June 16, 1959 F. M. WILLIAMSON 2,890,669

MECHANISMS FOR HYDRAULICALLY CONTROLLING MOVEMENT OF PADS IN DIES

Filed Sept. 10, 1954 5 Sheets-Sheet 1

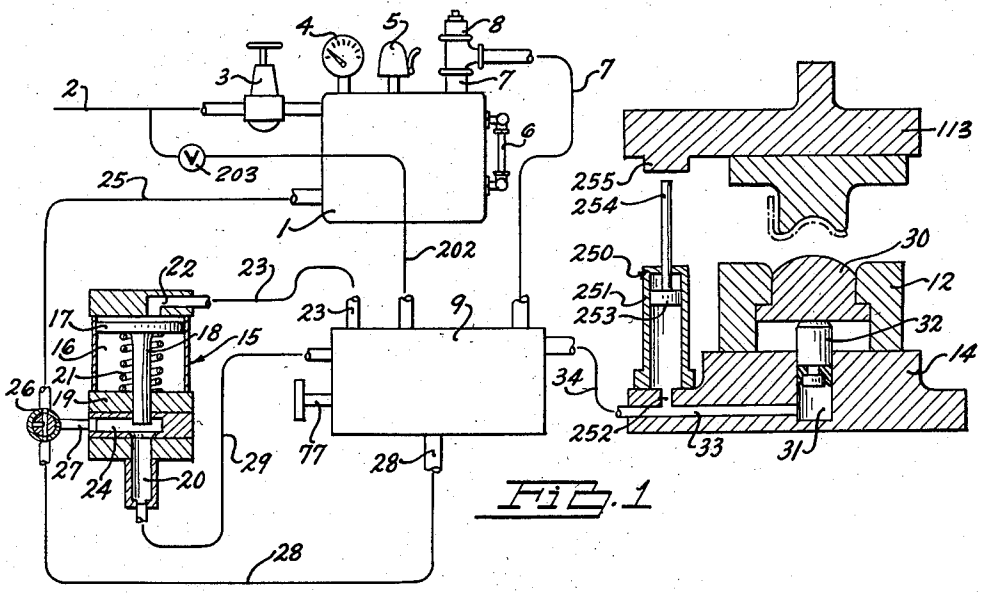


Fig. 1

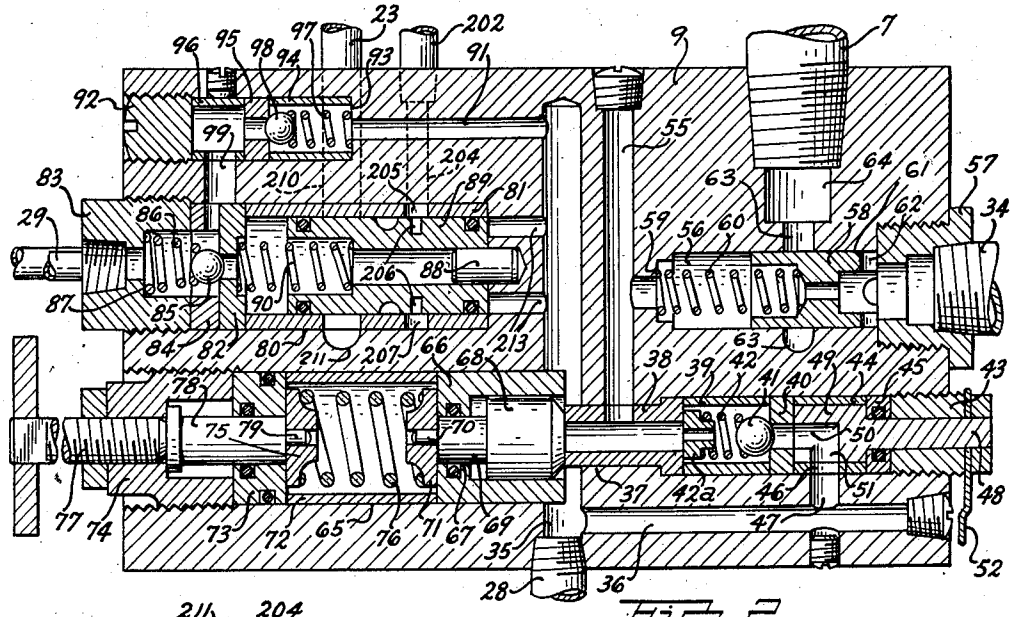


Fig. 2

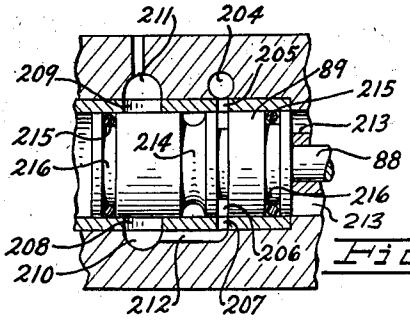


Fig. 4

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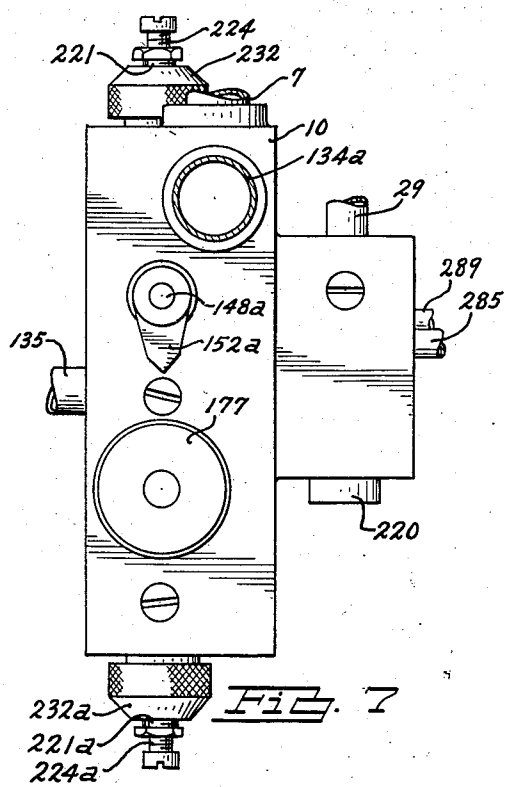


