

July 29, 1941.

E. C. FABER

2,250,450

DIE

Filed July 13, 1938

3 Sheets-Sheet 1

Fig. 1

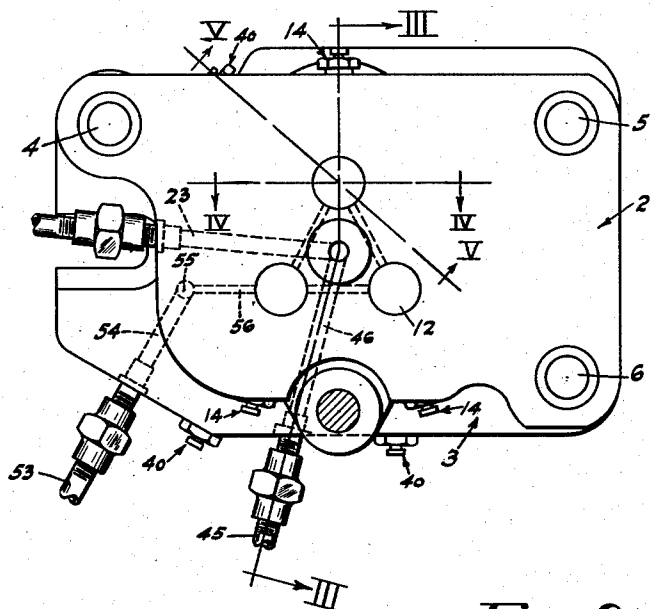
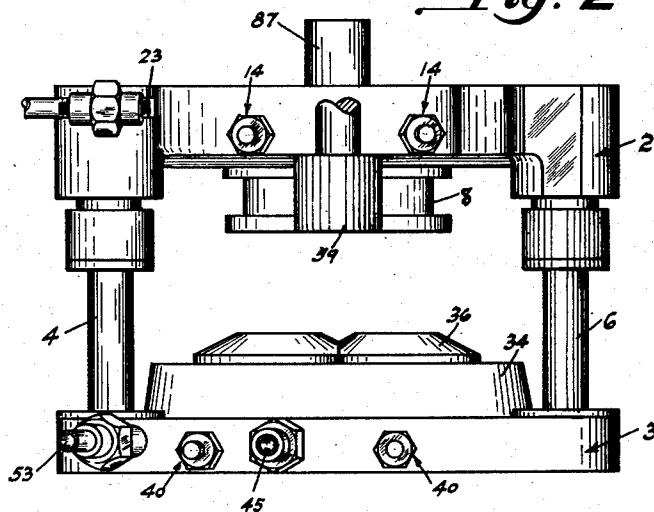


