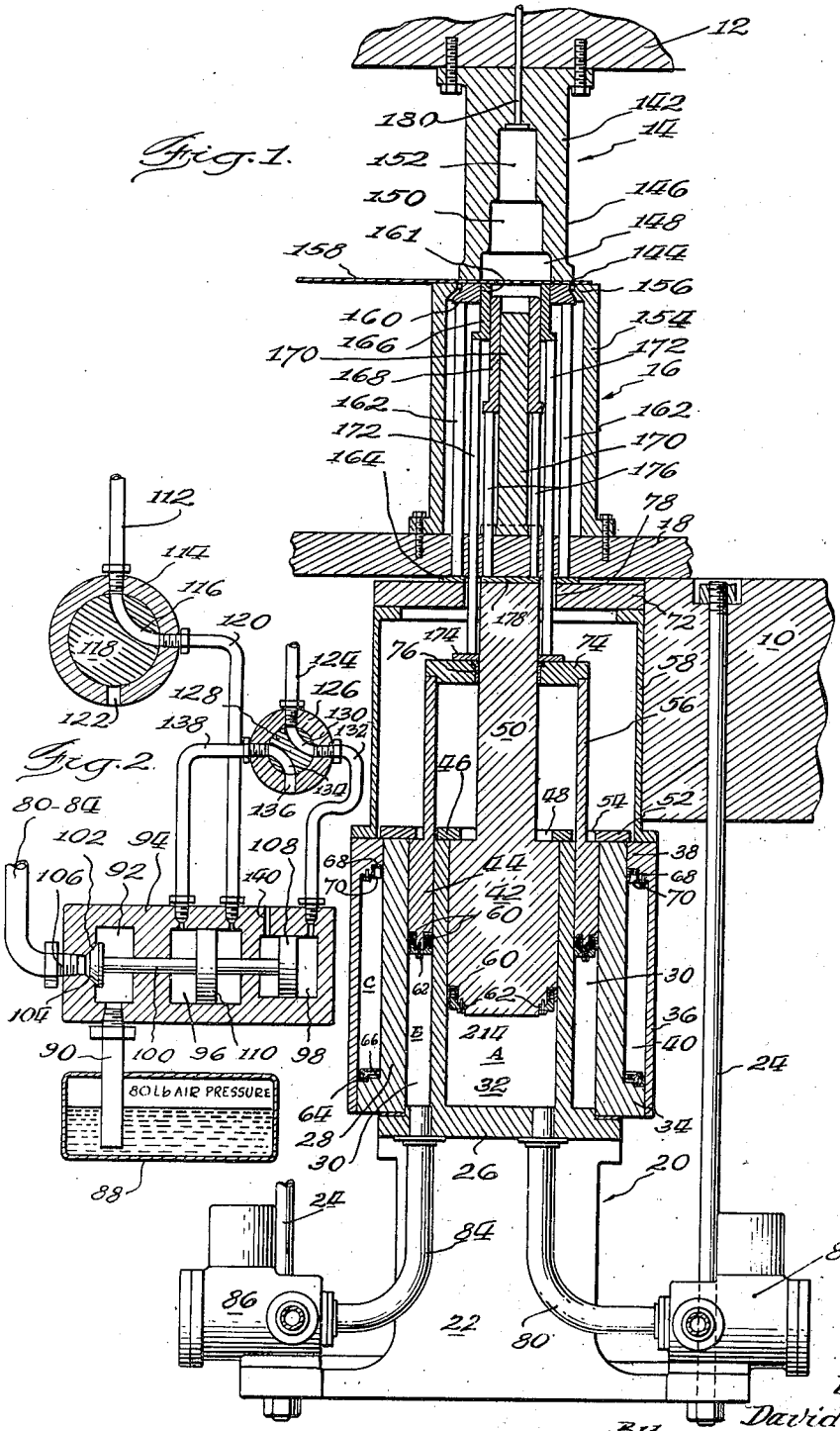
May 11, 1943. D. C. VERSON 2,318,819

MULTIPLE ACTION PUNCH PRESS DIE AND CUSHION

Filed Dec. 12, 1940 3 Sheets-Sheet 1

Fig. 1.



Inventor.
David C. Verson
By
Williams, Bradbury & Hinkle
Attys.

May 11, 1943. D. C. VERSON 2,318,819

MULTIPLE ACTION PUNCH PRESS DIE AND CUSHION

Filed Dec. 12, 1940 3 Sheets-Sheet 2

Fig. 3.

