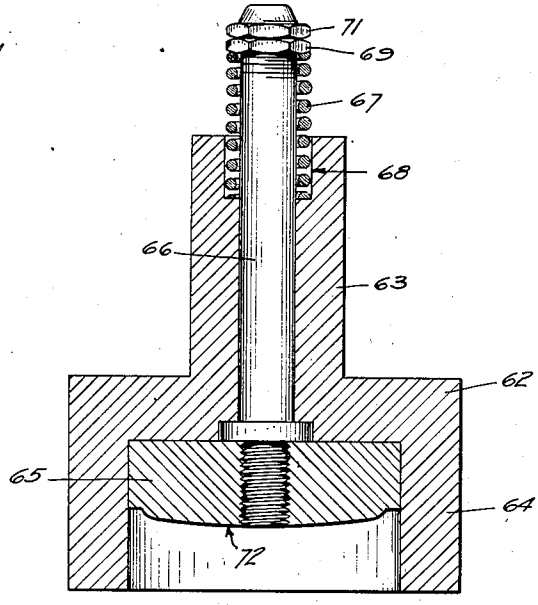
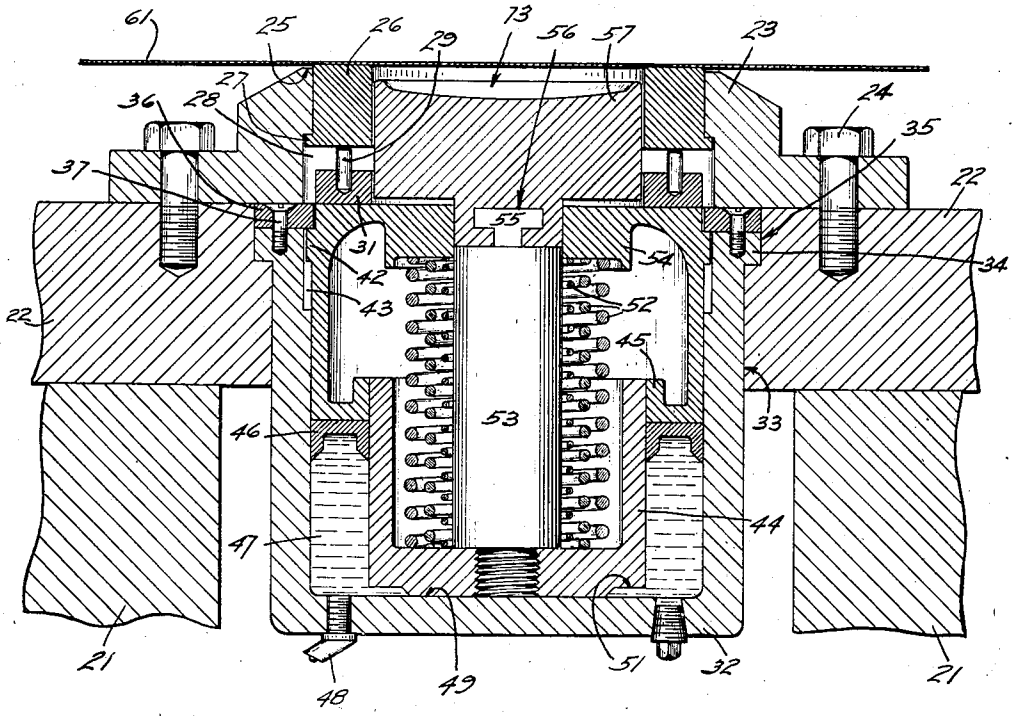
April 6, 1937. J. M. HOTHERSALL 2,075,847