Fig. 2



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3 Sheets-Sheet 2

Fig. 3

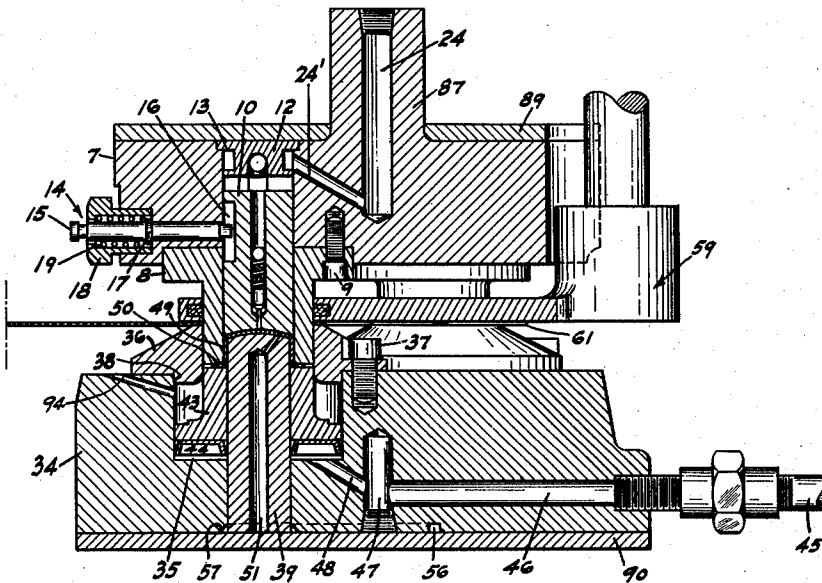


Fig. 4

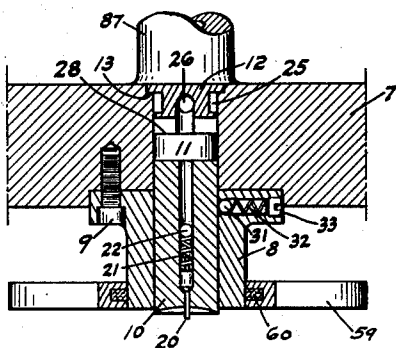
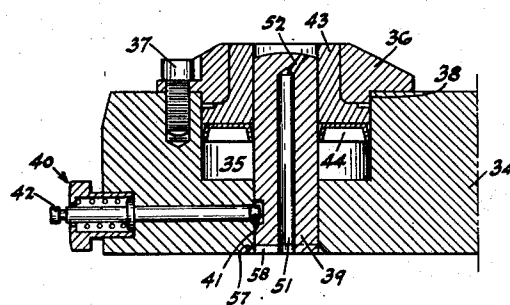


Fig. 5



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3 Sheets-Sheet 3

Fig. 6

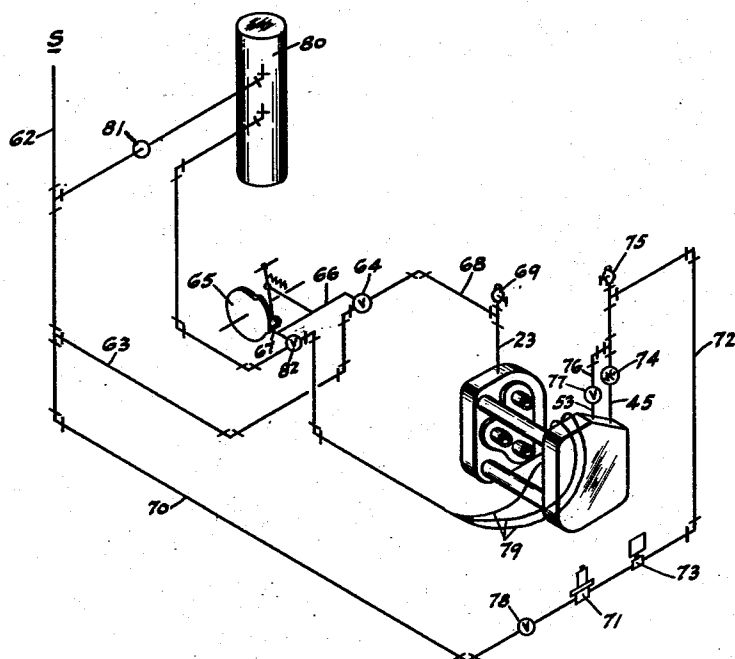


Fig. 8

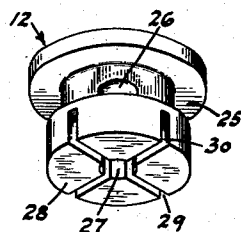
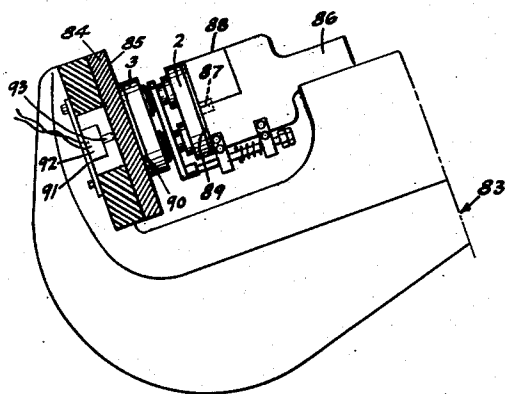


Fig. 7



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UNITED STATES PATENT OFFICE

2,250,450

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Application July 13, 1938, Serial No. 218,944

6 Claims. (Cl. 113—42)

This invention relates to improvements in sheet working dies and is more particularly concerned with a self-contained die unit in which the pressure means or cushion for the drawing ring, push-out, stripper or other loaded member is provided as an integral part of the unit, thus eliminating the use of spring, rubber or other external die cushions which are normally employed.

