May 12, 1970 D. H. KRAFT 3,511,491

SELF-CONTAINED DIE CUSHION WITH AIR SAVER

Filed July 13, 1967 3 Sheets-Sheet 1

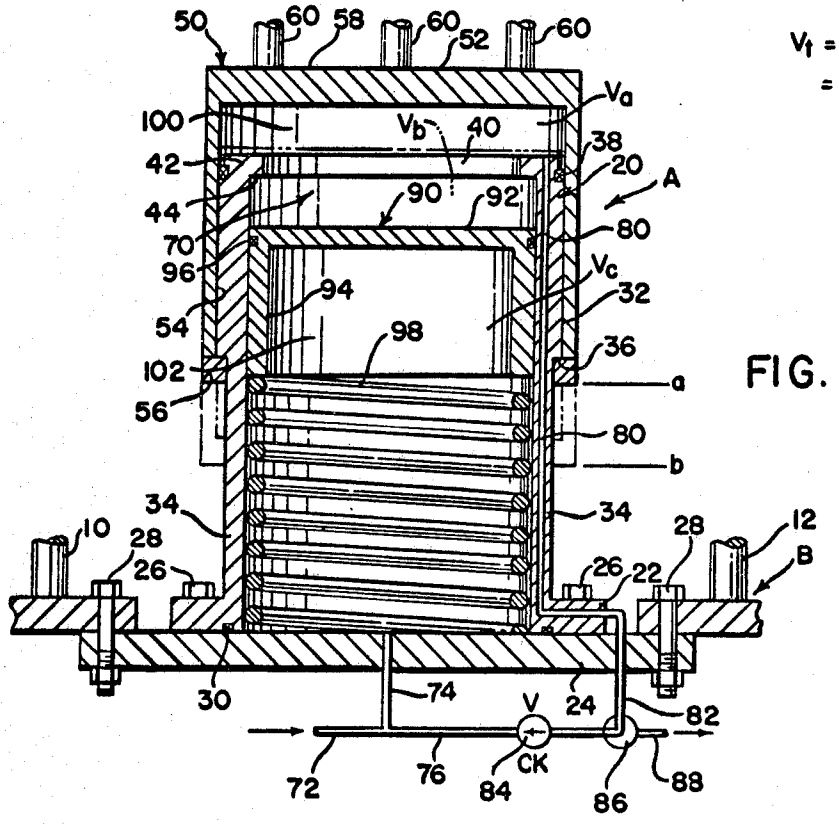
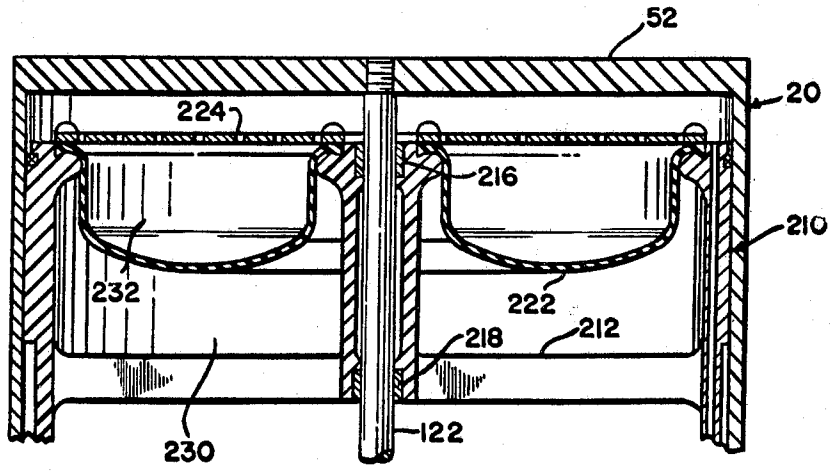