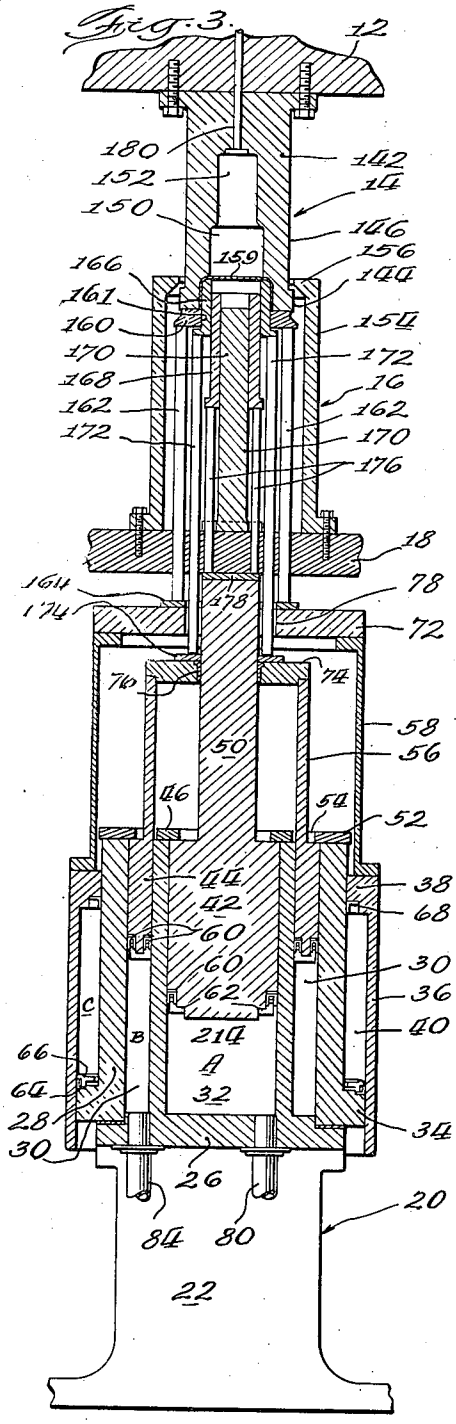
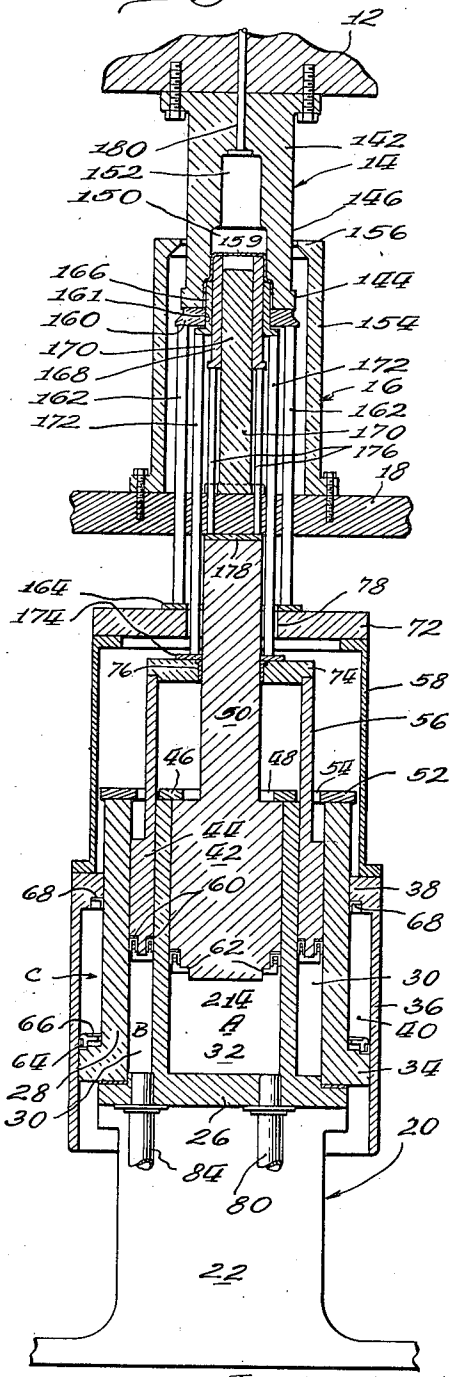


Fig. 4.



Inventor:
David C. Verson
By Williams, Bradbury & Hinkle. Attys.

May 11, 1943. D. C. VERSON 2,318,819

MULTIPLE ACTION PUNCH PRESS DIE AND CUSHION

Filed Dec. 12, 1940 3 Sheets-Sheet 3

Fig. 5.

