Nov. 16, 1954 J. HOENIG 2,694,567

METALWORKING PRESS

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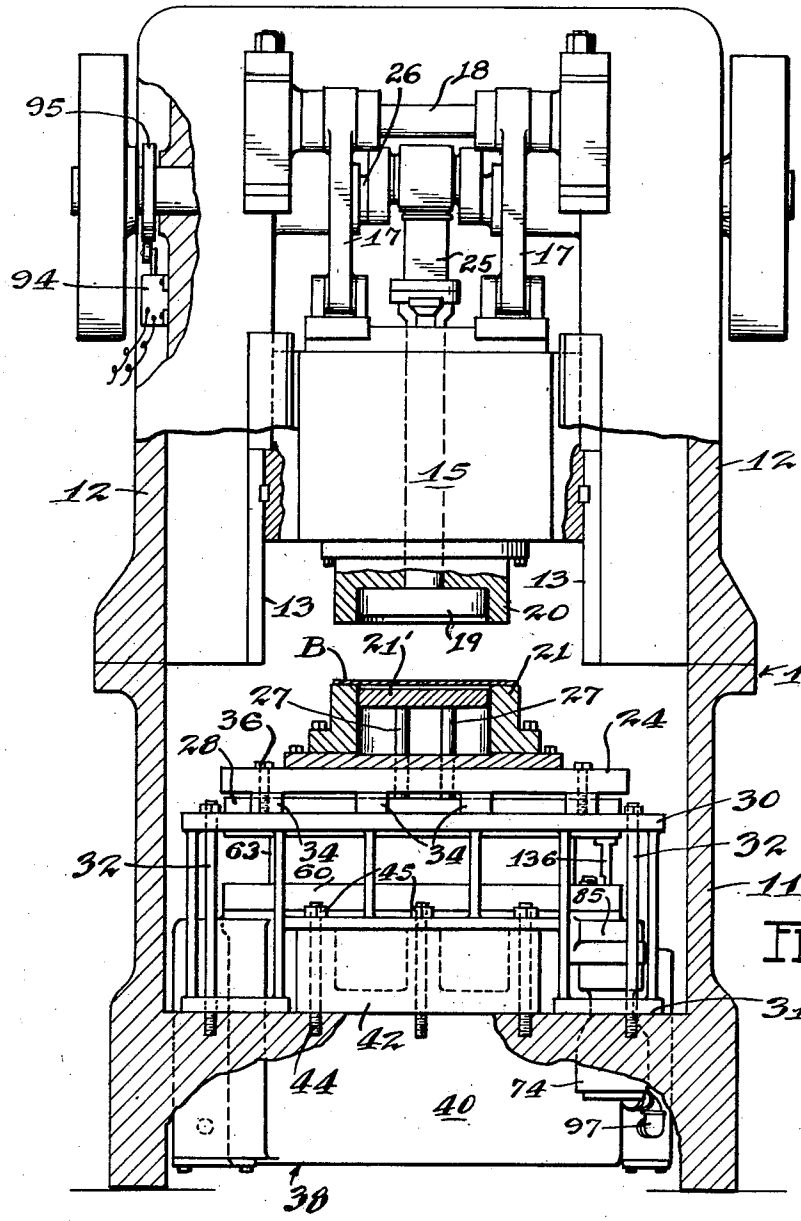


FIG-1-

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METALWORKING PRESS

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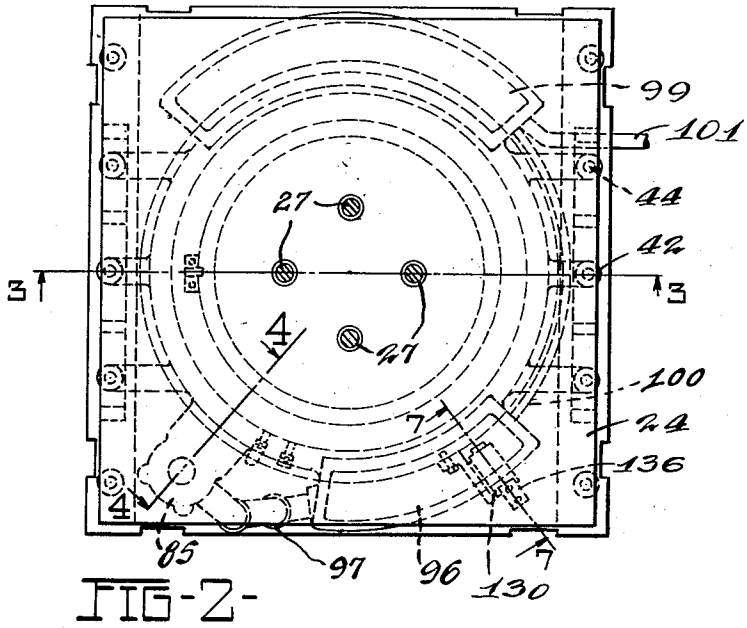