ART OF DRAWING

Filed May 16, 1930 3 Sheets-Sheet 1

Fig. 1





INVENTOR
John M. Hothersall
BY
John C. Carpenter
ATTORNEY

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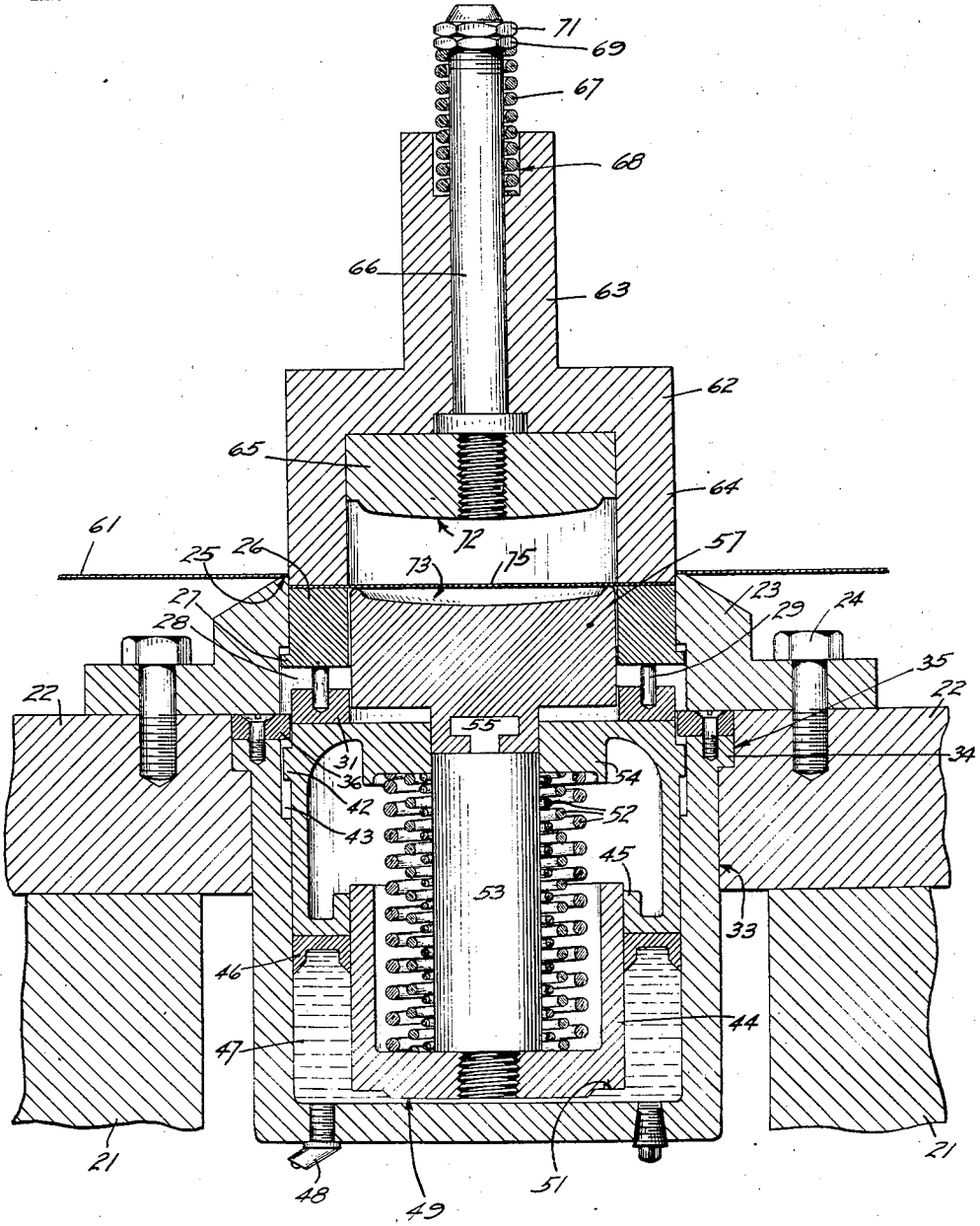
ART OF DRAWING

