Jan. 4, 1966 D. M. EVANS ETAL 3,227,022

METHOD OF METAL PUNCHING AND STRIPPING AND APPARATUS THEREFOR

Filed Sept. 14, 1960 5 Sheets-Sheet 1

Fig. 1.

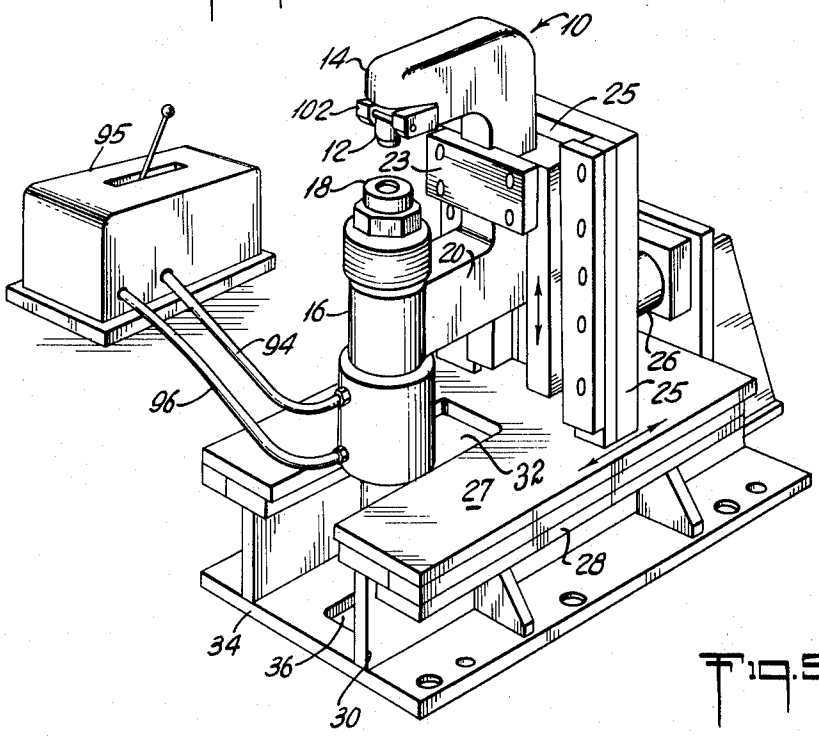



Fig. 5.

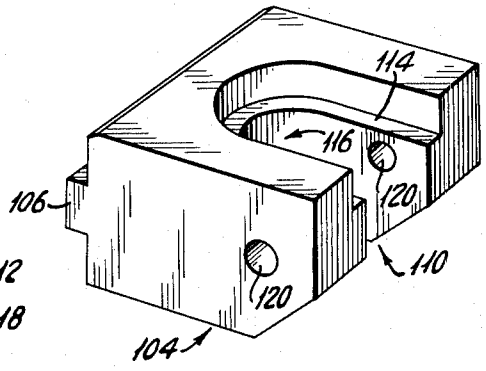
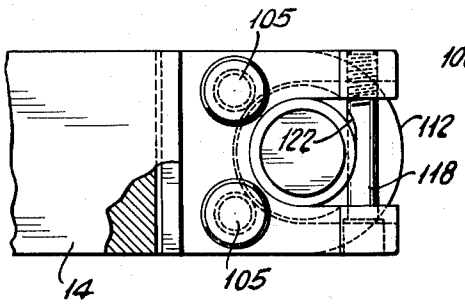



Fig. 4.




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METHOD OF METAL PUNCHING AND STRIPPING AND APPARATUS THEREFOR

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Fig. 2.

