June 3, 1969 R. V. VICKERS 3,447,795

SELF-CONTAINED DIE CUSHION WITH AIR SAVER

Filed July 13, 1967 Sheet 1 of 3

$V_t = V_c + V_a$
$= V_c + V_b$

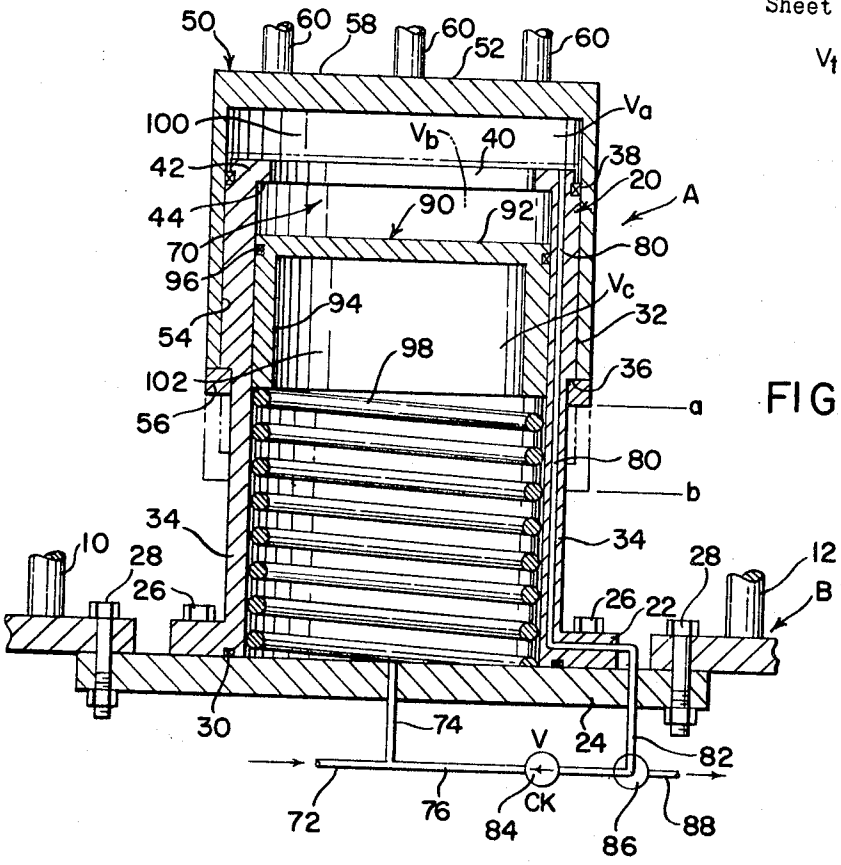