The invention is particularly useful in that aspect which contemplates sheet metal forming and drawing. It has been universal practice in the construction of dies for such purpose to load the draw ring to provide drawing pressure through the use of springs, rubber blocks or cylinder and piston units. Since the draw ring must be substantially uniformly loaded throughout its projected area in order to properly effect drawing, it has heretofore been common practice to provide a plurality of supporting pins for the draw ring, the pins varying in number from three for a small die to five or more on larger dies. These pins pass through appropriate openings in the die base and bolster plate and are attached to a plate, known as a saddle, disposed beneath the bolster plate, the saddle being slidable upon guide rods when the supporting pins are displaced. The saddle is generally either spring urged or operates against the resiliency of rubber blocks, and the effective loading of the draw ring is determined by the characteristics of the springs or rubber blocks and the compression applied thereto.

Such structures are objectionable for the reason that the forming and drawing presses with which they are used are generally utilized for the formation of various articles of varying size. This necessitates that the bolster be drilled to provide passageways for the supporting pins and saddle guide rods for each die. This is not only expensive and cumbersome, but the bolster plate and die base are weakened and are likely to become buckled or warped in service. It is also necessary to provide springs of different characteristics for each die unit and, where a multiple unit die is used, each unit must be separately adjusted to overcome variations in spring characteristics, nonuniform frictional engagement and the like, and separate supporting pins and saddles are generally provided for each draw ring.

Another problem, common to the industry, is to properly control the drawing pressure so as to obtain uniformity in the articles being formed. This problem is aggravated when draw ring sup-

porting pins are used, for variations in frictional engagement of the pins with the body of the die base or shoe caused by misalignment, burrs, foreign objects, and the like result in a variable loading of the draw ring, and under such conditions, it is impossible to uniformly draw the metal blank being operated upon. This same trouble is encountered at the supporting pin saddle where it engages the guide rods upon which it is slidable. If the draw ring is not uniformly loaded, the clamping action between the draw ring and the cooperating punch will not be uniform and as drawing proceeds those portions of the blank radially disposed with respect to the portions which are not so firmly clamped will be improperly drawn, resulting in an unevenly formed article.

Another problem which has been encountered in forming and drawing operations has been to properly align the cutting and forming members so that proper shearing of the metal is effected, if the forming and drawing be combined with shearing, and to prevent binding and wear of the parts which inevitably occurs if the parts are not properly aligned. In sheet metal shearing, drawing and forming, the parts must be made to interengage with often less than one-thousandth of an inch clearance between cooperating parts. By my invention, the bolster plate and ram head may be ground true and the die positioned thereon. Under such conditions proper alignment is attained without difficulty. The die is unitary and may be provided with smooth ground surfaces for engagement with an imperforate bolster and ram.

The die unit of the present invention is ideally suited for use in the formation of relatively small articles, such as bottle closure blanks, where delicate drawing is necessary, where metals of varying characteristics are being operated upon and where a single press may be used in the formation of many different sizes of closure blanks each requiring different drawing pressures.

One aspect of my invention contemplates a die in which the draw ring operates within a cavity formed in the die base against a fluid pressure loading, the draw ring being arranged to act as a piston within the cavity. Such a unit is entirely self-contained (except for connecting pressure fluid lines) and requires no complicated pressure pin and spring or rubber block loaded saddle arrangements. By utilizing fluid under pressure as the loading on the draw ring, it is possible to vary the drawing pressure

at will to compensate for variations in metal being drawn and sizes and shapes encountered and to accurately control the pressure thus established. Since the drawing ring acts as its own piston, the loading is uniform throughout its projected area and uniform drawing is always effected.

Another aspect of my invention contemplates a fluid pressure ejector which, when associated with a fluid pressure draw ring permits convenient removal of the forming members.

