

April 16, 1963

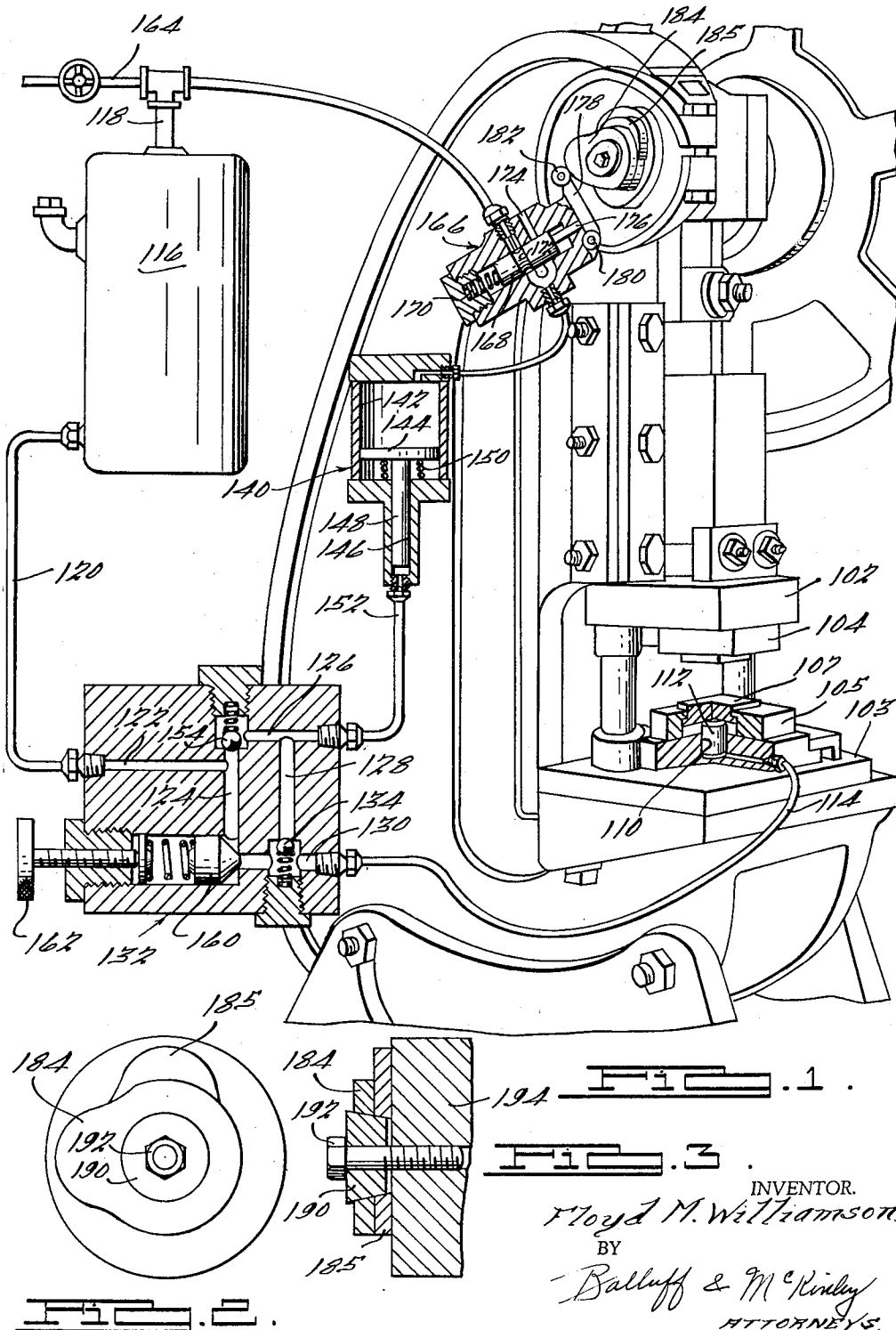
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3,085,530

HYDRAULIC PRESS RAM CUSHION

Filed Oct. 22, 1958

4 Sheets-Sheet 1



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HYDRAULIC PRESS RAM CUSHION

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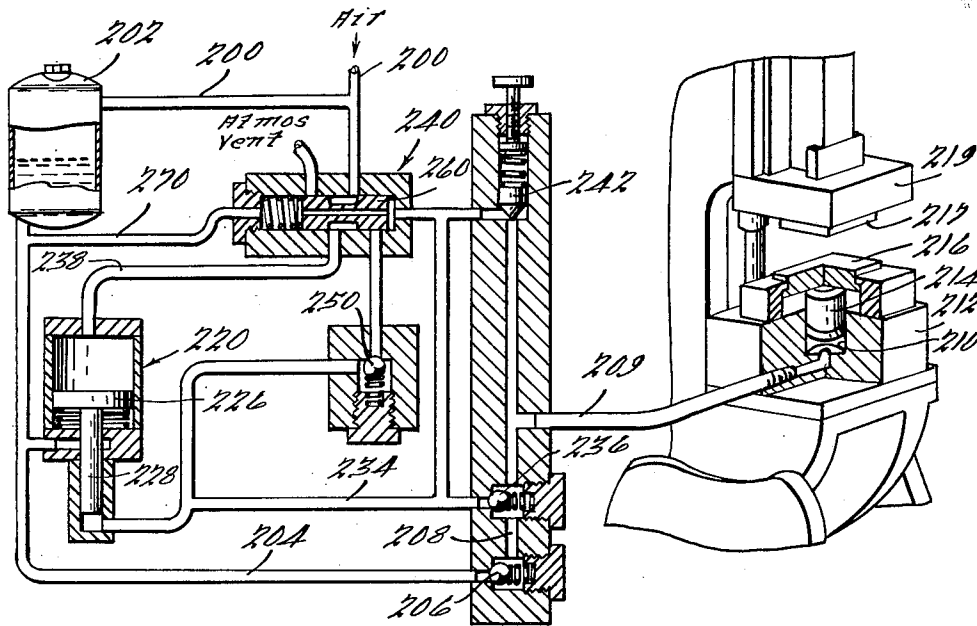


FIG. 4.