FIG. 1

FIG. 9



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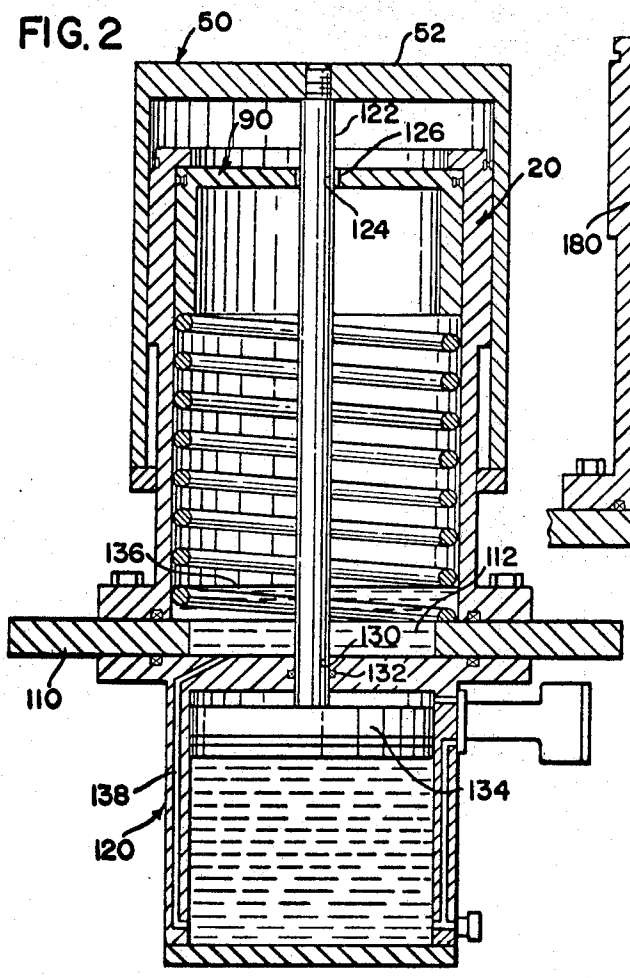
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SELF-CONTAINED DIE CUSHION WITH AIR SAVER