Fig. 7

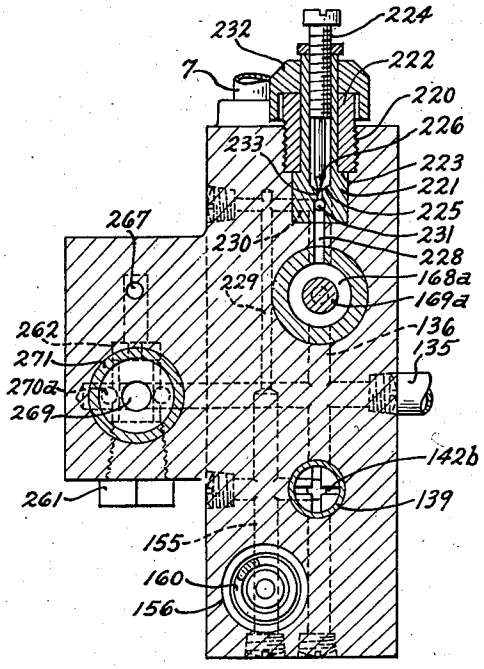


Fig. 8

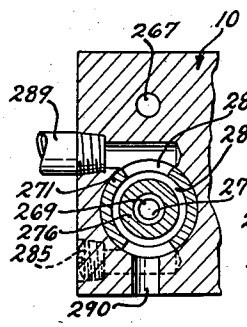


Fig. 13

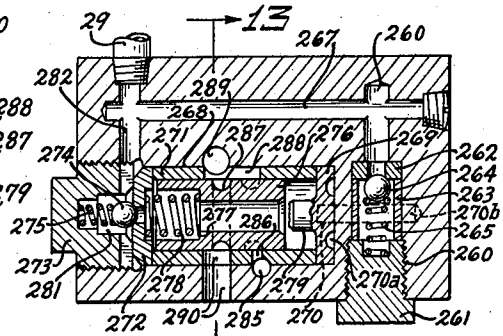


Fig. 12

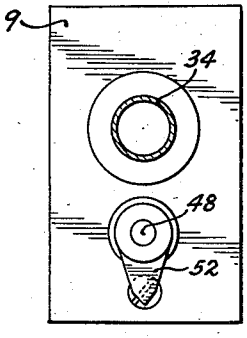


Fig. 3

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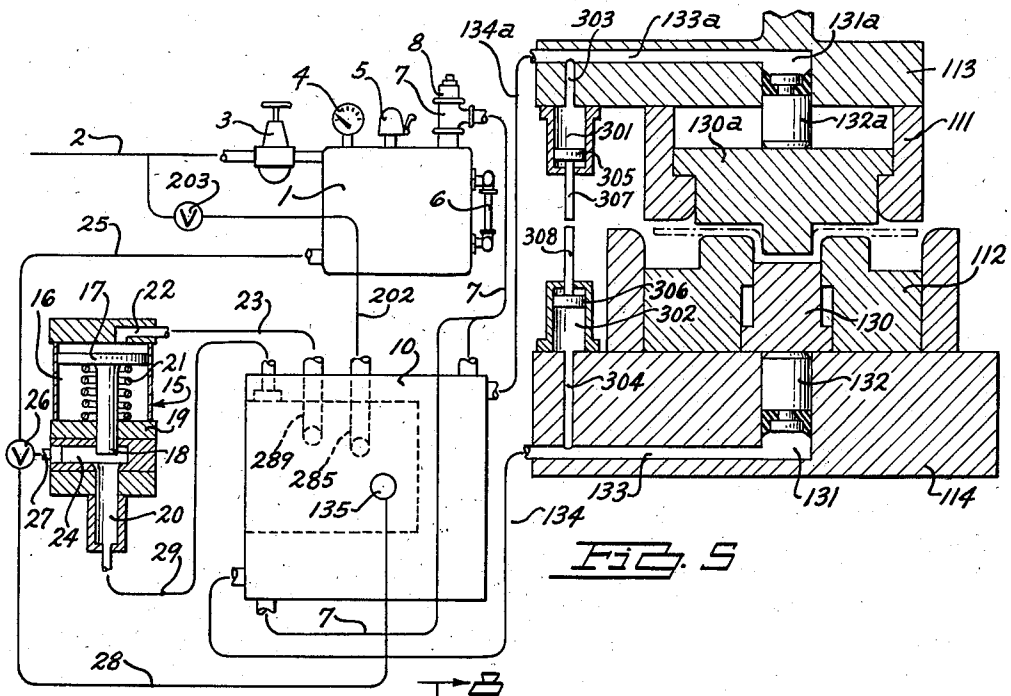


