise said bolster by increments in combination, cylinder and piston means for locking said bolster against being raised, control means comprising a cylinder and a double acting piston for intermittently relieving said locking means and a plurality of electrically operated valves, one of said valves when in one position being adapted to open a pipe connection for permitting escape

of oil from said locking cylinder to said control means, and when being in the other position adapted to shut off said locking means and allowing oil to return from said control means to a reservoir, and electric means for resetting said valves to its first mentioned position after said bolster has been raised for an increment.

6. In a machine of the class described comprising a reciprocating ram adapted to carry an upper die, a bolster to receive a die for cooperation with said die in said ram, and hydraulic means to raise said bolster by increments in combination, cylinder and piston means for locking said bolster against being raised, control means comprising a cylinder and a double acting piston for intermittently relieving said locking means and a plurality of electrically operated valves, one of said valves when in one position being adapted to open a pipe connection for permitting escape of oil from said locking cylinder to said control means, and when being in the other position adapted to shut off said locking means and allowing oil to return from said control means to a reservoir, and electric means adapted to be actuated by said double acting piston on the return stroke thereof, thereby resetting said valve to its first mentioned position after said bolster has been raised for an increment.

7. In a machine of the class described comprising a reciprocating ram adapted to carry an upper die, a workpiece holder to receive a die for cooperation with said die in said ram, means to raise said workpiece holder by increments in combination, means including a cylinder and a piston for locking said workpiece holder against being raised, control means for intermittently relieving said locking means, intensifying means for building up high pressure on said workpiece holder for the finishing step, said control means comprising a double acting piston adapted to advance under oil pressure and recede under pneumatic pressure, and a plurality of electrically operated valves, one of said valves permitting escape of oil from said locking means simultaneously with the admission of oil to said control means in one position, and shutting off said locking means and returning oil from said control means to a reservoir in its other position, and another valve for admitting oil to and shutting it off from said intensifying means respectively.

8. In a machine of the class described comprising a reciprocating ram adapted to carry an upper die, a workpiece holder to receive a die for cooperation with said die in said ram, means adapted to move said ram and said workpiece holder by increments to progressively closer relative positions between the cooperating parts after a series of workpieces have passed each single working step, said means including a cylinder and a piston for locking said workpiece holder against being raised, control means for intermittently relieving said locking means, said control means comprising a double acting piston adapted to advance under oil pressure and recede under pneumatic pressure, and electrically operated valve means permitting the admission of oil to said control means.

9. In a machine of the class described comprising a reciprocating ram adapted to carry an upper die, a bolster to receive a die for cooperation with said die in said ram, and hydraulic means to raise said bolster by increments after a series of workpieces have been passed through a single operating step in combination, cylinder and piston means for locking said bolster against being raised, control means comprising a cylinder and a double acting piston for intermittently relieving said locking means and a plurality of electrically operated valves, one of said valves when in one position being adapted to open a pipe connection for permitting escape of oil from said locking cylinder to said control means, and when being in the other position adapted to shut off said locking means and allowing oil to return from said control means to a reservoir, and electric means for resetting said valves to its first mentioned position after said bolster has been raised for an increment.

10. In a machine of the class described, a reciprocating ram adapted to a workpiece holder to receive a die for cooperation with said die in said ram, combined hydraulic and pneumatic means to raise said workpiece holder by increments, means for locking said workpiece holder against being raised, control means for intermittently relieving said locking means, and electric means having two operating positions, one of said positions being adapted to operate said control means after each reciprocation of said ram, in case a single workpiece is to be worked upon through all the increments successively, the other of said positions being adapted to operate said control means after a plurality of reciprocations, in case a series of workpieces is to be worked upon in every step.

11. A progressive drawing press having a frame with a die carrying ram and a shiftable die holding element each supported in spaced relation to the other for movement in said frame, drawing press mechanism for reciprocating the ram through a range extending toward and away from the shiftable die holding element, intermittently operated means operative with a force to move said shiftable die holding element toward one extreme reciprocated position of a die carried by the ram, a second intermittently operated means counteractive to that of the first named means to hold the shiftable element in a predetermined position and thereafter to move the die holding element away from said extreme position of the die carried by the ram and automatically operated means for predetermining the point of holding action of the intermittently operated counteracting means upon the first named means during each cycle of operation of the ram.

12. A progressive drawing press having a frame with a die carrying ram and a shiftable die holding element each supported in spaced relation to the other for movement in said frame, drawing press mechanism for reciprocating the ram through a range extending toward and away from the shiftable die holding element, hydraulic means operative with a force to move said shiftable die holding element toward one extreme reciprocated position of a die carried by the ram, a second hydraulic means counteractive to that of the first named hydraulic means to hold the shiftable element in a predetermined position and to move the die holding element away from said extreme position of the die carried by the ram and automatic means for predetermining the point of holding action of the second hydraulic means upon the first hydraulic means during each cycle of operation of the ram.

13. A progressive drawing press having a frame, die carrying ram and a shiftable die holding element each supported in spaced relation to the other for movement in said frame, drawing press

mechanism for reciprocating the ram through a range extending toward and away from the shiftable die holding element, hydraulic means operative with a force to move said shiftable die holding element toward one extreme reciprocated position of a die carried by the ram, a second hydraulic means counteractive to that of the first named hydraulic means to hold the shiftable element in a predetermined position and thereafter to move the die holding element away from said extreme position of the die carried by the ram and automatically operated means for predetermining the point of holding action of the second hydraulic means upon the first hydraulic means during each cycle of operation of the ram.