FIG. 1

FIG. 9

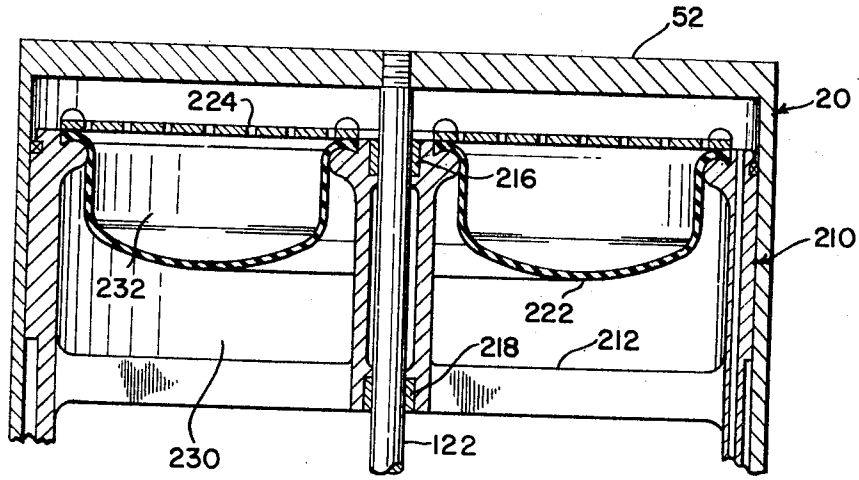

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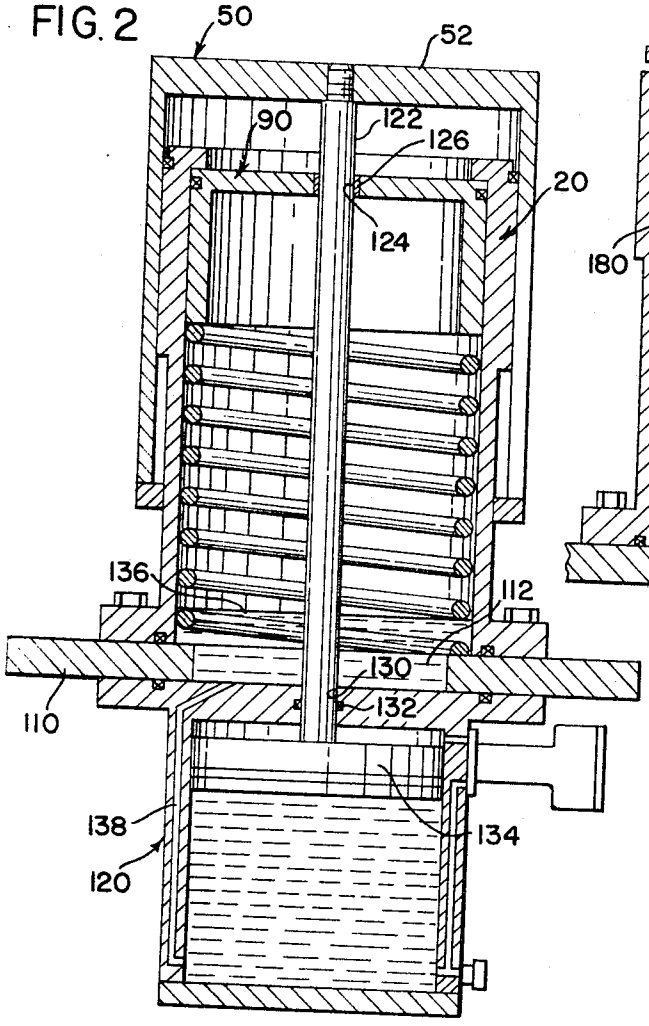
FIG. 2