Fig. 5

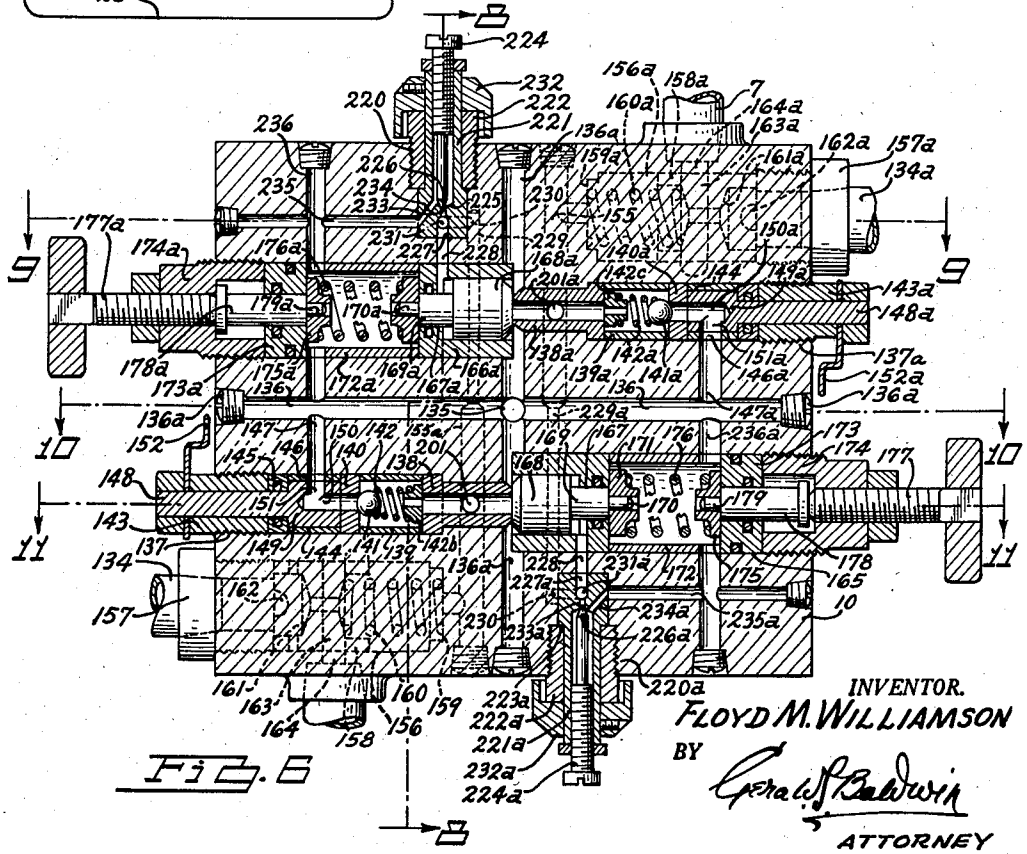


Fig. 6

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MECHANISMS FOR HYDRAULICALLY CONTROLLING MOVEMENT OF PADS IN DIES

Filed Sept. 10, 1954 5 Sheets-Sheet 4

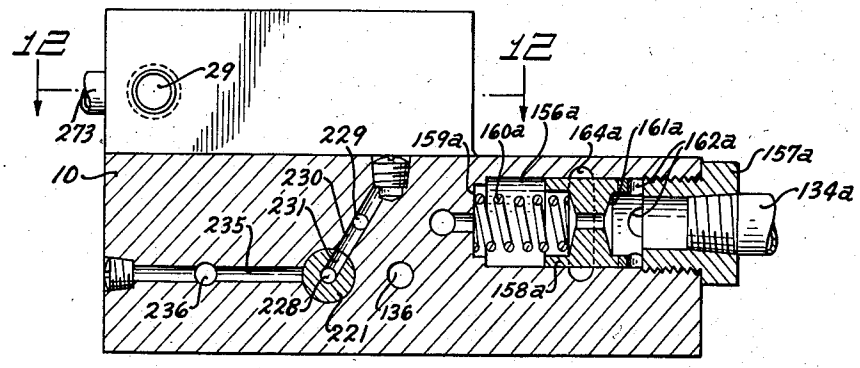


Fig. 9

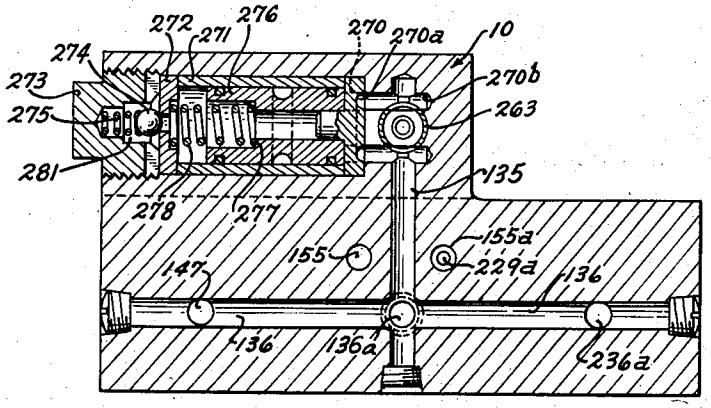


Fig. 10

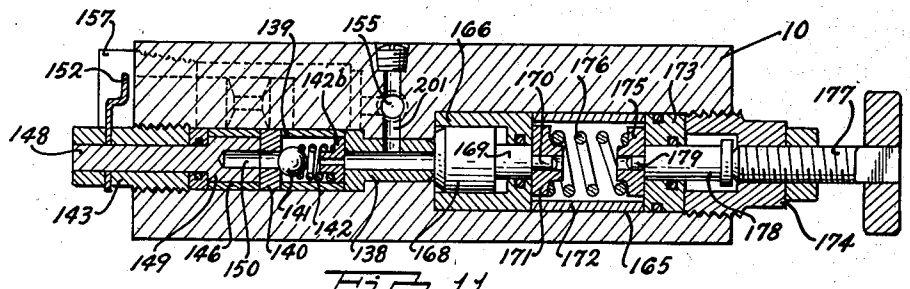


Fig. 11

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MECHANISMS FOR HYDRAULICALLY CONTROLLING MOVEMENT OF PADS IN DIES

Filed Sept. 10, 1954 5 Sheets-Sheet 5

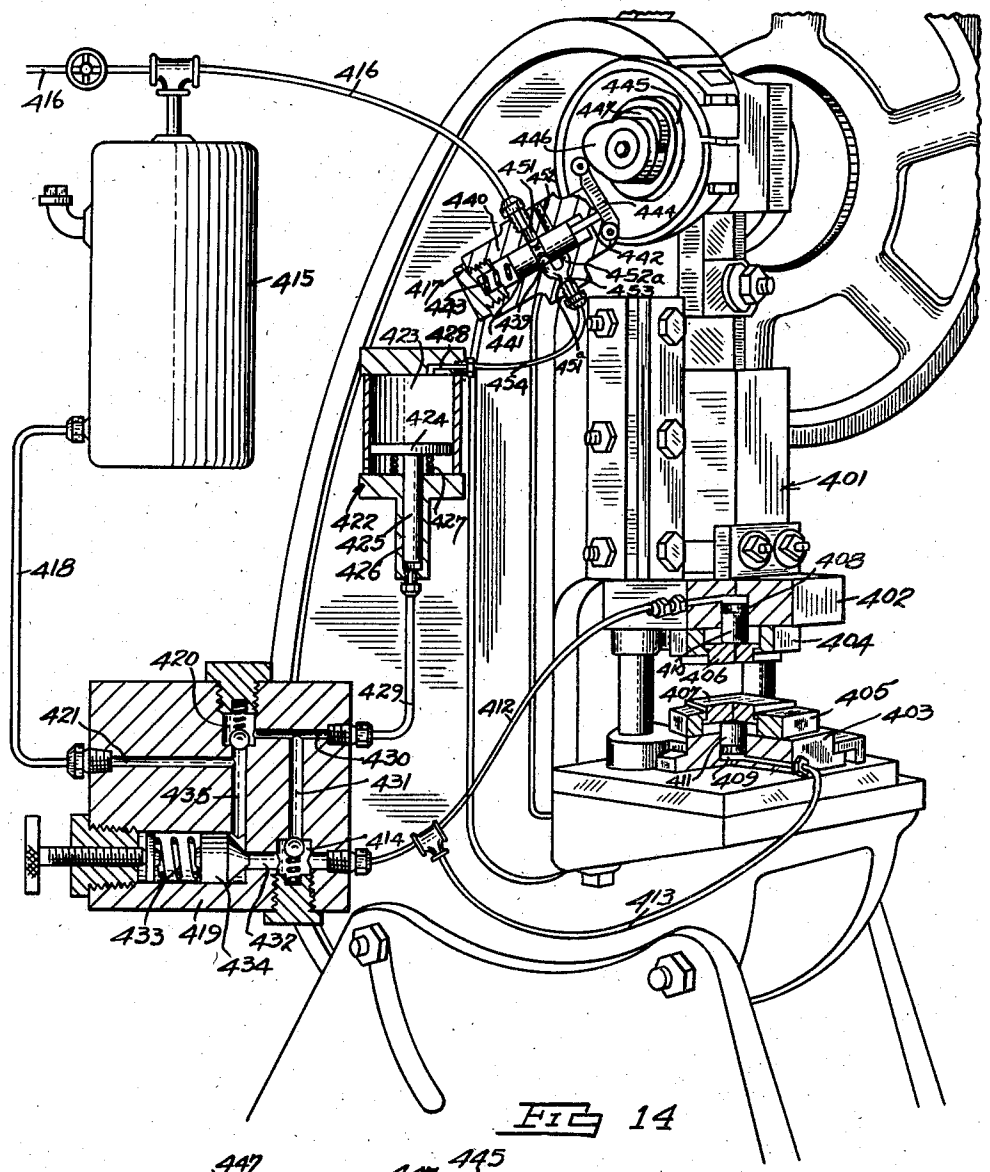


FIG 14

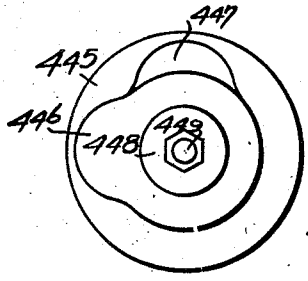


FIG 15

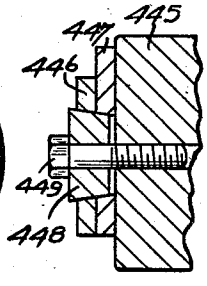


FIG 16

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United States Patent Office

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MECHANISMS FOR HYDRAULICALLY CONTROLLING MOVEMENT OF PADS IN DIES

Floyd M. Williamson, Detroit, Mich.

Application September 10, 1954, Serial No. 455,270

6 Claims. (Cl. 113—46)

This invention relates to improvements in mechanisms for hydraulically controlling movement of pads in dies.

At the present time springs are frequently employed for normally retaining pads in their forward positions in dies in mechanically operated presses. However their use for this purpose is open to a number of objections which include: lack of satisfactory means for adjustment of the pressure exerted for opposing inward movement of the pads; the fact that springs frequently break, or weaken with wear so that the pressure exerted by them does not remain constant; that the resistance offered by the springs to inward movement of the pads increases as the latter move inwardly, whereas uniform resistance to inward movement of the pads is desirable; and again, it is not possible to adjust the speed at which pressure acting upon the pads is released at the completion of the working portion of the stroke of the press.

It is an object of the invention to provide a mechanism for hydraulically controlling movement of a pad in a die, whereby a relatively low pressure is normally exerted upon the pad to retain it at its outward position, and whereby greater resistance is offered to inward movement of the pad during the working portion of the stroke of the press; and wherein the amount of resistance offered to the inward movement of the pad is adjustable, and, when adjusted, remains constant during the entire inward movement of said pad.

Another object of the invention is to provide such a mechanism which may operate either upon one pad, or upon two opposed pads, and wherein means are provided for separately adjusting the amount of resistance offered to the inward movement of each pad.

A further object of the invention is to provide such a mechanism wherein a booster is provided which may be employed for exerting somewhat increased pressure on the pads for moving them to their outward positions after completion of the working portion of the stroke of a press, as such increased pressure may be required for such purposes as stripping.

Another object of the invention is to provide such a mechanism wherein an intensifier is provided, for such operations as forming or drawing, by which gradually increasing pressure is exerted against the pads to retain them in their outward positions as the dies approach one another and prior to contact of the pads with the work. In this manner provision is made for proper engagement of the work by the pads and prevents wrinkling.

Yet another object of the invention is to provide such a mechanism wherein means are provided for retaining one paid immovable at its outward position until the other pad has been moved to its inward position against a predetermined amount of resistance, and wherein means are provided for freeing the first named pad for inward movement against a predetermined resistance as soon as the other pad has completed its inward movement. Moreover the same, or different amounts of, resistance may be offered to the inward movement of the two pads which occurs in sequence.

Another object of the invention is to provide such a mechanism wherein an unloader valve is arranged in the line between the pad actuating cylinder and the relief valve for the rapid release of any excess volume of hydraulic liquid that might otherwise build up greater pressure in the line than that for which the relief valve was set.

Another object of the invention is to provide such a mechanism for mechanically operated presses including a trapped hydraulic system wherein low pressure liquid, either direct from a tank or from a booster, flows to the pad operating cylinder during one portion of the stroke of the press, and during another portion of the stroke and by the operating of the press itself: The liquid is compressed and after it reaches a predetermined pressure is discharged through a relief valve; the booster is controlled by movement of the press; and the intensifier is operated by movement of the press. Consequently these movements must all synchronize with the movement of the press and function at certain portions of the stroke of the latter.

Another object of the invention is to provide means for delaying the return of the pad to its outward position to prevent distortion of the work before its removal from the press.

Having thus stated some of the objects and advantages of the invention I will now describe it with the aid of the accompanying drawings, in which:

Figure 1 is a diagrammatic view showing the mechanism applied to a pad mounted for movement in one die.

Figure 2 is a sectional view of the control device employed in Figure 1, and

Figure 3 is an end view thereof, on a reduced scale.

Figure 4 is a detail showing the valve through which fluid under pressure is admitted into and discharged from the booster.

Figure 5 is a diagrammatic view showing a modified form of the mechanism as applied to an upper and a lower pad mounted in an upper and a lower die, respectively.

Figure 6 is a sectional view of the control device employed in Figure 5.

Figure 7 is an end view of Figure 6.

Figures 8, 9, 10 and 11 are sections on the lines **8—8**, **9—9**, **10—10**, and **11—11**, respectively, of Figure 6.

Figure 12 is a section on the line **12—12** of Figure 9, and

Figure 13 is a section on the line **13—13** of Figure 12.

Figure 14 is a perspective view of a modified form of the invention applied to a press, and

Figures 15 and 16 are details of a cam arrangement employed thereon.

Referring first to part of the arrangement shown in both Figures 1 and 5, **1** designates a tank containing a hydraulic liquid, such as oil, on which pressure of say 100 pounds per square inch is maintained by compressed air delivered into the tank through a line **2** from a source not shown, though obviously other means may be employed for maintaining pressure on the hydraulic liquid. In the line **2** is a valve **3** for regulating the air supply to the tank **1**, and mounted on the tank are: a pressure gauge **4**, a relief valve **5**, and a sight gauge **6**. Extending from the tank **1** is a connection **7** provided intermediately of its length with a plugged opening **8** for filling the tank and terminating at its opposite extremity in a control device **9**, or **10**, the construction of which is hereinafter fully described.

