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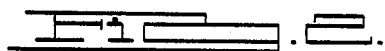
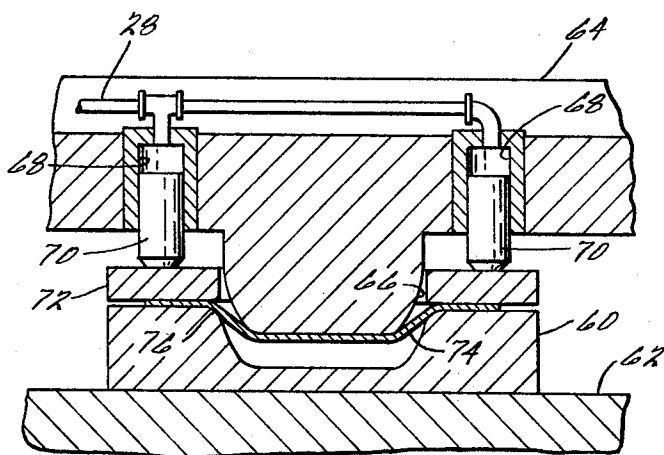
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HYDRAULIC CUSHION FOR DIES

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2 Sheets-Sheet 1



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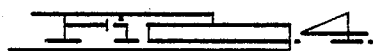
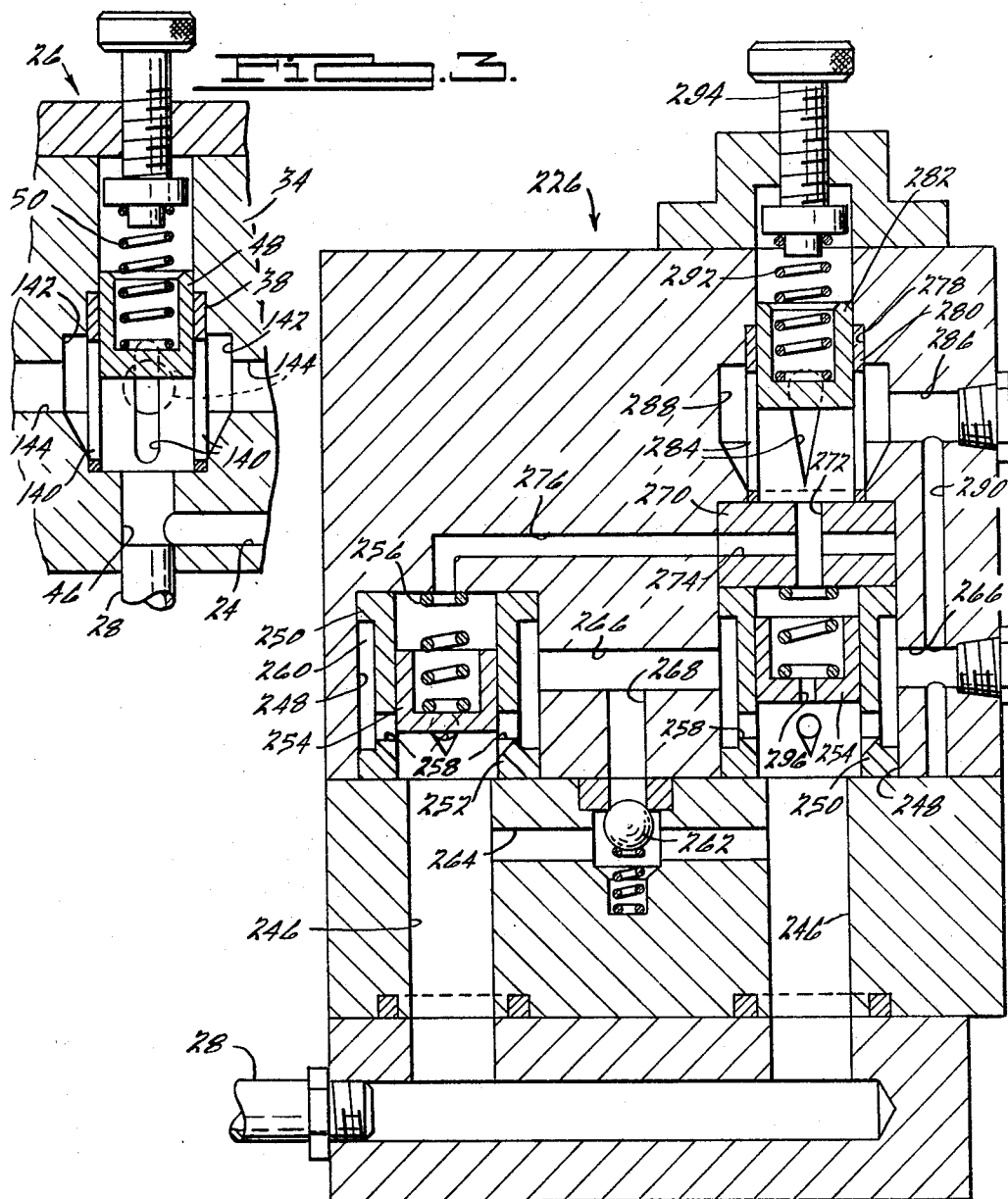
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HYDRAULIC CUSHION FOR DIES