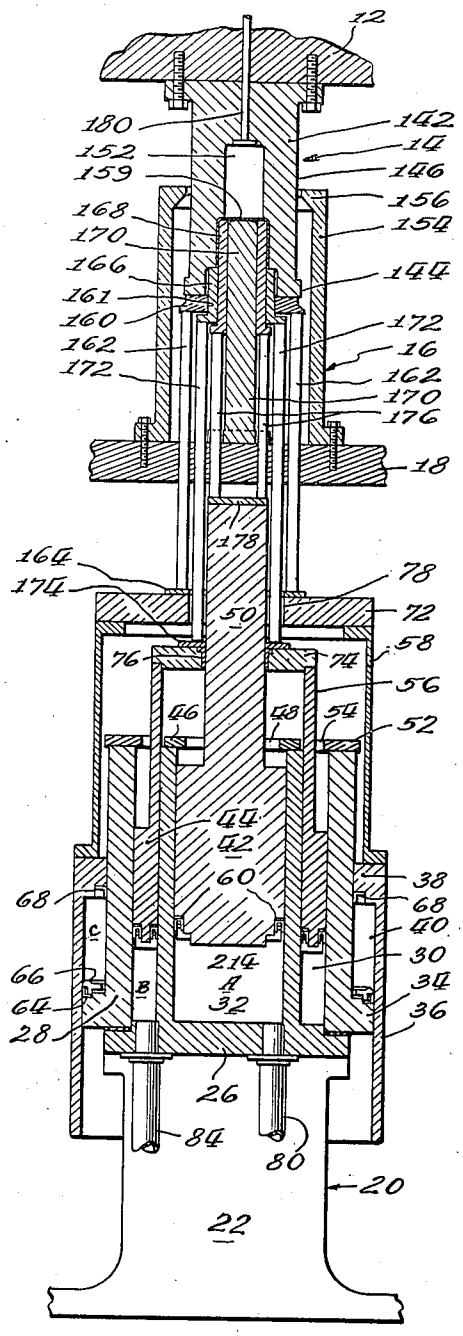
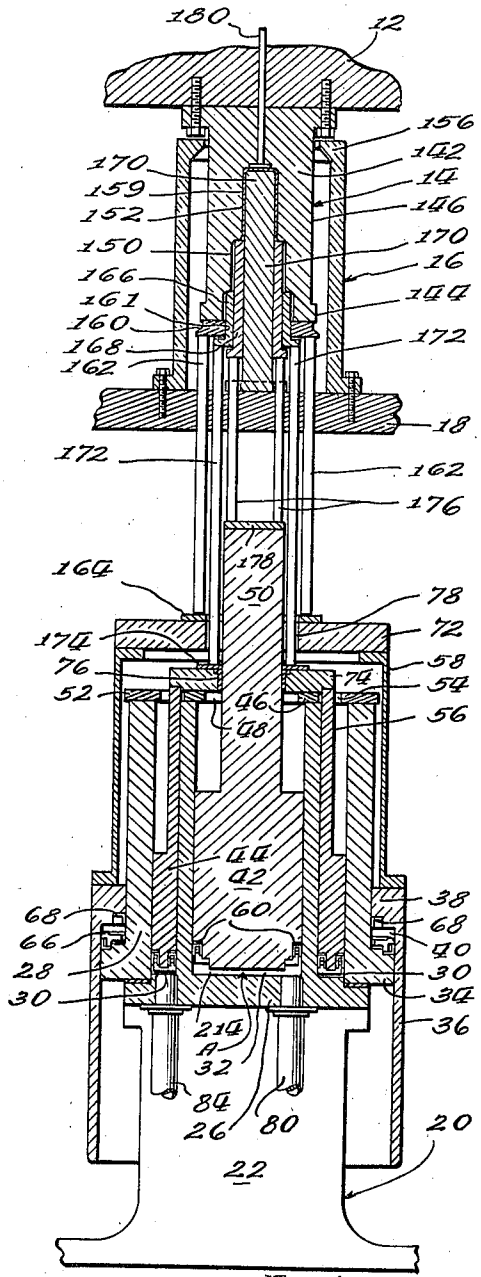


Fig. 6.



Inventor.
David C. Verson
By Williams, Bradbury & Hulbert Attys.

Patented May 11, 1943

2,318,819

UNITED STATES PATENT OFFICE

2,318,819

MULTIPLE ACTION PUNCH PRESS DIE AND CUSHION

David C. Verson, Chicago, Ill.

Application December 12, 1940, Serial No. 369,783

7 Claims. (Cl. 113—46)

This invention relates to the metal drawing art, and is concerned with the provision of a multiple action die cushion and die set for use therewith. By use of a device incorporating this invention, it is possible to draw in a single punch press stroke objects formerly requiring several successive strokes.

In the interest of clarity, the present invention is illustrated and described as incorporated in a set of dies and cushions to be used therewith for drawing a cylindrical steel can approximately ten inches long and five inches in diameter out of 21-plate gauge steel drawing stock. It is to be understood, however, that this invention is not limited to any such specific use. In order to draw such a can from a flat blank, it is necessary that the blank be made into a shallow dish and that by successive drawing operations this shallow dish be gradually reduced in diameter and drawn out in length until the final long, narrow can is produced.

The device of the present invention is particularly adapted for use with long stroke hydraulic presses or with a long stroke press of the type described in the copending application of Albert Clements, entitled "Screw Press," filed November 22, 1940, and given Serial No. 366,610. These two types of presses are mentioned as examples, although any press having a long stroke and sufficient capacity can be used with this device.

It is, therefore, an object of the present invention to provide a novel device that enables the drawing in one punch press stroke of objects formerly requiring a plurality of separate drawing operations.

Another object of the present invention is to provide a novel die set adapted for a plurality of successive drawing operations.