Filed May 16, 1930 3 Sheets-Sheet 2

Fig. 2



INVENTOR
John M. Hothersall
BY
John C. Carpenter
ATTORNEY

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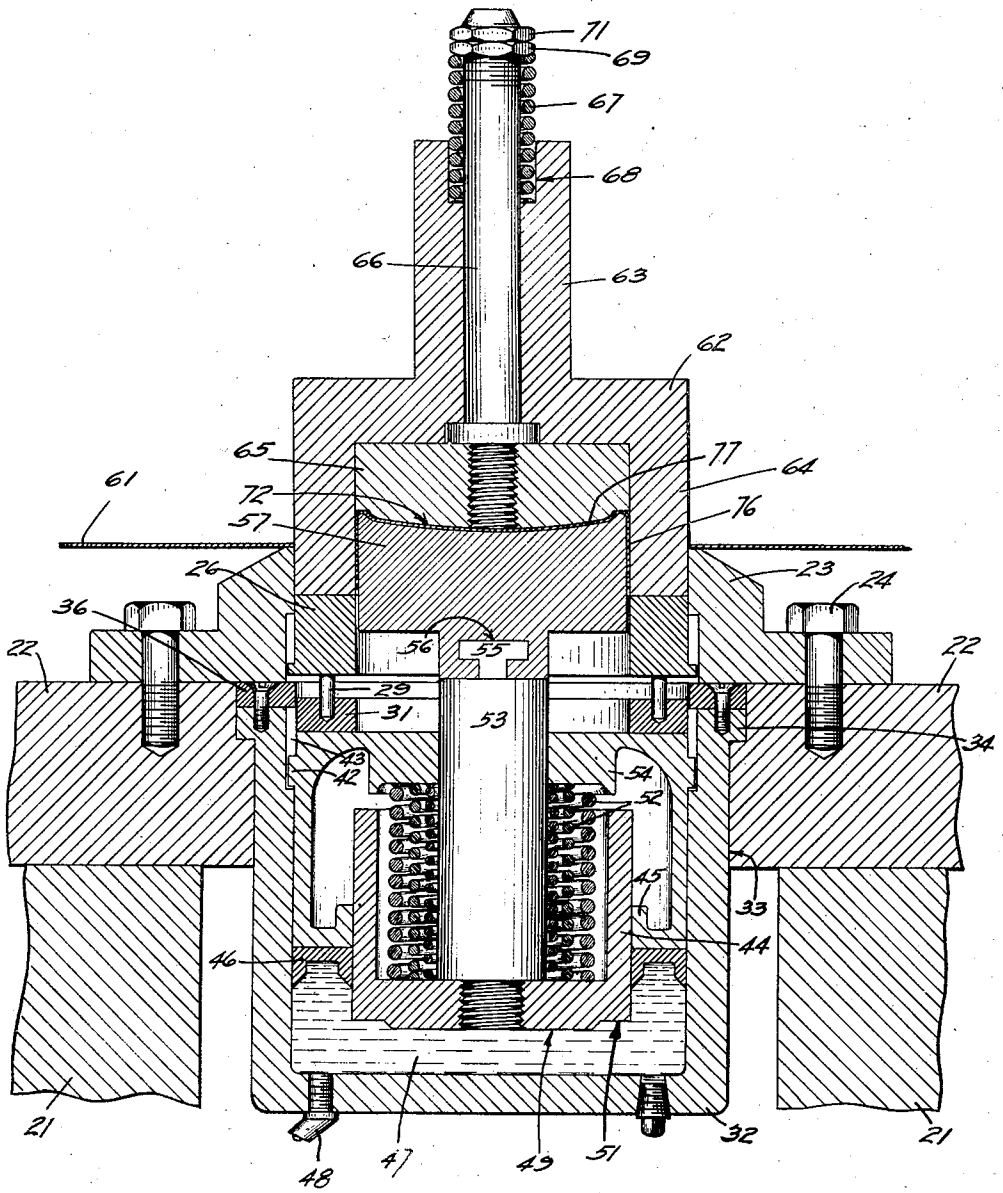
ART OF DRAWING

Filed May 16, 1930 3 Sheets-Sheet 3

Fig. 3



INVENTOR
John M. Hothersall
BY
John C. Carpenter
ATTORNEY

Patented Apr. 6, 1937 2,075,847

UNITED STATES PATENT OFFICE

2,075,847

ART OF DRAWING

John M. Hothersall, Brooklyn, N. Y., assignor to American Can Company, New York, N. Y., a corporation of New Jersey

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10 Claims. (Cl. 113—4.5)

The present invention relates to a drawing press mechanism and has particular reference to a self-contained compensating drawing and clamping device for shaping and holding the material being operated upon.