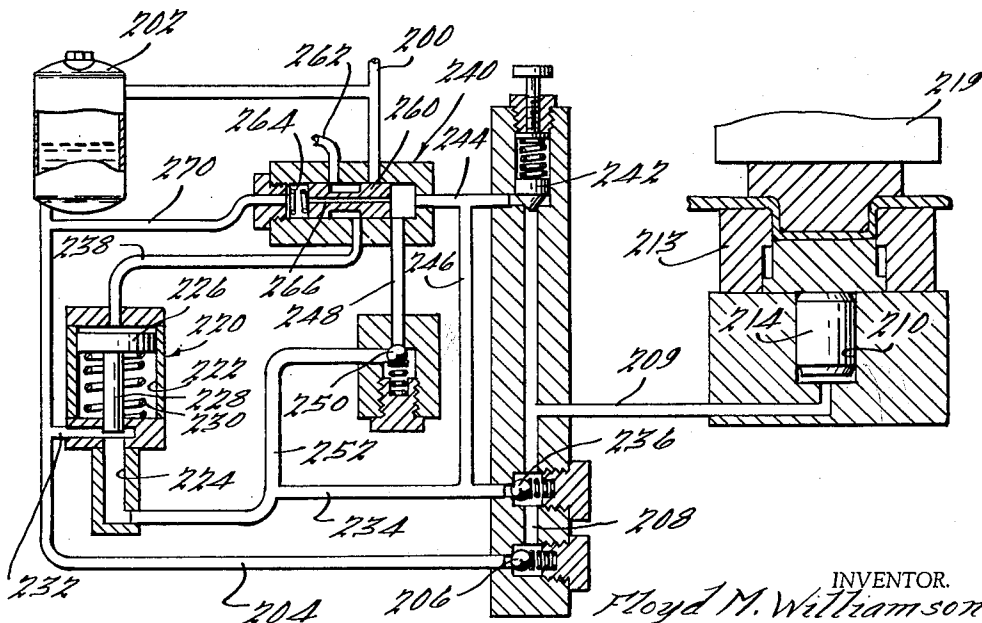


FIG. 5.

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4 Sheets-Sheet 3

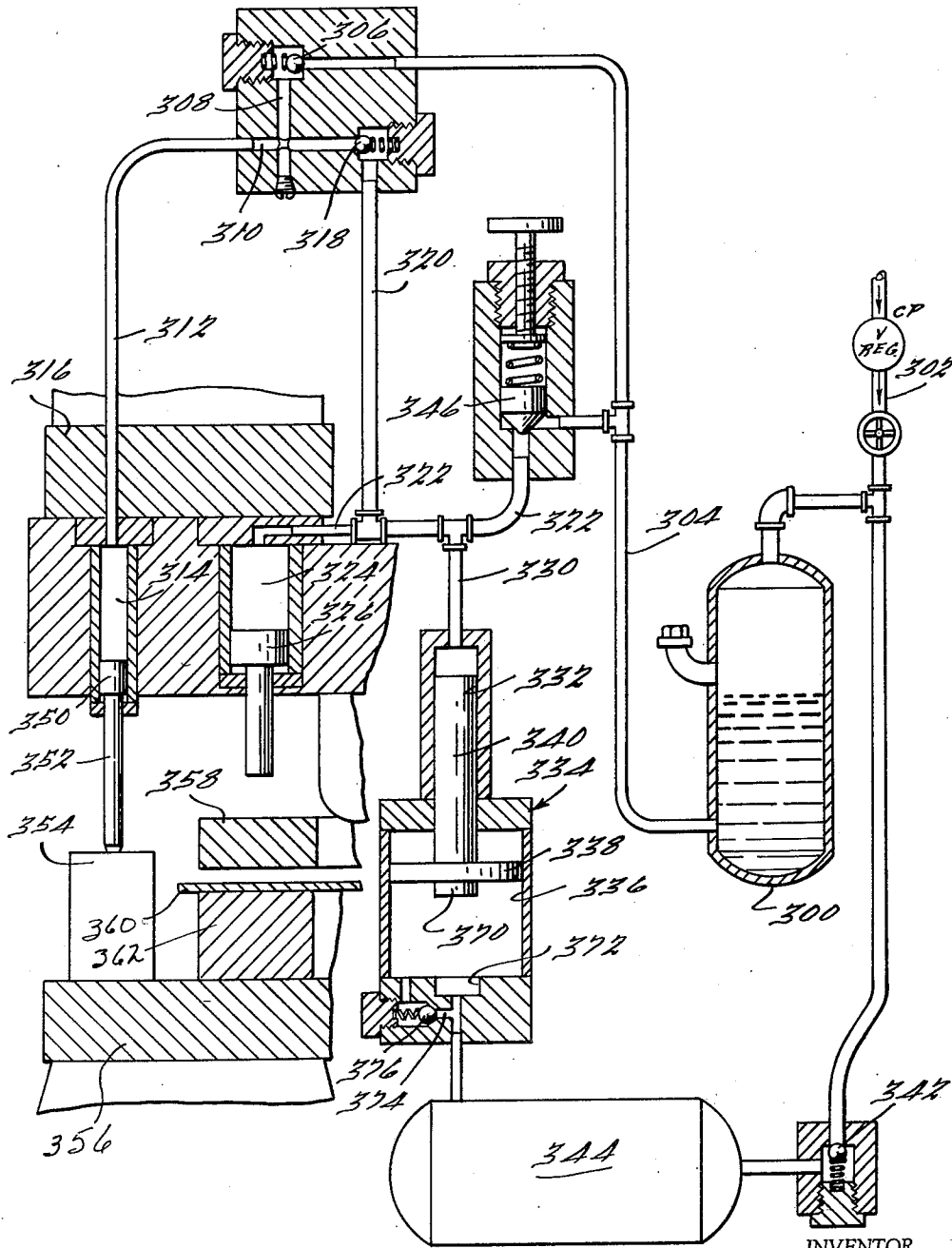


FIG. 6.

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4 Sheets-Sheet 4

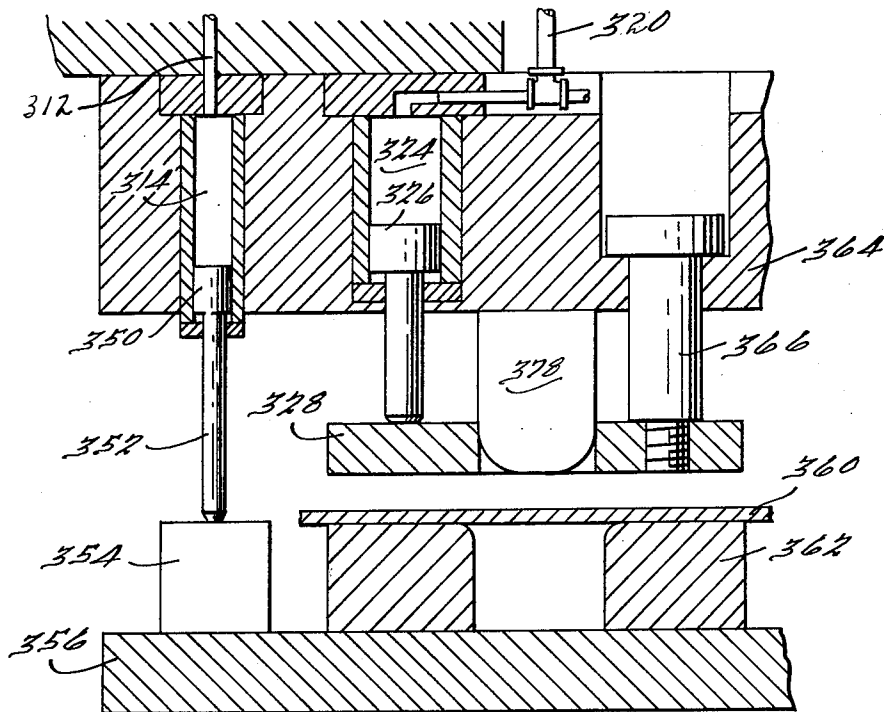


FIG. 7.