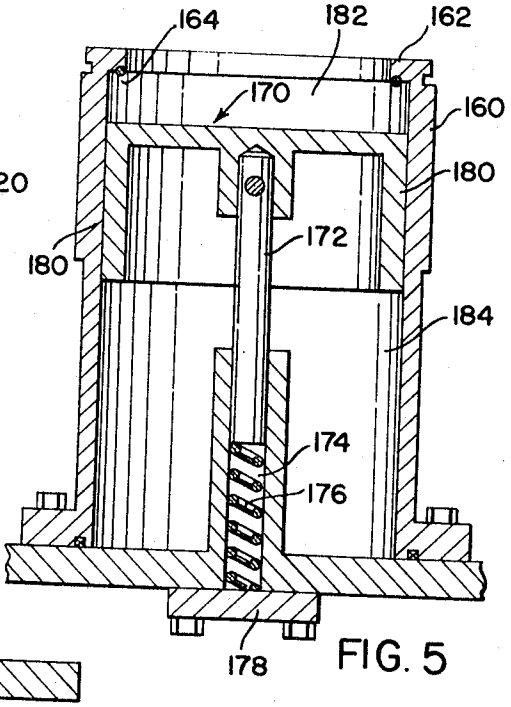


FIG. 5

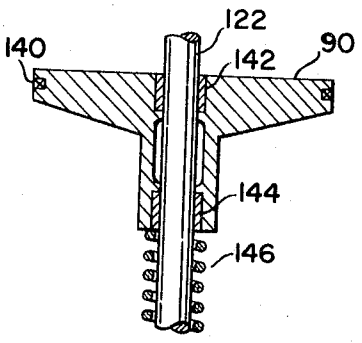


FIG. 3

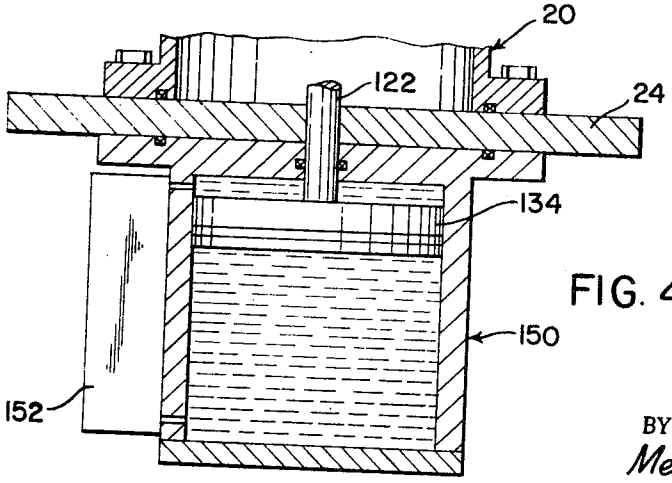


FIG. 4

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SELF-CONTAINED DIE CUSHION WITH AIR SAVER

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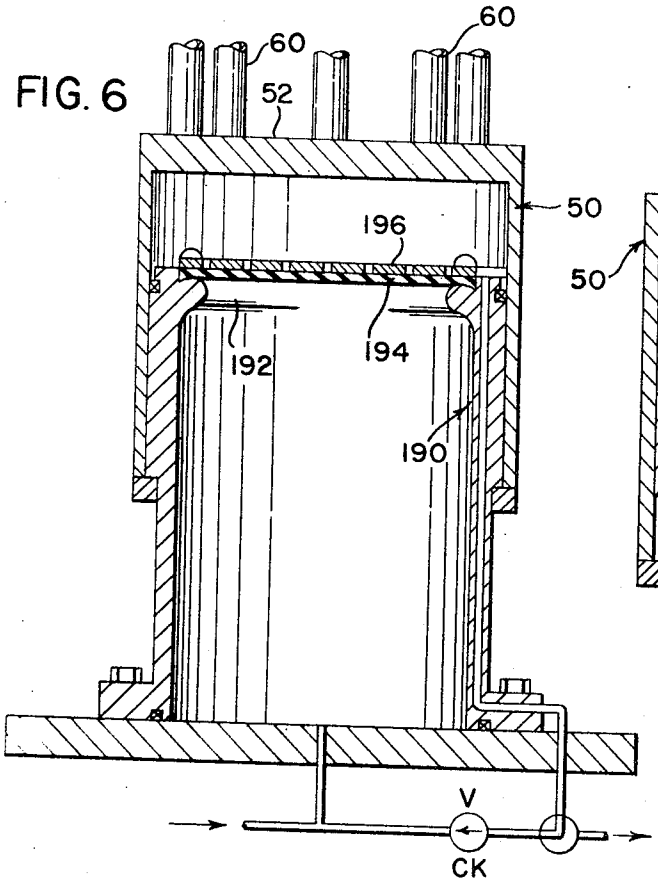
FIG. 6