In the drawing of articles from sheet material it is necessary in order to prevent wrinkles to provide a resisting and yielding clamping device for holding the material in a slip grip while it is being drawn off and shaped over an anvil, and in usual practice, drawing rubbers or springs have been employed as the active clamping elements in such a slip grip. As the drawing operation proceeds such rubbers or springs are brought under greater compression and the force or resistance delivered by them, which is effective in the slip grip, correspondingly increases. This in some cases, as will be later explained, is not desirable.

The present invention is directed to an improved apparatus for compensating or balancing the amount of clamping action effective upon the material in the slip grip and this clamping force is automatically adjusted in direct and constant ratio to the drawing pressure or drawing resistance of the material being acted upon. By means of such improvement the clamping action in the slip grip on the material is at its maximum when the greatest force is required in the drawing cycle, this being at the beginning of the drawing stroke. As the drawing resistance diminishes, the degree of clamping action in the slip grip correspondingly diminishes. Drawing of different thicknesses of material as well as the drawing of material of varying ductile strength to various depths may be readily performed in the same mechanism, where such operation is performed according to the present invention.

The principal object of the present invention is the provision of a mechanism for performing a drawing operation upon sheet material while preventing the formation of wrinkles by holding the same during the drawing action in a slip grip of compensated clamping strength.

An important object of the present invention is the provision of a mechanism adapted to uniformly draw an article from sheet material by properly holding the same in a varying self-compensating degree of clamping action dependent upon the resistance of the material being drawn.

An important object of the invention is the provision of a mechanism adapted to uniformly draw an article from sheet material by utilizing a clamping device which automatically adjusts the degree of clamping pressure to the drawing pressure or drawing resistance which is variable under varying conditions.

An important object of the invention is the provision of a mechanism adapted to uniformly draw an article from sheet material by utilizing a clamping device which automatically adjusts the degree of clamping action to such varying factors as size of blank, thickness or gauge of blank, kind of material, ductile strength, depth of draw, etc.

An important object of the invention is the provision of inter-acting elements hydraulically connected to perform a self-adjusting clamping action in a drawing operation.

A further important object of the invention is the provision of a drawing press mechanism utilizing a self-contained hydraulic connection between certain moving parts whereby movement of some of the parts in one direction is transmitted to other parts causing a movement in the opposite direction, the cooperation of movements providing increased drawing travel.

An important object of the invention is the provision of a die mechanism for holding sheet material in a suitable slip grip while drawing the same over a shaping member, the degree of clamping action in the slip grip varying directly with the forces required in the drawing operation.

An important object of the invention is the provision of a die mechanism utilizing an anvil or block over which the work is drawn, the anvil being connected hydraulically with a moving part to effect constant ratio between clamping and drawing pressures.

Another important object of the invention is the provision of a universal or permanent hydraulic cushion mechanism or unit in a draw press adapted to cooperate with a variety of different types and sizes of temporary or interchangeable die mechanisms without disturbing the setting of said unit in the press.

An important object of the invention is the provision of a press mechanism for forming a drawn article by cutting a disc from sheet material and holding the same clamped with an equalized slip grip which prevents wrinkling thereof during the drawing operation.

Numerous other objects of the invention will be apparent as it is better understood from the following description, which, taken in connection with the accompanying drawings, discloses a preferred embodiment thereof.

Referring to the drawings:—

Figure 1 is a longitudinal section through a cutting and drawing punch and die mechanism embodying the present invention, the view illustrating the parts in position prior to operation.