Still another object of the present invention is to provide an improved device which will cut a blank from a flat metal plate and then by successive drawing operations draw this blank into a long, thin object.

Yet another object of the present invention is to provide a novel multiple action die cushion together with means for controlling the action of such a cushion.

An additional object of my invention is to provide a multiple action die cushion and a die set cooperating therewith, such that some of the members of the die set will at one time act as punches to draw the metal, and will at other times act as draw rings around which the metal is drawn by a successive punching operation.

Other objects and advantages will become apparent from the following description of a preferred embodiment of my invention taken in conjunction with the accompanying drawings in which:

Fig. 1 is a vertical longitudinal sectional view through a die cushion and die set constructed to embody the present invention;

Fig. 2 is a somewhat diagrammatic sectional view of one set of duplicate control valves for use with the die cushion of the present invention;

Figs. 3, 4, 5, and 6 are vertical longitudinal sectional views similar to Fig. 1 showing successive positions of the various elements of the device during the course of a drawing operation.

Referring to Fig. 1 of the drawings, the punch press, of which only a portion is shown since it forms no part of the present invention, includes a bed 10 and a slide 12. An upper die member 14 is secured to the lower surface of the slide, while a lower die set 16 rests upon and is secured to a bolster plate 18, which, in turn, is secured to the press bed 10. The multiple action die cushion, indicated generally by the numeral 20, is comprised of a base 22 hung from the bed 10 upon a plurality of steel rods 24, so that the load tending to move the die cushion downwardly will be carried directly by the bed 10 through these rods. The base 22 supports an inner cylinder 26, while around this inner cylinder, a second cylinder 28 is positioned, both of these cylinders being secured to the base 22. Since the cylinder 28 is considerably larger in diameter than the cylinder 26, an annular space 30 will be provided between these cylinders, while a cylindrical space 32 will be provided within the cylinder 26.

At its lower end, the cylinder 28 has an outwardly extending flange 34 that provides a cylindrical surface which fits closely within a third cylinder 36 while at its upper end this third cylinder 36 has an inwardly extending flange 38 which closely fits the outer cylindrical surface of the second cylinder 28. Thus, between the cylinder 36 and the cylinder 28, a third annular space 40 is provided.

A cylindrical piston 42 fits within the cylindrical space 32, while an annular piston 44 fits within the annular space 30. An annular ring 46, somewhat smaller in external diameter than the external diameter of the cylinder 26, is secured to the upper end of cylinder 26 and is provided with a circular opening 48 somewhat smaller in diameter than the internal diameter of cylinder 26. An upward extension 50 of the piston 42 of smaller diameter than the piston extends through the opening 48, and thus, the extension 50 is free to move upwardly and downwardly within the opening 48, while the ring 46 serves as a stop to limit the upward movement of the piston 42. A similar annular ring 52 is secured to the upper end of cylinder 28. The central opening 54 in this ring is smaller in diameter than the internal diameter of cylinder 28, and thus the ring limits the upward movement of piston 44. An annular extension 56 of the piston 44, having an external diameter somewhat smaller than the internal diam-

eter of the ring 52, extends through this opening 54 and is free to move upwardly and downwardly through this opening. The external diameter of the ring 52 is somewhat greater than the external diameter of cylinder 28, and thus limits the upward movement of the outer cylinder 36 in a like manner, while an annular member 58 is secured to the top of the flange 38 and extends upwardly beyond the ring 52.

Each of the pistons 42 and 44 is sealed within its respective cylinder by means of cup washers 60 held in place by annular rings 62 in a well-known manner. In a similar manner the lower flange 34 of cylinder 28 is sealed by means of a cup washer 64 and ring 66 against the inner side wall of the outer cylinder 36. Similarly also, the upper flange 38 of the outer cylinder is sealed by means of a cup washer 68 and ring 70 to the external cylindrical surface of the intermediate cylinder 28.

For convenience in further discussion of the present invention, the cylindrical space 32, the annular space 30, and the annular space 40 will be referred to, respectively, as cylinders A, B, and C.

From the above discussion it will be seen that in the absence of pressure within these cylinders, the pistons 42 and 44 and the annular outer cylinder 36 will be free to move upwardly and downwardly within limits established by the rings 46 and 52 and the bottoms of the several cylinders. Likewise, the vertical positions of the upward extensions 50, 56, and 58 can be determined by the positions of their respective pistons 42, 44, and 36. For convenience, the outer annular cylinder 36 will be referred to as a piston hereafter, since its action in this device is somewhat similar to pistons 42 and 44, and since it moves relative to the base 22.