FIG-2-

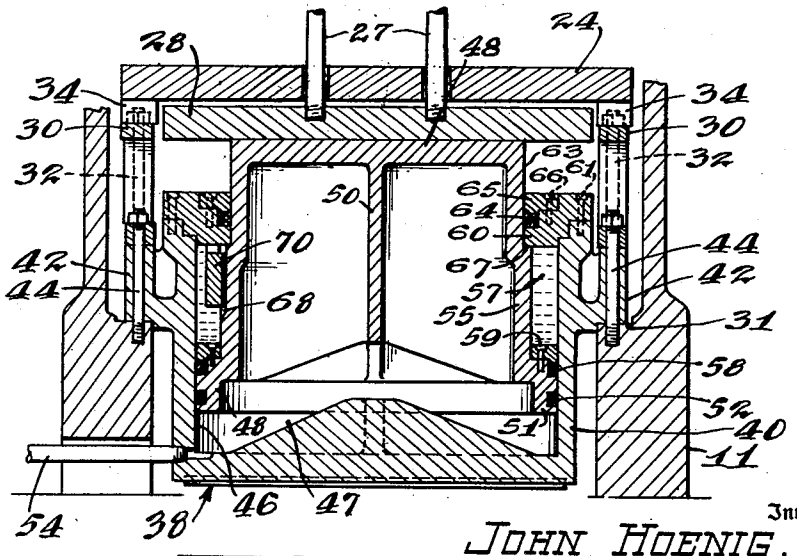


FIG-3-

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METALWORKING PRESS

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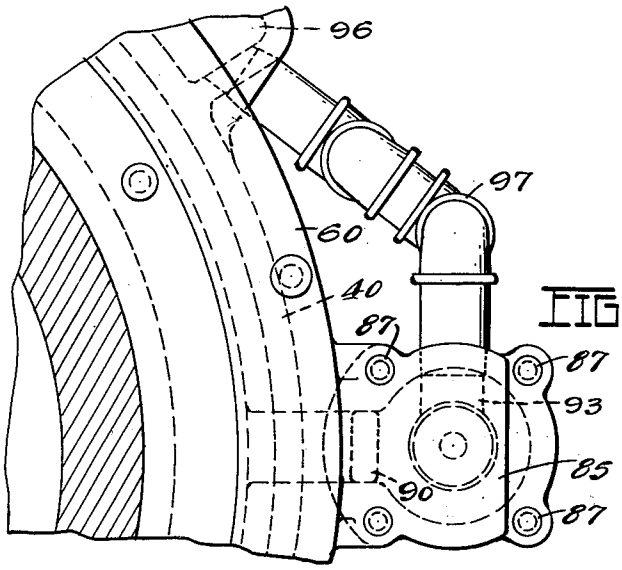