Fig. 2 is a view similar to Fig. 1, illustrating the parts in initial cutting position.

Fig. 3 is a sectional view similar to Fig. 1, illustrating the parts in completed drawing position.

The drawing press mechanism of the present invention is embodied in a suitable press frame 21 which carries a bolster plate 22 in the usual or preferred manner. An outer cutedge member 23 is mounted upon and secured by bolts 24 to the bolster plate 22 and is provided with an annular cutting edge 25.

An annular draw ring 26 is movably located inside of the cutedge member 23 and is concentric with the cutting edge 25. A projecting flange 27 formed in the draw ring 26 has movement within a counterbore 28 formed in the cutedge member 23 adjacent the cutting edge 25. The draw ring 26 rests upon pins 29 projected from a collar 31 positioned therebeneath.

A cylinder 32 is positioned within an opening 33 formed in the bolster plate 22, a projecting flange 34 thereof resting in a counterbore 35 formed in the bolster plate. An annulus 36 is held by screws 37 on the upper edge of the cylinder 32 and is engaged by the member 23 which rests upon and tightly holds the cylinder 32 in clamped position within the openings 33 and 35. This annulus also provides a stop shoulder for limiting the upward position of other working parts.

An outer piston 41 provided with a projecting shoulder 42 is located within the cylinder 32, its outer wall closely fitting but freely sliding therein. The piston 41 is normally held in raised position (shown in Fig. 1) wherein its shoulder 42, which has movement within a counterbore 43 formed in the cylinder 32, engages beneath the lower projecting inner edge of the annulus 36. The collar 31 rests directly upon the upper surface of the piston 41 and moves therewith.

An inner piston 44 is located within the cylinder 32 and has sliding movement inside of an inner lower wall 45 of the outer piston 41. A flexible sealing ring washer 46 is interposed between the inner face of the cylinder 32 and the outer face of the piston 44 and engages the lower wall of the piston 41 forming a liquid-tight joint packing.

A liquid, designated by the numeral 47, which may be oil, glycerine or the like is contained within the lower part of the cylinder 32 and between the inner wall thereof and the outer wall of the piston 44. This liquid may be conveniently inserted through a check valve nipple 48 of any usual construction which is threadedly secured in the bottom of the cylinder. A sufficient quantity of liquid is used to completely fill the chamber when the piston 44 is in its lowermost position and when the piston 41 is against the annulus 36 as shown in Fig. 1. A vent screw plug 50 is threadedly secured in the bottom wall of the cylinder 32 and in filling the cylinder with the liquid 47 this vent plug is removed, the entire unit contained within the cylinder being inverted for this purpose, it being understood that the filling operation is performed before the unit is inserted in the press.

The inner piston 44 may be formed with a bottom seating surface 49, and an outer raised annular surface 51 to receive upward oil pressure when the surface 49 is seated (Figs. 1 and 2). Provision is made for returning the pistons to normal position (Fig. 1) after each operation, the driving force comprising a series of relatively, flexible, quick-acting springs 52 located partially inside of the piston 44 and surrounding a vertically disposed stem 53 threadedly secured to the bottom of the piston 44.

The upper ends of the springs 52 engage a central boss 54 formed in the top of the piston 41. These springs when the die parts are in non-operating position hold the piston 44 downwardly with its surface 49 resting against the bottom of the cylinder 32 and also hold the piston 41 in its raised position with its shoulder 42 against the annulus 36. The piston 41 when in this raised position holds the collar 31, pins 29 and draw ring 26 in raised position (Fig. 1).

The stem 53 is provided at its upper extremity with a projecting T-shaped tongue 55 which is inserted in a correspondingly shaped slot 56 formed in the lower end of a die center block 57. This die center block is utilized in the drawing action as an anvil over which the work is shaped, as will be hereinafter fully explained. The tongue 55 extends the entire width of the stem 53 and the slot 56 extends laterally across the projecting lower part of the block 57.