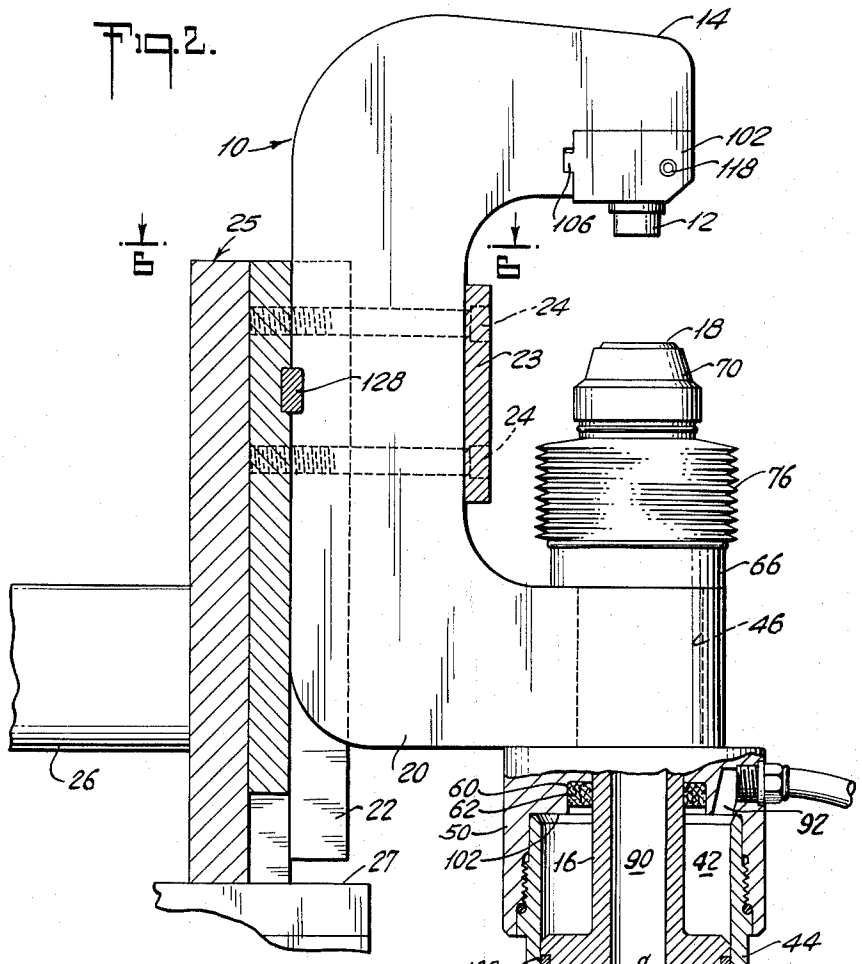
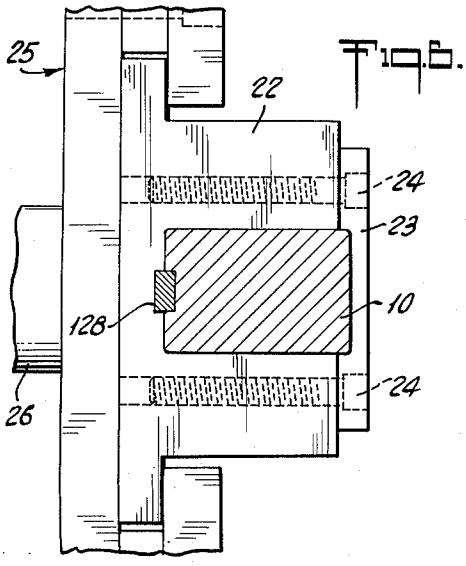



Fig. 5.