Thus, my invention provides a die unit which is simple to fabricate and maintain, conveniently adjustable as to drawing or forming pressure, so constructed and arranged that various forms may be drawn with a single die without the necessity of dismantling thereof and may be removed as a unit from a press and applied thereto without the necessity of careful check on alignment of the various component elements which are all preassembled and unitarily aligned. Other salient features, including a novel thrust button arrangement, an oil film seal breaking arrangement and other combinations will become apparent upon detailed description of a typical embodiment thereof in conjunction with the accompanying drawings, in which:

Figure 1 is a top plan view of the die unit of my invention;

Figure 2 is an end elevation thereof;

Figure 3 is a sectional view to enlarged scale taken along the line III—III of Figure 1, with the addition of thrust plates for the unit;

Figure 4 is a sectional view taken on line IV—IV of Figure 1 but showing the punch unit only;

Figure 5 is a sectional view taken on the line V—V of Figure 1 but illustrating a die unit only;

Figure 6 is a diagrammatic view showing the fluid pressure circuit;

Figure 7 is a diagrammatic view illustrating the air die unit mounted for operation in a forming press; and

Figure 8 is an isometric view of a novel thrust button.

In the illustrated embodiment, there is shown a triple die set for use in the formation of closure blanks. It will be understood that this invention is not concerned with the number of units associated within a single base; the invention, in its broader aspects at least, being useful in single or multiple unit arrangements. It is particularly advantageous in small multiple die units where relatively high working pressures are encountered for the reason that it is possible to obtain high working pressures with a small press, where, with the conventional die units, space limitations would militate against the use of a small press for such work.

The unit shown in the drawings comprises a punch assembly generally indicated by the numeral 2 and a die assembly generally indicated by the numeral 3, the punch assembly being movable on guide rods 4, 5 and 6 (Figures 1 and 2) toward and away from the die assembly to effect cooperative working relationship of the parts in cutting, drawing and forming.

The punch unit includes a punch base 7 to which are attached cutting punches 8, being secured by machine screws 9. One cutting punch is shown in section in Figures 3 and 4 and the description will be limited to this one unit since the other two units are substantially identical with it. An ejector 10, which in the embodiment under consideration also acts as a forming ele-

ment, is retractable within the punch 8, and moves within a bore 11 provided in the base 7 (Figure 4). The ejector 10 is shown in retracted position in Figure 3 and in extended position in Figure 4. Movement of the ejector 10 is limited in retracted position by engagement thereof with a thrust member or thrust button 12 disposed within the cavity 11 and having a shoulder 13 engageable within a recess provided in the base 7 to properly position the same, and movement to ejecting position is limited by a holder generally indicated by the numeral 14 (Figure 3). The holder is provided with a pin 15 which passes partially through the punch base 7 and into the chamber 11, passing freely into a slot 16 in the ejector. It will be noted that the ejector 10 is removable from the punch unit by movement in an axial direction, such movement being limited only by the pin 15. In the embodiment shown, the pin 15 is provided with an annular shoulder 17 which is disposed within a bore provided in base 7. A hollow bodied screw 18 is threaded into the bore in the base 7 and surrounds the portion of the pin lying within the bore. The head of the screw 18 is provided with an opening through which the end of the pin 15 projects. A spring 19 is positioned between the head of the screw 18 and the shoulder 17 on the pin 15 and normally urges the pin into position within the slot 16. The pin adjacent the head of the screw 18 is provided with an annular recess adapted to receive the bifurcated end of a tool which can be pivoted about the screw 18 to effect outward displacement of the pin against the pressure of the spring 19, permitting removal of the ejector 10.

The ejector is also provided with a push-out finger 20 which operates within a bore provided in the ejector body. The finger 20 is normally urged to a position exterior of the face of the ejector (Figure 4) by a spring 21 held in place by a pin 22 and serves to insure removal of the completed blank from the ejector head where it may otherwise adhere by reason of the lubricating film usually applied to the sheet stock.