FIG-5-

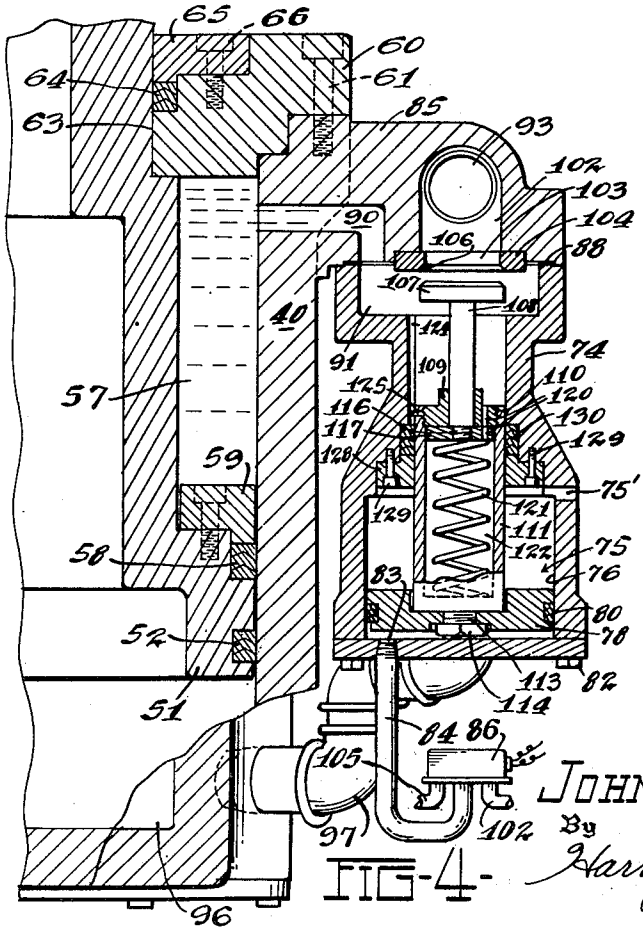


FIG-4-

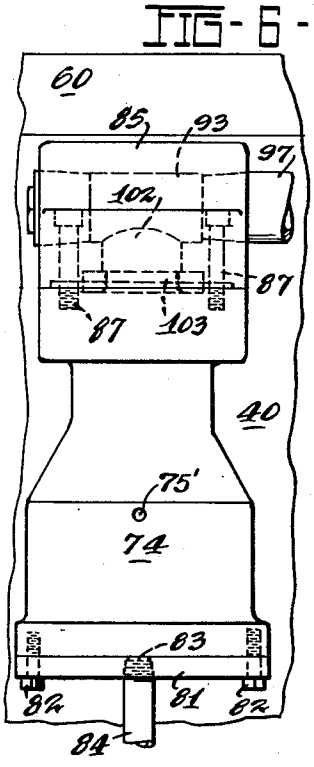


FIG-6-

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METALWORKING PRESS

Filed Dec. 9, 1950 4 Sheets-Sheet 4

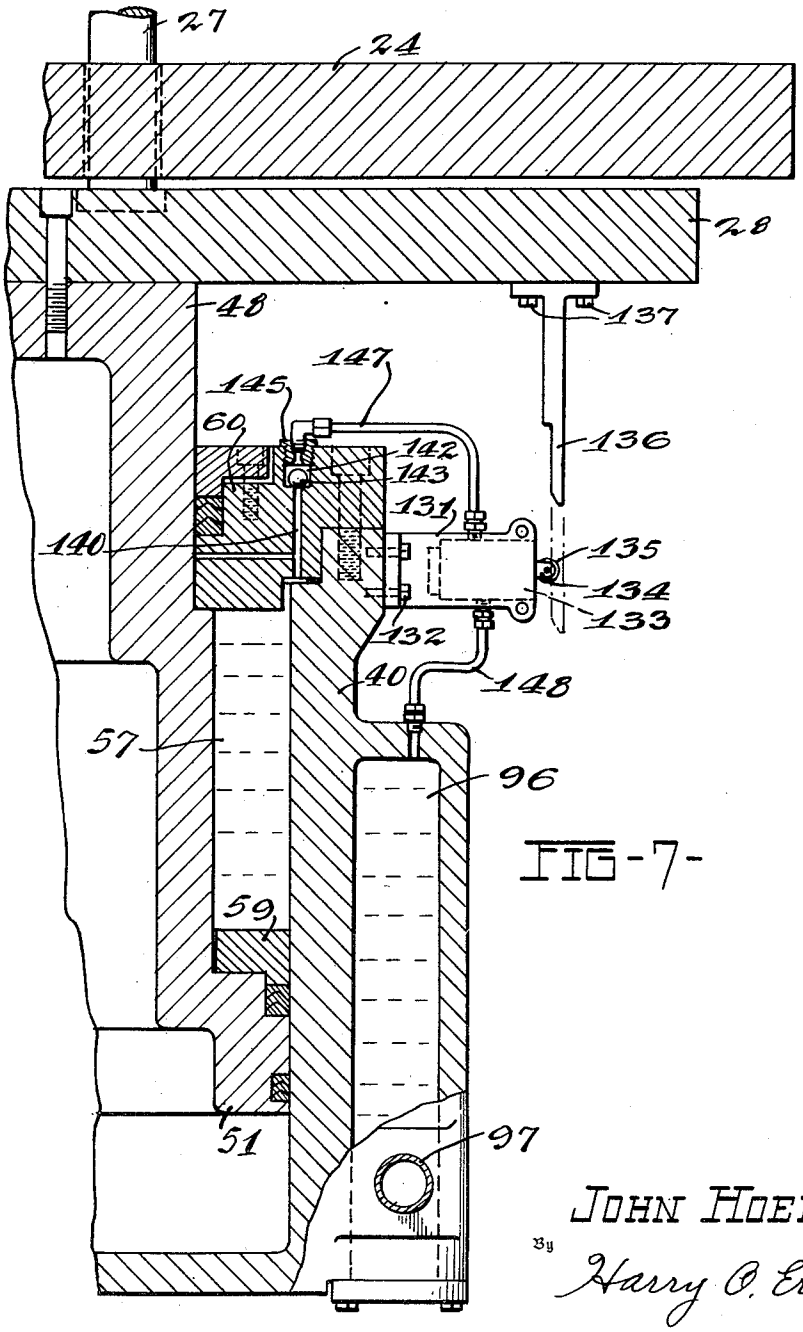


FIG-7-

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United States Patent Office

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METALWORKING PRESS

John Hoenig, Toledo, Ohio, assignor to Baker Brothers, Inc., Toledo, Ohio, a corporation of Ohio

Application December 9, 1950, Serial No. 200,063

5 Claims. (Cl. 267—1)

This invention relates to metal working presses and more especially to those of the type for drawing and forming sheet metal into various configurations and shapes.

In carrying on drawing and forming operations on sheet metal, it has been a usual practice to employ a blank holder pressure member to hold the metal sheet while the punch engages the metal to draw or form the same to a desired configuration, the blank holder serving the purpose of preventing the sheet metal from wrinkling. Pneumatic cushions or hydro-pneumatic cushions have come into extensive use for supporting the movable section or pressure pad adjacent the lower die as they provide for a more uniform pressure throughout the complete stroke of the forming punch whereby substantial variations in pressure are substantially eliminated. Air pressure or air-hydraulic combination arrangements have been used to supply the cushioning pressure.

In certain types of drawing and forming operations it is extremely desirable that the pressure pad, which also functions to eject the formed article from the lower die, should be delayed in its return to normal position until after the press slide or ram has begun its return stroke and the blank holder or ring has moved away from the lower die. To accomplish this, a locking device has been employed so as to permit the cushion to be locked or held at the bottom stroke until the press slide and punch have begun their recession movement. If a locking device is not employed as the press ram moves away from the lower die, the formed article will still be gripped under considerable pressure between the rising cushion at the bottom and the blank holding means, a condition which fosters buckling or distortion of the stamping or formed article. A locking device may be used advantageously on single action presses with spring or air knockout pads for removing the formed metal and it is also usable for delaying a knockout action so that the formed articles or stampings may be lifted off the die block instead of being raised by the punch member and afterwards permitted to fall out of the die on the upstroke.

Various types of locking means or mechanism have been devised to hold the die cushion assembly momentarily in its lowermost position, that is, at full down stroke position of the press slide and punch until the slide and punch have receded or begun their recession movement. One form of construction of locking device includes an oil chamber in which a piston is reciprocable with valve controlled bypass means for permitting transfer of oil from one side of the piston to the other in conjunction with means for preventing the transfer of oil providing a locking means to eliminate upward movement of the die cushion until a retracted movement of the punch has occurred and the blank holder has moved out of engagement with the blank.