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Filed Sept. 4, 1964, Ser. No. 394,511

8 Claims. (Cl. 267—1)

This application is a continuation in part of my co-pending application Serial No. 222,363 now Patent No. 3,147,962, filed September 10, 1962, for Two Stage Hydraulic Cushions for Dies.

This invention relates to hydraulic cushions for dies and has particular reference to certain improvements in such cushions for use on crank type presses whereby the cushion provides a relatively high resistance to the first part of the power stroke and a relatively low resistance during a succeeding part of the power stroke of the press. In press work it is often advantageous when deep drawing a part to have a relatively high resistance during the first part of the power stroke of the press so as to form the piece or set a bead and then to have a substantially lower resistance toward the end of the stroke so that the metal of the blank or work will not tear. This invention provides a novel, unique and adjustable variable pressure relief means which provides a relatively high pressure resistance to the initial discharge of hydraulic fluid from the cushion during the first part of the closing movement of the ram when the volume of flow of hydraulic fluid from the cushion is relatively high and a relatively low resistance to the discharge of hydraulic fluid from the cushion during the latter part of the closing movement of the press ram when such discharge of hydraulic fluid is decreasing rapidly.

A principal object of the invention is to provide a multiple pressure hydraulic die cushion for presses of the type in which the ram decelerates as it approaches closed position and wherein the resistance of the cushion decreases as the ram closes.

Another object of the invention is to provide a novel, simple and dependable variable pressure relief valve means for use in a system incorporating a hydraulic die cushion which is constructed and arranged so as to provide a high resistance to closing of the press ram during the initial part thereof, and a low resistance to the final closing movement of the press ram.

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 two sheets, which by way of illustration show preferred embodiments of the invention and what I now consider to be the best mode of applying the principles thereof. 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:

FIG. 1 is a schematic illustration of a crank type press having a hydraulic system embodying my invention associated therewith;

FIG. 2 is a schematic view of a crank type press showing one type of press operation in which a hydraulic system embodying this invention is particularly useful;

FIG. 3 is a schematic view illustrating a modified form of the invention; and

FIG. 4 is a schematic view illustrating a further modified form of the invention.

Referring now to FIG. 1, there is illustrated the ram 10 of a crank type press having a movable die pad 12 mounted on the bolster 14 of the press with a hydraulic cushion arranged to resist movement of the die pad 12 upon closing of the press ram and to return the die pad 12 to its extended position upon opening of the press.

The cushion comprises a hydraulic work cylinder 16 and a piston 18 reacting against the die pad 12. A tank 20 of hydraulic fluid under relatively low pressure, say, for example, 100 lbs. per square inch, is connected to the work cylinder 16 for supplying hydraulic fluid thereto under tank pressure, the tank 20 being connected to the cylinder 16 by hydraulic fluid flow and pressure transmitting connections which include the hydraulic pressure line 22, the passage 24 in the pressure relief valve means 26, and the hydraulic fluid line 28 which extends from the latter to the cylinder 16 so that the latter is always supplied with hydraulic fluid from the tank 20 under the pressure prevailing therein.

The upper part of the tank 20 is connected to a conventional air pressure line 30 so that the pressure at which the hydraulic fluid in the tank is maintained can be adjusted and maintained within relatively close limits. A check valve 32 in the passage 24 offers little or no resistance to flow of hydraulic fluid through the valve means 26 from the line 22 to the line 28 while preventing reverse flow through the passage 24.