15 denotes a booster by which the pressure of the liquid may be increased as it passes from the tank **1** to the control device **9**, or **10**, and includes a cylinder **16** having a piston **17** therein, and a rod **18** extending downwardly from the piston **17** which passes through a lower

cylinder cover 19 and is adapted to be reciprocated in a smaller cylinder 20 mounted coaxially with and beneath the cylinder 16. A helical spring 21 mounted around the rod and extending between the underside of the piston 17 and the top of the cover 19 normally retains the said piston in its raised position shown. A connection 22 opens into the top of the cylinder 16 and is connected by a pipe 23 to the control device 9, or 10, described hereafter, so that either air under pressure may flow into the top of the cylinder to force the piston 17 downward, or the air in the cylinder may be exhausted through the control device 9 or 10 whereupon the piston is returned by the spring 21 to its raised position shown.

Formed in one side of the booster 15 beneath the lower cylinder cover 19 is an inlet passage 24 which is in communication with the top of the smaller cylinder 20 and extends just below the bottom of the rod 18 when the latter is in its raised position shown. Extending from the tank 1 is a pipe 25 connected to one part in the body of a rotary 3-way valve 26. A second part in the body of the valve 26 positioned 90° away from the first port is connected by a pipe 27 to the inlet passage 24 and a third port 180° from the first port is connected by a pipe 28 to the control device 9 or 10. The rotary valve element has a diametric passage and a radial passage connected at right angles thereto. If liquid from the tank 1 passes into the smaller cylinder 20 and pressure is exerted upon it by downward movement of the rod 18, then the pressure of the liquid in the said cylinder beneath the rod 18, and in the pipe 29 connecting the lower extremity of the cylinder 20 to the control device 9 or 10, is increased. However if liquid is allowed to flow from the tank 1 through the pipes 25 and 28 to the control device, then obviously it reaches the latter at the same pressure as the liquid in the tank 1.

In the arrangement shown in Figure 1 a pad 30 is mounted for vertical movement in the lower die 12 and formed in a lower bolster 14 upon which the die is supported is a bore 31 in which a plunger 32 is mounted for reciprocation so that its upper extremity bears against and supports the underside of the said pad. Extending through the bolster 14 and terminating in the bottom of the bore 31 is a passage 33 to the outer extremity of which a line or pipe 34 is connected which extends from the control device 9. In this instance a solid upper die 11 is mounted on an upper bolster 13 for coaction with the lower die 12 and its pad 30.

I will now describe the control device 9, shown in Figures 1 to 4, inclusive, when the three-way valve 26 is so set that liquid under pressure flows directly from the tank 1 to the control device through the pipes 25 and 28.

Formed through the body of the control device 9 is a passage 35 to which the pipe 28 is connected, and extending from the passage 35, preferably at right angles thereto, is another passage 36. Formed also in the body of the control device, in the present instance substantially parallel with the passage 36, is an aperture 37 which terminates at its inner extremity in the passage 35. Mounted in the inner extremity of the aperture 37 is a bushing 38 the inner face of which is substantially in alignment with the axis of the passage 35. Bearing against the outer face of the bushing 38 is another bushing 39 of larger bore, and resting against the outer face of the bushing 39 is an annular seat 40 against which a ball inlet valve 41 is normally held by a helical spring 42 mounted in the bushing 39. The extremity of the spring 42 remote from the ball valve 41 bears against a spider 42*a* in the form of a cross so cut that liquid passes between its arms. This spider rests against the outer face of the bushing 38. Threaded into the outer extremity of the opening 37 is a nut 43 and interposed between the inner extremity of the latter and a bushing 44, which rests against the annular seat 40 is a disc 45 holding suitable packing. Formed radially through the bushing 44 is a port 46 which is in registry with an opening 47 in the body of the control device 9 and the opposite extremity of the opening 47 terminates in the passage 36. Extending axially through the nut 43 is a rotary spindle 48 which projects through the disc 45 and has an integral plug 49 of increased diameter at its inner extremity which is rotatable in the bushing 44. Extending axially into the plug 49 from its inner face is an aperture 50, and formed radially through the said plug from the aperture 50 is a passage 51 which is adapted to register with the port 46. Thus the spindle 48 may be so turned that a flow of liquid from the passage 36 passes into the aperture 50 to move the ball valve 41 from its seat. Moreover a pointer 52 is secured on the outer extremity of the spindle 48 so that the exact rotary position of the radial passage 51 may be determined relative to the port 46 to assist in gauging the extent of the flow to and past the ball valve.

Formed through the body of the control valve 9, preferably at right angles to the opening 37 is a passage 55 which also projects radially through the bushing 38 intermediately of the length of the latter, and extending from the passage 55 is another passage 56 preferably parallel with the opening 37. The passage 56 is of greatest diameter at its outer extremity which is threaded to receive a tubular connection 57 from which the line 34 extends. Inwardly of the threaded portion the passage 56 is of lesser diameter to receive an annular slide valve 58 the bore of which is greater from its inner extremity for a portion of its length. The inner extremity of the passage 56 is further reduced from and adjacent the passage 55 to form a shoulder 59 against which one extremity of a helical spring 60 bears. The opposite extremity of the spring 60 rests against the outer extremity of the enlarged portion of the bore of the valve 58. Projecting outwardly from and integral with the valve 58 is an annular member 61 having arcuate U-shaped notches 62 formed therein from its outer extremity. Formed in and around the passage 56 intermediately of its length and normally covered by the valve 58 is an annular groove 63, and extending from the latter through the body of the control device 9 is a vent 64 to which the pipe 7 is connected. The valve 58, groove 63 and vent 64 together with their coacting parts form the unloader valve hereinafter referred to.

From the foregoing it will be seen that liquid flows at the relatively low pressure in the tank 1 from the connection 28, through the passages 35 and 36, and, if the radial passage 51 in the plug 49 is in registry with the port 46, past the ball valve 41, through the passages 55 and 56, and through the annular valve 58 and pipe 34 to the bore 31 to raise the pad 30 to its outwardly extended position.

Extending through the control device 9 in alignment with the opening 37 is an aperture 65 having an annular bushing 66 therein the front extremity of which is in alignment with the axis of the passage 35. Moreover the outer extremity of the bore of the bushing 66 is materially reduced at 67. Mounted for axial movement in the bushing 66 is a plunger 68 which functions as a relief valve. The inner face of the plunger normally lies against the inner face of the bushing 38 and closes the adjacent extremity of the latter. The plunger 58 is bevelled around its outer periphery thereby forming an annular pocket in the inner extremity of the bushing 66. Extending outwardly from the plunger 68 is a coaxial guide 69 which is mounted for movement in the reduced opening 67 of the bushing 66. Formed integral with the guide 69 and projecting outwardly therefrom is a shank 70 on which a disc 71 is mounted. Resting against the outer face of the bushing 66 is a sleeve 72 which fits into the aperture 65, and resting against the outer extremity of the said sleeve is a circular member 73 which is held in place by a nut 74, in threaded engagement with the body of the control device 9. Bearing against the

inner face of the member 73 is a disc 75 and extending between the discs 71 and 75 is a helical spring 76. The nut 74 is internally threaded to engage a screw 77 the inner extremity of which bears against a rod 78 which projects through the member 73 and terminates at its inner extremity in a shank 79 on which the disc 75 is mounted.

When, by action of the press, pressure is exerted on the liquid in the cylinder 31 that liquid flows back through the passages 56 and 55 into the bushing 38 whence its passage into the port 46 is prevented by the ball inlet valve 41. Consequently the liquid exerts pressure against the plunger relief valve 68 and forces the latter outward against the tension of the spring 76 so that the said liquid enters the passage 35 and flows back to the tank 1 through the pipes 28 and 25. Obviously by adjustment of the screw 77 the strength of the spring 76 may be regulated so that the pressure needed to force the plunger relief valve 68 away from the bushing 38 may be adjusted. When the relief valve has been forced away from the bushing liquid flows from the bore 31 to and through the bushing 38 into the passage 35. When liquid under pressure is flowing through the annular valve 58 and past the relief valve 68, due to the fact that the outer portion of the bore of the valve 58 is smaller in cross section than any portion of the line between the said valve 58 and the relief valve 68, pressure in the line between the bore 31 and the valve 58 may build up to sufficiently exceed that in the line between the valves 58 and 68 to move the valve 58 inwardly and uncover the annular groove 63 so that excess liquid passes back to the tank 1 through the vent 64 and line 7. Thus the valve 58, the groove 63 and the event 64 constitute an unloader valve through which surplus liquid is allowed to return to the tank to prevent an accumulation of liquid pressure in excess of that for which the plunger relief valve is set. The purpose of the annular member 61 and its U-shaped arcuate notches 62 is to insure that the flow into the vent 64 commences sufficiently gradually, as the unloader valve opens, to prevent pulsation of the valve 58 which might otherwise occur.

Formed in the control device 9 is an opening 80 in which a bushing 81 is secured at its inner extremity. Resting against the outer extremity of the bushing 81 is an annular seat 82 which is retained in position by a nut 83 threaded into the outer extremity of the opening 80, and between the nut 83 and the seat 82 an annular spacer 84 is provided. The bore of the nut 83 is of increased diameter from its inner face for a portion of its depth and this inner bore portion is of substantially the same size as the bore of the spacer 84. A ball valve 85 is urged against the outer face of the annular seat 82 by a helical spring 86 the opposite extremity of which bears against a shoulder 87 formed around the outer extremity of the enlarged portion of the bore of the nut 83.