Herefore, locking devices of this character necessarily occupied considerable space and it became necessary to provide a comparatively deep pit or well beneath the press in order to accommodate the die cushion locking device. The incorporation of a locking means disposed beneath the press was very expensive and complicated in its operation.

One of the objects of the present invention is the provision of a pneumatically actuated liquid type locking means which may be incorporated in the press construction without the necessity of the use of a pit beneath the press construction to accommodate the locking means.

An object of the invention is the provision of a pneumatic and hydraulic cushioning device for a press wherein the hydraulic chamber forming an element of the locking means surrounds the pneumatic chamber whereby a saving in space is effected and efficient operation assured.

A further object of the invention is the provision of a simplified yet reliable means for locking the die cushion at its lowermost position in a manner whereby the die cushion is moved slightly below the position to which it is moved under the influence of the punch so as to completely disengage the pressure pad from the material in the lower die during the locking cycle. This provides an effective arrangement whereby the punch and the blank holder may be withdrawn from engagement with the blank prior to the release of the lower cushion for movement upwardly under the influence of air or other fluid pressure established beneath a die cushion piston.

Still a further object of the invention is the provision of an efficient and rapidly acting pressure actuated valve means for delaying return movement of the die cushion and concomitantly effecting further movement downwardly of the die cushion to release the formed metal article from pressure stresses which might otherwise damage the formed article of sheet metal.

Still a further object of the invention resides in the provision of a hydraulic locking means for a die cushion which is of universal application and is readily adaptable for incorporation in press constructions already built without the necessity of major reorganization of the elements of the press.

Still another object of the invention is the provision of a hydraulic locking device for a die cushion of a press construction which may be inexpensively manufactured and which is positive and reliable in its operation and functioning.

Further objects and advantages are within the scope of this invention such as relate to the arrangement, operation and function of the related elements of the structure, to various details of construction and to combinations of parts, elements per se, and to economies of manufacture and numerous other features as will be apparent from a consideration of the specification and drawing of a form of the invention, which may be preferred, in which:

Figure 1 is a front elevational view of a drawing or forming press embodying a form of the present invention;

Figure 2 is a top plan view of a die cushion arrangement embodying the invention;

Figure 3 is a vertical sectional view through the die cushion and hydraulic lock construction of the invention, the view being taken substantially on the line 3—3 of Figure 2;

Figure 4 is an enlarged detailed sectional view taken substantially on the line 4—4 of Figure 2;

Figure 5 is a top plan view of the construction illustrated in Figure 4;

Figure 6 is an elevational view of the construction illustrated in Figure 4, and

Figure 7 is an enlarged detailed sectional view taken substantially on the line 7—7 of Figure 2.

For purposes of illustration, a form of the present invention is embodied in a type of double acting forming or drawing press, but it is to be understood that the invention may be utilized in any type of press or in any construction where the same may be found to be adaptable and to have utility.

Referring to the drawings in detail and first with particular reference to Figure 1, the numeral **10** designates the frame of a machine or press for drawing or forming sheet metal or the like. The frame embodies a base construction **11** upon which is mounted uprights **12** formed with guides **13**. A reciprocating ram or slide **15** is supported on the guides **13** for reciprocable movement, and as shown the ram or slide member **15** is connecetd by links **17** with a crank shaft **18** which is driven from any suitable source of power.

Supported on the lower face of the slide member **15** is a blank or work holder **20** arranged to engage a sheet metal blank B which is placed in position upon the upper surface of a stationary die **21** mounted upon a press

bolster or bed plate 24. A relatively movable die or punch 19 is connected by means of a connection 25 with a crank 26, motion being imparted to the slide member and punch by rotation of the crank shafts from any suitable source of power, all of the above referred to parts being of the conventional and well known construction.

Slidably disposed within the stationary die 21 is a die plate or pad 21' which is supported by means of die pins 27. The die pins pass through suitable holes or bores in the bolster plate 24 and are carried by a cushion or pressure pad 28.

The bolster plate 24 is supported upon a skeleton-like sub-frame 30 which rests upon a ledge 31 formed upon the base frame 11. The sub-frame 30 is secured to the base frame by means of bolts 32 or other suitable securing means. Disposed between the bolster 24 and the upper surface of the sub-frame 30 is a plurality of spacing bars or blocks 34 which may be of a thickness or dimension suitable for the purpose of elevating the bolster 24 to the proper height dependent upon the type of die member 21 carried thereby. The blocks or spacing bars 34 may be held in position by suitable bolts 36.

The die cushion construction of my invention is of a generally cylindrical or drum shaped configuration and is designated by numeral 38. The die cushion construction is inclusive of a main housing 40 which is preferably formed with outwardly extending boss or flange portions 42 which also engage and are supported upon the ledge 31 formed on the base frame 11. The flange portions 42 are bored to accommodate threaded members 44, the upper ends of which are adapted to receive securing nuts 45 to securely anchor or fasten the die cushion housing 40 to the main frame 11. The interior wall 46 of the housing 40 is cylindrical in form and disposed in the chamber 47 of the housing 40 is a vertically reciprocable piston 48. The piston construction may be of a hollow configuration and centrally provided with suitable transversely extending reinforcing ribs or webs 50.