Filed July 13, 1967 3 Sheets-Sheet 2

FIG. 2



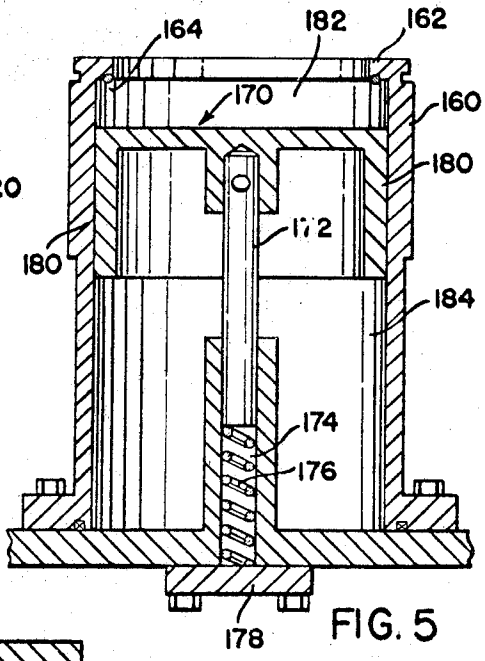


FIG. 5

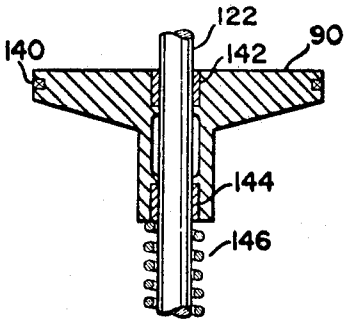


FIG. 3

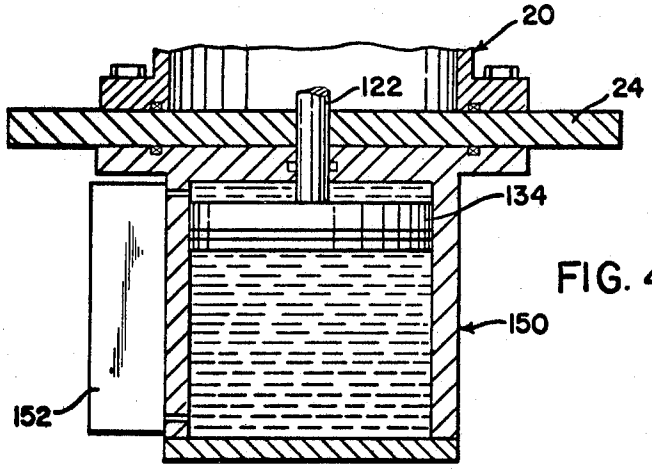


FIG. 4

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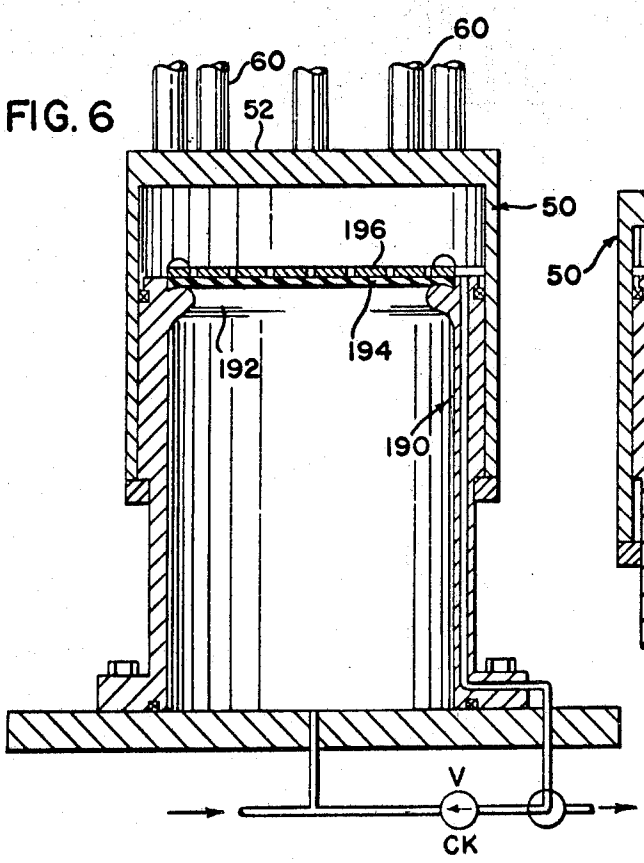
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May 12, 1970 D. H. KRAFT 3,511,491