The pressure relief valve 26 comprises a valve body 34 containing a bore 36 having a sleeve 38 disposed therein and provided with a series of tapered valve ports 40 spaced around the sleeve 38. An annular chamber 42 surrounds the sleeve 38 and is in communication with a passage 44 with which the line 22 communicates. The line 28 is connected to a passage 46 which opens into the lower end of the bore 36. The passage 24 provides a by-pass around the pressure relief valve in the bore 36 through which hydraulic fluid under tank pressure is supplied to the cylinder 16 to return the die pad 12 to its extended position.

A valve member 48 reciprocates within the sleeve 38 and is urged by a spring 50 toward its closed position in which the ports 40 are closed to shut off communication between the passage 46 and the passage 44. The spring 50 reacts at one end against the valve member 48 and at its other end against a stop 52 carried by an adjustable screw 54 so that the pressure of the spring 50 may be adjusted as required. The ports 40 are rather long and narrow in size and may be tapered as shown. With this arrangement the valve member 48 will gradually increase the effective cross section of the ports 40 as it opens, and will gradually decrease the same upon closing.

In crank type presses the movement of the press ram 10 will be much faster during the first part of the closing movement of the press than during the latter part due to the different angular positions of the crank during closing movement so that the ram decelerates as it approaches its closed position whereby the displacement of hydraulic fluid from the cylinder 16 will be substantially higher during the first portion of ram movement than during the final portion. With a pressure relief valve of the type described herein, initial displacement of the die pad 12 and the piston 18 which reacts against it will create high pressures in the cylinder 16 and in passage 46 so as to move valve member 48 upwardly. The size of the ports 40, however, is such as to substantially restrict the flow of hydraulic fluid through the sleeve 38 into passage 44 and back to the tank 20 during the initial part of the working stroke of the press ram, thereby providing relatively high resistance to movement of the die pad at such time.

As the rate of fluid displacement from the cylinder 16 decreases due to the decreasing speed of the ram as it approaches the bottom of its stroke, the spring 50 will move the valve member 48 toward its closed position, thereby reducing the effective area of the ports 40. The valve 48 has a relatively long travel and the spring 50 is a variable rate spring so that as the spring 50 is extended during closing of the valve member 48, its force will be

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reduced and thus the valve member 48 will offer reduced resistance to the discharge of hydraulic fluid from the cylinder 16. Thus the resistance to movement of the die pad offered by the valve member 48 will be a combination of the variable effective area of the ports 40 and the variable strength of the spring 50 as it is extended, thereby providing a variable resistance to the discharge of hydraulic fluid from the hydraulic cushion during closing of the press ram. The ports 40 are relatively long and narrow to achieve this result and may be tapered as shown in FIG. 1 to provide a very fine adjustment of the effective area of the ports as the valve member 48 nears its closed position. However, the ports 40 need not be tapered, but may be of uniform narrow width throughout their length, as shown in FIG. 3.

FIG. 2 illustrates a press operation in which a hydraulic cushion having the variable pressure relief valve structure described in FIG. 1 is particularly suitable. In FIG. 2 there is disclosed a die 60 mounted on the bolster 62 and a press ram 64 carrying a tapered punch 66 and a pair of cylinders 68 having pistons 70 therein reacting against a die pad 72 which engages the outer periphery of the work 74 as the ram closes. The hydraulic cushion including the cylinders 68 and pistons 70 corresponds to the hydraulic cushion described in FIG. 1, and the line 28 which communicates with the cylinders 68 is connected to a pressure relief valve means 26 and tank 20 as in FIG. 1.

In die work of the kind shown in FIG. 2, it is desirable to firmly clamp the work against the die 60 as the tool 66 engages the work and during the initial portion of the working stroke. However, as the draw progresses, the metal tends to work harden at the radius 76 so that less pressure is needed to prevent tearing of the metal. In addition, some slippage of the outer periphery of the work between the die 60 and the die pad 72 is frequently desirable during the final portion of the working stroke, and the variable resistance offered by the valve means 26 allows such slippage.

In the form of the invention shown in FIG. 3, the valve means 26 is identical in construction to that shown in FIG. 1 except that there are a series of separate recesses 142 in the valve body 34, with each recess 142 disposed opposite one of the ports 140. A separate passage 144 communicates each recess 142 with the tank 20. With this arrangement it is possible to provide not only a variable resistance to movement of a die pad during the working stroke of the press as described, but also to vary the capacity of the pressure relief means 26 as desired since a separate valve (not shown) could be provided in each line 144 leading back to the tank 20 so that one or more of the ports 140 could be made effective as required to vary the capacity of the valve.