Secured in the control device 9 and projecting into the inner extremity of the opening 80 coaxial with the bushing 81 is a guide pin 88, and mounted for axial movement in the bushing 81 is an annular slide valve 89 the bore of which at its inner extremity is such that it is adapted to slide loosely on the guide pin 88. The outer portion of the bore of the slide valve is of increased diameter to receive one extremity of a helical spring 90 the opposite end of which bears against the inner face of the seat 82. Thus the valve 89 is normally retained in its position shown.

Formed in the control device 9 is an aperture 91 which in the present instance is parallel with the opening 80. This aperture is plugged at its outer extremity as shown at 92, and at its inner extremity opens into the passage 35. The outer extremity of the aperture 91 is of larger diameter than its inner portion and resting against the shoulder 93 formed at the inner end of its larger portion is an inner bushing 94 against the outer face of which an annular seat 95 rests, and extending between the outer side of the latter and the plug 92 is an outer bushing 96. Held against the inner side of the seat 95 by a helical spring 97, the opposite extremity of which rests against the shoulder 93, is a ball valve 98; and formed partly through the seat 82 and partly through the spacer 84, and also extending through the outer bushing 96 and also through the body of the control valve 9 is a passage 99.

From the foregoing it will be clearly seen that when liquid is delivered from the booster connection 29 it passes into the bore of the nut 83, whence it flows through the passage 99, unseats the ball valve 98 and passes through the inner portion of the aperture 91 into the passage 35. Thereafter the liquid flows to the bore 31 along the same path as that heretofore described relative to liquid which entered the control device 9 through the pipe 28.

When liquid under slightly increased pressure is being delivered into the bore 31 from the booster feed pipe 29, it is necessary to provide means for actuating the piston 17 in the booster cylinder 16, which in the present instance is accomplished by compressed air in the following manner:

I will now describe the means shown in Figures 2 and 4 whereby fluid under pressure, in the present instance compressed air, is admitted into and discharged from the cylinder 16 of the booster 15 to cause reciprocation of the piston 17 therein, in coaction with the spring 21, so that the piston movement synchronizes with the required movement of the pad 30, and hydraulic liquid under boosted pressure, say 400 or 500 pounds per square inch instead of the tank pressure of say 100 pounds per square inch, is provided at the proper time during each stroke of the press to force the pad 30 to its outward position. It is however understood that other means for operating the piston 17 in synchronization with the movement of the press may be provided if desired.

Extending from the air line 2 is a pipe 202 having a shut-off valve 203 therein intermediately of its length and connected at its opposite extremity to a tubular passage 204 formed through the body of the control device 9. The inner extremity of the passage 204 is in registry with a port 205 formed radially through the bushing 81, and, when the inner extremity of the annular slide valve 89 is at the inner extremity of its stroke as shown in the drawings, the port 205 registers with an annular groove 206 formed in the outer periphery of the said valve 89. In substantially transverse alignment with the port 205 another port 207 is formed through the bushing 81. Also formed through the bushing 81 are two other substantially radial ports 208 and 209 which are longitudinally spaced from the ports 207 and 205. These ports 208 and 209 are in registry with passages 210 and 211, respectively, which extend in the present case substantially tangentially relative to the bushing 81 through the body of the control device 9. Formed in the bore of the latter in which the bushing 81 is secured and contiguous to the outer periphery of the said bushing is a slot 212 one extremity of which is in registry with the port 207 while its opposite extremity terminates in the passage 210. Thus when the annular slide valve 89 is in the position shown fluid under pressure flows through the passage 204, the port 205, around the annular groove 206, through the port 207, and along the slot 212 to the passage 210 the outer extremity of which is connected by the air line 23 to the connection 22 in the booster. Consequently at that time, if the valve 203 is open, compressed air flows from the line 2 into the booster 15 and forces the piston 17 therein downward, thereby moving the rod 18 downward in the smaller cylinder 20 and increasing the pressure of liquid therein.

Formed in the body of the control device 9 are a plurality of apertures 213 the axes of which are parallel with the axis of the annular slide valve 89. These apertures connect the inner extremity of the opening 80 with the passage 35 and are so positioned that their extremities

remote from the passage 35 are closed by the inner annular face of the valve 89 when the latter is at its inner position shown. Consequently when the valve 68 is moved away from the bushing 38 by hydraulic liquid under pressure, of say a few thousand pounds per square inch, some of this liquid passes through the apertures 213 and moves the valve 89 outwardly against the inner face of the annular seat 82 against the tension of the spring 90. Then the annular groove 206 is no longer in registry with the ports 205 and 207 so that fluid pressure no longer passes to the booster 15. Then however, an annular groove 214 formed around the valve 89 connects the opposed ports 208 and 209 so that fluid pressure from the booster flows back through the air line 23, the passage 210, the port 208, around the annular groove 214, and through the port 209 into the exhaust passage 211 the outer extremity of which is open to the atmosphere. Hydraulic liquid which passes through the apertures 213 flows through the bore of the valve 89 and back to the tank 1 through the valve seat 82, the pipe 29, the cylinder 20, and the pipes 27 and 25, as at that time the rod 18 is lifted out of the cylinder 20. As soon as high pressure is no longer exerted against the valve 89 the spring 90 returns it to its inward position shown so that the pipe 202 is again connected to the booster 15 to force its plunger 17, 18 downwardly. Suitable means such as packing rings 215 in grooves 216 in the outer periphery of the slide valve 89 prevent leakage between the latter and the bore of the bushing 81.

While for the sake of simplicity only a single bore 31 is shown in the bolster 14 it is understood that a plurality of such bores having plungers 32 therein may be employed for controlling the movement of a single pad 30, particularly if the pad is large and heavy. Under such conditions the low hydraulic pressure obtained from compressed air at normal line pressure may not be sufficient to effect rapid enough movement of the pad to insure that it will reach its outward position prior to commencement of the next operating stroke of the press. In such cases the booster 15 may be advantageously utilized, to deliver liquid at a pressure of say 500 pounds per square inch. The primary purpose, however, of the booster is to provide increased pressure for stripping, as previously stated.

The intensifier 250 includes a cylinder 251 mounted on the bolster 14. Formed through the bolster 14 and the underside of the cylinder 251 is an aperture 252 which terminates at its lower extremity in the passage 33. Mounted in the cylinder 251 is a piston 253 upwardly from which a rod 254 extends. When the bolsters 13 and 14 and their dies 11 and 12 are farthest apart the piston 253 is spaced just beneath a pad 255 which is dependingly mounted on the upper bolster 13. Consequently when the bolsters and their dies commence to approach one another the rod 254 and its piston 253 are thrust downwardly and as the dies continue their inward travel increasing pressure is exerted on the liquid in the passage 33 through the line back to the plunger relief valve 68, and upon the plunger 32 and thus upon the pad 30 to the pressure for which the said relief valve is set to open. As previously stated this arrangement is particularly advantageous for drawing and forming as it overcomes wrinkling of the work.

It will thus be seen that the pad 30 is moved to its outward position by low pressure liquid flowing, either directly from the tank 1 or through the booster 15, past the inlet ball valve 41 to the bore 31; that the operation of the press controls the operation of the booster; that pressure is exerted on the liquid in the bore 31 and between it and the relief valve 68 by operation of the press; and that the intensifier 250 is also directly operated by the press movement. Thus these movements are at all times synchronized with the press.

I will now describe the modification shown in Figures 5 to 13, inclusive.

In Figure 5, 113 designates an upper bolster to which an upper die 111 is secured, and mounted for vertical movement in the latter is an upper pad 130*a*. Provided in the upper bolster 113 is a bore 131*a* having a plunger 132*a* mounted for vertical movement therein, and bearing on the lower extremity of the plunger is the pad 130*a*. Extending through the upper bolster 113 from the bore 131*a* is a passage 133*a* to the outer extremity of which a pipe 134*a* is connected, and the opposite extremity of the pipe 134*a* is suitably secured to the control device 10. Similarly secured upon a lower bolster 114 is a lower die 112, and mounted for vertical movement in the latter is a lower pad 130. Provided in the lower bolster 114 is a bore 131 having a plunger 132 mounted for vertical movement therein, and secured to the upper extremity of the plunger 132 is a pad 130. Extending through the lower bolster 114 from the bore 131 is a passage 133 to the outer extremity of which a pipe 134 is connected, the opposite extremity of which is suitably secured to the control device 10.