A strip of sheet material 61 may constitute the work being operated upon by the press mechanism and this strip is first positioned on the upper surface of the draw ring 26, as illustrated in Fig. 1. The actuating upper parts for the cutting and drawing operations may comprise an inner cutedge or punch member 62 provided with a stem 63 and having an annular projecting wall 64 concentric with the draw ring 26 and the cutting edge 25. This punch member moves up and down along a vertical axis in the usual and preferred manner, the stem 63 being adapted for engagement with the standard type of movable slide, not shown.

A punch pad 65 is located within the wall 64 of the punch member and is threadedly secured to the lower end of a vertical rod 66 normally held in raised position by a spring 67 surrounding the upper end of the rod and resting within a counterbore 68 formed in the stem 63. An adjusting nut 69 and a locknut 71 threadedly engage the upper end of the rod 66 and confine the spring 67 in operating position. When it is desirable to provide a panel on the article being drawn, the punch pad 65 is formed with a suitable panelling surface 72 and the upper surface of the die center or anvil 57 is correspondingly shaped as at 73.

The punch member 62 and the draw ring 26 constitute the instrumentalities for clamping the strip 61 of sheet material just prior to a disc 75 (Fig. 2) being severed therefrom and afterwards they provide the slip grip on the disc while it is being drawn.

In cutting, the punch member 62 and its pad 65 are lowered and forced down upon the strip 61 and the outer cutting part of the wall 64 then cooperates with the cutting edge 25 of the cutedge member 23 to force the former into the latter and remove the disc 75 from the strip in the usual die press manner. The draw ring 26 and the parts 31, 29, 41 and 46 during this cutting operation move downwardly and the liquid 47 first acting against the surface 51 and then against both surfaces 49 and 51 forces the piston 44, its stem 53 and the anvil 57 upwardly into the position illustrated in Fig. 2. The upper surface of the anvil

is now against the lower surface of the disc 75. This is caused by the outer part of the liquid being forced down by the draw ring and outer piston 41 and the inner displaced part of the liquid being forced up against the inner piston 44.

The drawing operation immediately follows as the descending punch member 62 forces the draw ring 26 downwardly, the anvil 57 moving upwardly a corresponding distance of travel, the liquid 47 constituting the connecting medium between the descending and the ascending parts. In the meantime, the disc 75 is undergoing a change in shape, its center part being lifted by the ascending anvil while concentric sections of its outer edge, held in the slip grip of the parts 64 and 26, are being successively withdrawn from horizontal into vertical position forming a vertical wall 76 (Fig. 3) interiorly of the wall 64.

The cylinder 32 and parts contained therein constitute an element or unit which may be used for different sizes of dies within certain limits and it is only necessary in changing these die parts to remove the bolts 24 and replace the members 23, 26, 29, 31 and 57 with parts of the desired dimension. In making such a change the parts 23, 26, 29 and 31 are lifted off at which time it is merely necessary to depress the piston 41 to thereby raise the stem 53 until its slot 56 is above the surface of the bolster plate 22. The block 57 can then be easily slid from its connection and a new block 57 inserted. Other new parts 23, 26, 29 and 31 are then placed over the new block 57 and bolted in position.

In all sheet metal drawing operations two resistances must be overcome by the active drawing forces, this being the resistance against bending of the metal which is inherent in the metal itself, and the resistance against withdrawal of the edge of the disc from the slip grip, (which resistance must be created), to prevent wrinkling of the metal. The latter resistance in ordinary press practice is obtained by the supports of the draw ring including drawing rubbers or springs. The sum of these two resistances is greatest at the beginning of the drawing operation and the drawing rubbers or springs at that time must deliver a sufficient resistance in the slip grip to prevent wrinkling of the stock as it moves into the vertical wall of the shell being drawn.

As the drawing operation proceeds, the area of the disc held in the slip grip diminishes since a part of the disc is being constantly withdrawn from the slip grip. The actual clamping action imposed in the slip grip at such time, however, increases as the drawing rubbers or springs come under greater compression. A needless waste of energy results for it is not necessary to increase the slip grip to prevent wrinkles at such a time. In fact, there being less flange to hold, the slip grip necessary to prevent wrinkles is not as great. For some strengths and gages of metals, the clamping action in the slip grip becomes too great for the strength of the metal, and it gives way or fractures before the drawing operation is completed.