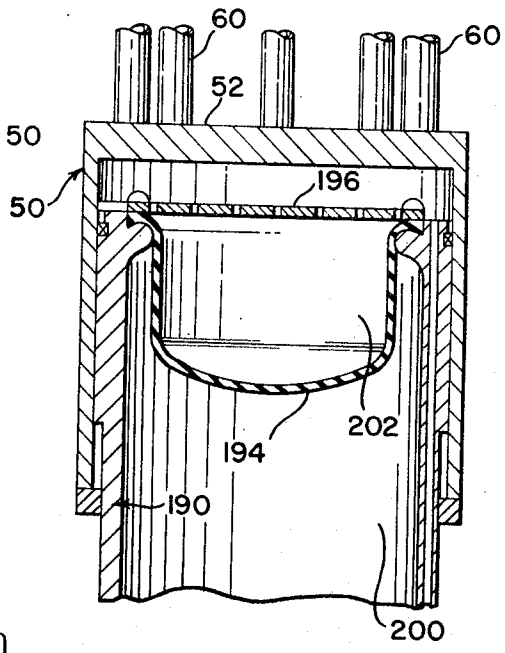


FIG. 7

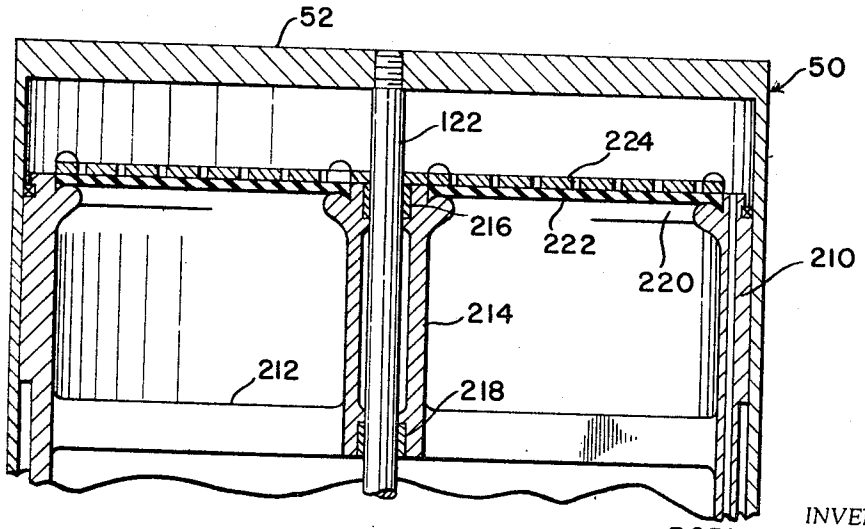


FIG. 8

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SELF-CONTAINED DIE CUSHION WITH AIR SAVER

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Int. Cl. F16f 1/22, 3/06
U.S. Cl. 267—1
15 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, such as a piston, to allow the fluid in the reservoir to assist in biasing the die cushion upwardly, but preventing exhaust of the reservoir fluid 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 incorporate hold-down rings or other auxiliary elements which are controlled, to a certain extent, by a die cushion located below the bed 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. These rods coact with movable elements within the die so that the sleeve is forced downwardly by the rods during the downward stroke of the press. The downward movement of the upper sleeve compresses the fluid within the cushion chamber so that the rods are forced in an upward direction by the upper sleeve 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 effort 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 hydaulic 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*. The improvement comprises providing the fluid means with means defining a cushion chamber filled with a compressible fluid and having a volume V_a when the member is at point *a* and a volume V_b when the member is at point *b*, V_a being greater than V_b. 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_a. 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 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.

These and other objects and advantages will become apparent from the following description used to illustrate preferred embodiments of the invention as read in con-

nection with the accompanying drawings in which:

FIGURE 1 is a partial, cross-sectional view illustrating, somewhat schematically, the preferred embodiment of the present invention;

FIGURE 2 is a partial, cross-sectional view illustrating a modification of the preferred embodiment of the present invention as shown in FIGURE 1;

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

FIGURE 6 is a cross-sectional view illustrating still a further modification of the present invention;

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

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

FIGURE 9 is a partial cross-sectional view showing the operating characteristics of the embodiment of the invention illustrated in FIGURE 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, FIGURE 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 **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 an 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 FIGURE 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 the 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 volume of fluid within chamber **70** is approximately V_a when the sleeve **50** is at point *a*. In like manner, the volume of chamber **70** is 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_a minus V_b.

In accordance with the present invention, 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 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 volume V_a and, in accordance with the embodiment of the invention illustrated in FIGURE 1, volume V_c is also substantially less than volume V_b. 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 portion **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 FIGURE 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.

The advantage of the invention as illustrated in FIGURE 1 is best illustrated by describing how the die cushion is dropped into its inoperative position. 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 FIGURE 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 chambers **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 embodiment of the invention illustrated in FIGURE 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 FIGURE 2, a modification of the preferred embodiment illustrated in FIGURE 1 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 FIGURE 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 FIGURE 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 FIGURE 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 FIGURES 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 FIGURE 5, a further modification of a preferred embodiment of the invention is illustrated. In accordance with this embodiment, 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 FIGURES 6 and 7. These figures illustrate a further embodiment 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 FIGURE 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 FIGURE 6. A similar device is illustrated in FIGURES 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 diaphragm 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 FIGURE 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, the improvement comprising: 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.

2. The improvement as defined in claim **1** wherein dividing means is a rigid wall reciprocally mounted within said first sleeve.

3. The improvement as defined in claim **2** wherein said limiting means is an abutment affixed to said first sleeve and above said movable wall.