In this instance the pipe 28 from the 3-way valve 26 is connected to a passage 135 in the body of the control device, and this passage opens into other passages 136 which extend in the form of a cross horizontally and vertically within the said body and are plugged at their outer extremities 136*a*. Extending from opposite sides of the control device and within the latter are two parallel openings 137 and 137*a* which are shown parallel to one another, and each of the said openings terminates in one branch of the passage 136. Mounted in the inner extremities of the openings 137 and 137*a* are bushings 138 and 138*a*, respectively, the inner extremities of which are each in alignment with the axis of one of the branches of the passage 136. Resting against the outer faces of the bushings 138 and 138*a* are other bushings 139 and 139*a*, respectively, of larger bore than the first named bushings, and bearing against the outer faces of the bushings 139 and 139*a* are annular seats 140 and 140*a* against which ball inlet valves 141 and 141*a* are urged by helical springs 142 and 142*a* mounted in the bushings 139 and 139*a*, respectively. The extremities of the springs 142 and 142*a* remote from their ball valves 141 and 141*a* bear against arms of spiders 142*b* and 142*c* which are in the form of a cross and rest against the outer faces of the bushings 138 and 138*a*, respectively. Threaded into the outer extremities of the openings 137 and 137*a* are nuts 143 and 143*a*, and interposed between the inner extremities of the latter and bushings 144 and 144*a*, which rest against the annular seats 140 and 140*a*, are discs 145 and 145*a*, respectively, which support suitable packing.

Formed radially through the bushings 144 and 144*a* are ports 146 and 146*a* which register with openings 147 and 147*a*, respectively, in the body of the control device 10, and the opposite extremities of the openings 147 and 147*a* terminate in branches of the passage 136. Extending axially through the nuts 143 and 143*a* are rotary spindles 148 and 148*a* which project through the rings 145 and 145*a* and have integral plugs 149 and 149*a* of increased diameter on their inner extremities which are rotatable in the bushings 144 and 144*a*, respectively. Extending axially into the plugs 149 and 149*a* from their inner extremities are apertures 150 and 150*a*, and formed radially through the said plugs from the said apertures are passages 151 and 151*a* which are adapted to register with the ports 146 and 146*a*, respectively. Thus by rotation of the spindles 148 and 148*a* flow of hydraulic liquid from the passage 136 to and past the ball valves 141 and 141*a* may be regulated, and such regulation or adjustment is further simplified by the provision of pointers 152 and 152*a* secured on the outer extremities of the spindles 148 and 148*a* which indicate the angular positions of the passages 151 and 151*a*, respectively.

Formed through the body of the control device 10 and extending radially through the bushings 138 and 13*a* are apertures 201 and 201*a* in communication with pas-

sages 155 and 155a, respectively, which are plugged at their outer extremities. Opening at their inner extremities into and extending laterally from the passages 155 and 155a are other passages 156 and 156a, the bore of which is reduced for a short distance from the said passages 155 and 155a, respectively. Secured in the outer ends of the passages 156 and 156a are tubular connections 157 and 157a from which the pipes or lines 134 and 134a extend to the bolsters 113 and 114 respectively. Inwardly of the tubular connections 157 and 157a annular slide valves 158 and 158a are mounted in the passages 156 and 156a, respectively. The bore of the valves 158 and 158a is increased from their inner extremities for a portion of their length to receive helical springs 160 and 160a the opposite extremities of which bear against annular shoulders 159 and 159a formed at the inner extremities of the larger portions of the bore of the passages 156 and 156a, respectively. Projecting outwardly from and integral with the valves 158 and 158a are annular members 161 and 161a having arcuate U-shaped notches 162 and 162a, respectively, formed therein from their outer extremities. Formed in and around the passages 156 and 156a intermediately of their length and normally covered by the valves 158 and 158a are annular grooves 163 and 163a, respectively; and extending from the grooves 163 and 163a through the body of the control device 10 are vents 164 and 164a to which the pipe 7 is connected by connections 7a and 7b, respectively. The valves 158 and 158a, grooves 163 and 163a and the vents 164 and 164a, respectively, together form unloader valves.

Thus it will be seen that hydraulic liquid is adapted to flow at relatively low pressure from the tank 1 and the connection 28 through the passages 135 and 136 and, if the plugs 149 and 149a are so turned that their radial passages 151 and 151a are in registry with the openings 147 and 147a, past the ball inlet valves 141 and 141a into the passages 156 and 156a, through the annular valves 158 and 158a and the passages 133 and 133a into the bores 131 and 131a, respectively. In this manner the pads 130 and 130a are returned to, and normally retained at, their outward positions.

Extending through the control device 10 in alignment with the openings 137 and 137a are apertures 165 and 165a having annular bushings 166 and 166a, respectively, therein, and the inner extremities of the said bushings are in alignment with the axis of one branch of the passage 136. Moreover the outer extremities of the bores of the bushings 166 and 166a are materially reduced at 167 and 167a, respectively. Mounted for axial movement in the bushings 166 and 166a are plunger relief valves 168 and 168a, the inner faces of which normally lie against the inner faces of the bushings 138 and 138a, respectively, and close the adjacent extremities of the latter. The plungers 168 and 168a are bevelled around their outer peripheries to form annular pockets in the inner extremities of the bushings 166 and 166a, respectively. Extending outwardly from the plungers 168 and 168a are coaxial guides 169 and 169a which are mounted for movement in the reduced openings 167 and 167a of the bushings 166 and 166a, respectively. Formed integral with the guides 169 and 169a and projecting outwardly therefrom are shanks 170 and 170a on which discs 171 and 171a, respectively, are mounted. Resting against the outer faces of the bushings 166 and 166a are sleeves 172 and 172a which fit into the apertures 165 and 165a, and resting against the outer extremities of the said sleeves are circular members 173 and 173a which are held in place by annular nuts 174 and 174a, respectively, in threaded engagement with the body of the control device 10. Bearing against the inner faces of the members 173 and 173a are discs 175 and 175a, respectively, and extending between the discs 171 and 175 and the discs 171a and 175a are helical springs 176 and 176a, respectively. The nuts 174 and 174a are internally threaded to engage the screws 177 and 177a the inner extremities of which bear against rods 178 and 178a which project through the members 173 and 173a and terminate at their inner extremities in shanks 179 and 179a on which the discs 175 and 175a, respectively, are mounted.

When by action of the press, pressure is exerted on the hydraulic liquid in the bores 131 and 131a this pressure is exerted on the plungers 168 and 168a tending to force them outward against the tension of the springs 176 and 176a, respectively. If this liquid pressure is sufficient to force the plungers outwardly it passes back to the tank 1 through the passages 136 and 135 and pipe 28. However means hereinafter described may be employed for delaying the inward movement of one of the said plungers, in which event only one of the plungers 168, or 168a, moves back to permit the escape of liquid between it and the opposed bushing 138, or 138a, from one of the bores 131, or 131a, and the pad 130a, or 130, actuated by the hydraulic liquid in the other bore remains in its outward position until the pad actuated by the liquid in the first bore has completed its inward movement, and then only does the liquid pressure exerted in the bore controlling movement of the pad which remained in its outward position overcome the resistance of its plunger 168a, or 168, and pass back to the tank 1.

Meanwhile if one of the plungers 168, or 168a, is pushed outward to permit a flow to occur from the bushing 138, or 138a, into the passage 136 to occur, and if excess pressure is built up in the passage 156, or 156a, the unloader valve therein opens. When this occurs the valve 158, or 158a, moves inwardly so that excess liquid may flow into the annular groove 163, or 163a, and thus to the vent 164, or 164a, whence it passes back to the tank 1, through the pipe 7.

I will now describe the regulating means referred to for delaying movement of one of the plungers 168, or 168a, away from its bushing 138, or 138a, until the other plunger has moved therefrom and returning hydraulic liquid under high pressure has passed in the passage 136.

Mounted in and projecting outwardly from the openings 220 and 220a formed in the body of the control device 10 are valve bodies 221 and 221a, respectively, which are of increased diameter for a short distance from their inner extremities. These valve bodies 221 and 221a are rotatably supported in bushings 222 and 222a threaded into the outer extremities of the openings 220 and 220a so that their inner faces engage annular shoulders 223 and 223a formed at the outer ends of the portions of the valve bodies 221 and 221a, respectively, of increased diameter. The valve bodies are tubular from their outer extremities for the major portion of their length, are internally threaded from their outer extremities to receive correspondingly threaded valve stems 224 and 224a, and their bores terminate at their inner extremities in inwardly tapered seats 225 and 225a to receive needle valves 226 and 226a formed on the inner extremities of the stems 224 and 224a, respectively.

Formed through the valve bodies 221 and 221a from their inner extremities are short axial passages 227 and 227a, respectively, which are in registry with openings 228 and 228a which extend through the body of the control device 10, through the adjacent sides of the bushings 166a and 166 and open into latter outwardly of the plungers 168a and 168, respectively. Extending from the passages 155 and 155a through the body of the control device 10 are extension openings 229 and 229a from which lateral passages 230 and 230a, respectively, extend. These passages 230 and 230a terminate at their opposite extremities in the openings 220 and 220a and are adapted to register with radial ports 231 and 231a which are formed through the valve bodies 221 and 221a and terminate in the passages 227 and

227*a*, respectively. 232 and 232*a* designate annular means secured around the outer extremities of the valve bodies 221 and 221*a* for turning the latter manually so that, when desired the ports 231 and 231*a* may be moved into or out of registry with the lateral passages 230 and 230*a*, respectively.