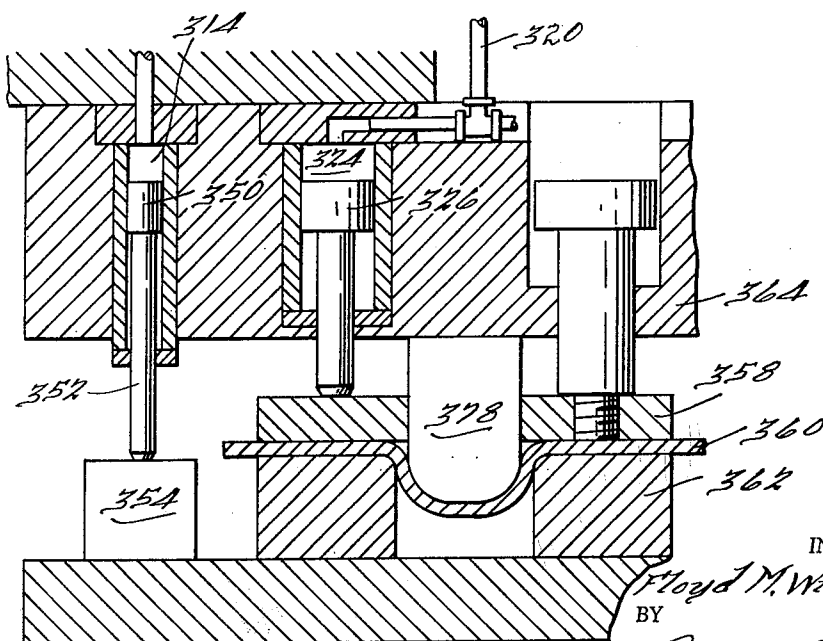


FIG. 8.

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3,085,530

HYDRAULIC PRESS RAM CUSHION

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Filed Oct. 22, 1958, Ser. No. 768,889
33 Claims. (Cl. 113—46)

This invention relates to hydraulic press ram cushions for use in crank and hydraulic presses, and has particular reference to a hydraulic system for controlling the movement of die pads. This application is a continuation-in-part of my prior application Serial No. 455,270, filed September 10, 1954, for "Mechanism for Hydraulically Controlling Movement of Pads in Dies," now Patent No. 2,890,669.

Springs are conventionally employed for normally retaining die pads in their forward or extended positions in dies in ram type presses. However, the use of springs for this purpose is open to a number of objections which include: lack of satisfactory means for readily adjusting the pressure exerted for opposing inward movement of the die pads; the springs frequently break, or weaken with wear so that the pressure exerted by them does not remain constant; the resistance offered by the springs to inward movement of the die pads increases as the latter move inwardly, whereas uniform resistance to inward movement of such pads is desirable; and in many cases the pressure exerted by such springs on the pads for stripping the work from the die is unsatisfactory.

An object of the invention is to provide a hydraulic system for 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 or extended position and substantially greater resistance is offered to inward movement of the pad during the working portion of the stroke of the press, the amount of such resistance offered to inward movement of the pad being adjustable, and when adjusted remaining constant during the entire inward movement of the pad.

A further object of the invention is to provide a hydraulic system for controlling movement of a pad in a die which includes a booster operable to provide substantially increased pressure on the pad for returning it to its outward position after completion of the working portion of the stroke of the press for efficiently stripping the work from the die.

Another object of the invention is to provide a hydraulic system for controlling movement of a pad in a die wherein air at relatively low pressure normally exerts a minimum pressure on the oil in the system and wherein an air operated booster energized by such low pressure air is effective for substantially increasing the pressure of the oil in the system during the working portion of the stroke of the press.

Another object of the invention is to provide such a system with means for preloading the system prior to the closing of the press to compensate for pressure lost due to leakage, and to permit the development of high pressure in the system prior to movement of the die pad.

Another object of the invention is to provide such a hydraulic system with means to automatically feed additional oil into the system by motion of the press to replace oil lost due to leakage.

Another object of the invention is to provide a hydraulic system of the character referred to in which means are provided for circulating the oil in the system for cooling purposes.

Other and further objects of the invention will be apparent from the following description and claims and may be understood by reference to the accompanying drawings, of which there are four sheets, which by way

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of illustration show preferred embodiments of the invention and the best mode of applying the principles of my invention. Other embodiments of the invention may be used without departing from the scope of the present invention as set forth in the appended claims.

In the drawings:

FIGURE 1 is a fragmentary perspective view of a press embodying the invention and wherein the hydraulic control system is schematically illustrated;

FIGURES 2 and 3 are details of a cam arrangement for the press which is cooperable with an air valve for controlling the supply of air under pressure to a booster and the release of such air therefrom;

FIGURE 4 is a schematic view of the hydraulic system for a modified form of the invention, showing the parts in their positions on the up stroke or opening movement of the press;

FIGURE 5 is a view similar to FIGURE 4 but showing the parts on the down stroke or during closing movement of the press;

FIGURE 6 is a schematic view of the hydraulic system of a modified form of the invention;

FIGURE 7 is a fragmentary view of a press having the system as shown in FIGURE 6 during the closing movement of the press; and

FIGURE 8 is a view of the parts shown in FIGURE 7 at the completion of the down stroke of the press.

In FIGURE 1 there is shown a conventional mechanical press including a reciprocating upper bolster or ram 102, a fixed bolster 103, a die 104 mounted on the ram 102, a die 105 mounted on the bolster 103, and a die pad 107 reciprocally mounted on the die 105 and shown in its extended position. The die pad 107 and die 105 are provided with interengageable abutments to limit the outward travel of the pad 107 relative to the die 105.

The lower die 103 is provided with at least one working cylinder 110 having a piston 112 reciprocally arranged therein. The piston 112 is adapted to react on the die pad 107 for applying pressure thereto for holding such die pad in its extended position and for controlling movement of such die pad 107 in accordance with the pressure of the hydraulic fluid supplied to the cylinder through the hydraulic pressure line 114. Normally hydraulic fluid, such as oil, is supplied to the cylinder 110 under a predetermined minimum pressure from a supply tank 116, the upper end of which is connected to an air pressure line 118 through which air under pressure—say, for example, 100 pounds per square inch—is supplied to the hydraulic fluid in the tank 116. The oil in the supply tank 116 is supplied to the line 114 through hydraulic pressure line 120 and passages 122, 124, 126, 128 and 130 in a valve indicated generally at 132. A check valve 134 disposed in passage 128 prevents return flow of oil, and it will be evident that the oil in cylinder 110 will be maintained at a minimum pressure by reason of the air pressure to which the oil in the supply tank 116 is subjected.

Means are provided for substantially increasing the pressure of the oil in the cylinder 110 above that at which it is maintained by the pressure in the oil supply tank, and such means as illustrated in FIG. 1 comprise an air operated booster 140 which includes an air cylinder 142 with a piston 144 therein, a hydraulic cylinder 146 with a hydraulic piston 148 therein, the effective diameter of the air cylinder 142 being at least several times, and preferably ten times, the effective diameter of the hydraulic cylinder 146, and the pistons 144 and 148 being connected so that movement of one effects movement of the other. A spring 150 biases the hydraulic air cylinder piston 144 and the piston 148 to their retracted positions.