The lowermost peripheral portion of the piston 48 is of a dimension to be slidably yet snugly received interiorly of the housing 40, the portion 51 of the piston being provided with a peripheral groove to accommodate a suitable sealing member or packing 52 which engages or contacts the interior wall 46 so as to establish a fluid tight seal therewith. The chamber 47 formed by the hollow interior of the piston 48 and the lower portion of the housing 40 is connected by means of a tube 54 with a suitable source of fluid pressure, as for example, compressed air or other expansible fluid.

The piston 48 above portion 51 is formed with a portion 55 of reduced diameter providing an annular space between the portion 55 of the piston and the interior wall of the housing 40 forming a chamber 57 adapted to receive a liquid which is substantially incompressible, as for example, oil or the like.

The peripheral zone of portion 55 of the piston is recessed to accommodate a sealing means or packing 58 which is held in place by means of an annular member or ring 59 secured to the piston and engageable with the packing 58 to hold the latter in snug sealing engagement with the interior wall of the housing 40. By means of the sealing devices 52 and 58 the expansible fluid or gas in the chamber 47 is prevented from moving along the interior wall 46 of the chamber 57 and likewise the liquid in chamber 57 is prevented from moving into the chamber 47.

The upper end of the liquid receiving chamber 57 is closed by means of an annular member 60 held in place by means of threaded members or screws 61 which pass through suitable bores in the member 60 and are threaded into registering openings in the upper peripheral portion of the housing 40. The piston 48 at its upper portion is formed with a still further reduced diameter indicated at 63, and a suitable sealing or packing means 64 is disposed in a groove formed in the annular member 60. The sealing means 64 is engageable with the exterior cylindrical wall of the portion 63 to prevent liquid from chamber 57 seeping along the wall 63 of the piston. The sealing means 64 is held in sealing engagement with the piston by means of an annular securing ring 65 held in place by means of bolts or threaded members 66 extending into the annular member 60 forming the closure for the fluid or liquid chamber 57. The ledge 67 on the piston 48 engages the lower surface of the annular member 60 to define the upper limit of movement of the piston relative to the housing 48.

The piston portion 55, as illustrated in Figure 3, is formed with a vertical slot or groove 68 adapted to receive a key formed as an integral part of a member 70, the latter being secured to and depending from the annular member 60. The key portion of member 70 extending into the groove 68 serves to prevent relative rotation of the piston 48 yet permitting vertical sliding movement of the piston in the housing.

In the usual operation of the die cushion, air under pressure is introduced through the tube 54 into the chamber 47 to normally hold the piston 48 in its uppermost position as shown in Figures 1 and 3. During reciprocable movements of the piston 48, oil is introduced into and expelled from the annular chamber 57 for purposes to be hereinafter explained.

In the operation of press constructions with which my invention is adaptable, it is imperative that the press slide 15 and punch 19, after completing their movement to the lowermost positions to form the sheet metal blank into the desired shape, initiate their return stroke without the influence of upward pressure of the die cushion in order to prevent buckling or distortion of the formed sheet metal article. The arrangement of my invention includes means for not only preventing immediate upward or retractive movement of the piston 48 after the down stroke of the punch has been completed, but such means functions to move the piston 48 and pressure pad 28 through a further downward increment in order that there will be no upward pressure acting upon the blank until the punch and press slide have completed their return stroke or have moved a substantial distance from their lowermost position. Figures 4 through 7 inclusive illustrate a form of arrangement for accomplishing this purpose.

As particularly illustrated in Figure 4, there is disposed at one side of the housing 40 a tubular casing or member 74, the lower portion being enlarged and formed with a chamber 75 having a cylindrical wall 76 in which is slidably disposed a piston 78. The periphery of the piston 78 is provided with a circumferential groove adapted to receive packing or sealing means 80 so as to establish a fluid seal with the wall of the chamber 75. The lower end of the casing 74 is closed by means of a plate 81 held in place by bolts 82 or other suitable securing means. The plate 81 is provided with a threaded opening 83 to accommodate a tube 84 for conveying pressure fluid such as compressed air into the chamber 75 beneath the piston 78. A vent 75' is formed in the wall of the casing 74 to allow free movement of air into and out of the chamber above the piston 78.

The upper portion of the casing 40 is formed with a laterally extending portion 85 to which the casing 74 is secured by means of threaded members 87, a sealing gasket 88 being disposed in a suitable recess in the portion 85 and engageable with the upper end surface of the casing 74 to establish a fluid tight seal. The wall of casing 40 is formed with an L-shaped port or duct 90 which is in communication with a chamber 91 formed in an upper portion of the casing 74 for conducting or conveying liquid into and away from the annular chamber 57 surrounding the piston 48. Oil or other suitable fluid is admitted to the duct 90 and chamber 91 through a passage 93 formed in the portion 85 which is in communication with an oil reservoir 96 through suitable pipes or ducts 97 illustrated in Figures 4 and 5.

The oil reservoir means may be disposed at any convenient position with respect to the die cushion but I have found that it is expedient to have the oil reservoir means as close to the chamber 57 as can be conveniently arranged. As illustrated in Figure 2 the reservoir 96 is in the form of an arcuate chamber provided in a hollow portion integrally formed with the housing 40. In order to provide for an ample supply of oil an additional reservoir means 99 may be formed opposite the reservoir 96 in the manner illustrated in Figure 2. The reservoirs 96 and 99 may be connected together by a suitable tube 100. Through the intercommunication of the reservoirs 96 and 99 and the pipes 97 oil from the reservoirs may be conveyed into the chamber 57 or returned to the reservoirs for purposes hereinafter described. It is preferable that the reservoir 99 be filled only partially with oil or other liquid so as to provide a space above the oil con-

nected by a tube **101** with a source of compressed air so that the oil in both reservoirs is under a constant pressure to facilitate the flow of oil into the chamber **57**.