When the piston 42 is at the top of its cylinder, the top end of the upward extension 50 will be spaced a short distance below the bolster plate 18 and will be in axial alignment with the upper die member 14. An annular crosshead 72 is secured to the upper end of the annular extension 58 and lies with its upper surface in approximately the same plane as the upper surface of the extension 50. A similar annular crosshead 74 is secured to the upper end of the annular extension 56 and lies somewhat beneath the crosshead 72. This latter crosshead 74 has a central opening provided with a bushing 76 fitted to the cylindrical extension 50. Thus, the extension 50 and the crosshead 74 are enabled to move vertically relative to each other, although relative movement in other directions that would cause misalignment is prevented. A similar opening 78 is provided in the center of the crosshead 72 to permit the passage of the extension 50 and also to permit the passage of a plurality of vertically extending circumferentially arranged rods to be described presently. The outer annular extension 58 is guided for vertical movement by the bed 10 of the punch press through which it passes, or, if desired, by a specially constructed bearing member secured to the press bed 10.

A pipe 80 communicates at one of its ends with the interior of cylinder A while its other end leads to a solenoid valve 82. In a similar manner, a second pipe 84 connects the cylinder B to a second solenoid valve 86. The two solenoid valves 82 and 86 are substantially identical and thus a description of one of these valves will suffice.

Referring to Fig. 2, which shows the construction of the solenoid valves diagrammatically, a closed oil reservoir 88 contains a quantity of oil maintained under a pressure of approximately 80 pounds per square inch. This pressure is maintained by connecting the reservoir to an air receiver, not shown, so that the space above the liquid in the reservoir contains air forced into the reservoir from the air receiver. A pipe 90 extends into the reservoir and has its lower end below the liquid level therein, while its upper end is connected to a forward chamber 92 of a pneumatically controlled hydraulic valve body 94. This valve body is also provided with an intermediate cylindrical chamber 96 and a rearward cylindrical chamber 98. The chambers 96 and 98 are in axial alignment and for the particular embodiment of the invention here shown, the chamber 96 is of somewhat greater diameter than the chamber 98. A valve rod 100 extends axially through these two chambers and into the forward chamber 92 where at its end it carries a conical valve plug 102. This conical plug seats in a complementary conical valve seat 104 at the forward end of the chamber 92 and this valve seat in turn communicates through the valve body with a pipe fitting 106 connected in turn to either the pipes 80 or 84, as the case may be.

The cylinder 98 contains a piston 108 fixed to the rearward end of the valve rod 100, while a second piston 110 is fitted within the intermediate cylinder 96 and is also secured to the valve rod 100. These two pistons are so positioned upon the rod 100 that when the conical valve plug 102 is seated in the valve seat 104, these two pistons will be at an intermediate point in their cylinders.

An air line 112 leads from an air receiver not shown, but which is maintained under approximately 80 pounds per square inch pressure, to a two-position valve 114. This valve, when in the position shown in Fig. 2, has a passage 116 in a rotary member 118 which conducts the air from the air line 112 to a conduit 120 so as to place the conduit under 80 pounds per square inch pressure. When the rotary member 118 of this valve is rotated in a clockwise direction, a matter of 90°, the passage 116 connects the conduit 120 to the atmosphere through a valve opening 122, thus placing the conduit 120 at substantially atmospheric pressure. The conduit 120 is connected at its opposite end to the valve body 94 in such a position that it communicates with the intermediate cylinder 96 in a position behind the piston 110, so that, when the valve 114 is in the position shown in Fig. 2, the piston 110 will be urged forwardly, thus seating the valve plug 102 in its seat 104.

A second air line 124 leads from the air receiver not shown and also carries air under approximately 80 pounds per square inch pressure to a second two-position valve 126. Within the valve 126 a rotary member 128 is provided with two passages. When this valve is in the position shown, one of these passages, indicated by the numeral 130, connects the air line 124 with a conduit 132 which leads to the rearward cylinder 98 at a position behind the piston 108, thus tending to urge the piston forwardly when the valve is in the position shown. A second passage 134, within the rotary member 128, connects a valve opening 136 leading to the atmosphere to a conduit 138 connected in turn to the forward portion of the intermediate cylinder 96. Thus, with the valve in the position shown, the forward portion of cylinder 96 is vented to the atmosphere.

When the rotary member 128 is swung through an angle of 90° in a clockwise direction, the conduit 132 will be vented to the atmosphere through the passage 130 while the conduit 138 will be connected to the air line 124 by the passage 134. In order to permit freedom of movement of the piston 108 in cylinder 98, a vent 140 through the valve body establishes a connection between the forward portion of this cylinder and the atmosphere.

Because of the differences in the areas of the pistons 108 and 110 and the area of the valve plug 102, it will be appreciated that the valve plug can be maintained in its seat by air pressure behind cylinders 110 and 98, or both of them, even though this air pressure is many times less than the back pressure in the pipes 80 or 84, as the case may be.

The operation of this portion of the device is as follows: first, assume that both the rotary valve members 118 and 128 are rotated through an angle of 90° in a clockwise direction from the positions shown. With the valve in this position, the rearward portions of cylinders 96 and 98 will be connected to the atmosphere, while the forward portion of cylinder 96 will be connected to the air line 124 and will, therefore, be under a pressure of 80 pounds per square inch. The pressure on the forward side of piston 96 will move the valve plug 102 rearwardly and oil within the reservoir 88, since it is under approximately 80 pounds per square inch pressure, will move upwardly through the pipe 90, into the chamber 92 and thence through the pipe 39 or 84 to either cylinder A or B, as the case may be.