In FIG. 4 there is disclosed a variable pressure relief valve means 226 in which the line 28 which is connected to the cylinder 16 of the hydraulic cushion communicates with a plurality of passages 246, each of which communicates with the lower end of a bore 248 in the valve body containing a sleeve 250 having a bore 252 therein. An unloading valve member 254 is reciprocable within each of the sleeves 250 and is urged by a spring 256 toward its closed position in which radial ports 258 in the sleeve 250 are closed by the valve member 254. Each of the sleeves is provided with a reduced diameter portion to define an annular chamber 260 between the sleeve and its bore 248 into which the ports 258 open.

A check valve 262 is provided in a passage 264 which communicates with passages 246. A cross passage 266 connects the bores 248 and communicates with a passage 268 leading to the check valve 262. A valve member 270 is seated against the upper end of one of the sleeves 250 and is provided with an axial passage 272 and a radial passage 274 which communicates with a passage 276 leading to the upper end of the other sleeve 250. A bore 278 contains a sleeve 280 and valve member 282 like the sleeve 38 and valve member 48 shown in FIG. 1. A passage 272 in valve member 270 opens into the lower end

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of the sleeve 280 which is provided with a series of ports 284 which communicate with a passage 286 through an annular recess 288 surrounding the sleeve 280. A passage 290 provides communication between the passages 286 and 266, the latter of which passages is in communication with the line 22 which leads to the tank 20 containing hydraulic fluid under pressure as in FIG. 1. A variable rate spring 292 backed up by an adjusting screw 294 urges the valve member 282 to its closed position.

When the press is open, the valve 282 and the valves 254 will be closed and subjected to equal pressures on opposite sides thereof from the hydraulic fluid in the supply tank. Hydraulic fluid is supplied from passage 266 to passage 268 past check valve 262 to line 28 and the hydraulic cushion cylinder to return the die pad to its extended position. As the press ram closes, the hydraulic fluid in the cylinder will be subjected to very high pressures and forced therefrom through the line 28 into the pressure relief valve 226. The valves 254 will remain closed until the pressure acting against the under side of the pilot valve 282 is sufficient to overcome the force of the spring 292. It is pointed out that at least one of the valves 254 is provided with an orifice 296 of smaller diameter than the passage 272 in the valve member 270 for transmitting the pressure in the hydraulic cushion cylinder to the valve member 282. As soon as the latter opens, the valve members 254 will open and the high pressure fluid will flow through ports 258 into passage 266 and back to the supply tank. As the working stroke of the ram progresses, the amount of hydraulic fluid displaced from the hydraulic cushions decreases and valve member 282 will begin to close. The elongated slots 284 in the sleeve 280 and the spring 292 will cause the valve member 282 to move toward its closed position in accordance with the volume of hydraulic fluid forced out of the hydraulic cushion cylinder and to offer decreasing resistance to the flow of hydraulic fluid during the final portion of the closing movement of the ram, as described in connection with FIG. 1.

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 crank type press wherein the press ram decelerates as it approaches its closed position and a die pad is engaged by the work upon the closing of the press ram, a hydraulic cushion arranged to resist movement of said die pad upon closing of the press ram and to return the die pad to its extended position upon opening of the press ram, said hydraulic cushion comprising a hydraulic system which includes a hydraulic work cylinder and piston reacting against said die pad and discharging hydraulic fluid therefrom at a decreasing rate as the ram closes, a tank of hydraulic fluid under relatively low pressure, hydraulic fluid flow and pressure transmitting connections between said tank and cylinder for supplying hydraulic fluid to the latter under tank pressure, and normally closed pressure relief means disposed in said hydraulic fluid flow and pressure transmitting connections between said tank and work cylinder so as to create a varying resistance to the discharge of hydraulic fluid from said work cylinder upon and during closing of the press ram, that improvement wherein said pressure relief means comprises a pressure relief orifice forming a part of said fluid flow connections and through which hydraulic fluid is discharged from said work cylinder, and hydraulic pressure operated valve means cooperable with said orifice and movable in response to the discharge of hydraulic fluid from the work cylinder to open said orifice to the maximum position for which it is set during the relatively fast closing movement of the press ram to provide a relatively high pressure resistance to the resulting discharge of hydraulic fluid from said work cylinder, said orifice

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being narrow in width and elongated in the direction of movement of said valve means, said pressure operated valve means being movable in response to a decreasing rate of discharge of hydraulic fluid from the work cylinder during the succeeding relatively slower closing movement of the press ram so as to reduce the extent of opening of said orifice and the resistance to the resulting discharge of hydraulic fluid from said work cylinder as the press ram moves to its closed position.

