April 28, 1964 H. L. STEGNER 3,130,963

INTERNALLY STABILIZED DEEP DRAW CUSHION FOR PUNCH PRESSES

Filed Nov. 20, 1961

2 Sheets-Sheet 1

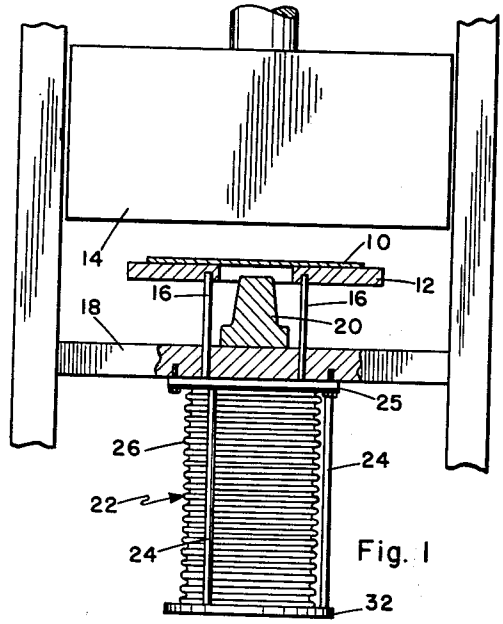


Fig. 1

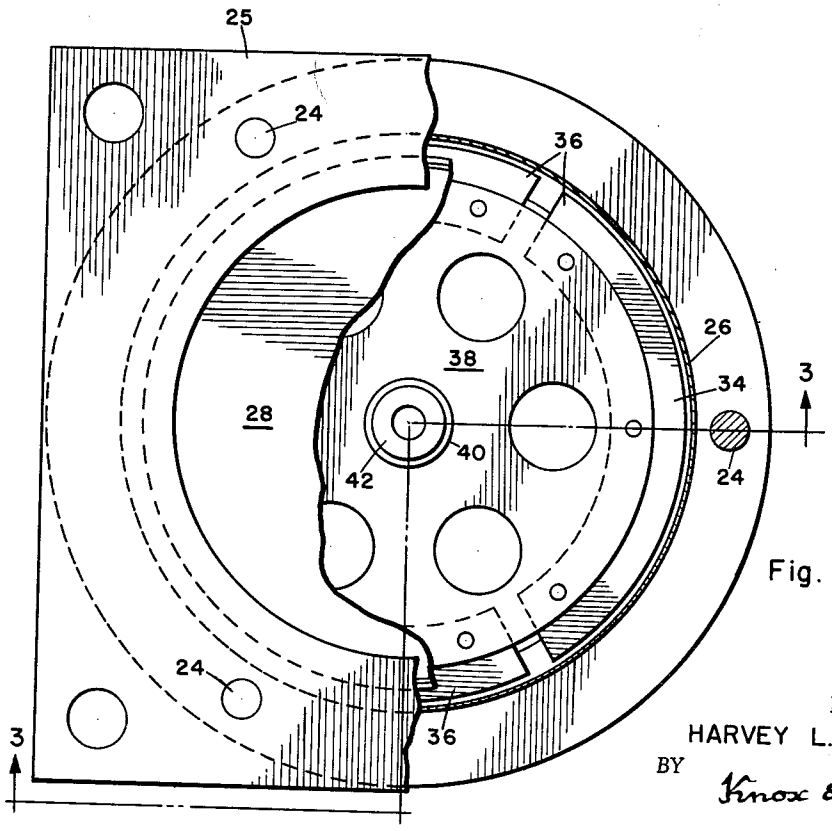


Fig. 2

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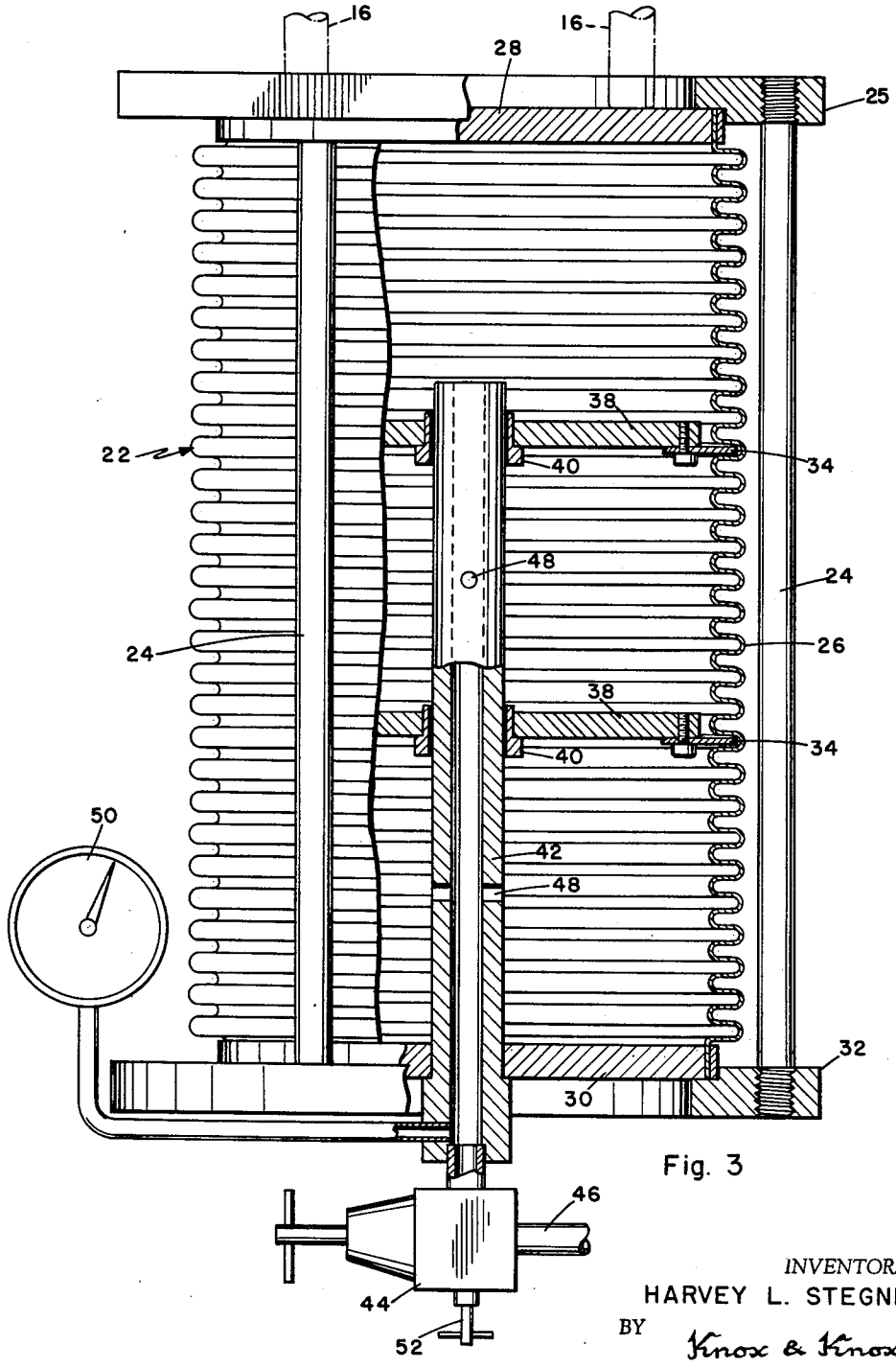


Fig. 3

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3,130,963

INTERNALLY STABILIZED DEEP DRAW CUSHION FOR PUNCH PRESSES

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This invention relates to the shaping of metals, and more particularly to apparatus that facilitates the production of cup-like shapes that are relatively deep.

Background

In order to form metals into certain shapes, such as cups, cylinders, and the like, a flat sheet of metal may have its central portion "punched" to the desired depth, diameter, curvature or other dimension. To accomplish this result, a machine known as a punch press is used; the movable ram of the punch press developing forces measured in the hundreds of tons for shaping relatively thick sheets of metal. The shaping process requires that the metal be stretched, or "drawn" to shape and deep-drawn shapes frequently acquire undesired wrinkles and deformations.