This oil under 80 pounds per square inch pressure in the cylinders A and B will move the pistons 42 and 44 upwardly against the stops provided by the rings 46 and 52. At this point in the cycle, both the rotary members 118 and 128 are rotated into the positions shown by solenoid actuating means not illustrated. The forward portion of cylinder 96 is, therefore, vented to the atmosphere while the rearward portions of cylinders 96 and 98 are placed under 80 pounds per square inch pressure. Pistons 110 and 108, therefore, move forwardly and seat the valve plug 102 tightly in its seat 104. The relative areas of piston 42, valve plug 102, and pistons 110 and 108 of valve 82 are such that under these conditions it will require a downward pressure on piston 42 of 21 tons to unseat valve plug 102 and permit the hydraulic fluid to be forced around this valve member and into the reservoir 88. Similarly, the relative areas of piston 44, valve member 102, and pistons 108 and 110 in valve 86 connected to cylinder B are such that under similar conditions it will require 30 tons pressure to move piston 44 downwardly to unseat valve member 102.

At a later point in the cycle of the machine, to be described in greater detail subsequently, the rotary member 118 of valve 114 is rotated 90° in a clockwise direction, thus connecting the rearward portion of cylinder 96 to the atmosphere. Under these conditions, the force tending to urge valve plug 102 into its seat will be exerted solely by piston 108 and it will therefore require less hydraulic back pressure to unseat the valve 102. The relative areas of the piston 110 and 108 are such that with the valve in the position last mentioned, a pressure of only 5½ tons will be required to move cylinder 42 downwardly, while a pressure of 7½ tons will move piston 44 downwardly. That is, these pressures will be sufficient to unseat the valve 102 and permit oil to flow from cylinders A and B around their respective valve members 102 and into the reservoir 88.

The space C in the die cushion of the present embodiment is connected directly to the air receiver and the area of the piston working in this space is such that a pressure of 10 tons is required to move the piston 36 downwardly against the air pressure of 80 pounds per square inch in this space.

The upper member 14 of the die set consists of a hollow punch 142 secured to the slide 12. At its lower end the external face of this punch provides a cylindrical surface 144 of the proper diameter to shear a circular blank from a strip of stock to be used to form the can. Above this surface 144 the external face of the punch is relieved somewhat at 146 in the usual manner. The lower portion of the punch is provided with a cylindrical cavity 148 somewhat broader than it is deep and of the proper shape to form the first draw from the circular blank. Above this cavity 148 is a second cylindrical cavity 150 which is somewhat narrower and deeper than the cavity 148. This cavity is of the proper shape to reduce the diameter and elongate the dish formed by the first drawing portion 148. Above the cavity 150 is a third cavity 152 which is narrower and deeper than the cavity 150 and is of the proper shape to form the can to its required final dimensions. In each instance the punch at the juncture between different sizes of cavities is provided with a radius of curvature so that no sharp edges are present.

The lower die set 16 comprises a cylindrical sleeve 154 secured to the bolster plate 18. At its upper end the sleeve 154 is provided with an inwardly flanged edge 156 having a circular opening therein fitted to the cylindrical surface 144 of the punch 142 so that as the punch moves downwardly with a strip 158 placed between the die members, the end of the punch in conjunction with the upper face of the flange 156 will shear a circular blank 159 of proper size from the strip.

An outer draw ring 160 has a cylindrical opening 161 therethrough somewhat smaller in diameter than the cylindrical opening of the cavity 148 in the punch 142. The lower portion of this draw ring is flanged outwardly somewhat so that the shoulder of the flange 156 will prevent the draw ring 160 from being raised substantially above the level of the top of the sleeve 154. This draw ring is secured to the upper ends of a plurality of circumferentially arranged rods 162 extending downwardly through the bolster plate 18 and connected at their lower ends to a ring 164 secured in turn to the upper face of the crosshead 72. Thus the draw ring 160 can be moved downwardly by the punch 146 against a resisting force of ten tons.

An annular punch 166 has its external face fitted to the internal surface 161 of the draw ring 160. The external diameter of this punch is such that the punch functions properly in drawing a sheet metal blank into the lower cavity 148 of the upper punch 142. The internal diameter of the annular punch 166 is somewhat smaller than the intermediate cavity 150 of the punch 142 and fitted to this internal surface is a second annular punch 168 of proper size to draw the dish formed in cavity 148 into the intermediate cavity 150. A third punch 170 of proper size to draw the dish formed in the intermediate cavity 150

into the final cavity 152 is fitted to the internal surface of the annular punch 168 and at its lower end is secured to the bolster plate 18. The external annular punch 166 is secured to vertical rods 172 which extend downwardly through the bolster plate and through the crosshead 72 and are connected at their lower ends to a ring 174 secured in turn to the crosshead 74. In a like manner, the annular punch 168 is supported upon rods 176 attached at their lower ends to a ring 178 secured to the upper end of the inner piston extension 50.