The passage **93** is in communication with a duct **102** and a port **103** formed in a valve plate or insert **104** fixedly secured to the portion **85**. The plate **104** is formed with a valve seat **106** adapted to be engaged by a valve **107** mounted upon a rod **108** in the manner illustrated in Figure 4. The rod **108** extends through a bushing **109** and has a portion **110** threaded into the upper end of a sleeve or relatively movable cylinder **111**, the latter extending to and being recessed into the piston or head **78**. The lower end wall of the sleeve **111** is formed with a tenon **113** extending through an opening in the piston **78**, a nut **114** being threaded on the tenon **113** to rigidly secure the piston **78** to the sleeve or cylinder **111**. The lower extremity of the valve rod **108** is threaded as at **116** and extends into the threaded opening in a circular plate or disc **117** as shown in Figure 4. Both the bushing **109** and the disc **117** are provided with registering openings **120** to facilitate the flow of liquid to and from the interior of the cylinder **111**.

An expansive coil spring **121** is disposed in the interior chamber **122** of the cylinder **111** and serves to urge the disc **117**, rod **108** and valve **107** to the outermost position illustrated in Figure 4. The wall of the casing **74** is provided with a vertical groove **124** and the sleeve or cylinder **111** is provided with a pin **125** which projects into the groove **124** so as to prevent relative rotation of the sleeve with respect to the casing **74**.

An annular member **128** surrounds the sleeve **111** and is secured to the casing by means of screws **129**. The casing **74** is provided with a suitable circular recess adapted to accommodate sealing or packing means **130** which is held in place by the annular member **128** so as to effect a fluid tight seal with the exterior wall of the sleeve **111**.

The admission of air under pressure through tube **84** to the chamber in casing **74** beneath the piston **78** is controlled by means of a solenoid actuated valve **86** controlled by a switch **94** operated from a cam **95** or other means operated by movement of the crankshaft or press slide. The valve **86** in one position directs compressed air from a line **102** into the chamber **75** and in another position exhausts air therefrom through an outlet **105**.

Means are provided for facilitating the bleeding of any air that may collect in the oil chamber **57**. This means is inclusive of a valve **133**, the support **131** thereof being secured to a boss formed on the housing **40** by means of screws **132**. The valve **133** is provided with an actuating plunger **134** carrying a roller **135** which is adapted to be engaged by a cam or projection **136** secured to the pressure pad **28** by means of screws **137**.

The annular member **60** is formed with a duct or passage **140** which communicates with the upper end of the chamber **57** as shown in Figure 7. The duct **140** is in communication with a chamber **142** in which is disposed a ball check valve **143** adapted under certain conditions to close the end of the passage **140**. A fitting **145** is threaded into the upper end of the chamber **142** and has a passage therethrough connected with a pipe or tube **147**, the latter being connected to the valve **133**. The air valve **133** is connected by means of a tube **148** with the upper portion of the oil reservoir **96**. The valve **133** is normally open in the position illustrated in Figure 7 and is closed through the engagement of the cam projection **136** with the roller **135** to move the valve plunger **134** when the die cushion piston **48** is in its lowermost position.

The operation of the arrangement of my invention is as follows: The press is equipped with conventional clutch mechanism (not shown) which is actuated to establish a driving connection with a source of power to the crankshafts **18** and **26** to move the press slide **15** and punch during a blank forming operation. In the form of press and die construction illustrated, the peripheral portion of the die **21** supports the sheet metal blank B which is engaged by the blank holder **20** while the punch **19** is moved downwardly to form the blank. Air under pressure, as for example, a presure of one hundred pounds per square inch, is impressed in the chamber **47** through the tube **54** providing a reactive force which must be overcome as the punch **19** moves downwardly to form the metal blank B into the die **21** while the peripheral portion of the blank is held between the blank holder and the peripheral portion of the die **21**. Thus during downward movement of the punch **19**, the plate or die **21'** is concomitantly moved downwardly exerting pressure through the pins **27** to the pressure pad **28** which directly contacts the piston **48** and forces the latter to a lower position. It is desirable that the oil or other liquid in the reservoirs **96** and **99** be under air pressure conveyed to the reservoir **99** through the tube **101**, from a supply of compressed air so that as the piston **48** moves downwardly effecting an enlargement of the chamber **57**, so that oil or liquid will flow past the valve **107** which is in open position as shown in Figure 4 thence through the duct or port **90** into the chamber **57**. When the punch **19** has reached its lowermost position to complete a predetermined configuration of the blank B, the cam projection **136** engages the roller **135** to actuate the valve plunger **134** closing the valve **133** to obstruct flow of oil through passage **140**. As the punch **19** approaches or reaches its lowermost position, the solenoid controlled valve **86** intercalated in the air line **102** with pipe **84** is actuated by operation of the switch **94** through the cam **95** to direct air under pressure into the chamber beneath the piston **78** in casing **74**. Under the influence of air pressure, the piston **78** is rapidly moved upwardly, actuating the valve **107** to a position closing the liquid inlet port **106**, this action being augmented under the influence of the spring **121** which transmits the movement of piston **78** to the valve **107**. As soon as the valve **107** is closed, the further upward movement of the piston **78** under air pressure beneath piston **78** compresses the coil spring **121** and causes further upward movement of the cylinder **111**. The interior chamber **122** is normally filled with oil entering through the ports or ducts **120** when the sleeve and piston are in the lowermost position as indicated in Figure 4. As the cylinder or sleeve **111** continues its upward movement under the influence of the air, forcing piston **78** upwardly, the disc **117** forms a relatively stationary piston because the valve **107** closing port **106** is incapable of further upward movement. As the spring **121** is thereafter contracted by further upward movement of cylinder **111**, the oil in the chamber **122** is forced through the ducts **120** and through the port **90** into chamber **57** thus causing further slight downward movement of the piston **48** and the pressure pad **28** so as to completely relieve the pins **27** and the plate **21'** of any upwardly acting force of the die cushion. During this interval, the piston **48** is locked in its lowermost position while the punch **19** and press slide **15** are returned to their initial positions.