SELF-CONTAINED DIE CUSHION WITH AIR SAVER

Filed July 13, 1967 3 Sheets-Sheet 3

FIG. 6



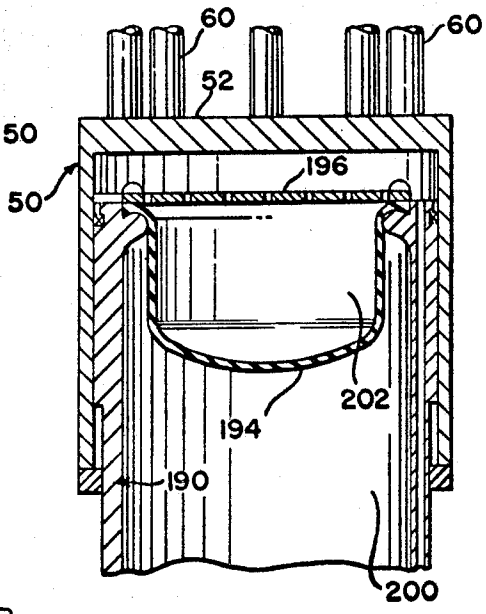


FIG. 7

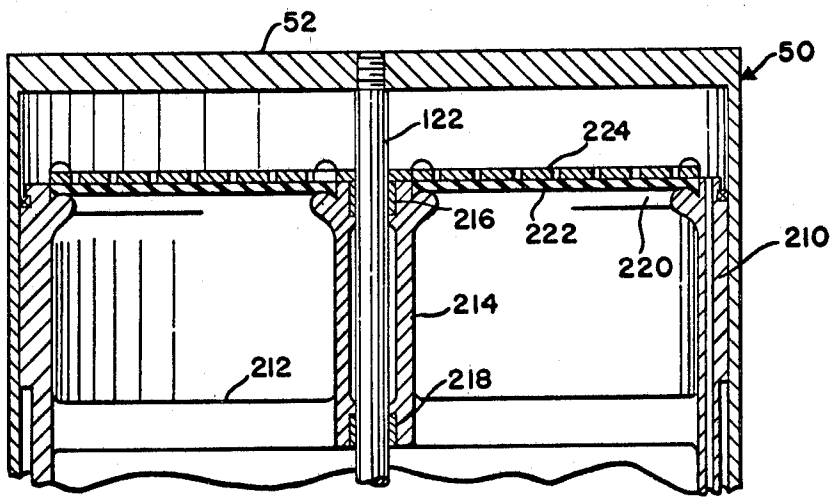


FIG. 8

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SELF-CONTAINED DIE CUSHION WITH AIR SAVER

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Int. Cl. B21d 24/02; F16f 9/04, 13/00
U.S. Cl. 267—1 6 Claims

ABSTRACT OF THE DISCLOSURE

A self-contained die cushion for use on a power press wherein the normal cushion chamber includes a separate reservoir sealed from the rest of the chamber and having a movable wall and a fixed wall to allow the fluid in the reservoir to assist in biasing the die cushion upwardly, but preventing exhaust of the reservoir when the chamber is exhausted to drop the cushion for changing or repairing dies in the press.

The present invention relates to the art of self-contained die cushions, and more particularly to a self-contained die cushion having an air saver or reservoir incorporated therewith.

This invention is particularly applicable for use in a power press wherein depending rods are used to support a hold-down ring of a drawing die, and it will be described with particular reference thereto; however, it is appreciated that the invention has much broader applications and may be used in various other environments wherein a die cushion is required.

Many dies used within power presses incorporated hold-down rings or other auxiliary elements which are controlled, to a certain extent, by a die cushion located below the bolster of the power press. These die cushions take a variety of forms; however, the most common die cushion includes two telescoped sleeves with end walls defining an internal cushion chamber filled with a compressible fluid which biases the upper sleeve in an upwardly direction. A plurality of rods extending downwardly from the die within the press rests upon the upper sleeve, generally known as a pressure pad. These rods coact with movable elements within the die so that the pressure pad is forced downwardly by the rods during the downward stroke of the press. The downward movement of the upper sleeve or pressure pad compresses the fluid within the cushion chamber so that the rods are forced in an upward direction by the pressure pad during the upward stroke of the power press. The volume of air, or other compressible fluid, within the chamber of the die cushion is quite large to provide the necessary biasing action for the downwardly extending rods. This presents a substantial difficulty.

When a die is to be repaired or replaced, the die cushion must be dropped into an inoperative position. One common way of accomplishing this is to exhaust most of the fluid from the chamber of the die cushion. This requires a substantial amount of time to exhaust and then replace the large volume of fluid within the die cushion. In an effect to reduce the time for exhausting and filling the chamber of the die cushion, relatively large supply hoses have been used. These are expensive, and they do not substantially reduce the total time required to drop the die cushion into its inoperative position and then raise the die cushion into its operative position. To overcome the disadvantages of this particular arrangement, it has been suggested that a fluid reservoir should be mounted adjacent the die cushion with a valve between the reservoir and the cushion. When the die cushion is to be dropped, the valve is opened to store fluid within the reservoir. The valve was then closed so

that the fluid would remain in the reservoir. To raise the die cushion, the valve was again opened which allowed flow of fluid back to the die cushion. This again involved complex and expensive mechanical arrangements to accomplish the operation of the die cushion.

The structure explained above has been modified to provide the reservoir and valve within the die cushion itself. When this is done, the piping between the reservoir and the die cushion chamber is eliminated; however, certain inherent disadvantages are built in. The valve between the reservoir and die cushion must be operated, mechanically, from a position outside of the die cushion. Thus, a rod or other valve operating means must be provided internally of the die cushion. Also, when the valve becomes defective, the die cushion must be taken apart and repaired. By providing internal valving within the die cushion, it is difficult to provide hydraulic snubbers or hydraulic hold-downs which are generally used in the operation of a die cushion. A hydraulic snubber is used to control the upward movement of the die cushion so that it is somewhat out of phase with the upward stroke of the power press. The hydraulic hold-down is utilized to lock the die cushion in a downward position when the die cushion is not to be used.