2. In a crank type press wherein the press ram decelerates as it approaches its closed position and a die pad is engaged by the work upon the closing of the press ram, a hydraulic cushion arranged to resist movement of said die pad upon closing of the press ram and to return the die pad to its extended position upon opening of the press ram, said hydraulic cushion comprising a hydraulic system which includes a hydraulic work cylinder and piston reacting against said die pad and discharging hydraulic fluid therefrom at a decreasing rate as the ram closes, a tank of hydraulic fluid under relatively low pressure, hydraulic fluid flow and pressure transmitting connections between said tank and cylinder for supplying hydraulic fluid to the latter under tank pressure, and normally closed pressure relief means disposed in said hydraulic fluid flow and pressure transmitting connections between said tank and work cylinder so as to create a varying resistance to the discharge of hydraulic fluid from said work cylinder upon and during closing of the press ram, that improvement wherein said pressure relief means comprises pressure relief orifice means disposed in fluid flow relation with respect to the discharge of hydraulic fluid from said work cylinder, and a normally closed hydraulic pressure operated valve means movable in response to the discharge of hydraulic fluid from the work cylinder to vary the extent of opening of said orifice throughout the extent of movement of said valve means, said valve means being adapted to open said orifice means to the maximum position for which it is set during the relatively fast closing movement of the press ram to provide a relatively high pressure resistance to the resulting discharge of hydraulic fluid from said work cylinder, spring means urging said pressure operated valve means toward its closed position, said pressure operated valve means being movable in response to a decreasing rate of discharge of hydraulic fluid from the work cylinder during the succeeding relatively slower closing movement of the press ram, to reduce the extent of opening of said orifice means and the resistance to the resulting discharge of hydraulic fluid from said work cylinder as the press ram moves to its closed position.

3. In a press according to claim 2, said pressure relief orifice means comprises a hollow sleeve within which said pressure operated valve means is reciprocable, said sleeve having an orifice therein through which said hydraulic fluid flows and which is relatively narrow in width and elongated in the direction of movement of said valve means.

4. In a press according to claim 3, said sleeve having a plurality of said orifices therein and a separate fluid flow connection between each of said orifices and said tank.

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5. In a crank type press wherein the press ram decelerates as it approaches its closed position and a die pad is engaged by the work upon the closing of the press ram, a hydraulic cushion arranged to resist movement of said die pad upon closing of the press ram and to return the die pad to its extended position upon opening of the press ram, said hydraulic cushion comprising a hydraulic system which includes a hydraulic work cylinder and piston reacting against said die pad and discharging hydraulic fluid therefrom at a decreasing rate as the ram closes, a tank of hydraulic fluid under relatively low pressure, hydraulic fluid flow and pressure transmitting connections between said tank and cylinder for supplying hydraulic fluid to the latter under tank pressure, and normally closed pressure relief means disposed in said hydraulic fluid flow and pressure transmitting connections between said tank and work cylinder so as to create a varying resistance to the discharge of hydraulic fluid from said work cylinder upon and during closing of the press ram, that improvement wherein said pressure relief means comprises a normally closed hydraulic pressure operated valve means disposed in fluid flow relation with respect to the discharge of hydraulic fluid from said work cylinder, said valve means including a valve orifice and a valve member movable across said orifice in response to the discharge of hydraulic fluid from the work cylinder to open said orifice fully during the relatively fast closing movement of the press ram to provide a relatively high pressure resistance to the resulting discharge of hydraulic fluid from said work cylinder, said pressure operated valve means being movable in response to a decreasing rate of discharge of hydraulic fluid from the work cylinder during the succeeding relatively slower closing movement of the press ram so as to reduce the extent of opening of said orifice means and the resistance to the resulting discharge of hydraulic fluid from said work cylinder as the press ram moves to its closed position.

6. In a press according to claim 5, said valve means including a variable rate spring urging said valve member toward its closed position and exerting substantially less force on said valve member in said closed position than when said valve member opens said orifice fully, whereby the resistance to discharge of hydraulic fluid from the work cylinder is a function of the extent of opening of said orifice and of the force exerted by said spring on said valve member.

7. In a press according to claim 6, said orifice being elongated in the direction of movement of said valve member.

8. In a press according to claim 7, said orifice being tapered to a smaller cross-sectional area at the end thereof toward which said valve member moves to its closed position.

No references cited.

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