The hydraulic cylinder 146 is also supplied with oil under pressure from the tank 116 through a hydraulic sup-

ply line which includes the line 120, the passage 122, the passage 124, the passage 126, and a hydraulic line 152. A check valve 154 is arranged in the passage 124. Normally the hydraulic piston or plunger 148 is retracted and oil from the tank 116 is supplied to the hydraulic cylinder 146 and maintained therein under pressure in response to the pressure of air applied to the oil in the supply tank 116.

Means are provided for supplying air under pressure to the booster air cylinder 142 whereby piston 148 of the booster hydraulic cylinder 146 will displace oil from such cylinder, and because the return of oil to the tank is prevented by the check valve 154, the oil displaced from the cylinder 146 is effective to increase the pressure of the oil in the work cylinder 110 substantially above that at which it is maintained by the pressure in the oil supply tank 116. A pressure relief valve 160 is arranged in a by-pass around the check valves 134 and 154, the by-pass consisting of passages 124 and 130 and the bore in which the pressure relief valve 160 is mounted. The pressure relief valve 160 is adjustable by means of the adjusting knob 162 but, once set, will dissipate excess pressure generated by the booster 140 or by movement of the piston 112 upon the closing movement of the press, by permitting the return flow of oil through the by-pass back to the tank 116.

The air operated booster 140 is supplied with air under pressure from an air pressure line 164 which is also connected to the line 118 for supplying pressure to the oil in the tank 116. A normally closed air valve 166 is disposed in the line 164. As shown, the slide valve member 168 of the valve 166 is disposed in its open position whereby the piston 144 of the booster 140 is subjected to the air pressure of the line 164. The valve member 168 is biased toward its closed position by a spring 170 so as to bring the groove 172 in the valve member 168 into registry with the exhaust port 174 for shutting off the supply of air to the cylinder 142 and for venting the air under pressure therein to atmosphere.

A stem 176 on the valve member 168 reacts on a lever 178, one end of which is pivoted at 180. A roller 182 on the other end of the lever 178 is positioned and biased so as to engage rotary cams 184 and 185 which are mounted on the crankshaft of the press so as to turn therewith. The cams 184 and 185 may be mounted on any shaft of the press which makes one revolution for each reciprocating stroke of the press. The cams 184 and 185 are engageable with the roller 182 on the arm 178 for positioning the latter, the spring 170 being effective through the slide valve member 168 and the plunger 176 for holding the roller 182 in contact with the edge of the cams. Thus the cams 184 and 185 and the valve 166 will be effective for controlling the energization of the booster 140.

As may be seen from FIGURES 2 and 3, the cams 184 and 185 are provided with tapered bores to receive a tapered plug 190, and extending through the latter is a bolt 192 which is threaded into a threaded opening in the end of the crankshaft 194 of the press. The cams 184 and 185 are positioned with their lobes offset from each other whereby two impulses are imparted in rapid succession to the slide valve 168 during each reciprocating stroke of the press for periodically actuating the booster 140. The cams 184 and 185 may be positioned so as to be effective to control the supply of air to the booster 140 at any desired times during the operating cycle of the press, and if operation of the booster 140 is desired only once during each cycle of press operation, the cams 184 and 185 may be so positioned that their lobes are aligned. Preferably the lobe of one of the cams 184 and 185 is set so as to energize the booster 140 immediately prior to engagement of the die 104 with the sheet metal work on the pad 107 whereby oil under high pressure is supplied at such time to the work chamber 110 so as to preload the piston 112 and also to compensate for any loss of pressure in the cylinder 110 and the line 114.

The pressure of the hydraulic system reacting on piston 112 holds the die pad 107 in its extended position so that the sheet metal work piece is firmly gripped between such die pad and the die 104. Downward movement of the die pad 107 due to downward movement of the die 104 and the pressure thereof on the work on pad 107 will move the piston 112 downwardly in the cylinder 110 and thereby increase the pressure in the cylinder 110 and line 114 so that the check valve 134 will isolate the booster 140 from the pressure in the line 114. However, when the pressure in the line 114 exceeds that for which the valve 160 is set, the latter will open and bleed off the excess pressure, but in doing so it will maintain a high pressure on the oil in the line 114 and thereby provide a uniform resistance to downward movement of the piston 112 and downward movement of the die pad 107.

As soon as the press moves past the bottom of its downward stroke, the pressure in the cylinder 110 and in the line 114 will fall, whereupon the oil under pressure will be supplied to the line 114 from the oil in the tank 116. The second cam 185 is preferably set so that just as the press passes the bottom of its downward stroke, the cam 185 will activate the valve 166 so as to energize the booster 140 to supply oil under high pressure to the line 114 so as to efficiently move the piston 112 and the die pad 107 to their extended positions for stripping the piece from the die 105.

In the modification shown in FIGURES 4 and 5 the die pad and press are the same but the hydraulic system differs in that the booster is energized in a different manner. As in the previous modification, air under pressure is supplied through an air pressure line 200 to an oil supply tank 202 for maintaining the hydraulic liquid therein under pressure, and oil is supplied under pressure from the tank 202 through line 204 past check valve 206 through duct 208 and line 209 to the work cylinder 210 in the fixed bolster 212 of the press. A piston 214 in such work cylinder is arranged to react on the die pad 216 for biasing and holding the same in its extended position.

An air operated booster 220 similar to the booster 140 is provided with an air cylinder 222, a hydraulic cylinder 224, a piston 226 for the air cylinder, a piston 228 for the hydraulic cylinder, and a spring 230 which normally biases the pistons 226 and 228 to their retracted positions, the piston 228 being connected to the piston 226 so as to move therewith. The hydraulic cylinder 224 is connected at one end by a hydraulic line 232 to the line 204 so as to be supplied with oil under pressure from the tank 202, while the discharge side of the hydraulic cylinder 224 is connected by a line 234 with the duct 208 so that upon energization of the air operated booster 220, hydraulic fluid under the discharge pressure of the booster will be supplied to the work cylinder 210 through the line 209. A check valve 236 prevents return flow of liquid from the duct 208 into the line 234.

The air cylinder 226 of the booster 220 is supplied with air under pressure through the line 238 under the control of valve 240 from the air pressure line 200. An adjustable pressure relief valve 242, like the valve 160, is arranged in a by-pass around the check valves 206 and 236, such by-pass including a part of the duct 208, a line 244, and a line 246 which extends between line 244 and line 234. In addition, when the valve 240 is in its atmosphere porting position as shown in FIGURE 5, oil which passes the valve 242 may also return through the line 248 past the check valve 250 and through the line 252 to the line 234, and thence through the hydraulic cylinder 224 and the line 232 to the line 204 and the oil supply tank 202.