When all of the members of the lower die set are in their maximum upper positions, the upper end of annular punch 166 is about two inches above the upper end of annular punch 168 while the latter in turn is approximately two inches above the upper end of the central punch 170. In each instance the noses of the punches are rounded off so that there will be no sharp corners present to tear the metal being drawn.

The operation of this device is as follows: Assuming that the die set and air cushion described are properly secured in place in a punch press of adequate capacity having a stroke of approximately 34 inches, and also assuming that the slide 12 is in its upper position and that rotary valve members 118 and 128 are in the positions shown in Figure 2, a strip 158 of sheet metal of proper gauge is inserted to cover the opening in the upper end of the sleeve 154. The press is then set in operation to cause the slide 12 carrying the punch 142 to move downwardly.

After the upper punch has moved downwardly approximately 10 inches or so, the lower end of the punch will come in contact with the sheet metal strip 158 and will clamp the strip 158 between the lower end of the punch and the upper face of the draw ring 160. Upon slight additional downward movement, the punch acting in conjunction with the sleeve 154, will shear a circular blank 159 of proper size from the strip 158. This blank is carried downwardly against the upper end of the outer annular punch 166 which is maintained against downward displacement by a pressure of approximately 30 tons. Under these conditions no appreciable downward movement of the punch 166 will take place. The sheet metal blank is, therefore, drawn radially inwardly across the contiguous faces of the draw ring 160 and the punch 142 and into the depression 148.

After the blank 159 has been fully drawn into the depression 148 the punch 166 can move no farther into the die 142 and will, therefore, start to move downwardly against the 30 tons pressure exerted by piston 44. The relative positions of the parts at this point in the cycle are shown in Figure 3. At this point in the cycle of the machine a limit switch establishes an electrical circuit which energizes the solenoid valve portion 114 of control valve 86 so that the rotary member 118 is rotated 90° in a clockwise direction from the position shown in Fig. 2. This establishes a connection between the rearward portion of cylinder 96 in the valve body and the atmosphere and as has been previously explained causes the pressure exerted by the piston 44 in an upward direction to drop from 30 tons to 7½ tons.

Since it takes an appreciable interval of time to cause the valve 86 to be shifted in the manner described, the upper end of punch 166 is spaced approximately two inches above the upper end of punch 168. Thus, sometime before the bottom of the dish formed by the punch 166 has been brought against the end of the intermediate punch 168, the pressure tending to prevent downward movement of the punch 166 will have dropped from 30 to 7½ tons. The outer punch, therefore, under this reduced pressure acts as a second draw ring as the second punch 168 draws the dish formed by the outer punch into the intermediate recess 150. The positions of the parts at one point in this stage of the draw are shown in Figure 4.

When the punch 168 has reached the bottom of the recess 150 and can go no farther, a limit switch operates valve 82 in the same manner that valve 86 was previously operated. That is, the rotary member 118 in this valve is rotated through an angle of 90° in a clockwise direction to connect the rearward portion of cylinder 96 to the atmosphere. As has been explained previously, this causes the pressure tending to maintain the punch 168 against downward movement to be dropped from 21 tons to 5½ tons. Continued downward movement of the punch 142 brings the bottom of the dish formed in cavity 150 against the upper end of the inner punch 170. The positions assumed by the parts at this point in the cycle are shown in Figure 5.

Since the pressure now tending to prevent downward movement of the annular punch 168 has dropped to 5½ tons, this member will act as a third draw ring and will cause the metal in the dish to be smoothly drawn into the uppermost recess 152 by the innermost punch 170. At the completion of the press stroke, the can for which these dies are made will be completely formed. The positions assumed by the parts at the end of the drawing cycle are shown in Figure 6.

As the slide 12 starts its upward movement, the rotary valve members 128 in both valves 82 and 86 will be caused to rotate in a clockwise direction from the position shown in Figure 2 and as has been previously described, oil under pressure in reservoir 88 will return the several elements of the die cushion to their original starting positions as the slide 12 moves upwardly. As in the previous instances, the shifting of the valve members 128 is accomplished by a limit switch which is tripped when the slide 12 reaches the lowest position in its stroke.

When the slide has reached a point near the top of its stroke, a limit switch will be tripped which will cause both the solenoid valves 82 and 86 to return their rotary members 118 and 128 to the positions shown in Figure 2, thus conditioning the multiple action die cushion and the die set for a succeeding draw.

In order to insure the finished can being ejected from the upper punch 142 as the upper punch moves upwardly, a knock-out bar 180 extends axially from above into the upper recess 152 of the punch 142. This knock-out bar operates in the conventional manner in that during the upward movement of the slide 12, this knock-out bar impinges against a stationary member which permits the upper die to move upwardly while for a moment the knock-out bar remains stationary. The knock-out bar, therefore, pushes the can from the inner recess 152.