The ejector is adapted for actuation by fluid under pressure, preferably air intermittently applied. Pressure fluid from a source is fed through a passageway 23 formed in the base 7 to a central distributing chamber 24 (Figure 3), through a feeder 24' into the chamber 11. The thrust button 12 is provided with an annular channel 25 (Figures 4 and 8) which communicates with the feeder 24'. There is a drilled opening 26 which passes diametrically through the button at the annular channel 25 and an axially disposed opening 27 communicating with the opening 26 to the face 28 of the button. In order to enlarge the area for communication of fluid to the end of the ejector, grooves 29 and 30 are provided therein which intersect at the opening 27.

When fluid under pressure is communicated to passageway 23, it travels therethrough to chamber 24, through feeder 24', channel 25, openings 26 and 27 and slots 29 and 30, thus applying force to the ejector 10 which moves the same axially of the punch 8, the pressure fluid filling the chamber 11 as the ejector moves away from the thrust button. Axial movement is limited by engagement of the pin 15 with the ejector body at the bottom of slot 16. The position of the ejector with respect to the punch

when in such ejecting position is shown in Figure 4.

In the manufacture of closure shells, it is common to provide differing top designs therein. For example, a 28 mm. size closure may be provided with a flat top, a full domed top, a partial domed top, a flat top with an annular depressed bead spaced circumferentially inwardly from the periphery thereof, or a domed top with a similar bead formation, on occasion as the dictates of the trade may demand. In all of these closures, the skirt length, flange length and other dimensions may be the same, the head portion only being altered. This requires only that the forming members be changed to suit the desired head configuration. By my invention the ejector 10, which as pointed out above may also serve as a former, is conveniently removable without disturbing the cutting punch 8 by the mere expedient of retracting pin 15 and permitting the ejector 10 to fall by gravity from within the cavity 11, or, if there be any tendency for the parts to stick, by reason of frictional engagement or otherwise, air may be slowly introduced into chamber 11 to jack the ejector from within the punch base.

A spring urged ball arrangement is shown in Figure 4 which serves to prevent undesired movement of the ejector 10. In this structure, the punch 8 is drilled to provide a chamber having an opening at the inner surface of the punch of somewhat lesser diameter than the diameter of the chamber. A steel ball 31 is positioned within the chamber with a portion thereof free to engage the surface of the ejector 10, being urged to such position by a spring 32 held in compression by setscrew 33, inward movement of the ball 31 being limited by the shoulder formed by the reduced diameter of the chamber adjacent the inner surface of the punch so that the ball remains in position when the ejector is removed. This arrangement is effective for holding the ejector against undesired movement except during the ejecting operation. When this structure is used, it is necessary to jack out the ejector, as above described.

The die unit 3 comprises a die base shoe 34 (Figures 3 and 5) which is provided with a cavity or cylinder bore 35. A cutting ring 36 is positioned about the mouth of the bore 35 and is secured to the base 34 by machine screws 37. The cutting ring 36 is provided with a shouldered annulus 38 which serves to align it in the die base. A forming member 39 is positioned within an opening in the die base 34 at the bore 35 and is held in place by a holding pin arrangement 40 substantially the same as the holder 14 for the ejector excepting that the opening 41 for the pin 42 is just sufficiently large to permit convenient assembly—the former 39 is normally fixed with respect to the die base 34. A draw ring 43 is positioned within the cavity or chamber 35 and encircles the former 39 and slides within the cutting ring 36. The draw ring 43 is shown in retracted position in Figure 3 and in elevated position in Figure 5, and is designed so as to form its own piston operating within cavity 35. In order to insure an air tight joint between the parts, a packing washer 44 is provided.

Draw ring 43 is adapted to be fluid pressure loaded. As shown in Figure 3, pressure fluid is communicated from a source through a pipe 45 which enters it into a passageway 46 formed in the die base for conveying the fluid to a central distributing chamber 47. Feeder passages 48 75

are provided which communicate the fluid from the distributing chamber 47 to the individual cavities 35.

Since the sheet material being operated upon often carries a lubricating film, and since it is desired to have the completed blank removed from the draw ring 43, the blank is caused to move with the punch 8 away from the former 39 and the draw ring 43. The blank 49, if it be provided with a flange 50 as shown in Figure 3, may have a tendency to adhere to the draw ring 43 by reason of the lubricating material used and the fact that a vacuum may be created within the blank 49 upon upward movement of the draw ring 43 with respect to the former 39. In order to insure that the blank 49 will be parted from the draw ring 43 upon upward movement of the punch unit 3, means are provided to break the seal between the draw ring and blank and to avoid the creation of a vacuum within the blank.