With the piston 212 and the die pad 216 in the position as illustrated in FIGURE 4, it will be evident that the oil in the cylinder 210 will be under approximately the pressure to which the oil in the tank 202 is subjected, and this pressure should be sufficient to hold the piston 214 and the die pad 216 in their extended positions so that the upper die 217 will firmly clamp the sheet metal work

piece against the die pad 216 before the latter begins to move.

The oil in the cylinder 210, the line 209, and the duct 208 is trapped therein by the check valves 206 and 236 and the pressure relief valve 242. However, when the pressure exerted by the ram 219 of the press on the die pad 216 causes the latter to begin its downward travel, the pressure in the cylinder 210, the line 209, and the duct 208 will rise until it approaches the bleed off pressure for which the valve 242 is set, and when this pressure is exceeded the excess pressure will be dissipated by the flow of oil through the by-pass and past the valve 242, thus permitting downward movement of the piston 214 against a resistance determined by the setting of the valve 242. At this time the booster 220 is deenergized and the valve 240 is positioned as shown in FIGURE 5 where the air cylinder 222 is ported to atmosphere through line 238 past slide valve 260 to atmospheric port 262. The oil which escaped past pressure relief valve 242 has reacted on slide valve 260 so as to move it to its position as shown in FIGURE 5 against the resistance of spring 264. The slide valve 260 is provided with a small passage 266 through which permits such valve 260 under the action of spring 264 to return to its right hand position, the oil which passes through the passage 266 being free to return to line 204 through line 270. So long as oil is escaping past the pressure relief valve 242, the slide valve 260 will be maintained in its position as shown in FIGURE 5, but as soon as the flow of oil under pressure past the pressure relief valve 242 stops, which occurs at the bottom of the stroke of the press, spring 264 will bias the valve 260 to its right-hand position. The rate of return will be governed by the flow of oil through the passage 266 plus the displacement of oil through the line 248 past the check valve 250. When the valve member 260 returns to its right-hand position as shown in FIGURE 4, the atmospheric port 262 will be cut off by the valve member 260 and the line 238 will be connected to the air pressure line 200 whereby air under pressure is supplied to the booster 220 for energizing the same.

Energization of the booster 220 will advance the piston 228 in the hydraulic cylinder 224, thereby discharging oil at high pressure through the line 234 past the check valve 236 and into the line 209 leading to cylinder 210. At this time the line 248 will be closed by the slide valve 260. Since the press is already past the bottom of its stroke, the oil under pressure supplied by the booster 220 will react on the piston 214 for returning it and the die pad 216 to their extended positions whereby the sheet metal work piece will be efficiently stripped from the die 213.

If the booster 220 upon energization thereof develops any excess pressure in the duct 208 and the line 209 and the cylinder 210 after the piston 214 is at the top of its stroke, the excess pressure will be bled off by the valve 242 and will serve to shift the valve 260 to a position to shut off the supply of air to the booster 220. However, the system is so designed that preferably the pressure effective for shifting the valve 260 from the position shown in FIGURE 4 to that shown in FIGURE 5 is developed by the downward movement of the piston 214 and the work cylinder 210 during the closing movement of the press so that at the end of the closing movement of the press and on the up stroke thereof the valve 260 will be free to return to its position as shown in FIGURE 4 for supplying air to the booster 220 for energizing the same for supplying additional oil under pressure to the cylinder 210 during the up stroke of the press for stripping the work from the die 213.

The arrangement shown in FIGURES 6, 7 and 8 includes an oil supply tank 300 in which the oil therein is maintained under a minimum pressure, say 100 pounds per square inch, by air under pressure from an air supply line 302. Oil from the tank 300 is supplied through line 304 past check valve 306 through ducts 308 and 310 and

line 312 to a preloading cylinder 314 carried by the ram 316 of a ram type press. The oil is also supplied from duct 310 and past check valve 318 through lines 320 and 322 to a work cylinder 324 also carried by the ram 316.

The piston 326 of the work cylinder is arranged to react on the die pad 358 for applying pressure thereto for holding such die pad in its extended position. The line 322 is also connected with a line 330 for supplying oil to the hydraulic cylinder 332 of an air operated booster 334 which includes an air cylinder 336, a piston 338, and a piston 340 which is arranged in the cylinder 332, the pistons 338 and 340 being interconnected for movement together.

The air line 302 is connected past a check valve 342 with a surge tank 344 which in turn is connected to the cylinder 336 for supplying air under pressure thereto. The effective diameters of the pistons 338 and 340, like the pistons of the boosters of the previous modification, have a ratio of about ten to one so that the booster is effective to increase the pressure on the oil in the system to a value of about ten times that of the air pressure supplied to the air cylinder of the booster.

A pressure relief valve 346 similar to those previously described is arranged between the line 322 and the line 304 for bleeding off oil from the line 322 when the pressure therein exceeds that, say 1100 pounds per square inch, for which the valve 346 is set.

The preloading cylinder 314 has a plunger 350 therein, the stem 352 of which is arranged to engage an abutment 354 on the lower bolster 356 of the press before the die pad 358 engages the work piece 360 positioned on the lower die 362 which is mounted on the fixed bolster 356. The die pad 358 is suspended from the die 364 by one or more headed pins 366 which permit continued downward movement of the die 364 after the pad 358 engages the work piece 360. As the stem 352 of the preloading cylinder piston 350 engages the abutment 354 before the pad 358 engages the work piece 360, the hydraulic fluid in the preloading cylinder 314 will be displaced therefrom through the line 312, the duct 310, past check valve 318, and through the lines 320 and 322 to the work cylinder 324 so as to preload the same. This not only increases the pressure in the cylinders 332 and 324 above that created by the booster 334, but also supplies additional oil to such cylinders so as to compensate for any leakage which may have occurred. Any excess oil displaced from the preloading cylinder 314 and not accommodated by cylinders 324 and 332 is forced past the valve 346 into the line 304 leading to the supply tank 300. Thus when the die pad 358 engages the work piece 360, the pressure in the cylinder 324 will be at its maximum. As the down stroke of the press continues, the piston 326 of the work cylinder will be retracted, thus displacing oil from the work cylinder 324 into the hydraulic cylinder 332 since the pressure developed therein is less than the relief pressure for which the valve 346 is set, thus forcing the booster pistons to their retracted positions. The air from the cylinder 336 displaced by the retractile movement of the piston 338 is returned to the surge tank 344.

One side of the piston 338 is provided with a boss 370 which has a sliding fit in a bore 372 in the end of the air cylinder 336 so that after the boss 370 penetrates the bore 372, the air trapped between the piston 338 and the end wall of the cylinder 336 will function as a cushion for the piston 338.

A by-pass 374 with a check valve 376 permits air under pressure from the surge tank 344 to be effective upon the entire diameter of the piston 338 as soon as the pressure in the cylinder 332 falls, which occurs just after the press passes the bottom of its down stroke.