The disadvantages of the prior die cushions are completely overcome by the present invention which is a completely new concept to the art of die cushions and includes a simplified structure which will allow movement of the die cushion between its upward operative position and its lower inoperative position.

In accordance with the present invention, there is provided an improvement in a self-contained die cushion, comprising a movable, operative member and fluid means for biasing the member in a given direction for movement between points *a* and *b* wherein the fluid means includes defining a cushion chamber filled with a compressible fluid and having a total volume V_a or V_{T1} when the member is at point *a* and a total volume V_b or V_{T2} when the member is at point *b*, V_{T1} being greater than V_{T2}. Also provided is a means defining a sealed fluid filled reservoir within the chamber with at least one movable exterior wall, this reservoir having variable volume V_c which forms part of the volume of the chamber and is, at all times, substantially less than volume V_{T1}. Also provided are means for exhausting fluid from the chamber while the reservoir remains filled with fluid. In this manner, the die cushion may be dropped by exhausting only a portion of the cushion chamber. During normal operation of the die cushion, the filled reservoir within the chamber coacts through the movable external wall to provide a continuous, relatively large volume of air against which the die cushion operates. The improvement to the device defined above is the formation of the sealed fluid chamber as a flexible diaphragm which defines colume V_c and a fixed rigid wall means for limiting the movement of the diaphragm in the volume expanding direction.

The primary object of the present invention is the provision of a self-contained die cushion which is inexpensive to produce, usable in existing presses without modification and easily and rapidly dropped into the inoperative position and raised into the operative position with a minimum of fluid.

Another object of the present invention is the provision of a self-contained die cushion which requires a lesser amount of air, or fluid, to shift from the inoperative position to the operative position.

Yet another object of the present invention is the provision of a self-contained die cushion which incorporates two separate, isolated fluid compartments in the cushion chamber, both of which coact to provide the biasing action of the cushion and one of which is exhausted to drop

the cushion into its inoperative position, which chamber is defined by a flexible diaphragm.

These and other objects and advantages will become apparent from the following description used to illustrate preferred embodiments of the invention as read in connection with the accompanying drawings in which:

FIG. 1 is a partial, cross-sectional view illustrating, somewhat schematically, the structure to which this invention is an improvement.

FIG. 2 is a partial, cross-sectional view illustrating a modification of the structure as shown in FIG. 1 with one aspect of the present invention shown;

FIGS. 3–5 are partial, cross-sectional views illustrating certain modifications of the structures shown in FIGS. 1 and 2;

FIG. 6 is a cross-sectional view illustrating the preferred embodiment of the main aspect of the present invention;

FIG. 7 is a partial, cross-sectional view illustrating the operational characteristics of the embodiment of the invention illustrated in FIG. 6;

FIG. 8 is an enlarged, cross-sectional view illustrating still a further modification of the present invention; and,

FIG. 9 is a partial cross-sectional view showing the operating characteristics of the embodiment of the invention illustrated in FIG. 8.

Referring now to the drawings, wherein the showings are for the purpose of illustrating preferred embodiments of the invention only and not for the purpose of limiting the same, FIG. 1 shows a self-contained die cushion A which is mounted on a support plate B attached to the under frame of a press (not shown) by a plurality of rods **10, 12**. The general operation of the die cushion is well known in the power press art; therefore, further discussion of the press itself, except with regard to the general operation of the die cushion, is not required.