It has been found that, to a certain extent, the deformations may be minimized by controlling the stretching forces; two ways of doing this being possible. The first requires that the movement of the punch press ram be controlled; but this necessitates different settings for various materials, thicknesses, and ultimate shapes. The second method of control comprises establishing a "cushion" against which the material is forced, thus producing a controllable resistive force.

One prior-art cushion used liquids, and since liquids are substantially incompressible, controlled the resistive force by varying the rate of escape of the liquid. This arrangement became quite complex, and required valves, cams, tanks, connecting tubes, mechanical linkages, and the like. Another prior-art cushion used a resilient material; but this had the disadvantage that the resistive force varied in a given non-controllable manner.

Objects and Drawings

It is therefore the principal object of my invention to provide an improved apparatus for shaping metals.

It is another object of my invention to provide improved apparatus for controlling the resistive force used in shaping metals.

It is a further object of my invention to provide an improved bellows-type cushion for a punch press.

It is a still further object of my invention to provide means for internally stabilizing the bellows of the cushion against irregular undulation or squirming even when used with a deep drawing punch press.

The attainment of these objects and others will be realized from the following specification, taken in conjunction with the drawings, in which:

FIGURE 1 is a diagrammatic view showing my invention applied to a punch press;

FIGURE 2 is a top plan view of my invention, partially cut away; and

FIGURE 3 is a sectional view taken on the line 3—3 of FIGURE 2.

Detailed Description of the Invention

The basic concept of my invention will be understood from FIGURE 1, wherein a "blank" or workpiece **10** comprising a flat sheet of metal is to be formed into some configuration such as an inverted cup-shape. To accomplish this result, workpiece **10** is positioned on a vertically movable blank-supporting template **12**. When the punch press is actuated, its ram descends, deforming the workpiece **10** and pinching the edges of workpiece **10** between the lower surface of ram **14** and the upper surface of template **12**.

The ram **14** may take any one of many forms, one of the most widely used forms being a block of resilient material such as rubber. As the ram **14** descends further, template **12** is forced downward; being restricted to vertical movement by means such as push rods **16**, which are slidable through bores in the bolster or bed **18**, of the punch press.

When the template **12** descends below the uppermost portion of die **20**, the central portion of the workpiece **10** is prevented from moving downward by the die, while the peripheral portions of the workpiece are carried downward by the pinching effect of pressure element **14** and template **12**. It may thus be seen that workpiece **10** is conformed to the shape of die **20**.

Two shortcomings now arise. First, the periphery of workpiece **10** tends to be pulled inwards, despite the pinching effect of the pressure element and the template. Second, the uncontrolled downward movement of pressure element **14** introduces unwanted distortions into the workpiece.

My invention overcomes both of the above short-comings. It comprises a cushion **22** that provides controlled resistance to the downward movement of the workpiece, and thus minimizes the amount of distortion introduced therein.

My cushion comprises two or more support rods **24** that have one end fastened to a top attachment plate **25** which is secured to bolster **18**, and have their other ends supporting a bottom flanged ring **32**. A sealed bellows **26**, preferably of metal, is positioned interiorly of or between the support rods **24**, bellows **26** having upper and lower end plates **28** and **30** respectively, the lower end plate **30** resting on the flanged ring **32** and the upper end plate **28** seating below a top attachment plate **25**. The construction of bellows **26** per se may be conventional, and it contains a given volume of air.

My invention operates as follows. As pressure element **14** descends, it gradually depresses template **12**, causing push rods **16**, which rest on the upper end plate **28**, to depress the end plate and thus compress the bellows **26**. This causes the air in the bellows to be compressed to a smaller volume, thus gradually increasing the pressure with which it resists the downward movement of template **12** and workpiece **10**.