The construction of the apparatus embodying the present invention provides a self-contained, self-acting and self-compensating slip grip in which the clamping force at all stages in the drawing operation is sufficient to prevent formation of wrinkles in the metal but is not in excess of the clamping force required. This will be more evident as the description proceeds.

Downward movement of the draw ring 26, under the active drawing element 62, is immediately transmitted through the parts 29, 31, 41, the liquid 47, and parts 44 and 53 to move the anvil 57 the same distance, but in a reverse or upward direction of travel. If no strip 61 is present in the die parts, downward pressure on the draw ring 26 will be met with practically no resistance as the anvil 57 is raised and practically no clamping force is present between the members 64 and 26.

When a metal disc 75 is clamped between the parts 64 and 26 and is brought against the anvil 57 (Fig. 2) the resistance inherent in the disc against bending over the edge of the anvil presents itself as a counter force acting to resist the moving part 64. In other words, the disc is forced against the anvil and a force is transmitted through the liquid 47 and the associated elements as an upward thrust of the draw ring 26 providing a clamping force in the slip grip. At the time of bending of the metal, the force exerted by the descending member 62 in overcoming the bending resistance, is the measure of force of the clamping action of the slip grip. As this resistance decreases, which it does as the drawing proceeds, the force applied to the slip grip correspondingly decreases by reason of the considerable amount of space under the inner piston 44 which quickly permits the flow of the liquid thereinto as soon as said piston is lifted from its seat (Fig. 3), and relieves upward pressure on the outer piston at the washer 46. This gives the desired clamping action and provides a slip grip which conserves energy and at the same time prevents the formation of wrinkles.

This self-compensating slip grip action accommodates different gages of metal in the same die parts. For example, resistance of thin metal such as taggers tin against bending being relatively small, the force necessary to draw it over the anvil 57 and withdraw its edge from the slip grip reacts as a relatively light clamping pressure for the slip grip. This pressure is sufficient to prevent the formation of wrinkles.

A relatively heavy gage metal such as regular ninety pound tinplate must be held with a heavier clamping action, say ten times that of taggers tin, in order to prevent the formation of wrinkles. In such a case the resistance against bending inherent in the metal will be ten times that of taggers tin and the heavier clamping force will be properly and automatically applied in the slip grip. It is believed that these examples illustrate the self-compensating action of the die parts.

The springs 52 are preferably flexible and quick-acting in order to present the minimum amount of resistance against operation of the piston 44 while at the same time they provide a means for rapidly returning the parts after a drawing operation.

After the drawing operation the punch members are lifted and the springs 52 return the lower die parts to normal position. The drawn shell is lifted with the punch member 62 until these parts are clear of the lower die mechanism when the upper end of the rod 66 may be engaged by any suitable staticnary part and the pad 65 being held against further movement, the wall 64 of the punch 62 moves away from the shell thereby stripping it from the punch in the regular manner.

In the preceding description no mention has been made of the relative diameters of pistons 41 and 44. A certain hydraulic advantage may be had in this connection and this advantage may

be utilized to produce a slip grip greater or less than that of the bending resistance force. The same self-compensation for variations in drawing resistance is present, however, as previously described. The relation of the effective areas of these pistons determines this hydraulic feature, these areas being the lower surfaces of the washer 46 for piston 41 and the lower area (surfaces 49 and 51) of the actuated piston 44. This ratio of areas is a constant in any particular die which may be changed to produce a particular drawing unit by either increasing or diminishing the diameter of the piston 44, the other parts 45 and 46 being altered correspondingly. This provides a flexibility of design permitting a large range of adaptation to any material being drawn.

It is thought that the invention and many of its attendant advantages will be understood from the foregoing description, and it will be apparent that various changes may be made in the form, construction and arrangement of the parts without departing from the spirit and scope of the invention or sacrificing all of its material advantages, the form hereinbefore described being merely a preferred embodiment thereof.