As shown in FIGURE 8, after the die pad 358 clamps the work piece 360 against the lower die 362, the punch 378 of the upper die 364 is effective to cooperate with the lower die 362 for forming the piece 360. During the down stroke of the press, oil displaced from cylinder

332 will effect the retraction of piston 340. Upon the up stroke of the press, the booster 334 will recharge cylinder 324, while the preloader cylinder will be recharged from the oil tank 300. The preloader insures that the ram cushion is fully charged with oil at high pressure during the full movement of the die pad 358, and sets up a circulation of oil which helps to keep the oil cool. This also keeps the work cylinder purged of gas bubbles. Preferably the displacement of the booster oil cylinder should be about equal to the combined displacement of the preloader and work cylinders. The booster 334 is effective at all times to maintain a high pressure (for example, 1000 pounds per square inch) on the oil in the work cylinder 324.

The preloader could be added to the other modifications. However, the booster of FIGURE 1 functions like the preloader of FIGURES 6, 7 and 8 because it adds oil at high pressure to the ram cushion just prior to the closing of the press.

While I have illustrated and described preferred embodiments of my invention, it is understood that these are capable of modification, and I therefore do not wish to be limited to the precise details set forth but desire to avail myself of such changes and alterations as fall within the purview of the following claims.

I claim:

1. In a ram type press provided with a die and a die pad engageable with the work upon closing of the press, a hydraulic cushion for said die pad including at least one hydraulic work cylinder provided with a reciprocable plunger therein arranged to react on said die pad for applying pressure thereto for holding said die pad in its extended position during closing of the press, a booster including an air cylinder with a piston therein and a hydraulic cylinder with a piston therein, the effective diameter of the air cylinder being at least several times the effective diameter of the hydraulic cylinder, the pistons of said booster cylinders being connected so that movement of one effects movement of the other, a hydraulic pressure line connecting said work cylinder to said hydraulic cylinder of the booster, an oil supply tank, means for maintaining oil in said supply tank under a predetermined pressure substantially above atmospheric pressure, a hydraulic pressure line connecting the booster hydraulic cylinder and the hydraulic work cylinder to the oil supply tank so that oil in said cylinders is maintained under a minimum pressure, a relief valve connected to such last-mentioned line to allow oil when under pressure above the pressure for which the relief valve is set to return to the supply tank, and means for supplying air under pressure to said booster air cylinder whereby the piston of the booster hydraulic cylinder increases the pressure on the oil in said work cylinder substantially above that at which it is maintained by pressure in said oil supply tank.

2. Apparatus according to claim 1 wherein said means for supplying air under pressure to said booster air cylinder includes an air valve and means operable in response to operation of said press for positioning said valve to admit air under pressure to said booster air cylinder at a predetermined time with respect to closing movement of said press.

3. Apparatus according to claim 1 wherein said means for supplying air under pressure to said booster air cylinder includes a surge tank, a fluid pressure line interconnecting said surge tank and said booster air cylinder, and means for supplying air under pressure to said surge tank so as to maintain air therein at a predetermined minimum pressure.

4. Apparatus according to claim 1 wherein said means for supplying air under pressure to said booster air cylinder includes a control responsive to opening movement of the press for supplying air under pressure to said booster air cylinder at such time when said work cylinder reacts on said die pad to move the same to its extended position so as to expedite stripping work from said die.

5. Apparatus according to claim 1 wherein said means for supplying air under pressure to said booster air cylinder includes a normally open valve for controlling the flow of air to such air cylinder having a normally open position which permits the supply of such air to said cylinder and a closed position which shuts off said air supply, and means responsive to the return of oil to said supply tank for closing said air control valve during such return flow of oil.

6. Apparatus according to claim 1 wherein said means for supplying air under pressure to said booster air cylinder includes a normally open valve for controlling the flow of air to such air cylinder having a normally open position which permits the supply of such air to said cylinder and a closed position which shuts off said air supply, and means operable in response to operation of said press for closing said valve during a part of each cycle of press operation.

7. In a ram type press provided with a die and a die pad engageable with the work upon closing of the press, a hydraulic cushion for said die pad including at least one hydraulic work cylinder provided with a reciprocable plunger therein arranged to react on said die pad for applying pressure thereto for holding said die pad in its extended position during closing of the press, a booster including an air cylinder with a piston therein and a hydraulic cylinder with a piston therein, the effective diameter of the air cylinder being at least several times the effective diameter of the hydraulic cylinder, the pistons of said booster cylinders being connected so that movement of one effects movement of the other, a hydraulic pressure line connecting said work cylinder to said hydraulic cylinder of the booster, an oil supply tank, means for maintaining oil in said supply tank under a predetermined pressure, a hydraulic pressure line connecting the booster hydraulic cylinder and the hydraulic work cylinder to the oil supply tank so that oil in said cylinders is maintained under a minimum pressure, an oil return line to said supply tank connected to said line connecting said work and booster hydraulic cylinders, a relief valve in such oil return line to allow oil when under pressure therein above the pressure for which the relief valve is set to return to the supply tank, means for supplying air under pressure to said booster air cylinder whereby the piston of the booster hydraulic cylinder increases the pressure on the oil in said work cylinder substantially above that at which it is maintained by pressure in said oil supply tank, and valve means for controlling the supply of air to said booster air cylinder by said air supply means in accordance with press operation.

8. In a ram type press provided with a die and a die pad engageable with the work upon closing of the press, a hydraulic cushion for said die pad including at least one hydraulic work cylinder provided with a reciprocable plunger therein arranged to react on said die pad for applying pressure thereto for holding said die pad in its extended position, a booster including an air cylinder with a piston therein and a hydraulic cylinder with a piston therein, the effective diameter of the air cylinder being at least several times the effective diameter of the hydraulic cylinder, the pistons of said booster cylinders being connected so that movement of one effects movement of the other, a hydraulic pressure line interconnecting said work cylinder and said hydraulic cylinder of the booster, an oil supply tank, means for maintaining oil in said supply tank under a predetermined pressure, a hydraulic pressure line connecting the booster hydraulic cylinder and the hydraulic work cylinder to the oil supply tank so that oil in said cylinders is maintained under a minimum pressure and a check valve in said line, an oil return line to said supply tank connected to said line interconnecting said hydraulic cylinders, a relief valve interposed in such oil return line to allow oil when under pressure above the pressure for which the relief valve is set to return to the supply tank, and means for supplying air

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under pressure continuously to said booster air cylinder whereby the piston of the booster hydraulic cylinder maintains the pressure on the oil in said work cylinder substantially above that at which it is maintained by pressure in said oil supply tank but less than the bleed off pressure of said pressure relief valve.