Self-contained die cushion A includes a fixed sleeve **20** having a lower flange **22** secured onto a lower end wall **24** by a plurality of circumferentially spaced bolts **26**. In like manner, bolts **28** secure the wall **24** onto the support plate B. An appropriate seal, such as O-ring seal **30**, is provided between flange **22** and wall **24**. Sleeve **20** also includes an outer bearing surface **32** which terminates at a recess **34** to form an abutment **36**. Adjacent the upper portion of sleeve **20** there is provided appropriate seal **38**, for a purpose which will be apparent from the further description of this embodiment. Also at the upper end of sleeve **20** is a relatively large opening **40** defined by a flange **42** having a lower abutment **44**.

Reciprocally and telescopically received on sleeve **20** is a movable sleeve, or pressure pad, **50** which forms the operative member of the die cushion, in a manner to be described later. Sleeve **50** has an upper end wall **52**, an inner mounting surface **54** slidably received on surface **32**, and a lower stop **56** adapted to coact with abutment **36** to prevent withdrawal of sleeve **50** from sleeve **20**. End wall **52** is provided with an upwardly facing, top surface **58** which is adapted to contact the lower end of operating rods **60**. These rods are connected to various elements within the die mounted upon the bolster of a power press, in a manner well known in power press art.

Sleeves **20, 50** combine to form the total air chamber, hereinafter referred to as the internal cushion chamber **70** which is filled with pressurized fluid from an input line **72**. Line **72** includes a branch **74** communicated with the lower portion of chamber **70** and a branch **76** communicated with the upper portion of chamber **70**. This last-mentioned communication is through a passage **80**, line **82**, check valve **84**, and control valve **86**. The valve **86** is positioned as indicated in FIG. 1. The upper portion of chamber **70** is communicated with pressurized fluid from input line **72**. Check valve **84** prevents fluid flow from the upper portion of chamber **70** to supply line. In a like manner, a check valve can be provided in branch **74**. To exhaust the upper portion of chamber **70**, valve **86** could be manually actuated to connect line **82** with exhaust line **88**. As so far described, the self-contained die cushion does not differ substantially from normal die cushions, except for flange **44** and certain aspects of the fluid inlet system.

In operation, rods **60** are connected onto certain elements within the die, such as knock-out pins or a drawing ring. As the power press moves downwardly to close the die, rods **60** push sleeve **50** downwardly from an upper point *a* to a lower point *b*. This is done against the fluid bias of cushion chamber **70**. As the power press moves upwardly, the fluid pressure within chamber **70** forces sleeve **50** back to its initial upper point *a*. The rods **60** are raised and perform the necessary function within the die, in accordance with the particular element being controlled by the rods. This procedure is repeated in each cycle of the power press. The total volume of fluid within chamber **70** is V_{T1} or V_a when the sleeve **50** is at point *a*. In like manner, the total volume of chamber **70** is V_{T2} or V_b when the sleeve **50** is at point *b*. Consequently, the difference in volume during the normal operation of die cushion A is V_{T1} minus V_{T2}.

Sleeve **20** is provided with a vertically movable wall **90**, in the form of a piston having a top **92**, a skirt **94**, and a peripheral seal **96**. Spring **98** biases the piston **90** in an upward direction. The movable wall **90** divides the total fluid volume of chamber **70** into an upper portion **100** and a lower portion **102**. The lower portion has a variable volume V_c which is dependent upon the position of the wall **90** with respect to sleeve **20**. The volume V_c is always substantially less than total volume V_{T1} and volume V_c is also substantially less than total volume V_{T2}. Piston or wall **90** forms two isolated, separate portions in chamber **70**. This has an extremely beneficial result which will be described later.

In operation, during normal function of the die cushion A, sleeve **50** moves between points *a* and *b*. This causes the fluid within chamber portions **100, 102** to be alternately compressed and expanded. During this operation, piston or wall **90** oscillates within sleeve **20**, and it does not substantially affect the operation of the die cushion. There is no inter-fluid flow between portions **100, 102** of the embodiment shown in FIG. 1. The interrelationship between these portions can be described as being mutual fluid pressure relationship or inter-force transmitting relationship. In other words, the air or other fluid within portions **100, 102** functions in a manner generally simulating a situation where no wall or piston **90** is used.