This has three distinct advantages. First, as the workpiece approaches its final shape, the resisting force increases, thus slowing down the shaping or forging action. Second, as the pressure element **14** descends, the increasing resistive force produces a stronger pinching action between pressure element **14** and template **12**, thus holding the periphery of the workpiece progressively more firmly in place. Finally, when the pressure element **14** has finished its downward stroke and the shaping of the workpiece and begins to move upwardly, the upward movement of the end plate **28** of the bellows raises the workpiece off die **20**.

It will thus be realized that my cushion overcomes the shortcomings of prior-art devices in that it is extremely simple, does not require cams and linkages to control the escape of liquids, and does not require tanks for the storage of the liquid.

It also has an advantage over prior-art rubber cushions, in that volume of air within the bellows may be controlled; and thus the amount and rate of increase of the resistive force may be readily controlled.

There are many instances when the workpiece is to be drawn to the shape of a relatively long cylinder. This requires that the pressure element, the template, the push bars, and the upper face of the bellows have a relatively

long stroke or movement. The bellows, in turn, must be appreciably longer than the stroke; and there is a possibility that the convolutions of the bellows might undulate or squirm, rather than remaining aligned vertically with the adjacent convolutions. This undulation or squirming of the bellows is undesirable because it weakens, and may permanently deform the bellows.

FIGURES 2 and 3 show an embodiment of my invention for obviating these perils. In this form, bellows **26** has a plurality of stabilizers **34** that minimize the danger of undulation.

Basically, stabilizers **34** are horizontally positioned discs or rings having an outer diameter slightly smaller than that of bellows **26**. Stabilizers **34** are positioned with their outer peripheries nested into the troughs of selected convolutions of the bellows, and adjacent the bottom of the troughs.

I have found it convenient to form stabilizers **34** of a plurality of arcuate sections **36** fitted together to form a more or less complete ring. Sections **36** are in turn mounted on vertically movable plates **38** having axial hubs **40** that slide along a guide rod **42**. Plates **38** are preferably apertured to equalize the pressure throughout the body of bellows **26**. While I have shown a centrally positioned guide rod **42**, a plurality of otherwise positioned guide rods may be used, in which case they would engage suitably positioned hubs of plates **38**.

Since the contacting surfaces of the guide rod **42** and hub **40** are in sliding contact, it is preferable that they be smooth and have friction-reducing means such as a coating of babbit metal, bearings, or the like.

In operation, the upper end plate **28** of bellows **26** moves downward as previously explained, and stabilizers **34** move downward in accordance with the movement of their associated convolutions. If there is any tendency for the convolutions of the bellows to deform irregularly, this is prevented by the contact between the trough of the convolutions and the peripheries of the stabilizer, which in turn is prevented from horizontal movement by plates **38** and the engagement between their hubs and the guide rod.

The downward movement and resultant compression of the air in the bellows produces the desired increasing resistive force.

It was previously indicated that the volume of air in the bellows may be controlled to vary the resistive force developed by the bellows. This result is readily achieved by use of a pressure regulator **44** connected between a source of pressurized air, not shown, but indicated by the pipe **46**. Air from the pressure regulator **44** flows through the hollow guide rod **42** and holes **48** into the body of the bellows. If another guide rod arrangement is used, the air may flow directly from the pressure regulator **44** through the lower end plate **30** into the body of the bellows. When a large resistive force is desired, air is admitted into bellows **26** to a pressure indicated by gauge **50**; whereas if a smaller resistive force is desired, air may be bled from the bellows through outlet **52**.

It may thus be seen that the bellows is internally stabilized against irregular deformation.

Advantages

My invention has several important advantages over prior-art apparatuses. It is formed of simple, readily available components, and can be used with most present-day punch presses. It effectively controls the shaping function of the punch press. And finally, its resistive force can be easily adjusted by merely introducing into, or bleeding air from, the bellows.

It is understood that minor variation from the form of the invention disclosed herein may be made without departure from the spirit and scope of the invention, and that the specification and drawing are to be considered as merely illustrative rather than limiting.