14. A progressive drawing press having a frame, die carrying ram and a shiftable die holding element each supported in spaced relation to the other for movement in said frame, drawing press mechanism for reciprocating the ram through a range extending toward and away from the shiftable die holding element, intermittently operated hydraulic means operative with a force to move said shiftable die holding element during each cycle of operation of the press toward one extreme reciprocated position of a die carried by the ram, a second hydraulic means intermittently counteractive to that of the first named hydraulic means to hold the shiftable element in a predetermined position and automatically operated means for predetermining the point of holding action of the second hydraulic means upon the first hydraulic means during each cycle of operation of the ram.

15. A progressive drawing press having a frame; a pair of die holder elements, each supported in spaced relation to the other for movement on said frame; means for reciprocating one of said elements through a range extending toward and away from the other element; means operative, with a force, to move said other element toward one extreme of said range of reciprocatory movement; other means operative to move said other element away from said range extreme; and means for predeterminately varying the force exerted by one of said moving means while the reciprocative element is moving intermediate said extreme and the other extreme of its reciprocatory range, whereby said other element, responding to the moving means, is moved a desired distance relative to the reciprocatory range of the reciprocative element.

16. A progressive drawing press having a frame; a ram supported for a range of reciprocatory movement on said frame; a die holder supported on said frame, proximate to and for movement relative to one extreme of the range of reciprocatory ram movement; means for reciprocating the ram through said reciprocatory range toward and away from the die holder; fluid pressure responsive means operative to move the die holder toward said range extreme; other fluid pressure responsive means operative to move the die holder away from said range extreme; fluid control means associated with one of said fluid pressure responsive means for producing a balanced counteracting response between the two fluid pressure responsive means to retain the die holder against movement, said fluid control means being operative for a predetermined time period to effect a fluid pressure differential between said fluid pressures whereby the die holder, responding to one responsive means, is moved a desired distance relative to said range extreme.

17. In a machine of the class described, a reciprocating ram adapted to carry an upper die, a shiftable bolster to receive a lower die for cooperation with said upper die, a main cylinder, a hydraulically operated piston for supporting the bolster and the lower die whereby the bolster and the lower die and the piston may be hydraulically and unitarily supported by fluid in the cylinder during a work forming operation, controlled hydraulic means for raising the piston an increment of total upward movement during each cycle of operation of the press including an opposing hydraulic locking means acting on said bolster supporting piston to oppose the upward movement thereof at predetermined points of upward movement of the bolster supporting piston and settable controller means operated during each cycle of operation of the press for permitting the escape of a predetermined amount of fluid from the hydraulic locking means during each increment of upward movement of the bolster supporting piston.

18. In a machine of the class described, a reciprocating ram adapted to carry an upper die, a hydraulic cylinder, a shiftable bolster adapted to support a lower die for cooperation with said upper die, said bolster having surfaces adapted to abut the frame of the machine when in an extreme upward position, spacer elements disposed on the said bolster surfaces whereby the final up position of the bolster may be determined with respect to the ram, a hydraulically operated piston in the cylinder for supporting the bolster and the lower die whereby the bolster and the lower die and the piston may be hydraulically and unitarily supported by fluid in the cylinder during a work forming operation, controlled hydraulic means for raising the piston an increment of total upward movement during each cycle of operation of the press including an opposing hydraulic locking means acting on said bolster supporting piston to oppose the upward movement thereof at predetermined points of upward movement of the bolster supporting piston and settable controller means operating during each cycle of operation of the press for permitting the escape of a predetermined amount of fluid from the hydraulic locking means during each increment of upward movement of the bolster supporting piston and during the final upward movement of the bolster spacer elements into abutting relation to the machine frame.

19. In a machine of the class described, a reciprocating ram adapted to carry an upper die, a shiftable bolster adapted to support a lower die for cooperation with said upper die, a main cylinder, a hydraulically operated piston disposed in the cylinder for supporting the bolster and the lower die whereby the bolster and the lower die and the piston may be hydraulically and unitarily supported by fluid in the cylinder during a work forming operation, controlled hydraulic means for raising the piston an increment of total upward movement during each cycle of operation of the press including an opposing hydraulic locking means acting on said bolster supporting piston to oppose the upward movement thereof at predetermined points of upward movement of the bolster supporting piston, settable controller means operating during each cycle of operation of the press for permitting the escape of a predetermined amount of fluid from the hydraulic locking means during each increment of upward movement of the bolster supporting piston and thereby determine the extent of the said upward movement and a dumping valve mechanism for releasing the fluid from the main cylinder upon

the completion of the press performance upon the work.

20. In a machine of the class described, a reciprocating ram adapted to carry an upper die, a hydraulic cylinder, a shiftable bolster to receive a lower die for cooperation with said upper die, a hydraulically operated piston in the cylinder for supporting the bolster and the lower die whereby the bolster and the lower die and the piston may be hydraulically and unitarily supported during a work forming operation, controlled hydraulic means for raising the piston an increment of total upward movement during each cycle of operation of the press including an opposing hydraulic locking means acting on said bolster supporting piston to oppose the upward movement thereof at predetermined points of upward movement of the bolster supporting piston settable controller means operated during each cycle of operation of the press for permitting the escape of a predetermined amount of fluid from the hydraulic locking means during each increment of upward movement of the bolster supporting piston and a third hydraulically operated means in the form of hydraulically adjustable down step pistons for limiting the downward movement of the bolster when the machine is being conditioned for the reception of a work piece blank.

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