When a die within the power press is to be repaired or replaced, the die cushion must be dropped. This is accomplished by exhausting portion **100** through valve **86**. As the pressure within portion **100** is reduced, the pressure within portion **102** drives wall or piston **90** upwardly against abutment **44**. In this manner, all of the fluid within portion **102** is retained within the die cushion, and it need not be replaced when the die cushion is again activated. To activate the die cushion, valve **86** is moved to the position illustrated in FIG. 1, and fluid pressure from input line **72** is forced through passage **80** into portion **100**. This immediately "pumps up" the die cushion into its operative position.

It can be appreciated that only the volume of air necessary to fill chamber portion **100** is required to activate the die cushion, although the die cushion operates against the complete volume of fluid within both portions **100, 102**. Since only a small volume of air is needed to activate the die cushion, the time required to activate and deactivate the die cushion is substantially reduced. Wall **90** provides a positive seal between the fluid in portion **100** and portion **102** when the die cushion is in its inactive position. There is no possibility of an inrush of air to portion **100** which would cause the die cushion to inadvertently move to its outward position while the die is being changed or repaired. The structure shown in FIG. 1 does not require complicated valving within the die

cushion itself or other complicated mechanisms to provide an internal reservoir of fluid which is not periodically exhausted and replaced when the die cushion is to be dropped and again actuated. The relatively small volume of air needed to activate the die cushion coacts with the air remaining within portion **102** to provide normal operation of the die cushion.

Referring now to FIG. 2, a certain aspect of the present invention is shown wherein sleeve **20** is secured onto a mounting plate **110** having a relatively large opening **112**. A somewhat standard hydraulic locking device **120** is secured to the lower end of plate **110**. The control rod **122** for the hydraulic locking device extends from end wall **52** of sleeve **50**, through an opening **124** in piston **90** having a bearing seal **126**, and through opening **130** of the device **120**. The usual operating piston **134** is provided within the hydraulic locking device **120** and hydraulic fluid **136** is provided within the lower portion of sleeve **20** and is communicated by line **138** to the interior of the locking device **120**. By utilizing the piston **90**, the self-contained die cushion may be provided with this standard hydraulic locking device without substantial modification of the die cushion. This is a substantial advantage because certain installations require the hydraulic locking device to hold the die cushion in an inoperative position during portions of a cycle or during various operations of the press itself.

Referring now to FIG. 3, a modification of the piston **90** is illustrated. Piston **90***a* is provided with an outer peripheral seal **140** and spaced vane seals **142**, **144** for passage of rod **122**. A spring **146** surrounds the rod **122** and biases the piston **90***a* in an upward direction.

Referring now to FIG. 4, a hydraulic snubber **150** is provided below the end wall **24** of sleeve **20**. The control rod **122** having a lower piston **134** is connected to the end wall **52**, as shown in FIG. 2. The hydraulic snubber **150** includes a control valving assembly **152** so that the movement of sleeve **50** in an upward direction after being first moved downwardly is controlled. This prevents abrupt upward movement of rods **60** during the operation of the die cushion shown in FIGS. 1 and 2. This embodiment of the invention illustrates the ease by which a standard hydraulic snubber may be incorporated within a die cushion constructed in accordance with the present invention.

Referring now to FIG. 5, a fixed sleeve **160** includes an inwardly extending flange **162** having a peripheral, lower seal **164**. Reciprocal piston **170** includes a downwardly extending rod **172** which is received within a bore **174** having a spring **176** held in place by a plate **178**. The piston **170** is provided with a plurality of peripheral grooves **180** which allow communication between the upper fluid portion **182** and the lower fluid portion **184** within sleeve **160**. The peripheral grooves **180** are sealed when piston **170** is in its uppermost position against seal **164**. Consequently, when a die cushion including this structure is to be dropped, fluid portion **182** and the interior of the upper sleeve **50**, not shown is exhausted. This causes a rapid increase in the pressure differential across piston **170**. This differential forces the piston in an upward direction to seal against seal **164**. The pressure within fluid portion **184** maintains the piston in its sealed condition until fluid pressure is again introduced into the portion **182**. This embodiment of the invention functions somewhat differently from the previously mentioned embodiments in that actual fluid communication is provided between the upper and lower fluid portions defined by the movable piston **170**.