No detailed description of the limit switches and the solenoid valve shifting elements or the circuits connecting these members is here given inasmuch as the arrangement and detailed construction of these members is a matter well within the skill of anyone familiar with this art. That is, limit switches and solenoid valves are

commonly used to institute and stop various cycles of operation in automatic and semiautomatic machines, including metal deforming machines, and the particular design and arrangement of these elements in any particular machine is largely a matter of choice and not a matter requiring invention.

From the above description of a preferred embodiment of my invention, it will be seen that I have provided a device which enables a sheet metal blank to be drawn through several drawing stages during a single stroke of a metal drawing press, and that this invention accomplishes all of the objectives set forth at the beginning of this specification.

Having described my invention, what I claim as new and useful and desire to secure by United States Letters Patent, is:

1. A punch press device comprising a central immovable punch, an annular punch surrounding said immovable punch and adapted for movement relative to said immovable punch, a die cushion piston adapted to support said annular punch with its outer end beyond the outer end of said immovable punch, and means cooperating with said die cushion piston to enable said piston to support different degrees of pressure during different portions of the punch press stroke, the last said means comprising a cylinder fitted to said piston, means to fill said cylinder with hydraulic fluid, escape valve means adapted to retain fluid in said cylinder until a predetermined cylinder pressure has been reached after which said valve means is adapted to open to permit escape of fluid under restraint, and means subsequently operative during the press stroke to cause said valve means to release said fluid at a positive pressure lower than said predetermined pressure.

2. In a multiple action die cushion, a die cushion cylinder, a hydraulic conduit leading from said cylinder, a valve to close said conduit against back pressure from said cylinder, said valve being seated against said back pressure by a plurality of cooperating force producing cylinders so arranged that one of said force producing cylinders acting alone will hold said valve in its seat against a certain amount of back pressure, while both of said force producing cylinders acting together will hold said valve in its seat against a different degree of back pressure, and means to actuate first both and then one of said force producing cylinders.

3. In a multiple action die cushion, a die cushion cylinder, a hydraulic conduit leading from said cylinder, a valve to close said conduit to prevent flow from said cylinder when the force acting upon the die cushion side of said valve tending to push said valve from its seat is less than the force tending to seat said valve, a plurality of cooperating air cylinders adapted to seat said valve so arranged that one of said air cylinders acting alone will hold said valve in its seat against a certain degree of back pressure from said die cushion cylinder, while both of said air cylinders acting together will hold said valve in its seat against a different degree of back pressure, and means to connect first both and then one of said air cylinders to a source of air under pressure.

4. In a punch press device, an inner punch and an outer punch, said outer punch being adapted to reciprocate relative to said inner punch, hydraulic cylinder means to support said outer punch to inhibit said relative reciprocation, relief valve means adjusted at the beginning of a drawing operation to prevent escape of fluid from said hydraulic cylinder means until a certain predetermined cylinder pressure has been reached and to permit escape of fluid from said cylinder at said predetermined pressure, and means subsequently operative during the drawing operation to permit the escape of said fluid from said cylinder at a positive pressure substantially less than the first said pressure.

5. A punch press die cushion comprising a plurality of cylinders, a plurality of pistons adapted to reciprocate in said cylinders, means to fill said cylinders with a hydraulic fluid so as to move said pistons outwardly, escape valve means adapted when in closed position to prevent escape of fluid from said cylinders and when in open position to permit the escape of fluid therefrom, said valve means being so arranged that pressure in said cylinders tends to force said valve means toward open position, resilient loading means adapted to apply a force to urge said valve means toward closed position, means adapted when operated to decrease the force applied by the loading means, and means operated by the punch press mechanism during the course of a punch press stroke for actuating the last said means.

6. In a multiple action die cushion, a die cushion cylinder, a hydraulic conduit leading from said cylinder, valve means to close said conduit against back pressure from said cylinder, said valve means being so arranged that pressure from said cylinder will tend to open said valve means to permit the escape of fluid from said cylinder, force producing means adapted resiliently to bias said valve means toward closed position against the pressure in said cylinder so that the pressure developed in said cylinder before opening said valve means depends upon the pressure exerted by said force producing means, and means to develop a certain degree of force in said force producing means and subsequently a less degree of force in said force producing means.

7. In a punch press device, a plurality of concentric metal drawing punches, said concentric punches being movable relative to each other and being telescoped when at rest with each successively outwardly spaced punch having its outer end extending a substantial distance beyond the outer end of the adjacent inner punch, die cushion means supporting said movable punches and adapted to resist movement of the latter, said die cushion means being adapted to offer different degrees of resistance to movement of said movable punches at different positions in the press stroke, whereby the outermost of said concentric punches will be yieldingly restrained against movement for a portion of a punch press stroke and will subsequently be permitted to move under less restraint during the remainder of the punch press stroke so that the outermost of said concentric punches will first act as a yieldingly supported drawing member and later as a draw ring while another of said punches is acting as a drawing member.

DAVID C. VERSON.