The air pressure is constantly maintained in chamber **47** beneath the piston **48** so that there is always available an upwardly acting force to return the piston **48** to its normal or uppermost position. This condition is provided by maintaining air pressure in the line **54**. It will be noted from Figure 3 that in the die cushion illustrated the full stroke of the die cushion or piston **48** is comparatively short so that while the air contained in chamber **47** may be compressed by movement of the piston to a slightly higher pressure, such increase in pressure is not sufficient to interfere with the operation of the die cushion.

In press constructions where the die cushion has a greater relative movement, it may be found desirable to interpose a surge tank connected with the tube **54** to provide for the increased pressure that may be built up by a comparatively long stroke or travel of the die cushion or piston.

After the punch and press slide have substantially completed their return recession movements after having completed a metal forming operation, the valve **86** controlling the flow of compressed air to the chamber beneath the piston **78** in casing **74** is actuated to permit the pressure air beneath the piston **78** to be exhausted through an outlet **105** to the atmosphere. Under the influence of the oil pressure acting against the upper surface of the valve **107** which is in closed position and by reason of the expansive pressure of the spring **121**, the piston **78** is returned to its lowermost position as shown in Figure 4 causing the opening of the valve port **103** to provide a return path for the oil in chamber **57** to flow to the reservoirs **96** and **99**. Thus the air pressure beneath the piston **48**, while moving the latter upwardly concomitantly forces oil from the chamber **57** through the duct **90**, chamber **91**, port **103**, passage **102** and tube **97** to the oil reservoirs.

After the die cushion locking mechanism contained in casing **74** is returned to normal position in the manner above described to effect a release of the die cushion or piston **48**, the latter moves upwardly, which movement disengages the cam projection **136** from roller **135** permitting outward movement of the valve plunger **134** to open the valve **130** and reestablish communication between tubes **147** and **148** to bleed any air from the oil chamber **57**.

It is apparent that, within the scope of the invention, modifications and different arrangements may be made other than is herein disclosed, and the present disclosure is illustrative merely, the invention comprehending all variations thereof.

I claim:

In combination with a metal working press having a reciprocating member adapted to carry a die, a die cushion disposed beneath said member and arranged to support a die for cooperation with the die carried by the reciprocating member, said die cushion being adapted to be moved downwardly by downward movement of the reciprocating member, a piston element connected with the die cushion, a housing element having a bore formed therein, said piston element having sealing engagement with the wall of said bore, means for establishing a fluid pressure beneath said piston for resisting downward movement of the piston, one of said elements having a portion of different diameter forming with the other of said elements an annular liquid-receiving chamber surrounding the piston, a liquid reservoir for supplying liquid to said annular chamber, means for establishing pressure upon the liquid in said reservoir, a valve casing associated with the housing element, said casing being formed with a cylindrical liquid-receiving chamber having communication with said reservoir and said annular chamber, a normally open valve in said casing adapted to be closed to interrupt communication between the reservoir and the annular chamber, pressure-actuated means in said casing for closing said valve, a cup-shaped member reciprocably disposed in said chamber in said casing, a spring having engagement with said cup-shaped member and said valve, said pressure-actuated means being effective to move said cup-shaped member to close the valve and inject liquid contained in said valve chamber into the annular chamber to effect downward movement of said piston, said spring being arranged to be compressed by the pressure-actuated means acting upon said cup-shaped member, means for releasing the pressure on said pressure-actuated means whereby the cup-shaped member is retracted by said spring, said valve being adapted to be opened by the pressure in said liquid reservoir upon retraction of the cup-shaped member to re-establish communication between the liquid reservoir and the annular chamber.

2. In combination with a metal working press having a reciprocating member adapted to carry a die, a die cushion disposed beneath said member and arranged to support a die for cooperation with the die carried by the reciprocating member, said die cushion being adapted to be moved downwardly by downward movement of the reciprocating member, a piston connected with the die cushion, a housing having a bore formed therein, said piston having sealing engagement with the wall of said bore, means for establishing fluid pressure beneath said piston in the bore in the housing for resisting downward movement of the piston, said piston having a portion of reduced diameter forming with the wall of said bore an annular liquid-receiving chamber surrounding the piston, a liquid reservoir for supplying liquid to the annular chamber in the housing, means for establishing pressure upon the liquid in said reservoir, a casing secured to the housing, said casing being formed with a liquid-receiving valve chamber having communication with said reservoir and said annular chamber, a normally open valve in said chamber adapted to be closed to interrupt communication between the reservoir and the annular chamber, pressure-actuated means operative in said casing for closing said valve, a cup-shaped member reciprocably disposed in the chamber in said casing, resilient means disposed between said cup-shaped member and said valve, said pressure-actuated means being effective to move said cup-shaped member to inject liquid contained in said valve chamber into the annular chamber to effect downward movement of said piston, means for releasing the pressure on said pressure-actuated means whereby the cup-shaped member is retracted by said resilient means, said valve being adapted to be opened by the pressure in said liquid reservoir upon release of pressure on the pressure-actuated means to re-establish communication between the liquid reservoir and the annular chamber.