Extending axially through the valve bodies 221 and 221*a* from the valve seats 225 and 225*a* to the passages 227 and 227*a* are quite small apertures 233 and 233*a*, respectively, and extending substantially radially through the valve bodies 221 and 221*a* from adjacent the tops of the seats 225 and 225*a* are small bleeder holes 234 and 234*a* which are adapted to register with drain openings 235 and 235*a*, respectively, also formed through the body of the control device 10. The drain openings 235 and 235*a* connect with other passages 236 and 236*a*, respectively, also formed through the body of the said device 10, and the said other passages terminate in branches of the passage 136. Thus when the valve bodies 221 and 221*a* are so turned that their radial ports 231 and 231*a* register with the lateral passages 230 and 230*a* liquid under pressure flows from the passages 155 and 155*a* into the bushings 166*a* and 166 to hold the plungers 168*a* and 168, respectively, against outward movement. When the radial ports 231 and 231*a* register with the passages 235 and 235*a*, which are in alignment with them, the pressure in the bushings 166*a* and 166 is equalized with that in the passage 136. The purpose of the small apertures 233 and 233*a* and the bleeder holes 234 and 234*a* is to permit, by exact setting of the needle valves 224 and 224*a*, small amounts of hydraulic liquid to pass from within the bushings 166*a* and 166 as the pistons 168*a* and 168 are forced away from the bushings 138*a* and 138.

Obviously at no time may more than one valve body 221, or 221*a*, be so turned that its radial port 231, or 231*a*, is in registry with the lateral passage 230, or 230*a*, to admit high pressure liquid returning through the line 134, or 134*a*, into the bushing 166*a*, or 166, since the purpose is to delay inward movement of one pad 130*a*, or 130, until the other pad has moved inward and is no longer exerting high pressure on the liquid in the line 134, or 134*a*. Then delayed outward movement of the plunger 168*a*, or 168, due to pressure exerted thereon through the bushing 138*a*, or 138, from the line 134*a*, or 134, occurs.

It will be noted that the area of the outer face of the plunger relief valve 168*a*, or 168, against which pressure is exerted through the radial ports 231, or 231*a*, is materially greater than the area of its inner face against which pressure is exerted through the bushing 138*a*, or 138, and it is for that reason that escape of liquid from the said bushing into the passage 136 is prevented until the pressure flow from the line 134, or 134*a*, ceases. It may also be noted that if inward movement of both pads 130 and 130*a* is to occur simultaneously instead of in sequence, both valve bodies 221 and 221*a* are so turned that their radial ports 231 and 231*a* are out of registry with the lateral passages 230 and 230*a*.

Formed in the control device 10 is an aperture 260 (Figure 12) closed at its outer extremity by a plug 261, and resting against its inner extremity is an annular seat 262. Mounted in the aperture 260 and extending between the seat 262 and the plug 261 is a bushing 263 having a ball valve 264 therein which is urged against the seat 262 by a helical spring 265, the opposite extremity of which bears against the inner face of the plug. Projecting radially through the bushing 263 is a continuation of the passage 135 (see Fig. 10). Extending from the inner end of the aperture 260 is a passage 267 the opposite end of which opens through one side of the body of the said device where the pipe 29 from the booster 15 is connected thereto. Thus liquid flowing under pressure from the booster into the passage 29 passes through the passage 267, and through the seat 262 into the bushing 263 through the opening 263*a* into the passage 135 (Fig. 10).

Provided in the control device 10 is an opening 268 against the inner extremity of which a disc 269 having circularly spaced holes 270 therethrough rests. 271 denotes a bushing the inner extremity of which rests against the disc 269, and bearing against the front extremity of the said bushing is an annular seat 272 which is held in position by a plug 273 in threaded engagement with the outer extremity of the opening 268. Resting against the outer face of the seat 272 is a ball valve 274 and urging the latter against its seat is a helical spring 275 the opposite extremity of which bears against the inner face of the plug 273. Slidably mounted in the bushing 271 between the disc 269 and the seat 272 is an annular valve 276 the bore of which is increased from its outer extremity for a portion of its length thereby forming a shoulder 277 therein. Resting at one extremity against the inner face of the seat 272 is a helical spring 278 the opopsite extremity of which bears against the shoulder 277 and urges the valve 276 inwardly against the disc 269, so that a guide 279 projecting axially outward from the said disc is adapted to engage the inner extremity of the bore of the valve. Formed in the inner face of the disc 269 is an annular groove 270*a* connecting the holes 270, and extending through the body of the control device 10 are passages 270*b* extending from the passage 136 and terminating in registry with the annular groove. Thus when liquid under pressure flows back from the cylinders 131 or 131*a* and passes into the passage 136 some of it flows through the passages 270*b* and the holes 270 and moves the valve 276 against the tension of the spring 278. When the valve has moved sufficiently outward to become disengaged from the guide 279 this liquid flows through the bore of the said valve past the ball valve 274 and into an axial pocket 281 formed in the inner face of the plug 273. Extending radially through the latter from the pocket 281 therein and through the body of the control device 10 to the passage 267 is an outlet opening 282. The liquid then passes through this outlet opening 282, and through the passage 267 into the pipe 29 whence it flows through the smaller cylinder 20 of the booster 15 and back to the tank 1.

When air flows through the line 202 into the control device 10 it passes through the passage 285, through a radial port 286 in the bushing 271, and around an annular groove 287—when the slide valve 276 is in its inward position against the disc 269—into a slot 288 formed in the said bushing, and from the latter into a passage 289 to the outer extremity of which the air line 22 to the booster 15 is connected. Consequently the piston 17 is then moved downward in the cylinder 16. However when the valve 276 is moved to its outward position shown in Figure 13 air from the booster returns through the passage 289 into the annular groove 287 through the slot 288, and from the said groove into an exhaust passage 290 the opposite extremity of which is open to the atmosphere. Then when the air is exhausted from the cylinder the piston 17 therein is returned to its raised position by the spring 21.

In this instance the intensifier 300 (Figure 5) includes two cylinders 301 and 302 which extend toward one another and are mounted on the bolsters 113 and 114 respectively. Connecting the interiors of the cylinders 301 and 302 with the bolster passages 133*a* and 133 are apertures 303 and 304 respectively. Mounted in the cylinders 301 and 302 are pistons 305 and 306 outwardly from which rods 307 and 308, respectively, extend. When the bolsters and their dies are at their outward positions the adjacent extremities of the rods 307 and 308, which are of course in vertical alignment, are somewhat spaced from one another, but as the bolsters commence to approach each other the rods move into engagement prior to engagement of the work by the pads 130*a* and 130.

The pressure exerted by the rods against one another functions in the manner above described wherein only a single cylinder and piston was employed. However by utilization of two opposed cylinders the intensifier is operative when the pads 130*a* are moved in sequence.

In the arrangements hitherto shown, as in Figures 2 and 4, the timing of the operation of the booster is absolutely fixed relative to the operating cycle of the press. In that case the valve 89 is moved to permit the exhaust of fluid from the booster cylinder 16 when the relief valve 68 opens, and the piston 17 is moved downward again in the cylinder 16 to increase pressure in the line to the pad bore 31 immediately the relief valve closes. Again, this arrangement only provides for a single stroke of the booster piston 17 during each reciprocating stroke of the press. However, there are occasions when it may be very desirable to retard the operating stroke of the booster relative to the press cycle, or to provide a plurality of strokes of the booster in rapid succession during the operating cycle, as in certain cases to facilitate stripping. Neither of these results may be obtained by the arrangement heretofore described. For that reason a modification is shown, in Figures 14 to 16, inclusive, wherein the operation of the press itself is employed for controlling the flow of fluid pressure to and from the booster cylinder; wherein means are provided for rapidly adjusting the setting of the control means relative to the operating cycle of the press; and whereby a plurality of strokes of the booster in rapid succession may be obtained during each operating cycle.

Referring to Figures 14 to 16, inclusive, 401 shows a conventional mechanical press, including upper and lower bolsters 402 and 403 having upper and lower dies 404 and 405 mounted thereon and upper and lower pads 406 and 407, respectively, mounted on the said dies. As before, cylinders 408 and 409, provided in the bolsters 402 and 403, having plungers 410 and 411 therein, are connected to liquid pressure lines 412 and 413, respectively; and both the lines 412 and 413 are connected to an inlet valve 414 in a control device 419.

415 denotes a tank containing hydraulic liquid on which pressure is maintained by compressed air introduced through a pipe 416. The latter is also connected to a booster control mechanism 417 suitably mounted on the press 401. Extending from the tank 415 is a line 418 connected by a passage 421 in the control device to a check valve 420 in the latter.