I claim:

1. Apparatus for use with a punch press, comprising:
an air bellows having an upper end plate and a lower end plate;
means for supporting said lower end plate of said bellows;
means for causing downward movement of said punch press to cause downward movement of said upper end plate and causing the air in said bellows to be compressed to develop a resistive force;
stabilizing means, positioned internally of said bellows, for preventing undulation and squirming of said bellows;
said stabilizing means comprising plate means and a plurality of arcuate segmental sections positioned on said plate means to form a substantially continuous circular, composite element positioned with its outer periphery in engagement with a trough of a convolution of said bellows; and
means for preventing movement of said element in a direction non-axial to said bellows.

2. Apparatus for use with a punch press, comprising:
an air bellows having an upper end plate and a lower end plate;
means for supporting said lower end plate of said bellows;
means for causing downward movement of said punch press to cause downward movement of said upper end plate and causing the air in said bellows to be compressed to develop a resistive force;
stabilizing means, positioned internally of said bellows, for preventing undulation and squirming of said bellows;
said stabilizing means comprising a plurality of segmental sections positioned to form a plurality of substantially complete circular elements with peripheries located within the troughs of selected convolutions;
means for mounting each said element on a plate having a hub; and
at least one guide rod vertically positioned with respect to said lower end plate of said bellows, said guide rod traversing said hub, whereby said plate and said arcuate element are prevented from moving non-axially of the bellows.

3. A cushion for use with a punch press, comprising:
an air bellows having an upper end plate and a lower end plate;
means for fixedly positioning said lower end plate;
a guide rod positioned vertically on said lower end plate;
means for causing downward movement of the ram of said punch press to cause downward movement of said upper end plate of said bellows to compress the air within said bellows and produce a resistive force;
bellows stabilizing means, positioned within said bellows, for preventing the convolutions of said bellows from undulating and squirming, said stabilizing means comprising a plurality of plates having hubs positioned to slide vertically along said guide rod;
a plurality of arcuate elements positioned on each of said plates to form a substantially complete circle, the peripheries of said arcuate elements fitting into certain troughs of the convolutions of said bellows to prevent sidewise movement thereof.

4. A cushion for use with a punch press, comprising:
a plurality of vertical support rods having one end attached to said press;
a support ring attached to the lower ends of said rods;
an air bellows having an upper end plate and a lower end plate; said lower end plate being positioned on said support ring;
a guide rod positioned vertically on said lower end plate;
means for causing downward movement of the ram of

said punch press to cause downward movement of said upper end plate of said bellows to compress the air within said bellows and produce a resistive force;

bellows stabilizing means, positioned within said bellows, for preventing the convolutions of said bellows from undulating and squirming, said stabilizing means comprising a plurality of plates having hubs positioned to slide vertically along said guide rod;

a plurality of segmental sections positioned on each of said plates to form a substantially complete circular composite element, the peripheries of said elements fitting into certain troughs of the convolutions of said bellows to prevent sidewise movement thereof; and

means for controlling the amount of air in said bellows to control the pressure therein.

5. A cushion for use with a punch press, comprising:

a plurality of support rods having the upper ends thereof attached to said press;

a support ring attached to the lower ends of said rods;

an air bellows having an upper end plate and a lower end plate, said lower end plate being positioned on said support ring;

a hollow centrally positioned guide rod secured to and extending vertically upwardly from said lower end plate;

means for causing downward movement of the ram of

said punch press to cause downward movement of said upper end plate of said bellows to compress the air within said bellows and produce a resistive force;

bellows stabilizing means, positioned within said bellows, for preventing the convolutions of said bellows from undulating and squirming, said stabilizing means comprising a plurality of plates having axial hubs positioned to slide vertically along said guide rod;

a plurality of arcuate segmental sections positioned on said plates to form substantially complete circular elements the peripheries of said elements fitting into certain troughs of the convolutions of said bellows to prevent non-axial movement thereof;

means for admitting air thru said guide rod into said bellows to increase the pressure therein;

means for bleeding air from said bellows thru said guide rod to decrease the pressure therein; and

means for metering the air pressure in said bellows.

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