3. In combination with a metal working press having a reciprocating ram, a die cushion disposed beneath said member, said die cushion being adapted to be moved downwardly by downward movement of the ram, a piston connected with the die cushion, a housing having a bore formed therein, said piston having sealing engagement with the wall of said bore, means for establishing fluid pressure beneath said piston for resisting downward movement of the piston, said piston having a portion of different diameter forming with the wall of said bore an annular liquid-receiving chamber surrounding the piston, an arcuately shaped liquid reservoir integrally formed in a wall of said housing for supplying liquid to the annular chamber in the housing, means for establishing pressure upon the liquid in said reservoir, a casing secured to the housing formed with a liquid-receiving chamber having communication with said reservoir and said annular chamber, a normally open valve in said casing adapted to be closed to interrupt communication between the reservoir and the annular chamber, pressure-actuated means in said casing for closing said valve, a cup-shaped member reciprocably disposed in said casing, said valve having a portion projecting into the cup-shaped member, a spring disposed in said cup-shaped member and engageable with the valve, said pressure-actuated means arranged to move said cup-shaped member to close the valve and inject liquid in said valve casing into the annular chamber to effect further downward movement of the piston, said spring being compressed upon movement of said cup-shaped member under the influence of the pressure-actuated means, means for releasing said pressure-actuated means to effect a retraction of the cup-shaped member to its initial position under the expansive pressure of the spring, the pressure on the liquid in said reservoir being effective to open said valve upon release of the pressure-actuating means to re-establish communication between the liquid reservoir and the annular chamber.

4. In combination with a metal working press having a reciprocating member, a die cushion disposed beneath said member, said die cushion being adapted to be moved downwardly by downward movement of the reciprocating member, a piston connected with the die cushion, a housing having a bore formed therein, said piston having sealing engagement with the wall of said bore, means for establishing fluid pressure beneath the piston for resisting downward movement of the piston, said piston having a portion of reduced diameter forming with the wall of said bore an annular liquid-receiving chamber surrounding the piston, a liquid reservoir for supplying liquid to the annular chamber in the housing, means for establishing pressure upon the liquid in said reservoir, a casing having a valve chamber secured to the housing, said valve chamber being formed with a cylindrical zone, passages in said casing connecting the valve chamber with said reservoir and said annular chamber, a normally open valve in said casing adapted to be closed to interrupt communication between the reservoir and the annular chamber, a pressure-actuated means in said casing for closing said valve, a hollow cylindrically shaped member reciprocably disposed in the cylindrical zone of the valve chamber in said casing, a head secured to the hollow member, said valve having a stem projecting through an opening in said head, a plunger contained within the hollow member secured to said valve stem, said plunger and head having a liquid metering passage to provide for flow of liquid into and out of the hollow member, yieldable means disposed in said hollow member engageable with the plunger for normally holding the plunger in one position in said hollow member, said pressure-actuated means arranged to move said hollow member to close the valve and inject liquid from said valve casing into the annular chamber to effect further downward movement of the piston, means for releasing said pressure-actuated means to effect a retraction of the hollow member to its initial position under the influence of the yieldable means, the pressure on the liquid in said reservoir opening said valve upon release of the pressure-actuating means to re-establish communication between the liquid reservoir and the annular chamber.

5. In combination with a metal working press having a reciprocating member adapted to carry a die, a die cushion disposed beneath said member and arranged to support a die for cooperation with the die carried by the reciprocating member, said die cushion being adapted to be moved downwardly by downward movement of the reciprocating member, a piston connected with the die cushion, a housing having a bore formed therein, said piston having sealing engagement with the wall of said bore, means for establishing a fluid pressure beneath said piston for resisting downward movement of the piston, said piston having a portion of reduced diameter forming with the wall of said bore and annular liquid-receiving chamber surrounding the piston, a liquid reservoir for supplying liquid to the annular chamber in the housing, means for establishing pressure upon the liquid in said reservoir, a casing having a valve chamber secured to the housing, said chamber being formed with a liquid-receiving cylindrical zone having communication with said reservoir and said annular chamber, a normally open valve in said casing adapted to be closed to interrupt communction between the reservoir and the annular chamber, pressure-actuated means in said casing for closing said valve, a cup-shaped member reciprocably disposed in said chamber in said casing, a head secured to said cup-shaped member, said valve having a portion projecting through said head, a piston element contained within the cup-shaped member secured to the projecting portion of the valve, said piston element and head having a liquid

metering passage to provide for restricted flow of liquid into and out of the cup-shaped member, a spring disposed in said cup-shaped member and engageable with the piston element for normally holding the piston element in one position in said cup-shaped member, said pressure-actuated means arranged to move said cup-shaped member to close the valve and inject liquid from the valve casing into the annular chamber to effect further downward movement of the piston, said spring being compressed upon movement of said cup-shaped member under the influence of the pressure-actuated means, means for releasing said pressure-actuated means to effect a retraction of the cup-shaped member to its initial position under the expansive pressure of the spring, the pressure on the liquid in said reservoir opening said valve upon release of the pressure-actuating means to re-establish communication between the liquid reservoir and the annular chamber.

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