Attention is now directed to FIGS. 6 and 7. These figures illustrate the primary aspect of the present invention wherein a fixed sleeve **190** has an upper opening **192** which is covered by a flexible diaphragm **194**. Above the diaphragm there is secured, onto the sleeve **190**, a rigid perforated plate **196**. The diaphragm divides the fixed sleeve into two separate, sealed, isolated fluid portions **200**, **202**. In FIG. 6, portion **202** is substantially zero. The diaphragm **194** flexes downwardly as sleeve **50** is forced downwardly by rods **60** and flexes upwardly as the rods **60** are allowed to move upwardly.

When portion **202** in the interior of sleeve **50** is exhausted, fluid within portion **200** is retained as diaphragm **194** moves upwardly into contact with plate **196**, as shown in FIG. 6. A similar device is illustrated in FIGS. 8 and 9. In this embodiment, a fixed sleeve **210** is provided with a support spider **212** onto which is mounted a rod guide **214**. Rod **122**, for a hydraulic snubber, or locking device, is received within the guide by bearing seals **216**, **218**. Since the central guide is used, an annular opening **220** is provided at the upper portion of the fixed sleeve, and this opening is sealed by an annular diaphragm **222**. Above the disphragm there is secured an annular perforated plate **224** which limits the upward extent or deflection of diaphragm **222**. The diaphragm divides the interior of the fixed sleeve into separate, isolated, sealed portions **230**, **232** with portion **232** being substantially zero when the diaphragm is in its upwardmost position, as shown in FIG. 8.

The present invention has been described in connection with certain structural embodiments; however, many modifications of these embodiments can be made.

Having thus defined my invention, I claim:

1. In a self-contained die cushion comprising a first sleeve, a second sleeve telescopically and reciprocally received on said first sleeve, said sleeves having end walls and combining to define a cushion chamber for a compressible fluid between said end walls, said second sleeve being biased upwardly by the fluid in said cushion chamber during operation of said die cushion and being dropped to an inoperative position when said die cushion is to be inoperative, means for dividing said chamber into separate, isolated first and second fluid chamber portions, means for limiting the expanded volume of said first portion to an extent incapable of preventing said second sleeve from dropping to an inoperative position upon exhausting of said second portion, and means for exhausting said second portion to drop said second sleeve to the inoperative position, the improvement comprising: a spring means for biasing said movable wall in an upward direction.

2. The improvement as defined in claim **1** wherein said movable wall includes a downwardly extending rod and said end wall of said first sleeve includes a passage for journaling said rod.

3. The improvement as defined in claim **2** including a spring means in said passage for biasing said rod and said wall in an upward direction.

4. In a self-contained die cushion comprising a first sleeve, a second sleeve telescopically and reciprocally received on said first sleeve, said sleeves having end walls and combining to define a cushion chamber for a compressible fluid between said end walls, said second sleeve being biased upwardly by the fluid in said cushion chamber during operation of said die cushion and being dropped to an inoperative position when said die cushion is to be inoperative, means for dividing said chamber into separate, isolated first and second fluid chamber portions, means for limiting the expanded volume of said first portion to an extent incapable of preventing said second sleeve from dropping to an inoperative position upon exhausting of said second portion, and means for exhausting said second portion to drop said second sleeve to the inoperative position, the improvement comprising: said first sleeve being mounted on a support plate and including a rod extending from the end wall of said second sleeve, through said chamber, through said dividing means, and through said plate, and means on said plate opposite said sleeves for controlling the rate of movement of said second sleeve in, at least, the upward direction.

5. The improvement as defined in claim **4** wherein said

dividing means is a rigid wall reciprocally mounted in said first sleeve and said rod extends through said rigid wall.

6. The improvement as defined in claim 4 wherein said dividing means is a rigid wall reciprocally mounted in said first sleeve and said rigid wall having a central bearing bore, said bearing bore reciprocally mounting said rigid wall onto said rod.

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