4. The improvement as defined in claim **2** wherein said movable wall includes a skirt portion reciprocally supported in said first sleeve.

5. In a self-contained die cushion comprising a first sleeve, a second sleeve telescopically and reciprocally received on said first sleeve, said sleeves having generally closed ends and combining to define a cushion chamber for a compressible fluid between said ends, the improvement comprising: a vertically movable wall means in said first sleeve for dividing said cushion chamber into a first portion above said movable wall means and a second portion below said wall means, said portions being substantially sealed from each other, means for limiting the upwardmost vertical position of said wall means, and means for exhausting said first portion whereby said second sleeve is dropped to an inoperative position.

6. In a self-contained die cushion comprising a generally fixed sleeve with a lower closed end and an upper opened end, a cup-shaped element having an upper closed end and a lower open end, said element being telescopically and reciprocally received on said fixed sleeve whereby said sleeve and element define a cushion chamber to be filled with a compressible fluid, the improvement comprising: a vertically movable partition dividing said chamber into an upper portion and a lower portion, means

limiting the vertical movement of said partition, and means for exhausting said upper portion of said chamber to drop said element into an inoperative position whereby fluid is retained in said lower portion.

7. The improvement as defined in claim **6** wherein said partition is a rigid piston reciprocally mounted in said fixed sleeve and said limiting means is an abutment on said sleeve to prevent excessive expansion of said lower portion of said chamber.

8. The improvement as defined in claim **6** including means for filling said upper portion with pressurized compressible fluid.

9. In a self-contained die cushion comprising a container having an internal fluid reservoir and an opening, a cover reciprocally mounted on said container and having an internal fluid chamber communicated with said opening, said chamber and reservoir combining to form a cushion compartment which contains fluid to bias said cover upwardly, the improvement comprising: means for sealing a portion of said reservoir from said chamber, said sealing means being vertically movable upon changes in pressures within said chamber and reservoir; and means for exhausting fluid from said chamber.

10. In a self-contained die cushion comprising a movable operative member and a fluid means for biasing said member in a given direction, the improvement comprising: said fluid means including means defining first and second separate, fluid chambers; said chambers being contractible and expandable upon increases and decreases of externally applied forces; said chambers being in interforce transmitting relationship; said first chamber having a limited expanded volume; and means for exhausting said second chamber.

11. The improvement as defined in claim **10** wherein chamber defining means includes a cylinder and a pressure, movable piston in said cylinder.

12. In a self-contained die cushion comprising a movable, operative member and a fluid means for biasing said member in a given direction, the improvement comprising: said fluid means including first and second fluid chambers; a pressure movable, impervious element isolating said chambers from interfluid flow and connecting said chambers in mutual fluid pressure relationship whereby both of said chambers contribute to the biasing action of said fluid means; and means for exhausting fluid from said first chamber to change the operative position of said member by changing the total volume of said chambers.

13. In a self-contained die cushion comprising a movable, operative member and fluid means for biasing said member in a given direction for movement between points *a* and *b*, the improvement comprising: said fluid means including means defining a cushion chamber filled with a compressible fluid and having a volume V_a when said member is at point *a* and V_b when said member is at point *b*, V_a being greater than V_b; means defining a sealed fluid filled reservoir in said chamber with at least one movable exterior wall, said reservoir having a variable volume V_c which forms part of the volume of said chamber and is, at all times, substantially less than V_a; and means for exhausting fluid from said chamber while said reservoir remains filled with fluid.

14. The improvement as defined in claim **13** wherein V_c is, at all times, greater than V_b.

15. In a self-contained die cushion comprising a movable member and a generally fixed member, said movable member being reciprocally mounted on said fixed member and said members being hollow to define a cushion chamber, and means for filling said chamber with a compressible fluid to bias said movable member away from said fixed member, the improvement comprising: a movable piston in said hollow fixed member dividing the interior of said fixed member into first and second portions, the position of said piston being determined by the relative fluid pressures within said portions; an abutment in said fixed member to stop movement of said piston at a given point in a direction increasing said second portion; means on said piston for sealing said portions, at least, when said piston is at said given point; and means for exhausting fluid from said first portion and the interior of said movable member when said die cushion is to be dropped whereby said piston is forced to said point by fluid pressure in said second portion.

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U.S. Cl. X.R.

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