I claim:

1. In a sheet metal drawing apparatus the combination, with cutting dies, a draw ring and an anvil, of a fluid-container, a movable member having a contact with the fluid and arranged to be pressed downward by the draw ring, another movable member connected with the anvil and arranged so as to be in contact with and to be pressed upward by the same fluid, and means for pressing said movable members away from each other to restore them to initial position.

2. In a sheet metal drawing apparatus the combination, with cutting dies, a draw ring and an anvil, of a fluid-container, inter-fitting pistons in the container and a spring normally pressing said pistons away from each other, one of said pistons being in contact with said draw ring to be moved thereby and the other of said pistons being in contact with said anvil to move the same, said pistons both being in contact with the fluid within the container and acting in connection with the movement of the draw ring to change the shape of the body of the fluid.

3. In an apparatus for drawing sheet metal, the combination of opposing cutting dies, a draw ring, an anvil, a fluid-container, pistons in said container arranged one within the other and so as to be both in contact with different parts of the same body of fluid, one of said pistons being in contact with said draw ring to be moved thereby and the other of said pistons being in contact with said anvil to move the same, and means for pressing said pistons in directions away from each other to restore them and said fluid to initial position.

4. In a press for drawing sheet metal, in combination, a fixed die, a movable block in said fixed die, a draw ring in said fixed die, a closed chamber, a liquid completely filling said chamber, means associated with the draw ring for compressing said liquid, said means, including a ram, which latter carries a die, and means associated with said movable block whereby same is actuated by the compression of the liquid, said latter means including a plunger and a bearing therefor.

5. In a press for drawing sheet metal, in combination, a fixed die, a movable block in said fixed die, a draw ring in said fixed die, a closed chamber, a liquid completely filling said chamber, means associated with the draw ring for compressing said liquid, a headed rod rigidly associated with said movable block, the head of said rod being disposed in said liquid for actuation by the compression of said liquid, and means for returning said block when the pressure upon the draw ring is relaxed.

6. In a sheet metal press, the combination of a liquid container, movable ring and block elements, plungers associated with said elements and having their ends disposed in the liquid, and a movable die for urging said ring in one direction whereby to move said block in the opposite direction.

7. In a sheet metal press, the combination of a table, a liquid container, cooperating movable draw ring and block elements disposed above said table for receiving a sheet, plungers passing through said table and the wall of said container, said plungers having their ends disposed in the liquid, one of said plungers being in contact with said draw ring to be moved thereby and the other of said plungers being in contact with said block to move the same, and a movable die for urging said ring in one direction, whereby to move said block in the opposite direction for pressing the sheet.

8. In a press for drawing sheet metal, a fixed die, a movable block in said fixed die, a closed chamber containing a liquid, a plunger connected to the movable block and passing into said chamber, a spring opposing the movement of said plunger in one direction, a draw ring, a table supporting said draw ring, and a plunger passing into said chamber and supporting said table.

9. In a drawing press, in combination, opposed die mechanisms, a hydraulic cushion unit, one of said mechanisms comprising a movable draw ring and a movable die center, said unit comprising a chamber containing a hydraulic fluid, a piston movable in said fluid and adapted to support said draw ring, and a second piston in said chamber adapted to support said die center, said unit adapted to be permanently set in said press and said latter mentioned die mechanism adapted to be removable with said hydraulic cushion unit without disturbing the setting of said unit.

10. In an apparatus for drawing sheet metal, the combination of opposing cutting dies, a draw ring, an anvil, a fluid-container and pistons in said container arranged each in contact with a part of the fluid and movable in opposite directions by pressure exerted on one of said pistons, said opposite movement of the pistons being accompanied by downward and upward displacement of the said contacting parts of the fluid respectively, one of said pistons being in contact with said draw ring to be moved thereby and the other of said pistons being in contact with said anvil to move the same.

JOHN M. HOTHERSALL.