9. In a ram type press provided with a die and a die pad movable to an extended position for engagement with the work upon closing of the press ram, a hydraulic cushion for said pad including at least one hydraulic work cylinder provided with a reciprocable plunger therein arranged to react on said die pad for applying pressure thereto for holding said pad in its extended position during closing of said press ram, a booster including an air cylinder with a piston therein and a hydraulic cylinder with a piston therein, the effective diameter of the air cylinder being at least several times the effective diameter of the hydraulic cylinder, the pistons of said booster cylinders being interconnected so that movement of one effects movement of the other, a hydraulic pressure line interconnecting said work cylinder and said hydraulic cylinder of the booster, an oil supply tank, a hydraulic pressure line having a check valve therein connecting said booster hydraulic cylinder and said work cylinder to the oil supply tank so as to maintain oil in said cylinders, a pressure relief valve connected to such last-mentioned line to dissipate pressure when oil in said cylinders exceeds the pressure for which the relief valve is set, means for supplying air under pressure to said booster air cylinder whereby said booster hydraulic cylinder substantially increases the pressure on the oil in said work cylinder, a preloading cylinder having a plunger therein arranged on the closing of the press ram to be moved thereby before movement of the work cylinder plunger, a hydraulic pressure line connecting the preloading cylinder to the oil in the supply tank to allow free flow of fluid from the supply tank to the preloading cylinder, a hydraulic pressure line connecting the preloading cylinder to the booster hydraulic cylinder and said work cylinder to allow free flow from the preloading cylinder to the booster hydraulic cylinder and work cylinder prior to movement of said work cylinder plunger.

10. In a ram type press provided with a die and a die pad movable to an extended position for engagement with the work upon closing of the press ram, a hydraulic cushion for said pad including at least one hydraulic work cylinder provided with a reciprocable plunger therein arranged to react on said die pad for applying pressure thereto for holding said die pad in its extended position during closing of said press ram, a booster including an air cylinder with a piston therein and a hydraulic cylinder with a piston therein, the effective diameter of the air cylinder being at least several times the effective diameter of the hydraulic cylinder, the pistons of said booster cylinders being interconnected so that movement of one effects movement of the other, a hydraulic pressure line interconnecting said work cylinder and said hydraulic cylinder of said booster, means for maintaining oil in said booster hydraulic cylinder and said work cylinder so that oil in said cylinders is maintained under a minimum pressure, a pressure relief valve connected to said hydraulic cylinders to dissipate pressure when oil in said cylinders exceeds the pressure for which the relief valve is set, means for supplying air under pressure to said booster air cylinder whereby said booster hydraulic cylinder substantially increases the pressure on the oil in said work cylinder above said minimum pressure, a preloading cylinder supplied with oil and having a plunger therein arranged on the closing of the press ram to be moved thereby before movement of the work cylinder plunger, a hydraulic pressure line connecting the preloading cylinder to the booster hydraulic cylinder and said work cylinder to allow free flow from the preloading cylinder to the booster hydraulic cylinder and work cylinder prior to movement of said work cylinder plunger.

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11. Apparatus according to claim 10 wherein said means for supplying air under pressure to said booster air cylinder includes a surge tank, a fluid pressure line connecting said surge tank to said booster air cylinder, and means for supplying air under pressure to said surge tank so as to maintain air therein at a predetermined minimum pressure.

12. Apparatus according to claim 10 wherein said work, preloading and booster hydraulic cylinders are supplied with oil under pressure from a common source to which oil which passes said relief valve is returned.

13. In a ram type press provided with a die and a die pad engageable with the work upon closing of the press, a hydraulic cushion for said pad including at least one hydraulic work cylinder arranged to react on said press and provided with a reciprocable plunger therein arranged to react on said die pad for applying pressure thereto for holding said die pad in its extended position, a booster including a hydraulic cylinder with a piston therein, a hydraulic pressure line interconnecting said work cylinder and said hydraulic cylinder of said booster, means for supplying oil to said booster hydraulic cylinder and said work cylinder so that oil in said cylinders is maintained under a minimum pressure, a pressure relief valve connected to such hydraulic cylinders to dissipate pressure when oil in said cylinders exceeds the pressure for which the relief valve is set, said booster being operable to substantially increase the pressure on the oil in said work cylinder to a value above said minimum pressure but below the pressure for which said relief valve is set, and means arranged on the closing of the press and operable before movement of the work cylinder plunger to automatically feed additional oil to that part of the hydraulic system which includes said hydraulic cylinder and work cylinder.

14. In a ram type press provided with a die and a die pad movable to an extended position for engagement with the work upon closing of the press ram, a hydraulic cushion for said pad including at least one hydraulic work cylinder provided with a reciprocable plunger therein arranged to react on said die pad for applying pressure thereto for holding said die in its extended position, an oil supply tank, means for maintaining oil in said supply tank under a predetermined pressure, a hydraulic pressure line having a check valve therein connecting said work cylinder to the oil supply tank so that oil in said cylinder is thereby maintained under a minimum pressure, a pressure relief valve connected to such line to permit the return of oil to said tank when oil in said cylinder exceeds the pressure for which the relief valve is set, fluid pressure means arranged to react on the oil in said cylinder to substantially increase the pressure on the oil in said work cylinder to a value above said minimum pressure but below the pressure for which said relief valve is set, a preloading cylinder having a plunger therein arranged on the closing of the press ram to be moved thereby before movement of the work cylinder plunger, a hydraulic pressure line connecting the preloading cylinder to the oil in the supply tank to allow free flow of fluid from the supply tank to the preloading cylinder, a hydraulic pressure line connecting the preloading cylinder to said work cylinder to allow free flow from the preloading cylinder to said work cylinder prior to movement of said work cylinder plunger.

15. In a ram type press provided with a die and a die pad movable to an extended position for engagement with the work upon closing of the press ram, a hydraulic cushion for said ram including at least one hydraulic work cylinder provided with a reciprocable plunger therein arranged to react on said die pad for applying pressure thereto for holding said die pad in its extended position, an oil supply tank, means for maintaining oil in said supply tank under a predetermined pressure, a hydraulic pressure line connecting said cylinder to the oil supply tank and having an adjustable relief valve inter-

posed in such line to allow oil under pressure in said cylinder above the pressure for which the relief valve is set to flow back to the supply tank, a preloading cylinder having a plunger therein arranged on the closing of the press ram to be moved thereby before movement of the work cylinder plunger, a hydraulic pressure line connecting the preloading cylinder to the oil in the supply tank to allow free flow of fluid from the supply tank to the preloading cylinder, and a hydraulic pressure line connecting the preloading cylinder to said work cylinder to allow free flow from the preloading cylinder to said work cylinder.

16. Apparatus according to claim 1 wherein said means for supplying air under pressure to said booster air cylinder includes a valve for controlling the flow of air to such air cylinder, said valve having an open position which permits the supply of such air to said air cylinder and a closed position which shuts off said air supply, and means operable in response to operation of said press for opening and closing said valve.

17. Apparatus according to claim 1 wherein the pressure under which oil is maintained in said supply tank is less than the bleed-off pressure of said pressure relief valve.

18. Apparatus according to claim 1 wherein said means for supplying air under pressure to said booster air cylinder comprises means for applying and releasing such air pressure periodically during cycling of the press.

19. Apparatus according to claim 1 including means actuated by closing of the press for increasing the pressure of the oil in said hydraulic work cylinder.