In the embodiment shown in the drawings, the former 39 is provided with a central bore 51 which is formed from the bottom of the former to a point adjacent its top. Small bleeder passages 52 run from the bore 51 to an exposed surface of the head. A group of three radially spaced bleeders has been utilized with good results. Fluid under pressure is communicated from a source through pipe 53 (Figure 1) through a passageway 54 to a central distributing chamber 55 formed in the die base 34 as shown in Figure 1. Slots 56 are provided in the bottom of the die base 34 which lead to each of the die units as shown in dotted lines in Figure 1. Channels 57 for connecting the various units are formed by chamfering the die base 34 at the zone of contact with the formers 39 as shown in Figures 3 and 5 and each of the formers 39 is provided with a radial slot 58 (Figure 5) which connects the central bore 51 with the passageway 58, through the chamfered channel 57. Thus communication of fluid under low pressure from the pipe 53 to the head of each of the formers 39 is established.

A stripper 59 is provided, when sheet stock is being operated upon, having openings through which the punches 8 pass. In order to prevent frictional wear and to facilitate movement of the parts, felt washers 60 are provided for the application of lubricating material to the punches 8. The stripper 59 is normally spring urged to the position shown in Figure 4, being retracted to the position shown in Figure 3 in the forming operation. Upon separation of the punch and die units, the skeleton 61 of sheet material is stripped from the punches 8.

Compressed air is preferably used as the fluid under pressure and a schematic diagram of the air line arrangement is shown in Figure 6. Compressed air is fed from the source S through a pipe 62 and a pipe 63 to a valve 64, the operation of which is controlled by a cam 65 and an operating arm 66 connected to a cam follower 67. Rotation is imparted to the cam 65 to open and close the valve 64 in synchronism with the punch unit so that air is fed from the source S through pipes 62 and 63 and intermittently through valve 64 to a pipe 68 connecting with the line 23 which leads to the central distribution chamber 24 of the ejectors (previously described). A petcock 69 is provided to admit lubricating fluid to the air lines to lubricate the ejectors 10. A pipe 70 connects with the source S, through pipe 62, and communicates compressed air to a reducing valve

71 which is adapted for manual control to vary the fluid pressure. The compressed air is then communicated through a pipe 72 connected to line 45 for the draw rings as previously described.

A safety control 73 is provided in the line 72 between the reducing valve 71 and the line 45 which control is effective for shutting down the press in the event the fluid pressure drops below a predetermined minimum.

It has been determined that drawing of metal objects can be better accomplished if the pressure on the draw ring increases as the blank is drawn. As drawing progresses, the area of the metal clamped between the draw ring and the punch decreases and the metal in the skirt is compressed and increased slightly in thickness requiring more pressure to effect proper drawing. By my invention, utilizing fluid under pressure as the loading force in drawing, this is accomplished by placing check valve 74 in the line leading from the control valve 71 which check valve permits free passage of air into the draw ring cavity 35 but prevents the return of air to the line upon movement of the draw ring downwardly in the drawing operation. Since the air initially fed to the cavity is thus trapped by the check valve, it is compressed and thus the drawing pressure is progressively increased as the blank is drawn. In order to lubricate the draw rings, a petcock 75 is provided which connects to the line feeding compressed air to the draw ring cavity. Fluid under pressure for the seal breakers 52 in the formers 39 is fed from line 72, through pipe 76 to line 53, previously described and a cut off valve 77 is provided in the branch line to limit the flow of fluid. A shut off valve 78 is provided in the line 70 to cut off the supply of air when the dies are not in use.