The booster 422 is similar to that already described and includes a cylinder 423 having a piston 424 mounted therein from which a rod 425 extends down into a depending tubular member 426 of smaller cross section than the said cylinder. A spring 427 urges the piston 424 upward, and through the top of the cylinder is a fluid pressure passage 428 for the admission and discharge of compressed air. Extending from the underside of the tubular member 426 is a pipe 429 connected to a passage 430 in the control device which terminates at its opposite extremity in the check valve 420. Extending from the passage 430 intermediately of its length and terminating in the inlet valve 414 is another passage 431. The valve 414 is so arranged that a flow may occur from the passage 431 into the lines 412 and 413 but liquid can not pass from the last named lines into the said passage 431. Thus it will be clearly seen that the line 429 connected to the underside of the booster is full at all times. Extending through the control device from the inlet valve 414 is a passage 432 on the opposite extremity of which an annular seat of a relief valve 433 is formed. This valve is provided with an adjustable spring-loaded valve 434, and extending from one side of the valve 433 is a passage 435 which terminates in the passage 421.

The booster control mechanism 417 includes a cylinder 440 having a circular slide valve 441 mounted therein for reciprocation, and formed around the valve intermediately of its length is an annular groove 439. Extending from one extremity of the valve 441 is a rod 442 which projects through one extremity of the cylinder 440, and bearing against the opposite extremity of the valve and urging it and the rod 442 outward is a helical spring 443. Pivotally mounted on the cylinder is one extremity of an arm 444 against which intermediately of its length the rod 442 hears. Mounted on the press 401 and forming a part thereof is a shaft 445 which makes one revolution of each reciprocating stroke of the press. Fixed on one extremity of the shaft 445 are cams 446 and 447 which are adapted to contact the outer extremity of the arm 444 and move the latter inwardly against the tension of the spring 443. As may be clearly seen from Figures 15 and 16, the cams 446 and 447 are provided with progressively tapered bores to receive a tapered plug 448, and extending through the latter is a bolt 449 which is in threaded engagement with and extends axially into the shaft 445.

Extending radially through the cylinder 440 from one side of its periphery and opening into the bore thereof are two spaced, parallel passages 451 and 452, and extending radially into the cylinder from its opposite side is a single passage 453 inwardly from which two branches 451*a* and 452*a* extend into the bore of the cylinder and have their inner extremities in alignment with the passages 451 and 452 respectively. Connecting the passage 453 with the booster passage 430 is a line 454, and the pipe 416 is connected to the passage 451. Thus when the slide valve 441 is pushed inward by the arm 444 (as shown in Figure 14) the annular groove 439 connects the passage 451 and 451*a* and thereby permits a flow of fluid from the line 416 into the booster cylinder 423, and when the groove 439 is in registry with the passages 452 and 452*a* the fluid from the booster cylinder is allowed to escape through the passage 452 which is opened to the atmosphere.

It will be noted that when the cams 446 and 447 are in their positions shown with their lobes angularly disposed to one another two impulses are imparted in rapid succession to the valve 441 during each reciprocating stroke of the press. By the simple expedient of removing the bolt 449 and plug 448 the cams may be quickly reset so that they operate at any desired time interval during the operating cycle of the press, and at any desired interval to one another. Again, if only one impulse is to be imparted to the valve 441 during each operating cycle the cams may be so positioned that their lobes are in transverse alignment; or again, if the boster is not to be employed both cams may be removed, thereby saving wear and tear on the booster and its control mechanism.

What I claim is:

1. A control for controlling the movement of die pads in a drawing apparatus of the type including a stationary lower bolster and a ram operated, upper bolster movable toward and away therefrom, a bore with a piston mounted therein associated with each bolster, an upper die pad and a lower pad engaged by the respective pistons to be moved thereby towards each other, said pads engaging opposite sides of a sheet metal workpiece, a hollow die mounted on the upper bolster and surrounding the upper die pad, means on said die and upper pad to limit the outward movement of said pad and to raise the latter when said upper bolster and die are raised, a lower die secured to said stationary bolster and surrounding said lower pad, said lower die cooperating with the upper die pad for a first die shaping operation and then with the upper die for a second die shaping operation, means on the lower die and pad to limit the upward movement of the latter, said control comprising a fluid supply, a control valve having an inlet port and two outlet ports, one for each bore, a line connecting said supply to said inlet port, individual lines connecting each of said outlet ports to its respective bore, a pair of parallel lines in said valve between said inlet port and each of said outlet ports, a

check valve in one of each of said parallel line connections permitting one way flow from the inlet port to the respective outlet ports, an adjustable pressure relief valve in the other of each of said parallel line connections permitting flow from the respective outlet ports to the inlet port, a by-pass line in said control valve connecting the outlet port for the lower bore and the inlet port side of the relief valve in the line connection for the outlet port for the upper die pad to permit flow of fluid pressure from the lower die pad bore line to the relief valve for the upper die pad to lock said die pad in its outward die shaping position during the downward travel of the latter for performing said first die shaping operation.

2. A control according to claim 1 including intensifier cylinders mounted on said bolsters, the cylinders being in axial alignment, individual lines connecting the cylinder and bore on each bolster, a piston in each of said cylinders, said pistons having piston rods in axial alignment, the piston rods being spaced apart when the upper die and die pad are in their inoperative position and are engaged during the downward movement of the latter whereupon the pressures in the aforesaid die pad bores are intensified.

3. A control for controlling the movement of die pads in a drawing apparatus of the type including a stationary lower bolser and a ram operated, upper bolster movable toward and away therefrom, each bolster having a bore and a piston mounted therein, an upper die pad and a lower pad engaged by the respective pistons to be moved thereby toward each other, said pads engaging opposite sides of a sheet metal workpiece, a die mounted on the upper bolster adjacent the upper die pad, means on said die and upper pad to limit the outward movement of said pad and to raise the latter when said upper bolster and die are raised, a lower die secured to said stationary bolster adjacent said lower pad, said lower die cooperating with the upper die pad for a first die shaping operation and then with the upper die for a second die shaping operation, means on the lower die and pad to limit the upward movement of the latter, said control comprising a fluid supply, a control valve having an inlet port and two outlet ports, one for each bore, a line connecting said supply to said inlet port, individual lines connecting each of said outlet ports to its respective bore, a pair of parallel lines in said valve between said inlet ports and each of said outlet port, a check valve in one of each of said parallel line connections permitting one way flow from the inlet port to the respective outlet ports, an adjustable pressure relief valve in the other of each of said parallel line connections permitting flow from the respective outlet ports to the inlet port, a by-pass line in said control valve connecting the outlet port for the lower bore and the inlet port side of the relief valve in the line connection for the outlet port for the upper die pad to permit flow of fluid pressure from the lower die pad bore line to the relief valve for the upper die pad to lock said die pad in its outward die shaping position during the downward travel of the latter for performing said first die shaping operation.

4. The combination in claim 3, including an adjustable metering valve in each line connecting the check valve with the inlet port to restrict the flow to and the return movement of the pistons and die pads upon the upward movement of the upper die.

5. A control for controlling the movement of die pads in a drawing apparatus of the type including a stationary lower bolster and a ram operated, upper bolster movable toward and away therefrom, each bolster having a bore and a piston mounted therein, an upper die pad and a lower pad engaged by the respective pistons to be moved thereby toward each other, said pads engaging opposite sides of a sheet metal workpiece, a hollow die mounted on the upper bolster and surrounding the upper die pad, cooperating flanges on said die and upper pad to limit the outward movement of said pad and to raise the latter when said upper bolster and die are raised, a lower die secured to said stationary bolster and surrounding said lower pad, said lower die cooperating with the upper die pad for a first die shaping operation and then with the upper die for a second die shaping operation, cooperating flanges between the lower die and pad to limit the upward movement of the latter, said control comprising a fluid supply, a control valve having an inlet port and two outlet ports, one for each bore, a line connecting said supply to said inlet port, individual lines connecting each of said outlet ports to its respective bore, a pair of parallel lines in said valve between said inlet port and each of said outlet ports, a check valve in one of each of said parallel line connections permitting one way flow from the inlet port to the respective outlet ports, an adjustable pressure relief valve in the other of each of said parallel line connections permitting flow from the respective outlet ports to the inlet port, a by-pass line in said control valve connecting the outlet port for the lower bore and the inlet port side of the relief valve in the line connections for the outlet port for the upper die pad to permit flow of fluid pressure from the lower die pad bore line to the relief valve for the upper die pad to lock said die pad in its outward die shaping position during the downward travel of the latter for performing said first die shaping operation.

6. A control according to claim 5 including intensifier cylinders mounted on said bolsters, the cylinders being in axial alignment, individual lines connecting the cylinder and bore on each bolster, a piston in each of said cylinders, said pistons having piston rods in axial alignment, the piston rods being spaced apart when the upper die and die pad are in their inoperative position and are engaged during the downward movement of the latter whereupon the pressures in the aforesaid die pad bores are intensified.

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