20. In a press having a movable pressure pad engaged by the work so as to be moved in one direction upon closing of the press ram, a hydraulic cushion reacting against said pad to resist such movement of said pad and to effect return movement of the pad upon opening of the press ram, said hydraulic cushion including a cylinder and a piston therein, a tank containing hydraulic fluid under pressure, a booster cylinder, a fluid connection between said tank and booster cylinder, a check valve in said connection past which hydraulic fluid flows from said tank to said booster cylinder, a passage connecting said booster cylinder and said hydraulic cushion cylinder, a normally closed valve in said passage, a piston in said booster cylinder, a control valve connecting said booster cylinder to a source of pressure fluid and adapted when open to actuate said booster piston in a direction to force the hydraulic fluid in said booster cylinder through said passage past the valve therein to said hydraulic cushion cylinder to increase the pressure in the latter cylinder to effect return movement of said pad, control means connected to said control valve and actuated by a part of the press movable with the press ram for opening said control valve to actuate said booster piston at a predetermined time during each cycle of the press, said control means including a rotatable cam driven with the press and means connected to said valve and actuated by said cam for opening said valve at said predetermined time during each cycle of the press, a return line connected into said passage and to said tank through which hydraulic fluid flows from said hydraulic cushion cylinder to said tank upon closing of the press, and a pressure relief valve in said return line providing resistance to movement of said die pad and adapted to open when the pressure in said hydraulic cushion cylinder exceeds a predetermined pressure.

21. In a press having a movable pressure pad engaged by the work so as to be moved in one direction upon closing of the press ram and a hydraulic cushion reacting against said pad to resist such movement of said pad and to effect return movement of the pad upon opening of the press ram, said hydraulic cushion including a cylinder and a piston therein, a tank containing hydraulic fluid under pressure from which the cylinder of the hydraulic cushion is supplied with hydraulic liquid, a fluid pressure transmitting connection between said tank and

said cylinder through which pressure in said tank may be transmitted to said cylinder to increase the pressure therein, a normally closed valve in said connection, a pressure relief passage between said tank and cylinder providing resistance to movement of said die pad upon closing of the press ram and constructed so as to open in response to pressure in said passage when the pressure in said hydraulic cushion cylinder exceeds a predetermined pressure, means for effecting the opening of said normally closed valve to allow the transmission of fluid pressure through said connection from said tank to said cylinder after the pressure in the cylinder falls due to the opening of the press ram, said means being controlled by said press so as to open said normally closed valve a predetermined time interval after the press ram begins to open during each cycle of the press.

22. Apparatus according to claim 21 wherein said normally closed valve comprises a spool type valve.

23. Apparatus according to claim 21 wherein said means includes a cam rotatable in accordance with movement of said press ram.

24. In a ram type press provided with a die and a die pad movable to an extended position for engagement with the work upon closing of the press ram, a hydraulic cushion for said die pad including at least one hydraulic work cylinder provided with a reciprocable plunger therein arranged to react on said die pad for applying pressure thereto for yieldably holding said die pad in its extended position, an oil supply tank, means for maintaining oil in said supply tank under a predetermined pressure, a hydraulic pressure line connecting the hydraulic work cylinder to the oil supply tank for supplying oil from said tank to said work cylinder so that oil in said cylinder is normally maintained under a minimum pressure by the pressure in said tank, a pressure operated relief valve connected to such last-mentioned line to allow oil to return to the supply tank when the pressure in the work cylinder due to the closing of the press rises above the pressure for which the relief valve is set, and means operable during closing of the press ram and before retractile movement of the work cylinder plunger to increase the pressure of the oil in the work cylinder substantially above that at which it is maintained by pressure in said oil supply tank but less than the bleed off pressure of said pressure relief valve.

25. A ram type press according to claim 24 wherein said last named means for increasing the pressure of the oil in the work cylinder comprises an air pressure operated booster.

26. A ram type press according to claim 24 wherein said last named means for increasing the pressure of the oil in the work cylinder comprises a preloading hydraulic pressure cylinder connected to the work cylinder side of said hydraulic pressure line and disposed so as to be operated by closing of the press.

27. In a ram type press provided with a die and a die pad engageable with the work upon closing of the press, a hydraulic cushion for said die pad including at least one hydraulic work cylinder provided with a reciprocable plunger therein arranged to react on said die pad for applying pressure thereto for yieldably holding said die pad in its extended position, an oil supply tank, means for maintaining oil in said supply tank under a predetermined pressure, a hydraulic pressure line connecting the hydraulic work cylinder to the oil supply tank for supplying oil from said tank to said work cylinder so that oil in said cylinder is normally maintained under a minimum pressure by the pressure in said tank, a pressure operated relief valve connected to said work cylinder and operable to relieve pressure therein when the pressure in the work cylinder due to the closing of the press rises above the pressure for which the relief valve is set, and pressure boosting means operable constantly on the oil in the work cylinder during the complete cycle of press operation and independently of the cycling of the press to

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apply a pressure on such oil in the work cylinder substantially above the pressure in said oil supply tank but less than the bleed off pressure of said pressure relief valve.

28. A ram type press according to claim 27 wherein said last-named means comprises a pressure operated hydraulic booster, and means operable automatically and repetitively during press operation and when said pressure relief valve is closed to supply small charges of oil under a pressure substantially above the pressure in said oil supply tank to said work cylinder and hydraulic booster.

29. A ram type press according to claim 27 wherein said last-named means comprises a hydraulic booster, a preloading hydraulic cylinder, a hydraulic pressure line connecting said preloading cylinder to said supply tank, a valve interposed in said last-named line operable to permit flow of hydraulic fluid under tank pressure from said tank to said preloading cylinder, a second hydraulic pressure line connecting said preloading cylinder to said work cylinder and to said hydraulic booster, a valve interposed in said second line which permits flow of hydraulic fluid from said preloading cylinder to said work cylinder and to said hydraulic booster, said preloading cylinder being operable prior to closing of the press to supply fluid through said second pressure line to said work cylinder and to said hydraulic booster to replace hydraulic fluid bled off through said pressure relief valve and to maintain a working quantity of hydraulic fluid in said hydraulic booster.

30. A ram type press according to claim 27 wherein said last-named means comprises a hydraulic booster, and means to maintain a working quantity of hydraulic fluid in said hydraulic booster and to replace oil bled off

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through said pressure relief valve comprising a preloading oil pumping cylinder operable prior to full closing of the press, a first hydraulic pressure line connecting the preloading cylinder to said tank with a valve interposed in said line allowing free flow of oil from the tank to said preloading cylinder, and a second hydraulic fluid line connecting said preloading cylinder to the work cylinder and hydraulic booster with a valve interposed in said line to allow free flow of oil from said preloading cylinder to said work cylinder and hydraulic booster under the pressure generated in said preloading cylinder.

31. Apparatus according to claim 7 wherein said press includes a crankshaft and means rotatable with said shaft and cooperable with said valve means for effecting operation of said valve means to control the supply of air to said booster air cylinder.

32. Apparatus according to claim 31 wherein the means for effecting operation of said valve means is adjustably mounted on said shaft whereby the booster may be actuated at any desired time during the operating cycle of the press.

33. Apparatus according to claim 31 wherein the means rotatable with said shaft for effecting operation of said valve means are constructed and arranged to operate the latter and thus actuate the booster more than once during each rotation of said shaft.

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