In order to provide a convenient means for directing the completed blanks from the die into a suitable tote box or conveyor, air jets 79 are provided. These require a relatively large volume of air, intermittently supplied, to properly effect directional travel of the blanks, and to avoid such surges in the air line pressure which would deleteriously affect the drawing pressure, the system includes a reserve tank 80 for compressed air for the jets 79. The tank is supplied from the source S through a reducing orifice 81 which permits the bleeding of only a small amount of air into the tank 80 so that even though a relatively large volume of air be intermittently supplied to the jets 79 from the tank 80, thus reducing the air pressure therein, the reducing orifice 81 permits only a gradual replenishment thereof, thus obviating any material change in pressure in the air line which might deleteriously affect the drawing operation. The intermittent supply of air to the jets 79 is conveniently controlled by a valve 82 which is connected to the operating arm 66 controlling the valve 64 for supplying air to the ejectors.

Figure 7 illustrates the die unit of my invention applied to a conventional press generally indicated by the numeral 83. It will be noted that the bolster plate 84 is imperforate and provided with a smooth, plane face 85 which receives the die unit 3. The punch unit 2 is attached to the ram 86 of the press. Since the press is of conventional form, the punch unit 2 is provided with a shank 87 which is gripped in the usual manner by the split clamping block 88 of the press ram.

A pair of hardened steel press plates 89 and 90 are applied to the faces of the punch and die

units respectively to obviate any scoring of the press surfaces which might affect proper alignment or might cause wear of the parts under the pressure of drawing, particularly the thrust buttons 12 and the forming members 39. The plate 90 also serves to seal the openings 51, the grooves 56 and the channels 57 and 58 (Figures 3 and 5) for communicating fluid under pressure to the seal breakers in the formers 39.

Since it is desired to have a unitarily removable die set and such arrangement does not conveniently permit of mechanical means for stopping the press in the event a blank becomes lodged in the die, I provide a bar 91 which is affixed to the press bed and spans the opening therein and attach to this bar a sensitive switch 92 having an operating finger 93 engageable with the bolster plate 84. This switch is responsive to any minute deflection of the bolster plate 84 and controls the movement of the press ram so that in the event the die fail to function properly and permit a blank to become lodged therein, the press will not be broken or injured since the movement of the ram is arrested upon any slight deflection of the bolster plate.

In the operation of my device, a sheet of material T to be operated upon is fed to the dies (see Figure 3), with the punch unit moved away from the die unit and the parts assuming the respective positions shown in Figures 4 and 5. Relative movement is imparted between the punch and die units, preferably by moving the press ram, which carries the punch unit, toward the die unit. The sheet T is severed into a disk by the punch 8 acting against the cutting ring 36. This blank is clamped between the punch 8 and the draw ring 43 and as downward movement of the punch continues, the disk is drawn over the forming surface 39 to form the hat-shaped article 49 as shown in Figure 3. Since air is continuously applied to the chamber 35 in which the draw ring 43 operates, there is continuously applied to the draw ring 43, pressure in an upward direction which firmly clamps the blank between the punch 8 and the draw ring 43. If the check valve 74 be provided in the air line 72 as described, this pressure is gradually increased as drawing progresses. After completion of the forming operation, the punch unit is moved away from the die unit, the air pressure in the chamber 35 causing the draw ring 43 to move to its normal position (Figure 5), a passageway 94 (Figure 3) being provided in the die base above the draw ring for the escape of air upon return movement of the draw ring. As the punch leaves the draw ring, the air fed to the seal breaker feed line 54 causes the blank to be moved away from the top of the draw ring 43 and to be carried upwardly within the punch 8. As upward movement continues, the punch 8 is retracted through the openings in the stripper 59 and the skeleton 61 of the sheet T is stripped from the punch. Air is supplied to the central distributing chamber 24 and thence to the chamber 11 of the ejector pin 10 and it is moved in an axial direction to the position shown in Figure 4, ejecting the completed blank from within the punch 8. If there be any tendency for the blank to adhere to the head of the ejector 10, the spring urged extractor pin seal breaker 20 breaks the bond and the blank falls by gravity downwardly, is caught by the directing air from the jets 79 and delivered to a tote box or conveyor. The

sheet T is then intermittently moved to the right (Figure 3) and the operation is repeated.

While I have illustrated and described certain specific preferred embodiments of my invention, it will be understood that the invention is not limited to the form shown and described but may be otherwise embodied and practiced within the scope of the following claims.

I claim:

1. A sheet forming device comprising a pair of cooperating die and punch members, a source of supply of fluid under pressure, a line for conveying said fluid from said source to said die member to uniformly load the same, a fluid pressure directing jet, a storage tank for fluid under pressure, a line for conveying fluid under pressure intermittently from said storage tank to said jet, a line conveying said fluid from said source to said storage tank and a reducing orifice in said last mentioned line, whereby said intermittent supply of fluid to the directing jet does not deleteriously affect the supply of fluid under pressure to said die member.

2. A sheet forming die comprising a die base having a cavity therein, said base being adapted to be positioned on the bolster of a press, a forming member disposed within said cavity, a drawing member positioned about said forming member and slidable within said cavity, means communicating fluid under pressure to said cavity below said drawing member to uniformly load the same, a punch base adapted to be secured to the ram of a press and movable into cooperative relationship with respect to said die member, an electrical switch attached to the press below said bolster, said switch being operative to arrest movement of said ram upon deflection of said bolster to a predetermined point.

3. A unitary self-contained air die unit comprising a die base having a chamber formed therein, a forming member secured to the base and disposed within said chamber, a drawing member encircling said forming member and slidable axially within said chamber, a cutting ring detachably secured to said base and encircling said forming member, said drawing member being displaceable with respect to said cutting member and said forming member, means communicating fluid under pressure to said chamber to uniformly load said drawing member, a punch base, a punch secured to said base and adapted to cooperate with said drawing member to clamp a blank to be drawn therebetween, a forming and ejecting member slidable axially within said punch and adapted to be retracted therein, a holding member passing through said punch base and operable within a slot formed in the ejecting member, said holding member being retractile to permit removal of said forming and ejecting member without dismantling of the assembly, and a holding member passing through said die base and into an opening provided in said forming member disposed therein, said pin being retractile to permit removal of said forming member without dismantling of the assembly.

4. A unitary self-contained sheet material

working die satisfactory for use with an imperforate bolster plate comprising a die base having a bore therein, a forming member carried by the base and projecting into said bore, drawing means disposed about said forming member and reciprocable with respect thereto, said drawing means constituting, with said forming member, a substantially fluid tight closure for said bore, said drawing means being slidable as a piston within said bore, means communicating fluid under pressure into said bore in which the drawing means operates and therebelow to directly load said drawing means, such fluid pressure loading of said drawing means being substantially uniform over the entire projected area thereof, a punch base movable with respect to said die base, a punch secured to said base and adapted to cooperate with said drawing means to clamp a blank to be drawn therebetween, a forming and ejecting member carried by said punch base and slidable axially within such punch, a thrust button carried by said punch base and adapted to receive the thrust of said forming and ejecting member, said thrust button being provided with a passageway for fluid under pressure opening into the face of said thrust button engageable by said forming and ejecting member, and means for intermittently supplying fluid under pressure to said passageway to effect movement of said forming and ejecting member with respect to said thrust button.

5. A sheet material working die satisfactory for use with an imperforate bolster plate comprising a die base having a bore therein, a forming member carried by said base and projecting into said bore, drawing means disposed about said forming member and reciprocable with respect thereto, said drawing means constituting, with said forming member, a substantially fluid tight closure for said bore, said drawing means being slidable as a piston within said bore, means communicating and maintaining fluid under pressure in said bore in which the drawing means operates and therebelow to directly load said drawing means, such fluid pressure loading of said drawing means being substantially uniform over the entire projected area thereof, a punch base, a punch secured to said base and adapted to cooperate with said drawing means to clamp a blank to be drawn therebetween, an ejecting member slidable axially within said punch disposed within a cavity in said punch, and adapted to be retracted therein and a holding member for said ejecting member passing through said punch base and operable within a slot formed in the ejecting member, said holding member being retractile to permit removal of said ejecting member without dismantling of the assembly.

6. A unitary self-contained sheet material working die satisfactory for use with an imperforate bolster plate constructed in accordance with claim 5 in which means are provided for intermittently supplying fluid under pressure to the ejecting member to move the same with respect to the punch to effect ejection of a formed article from the punch.

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