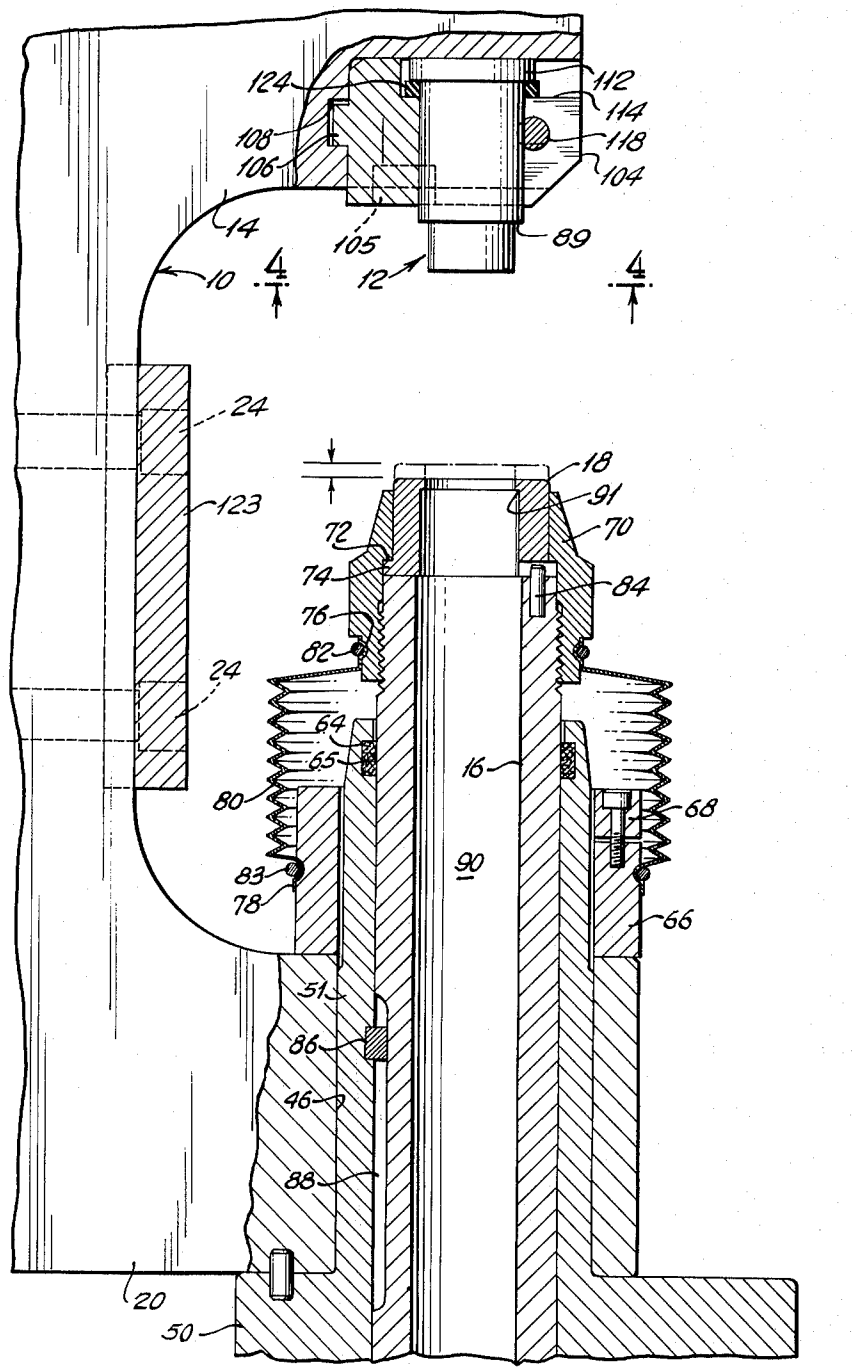

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Fig. 3.




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METHOD OF METAL PUNCHING AND STRIPPING AND APPARATUS THEREFOR

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Fig. 9.

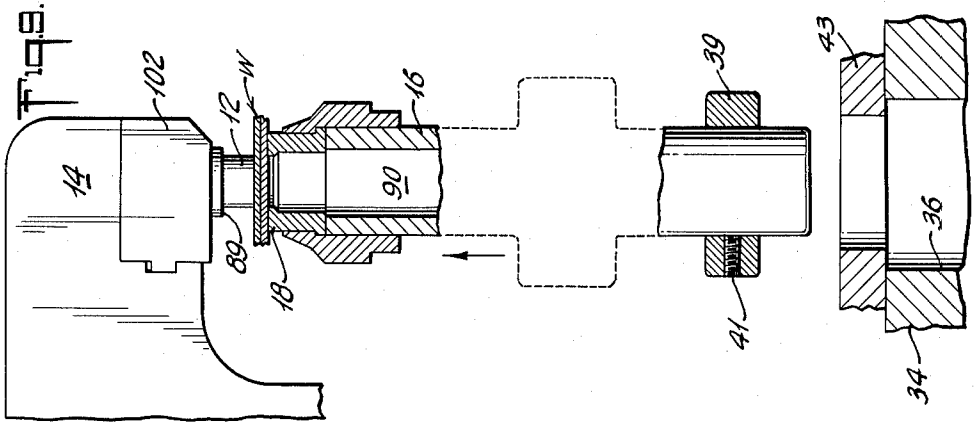



Fig. 8.

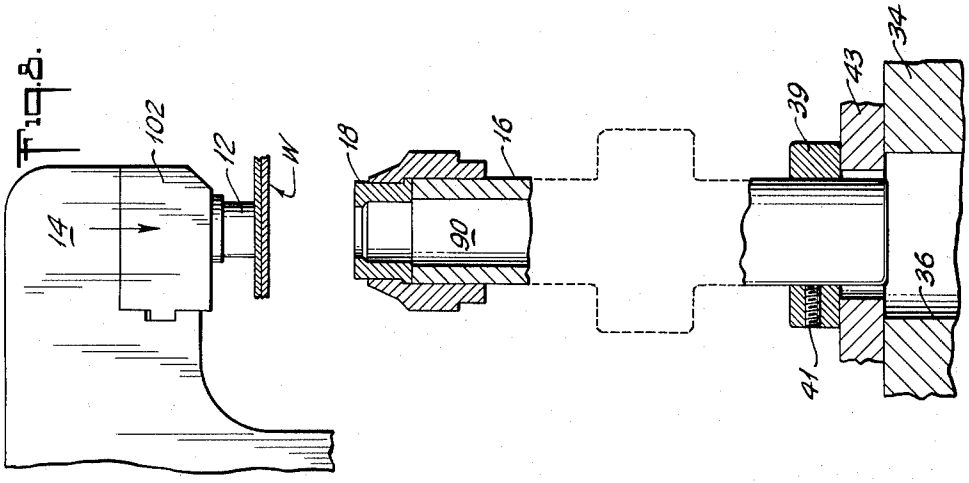
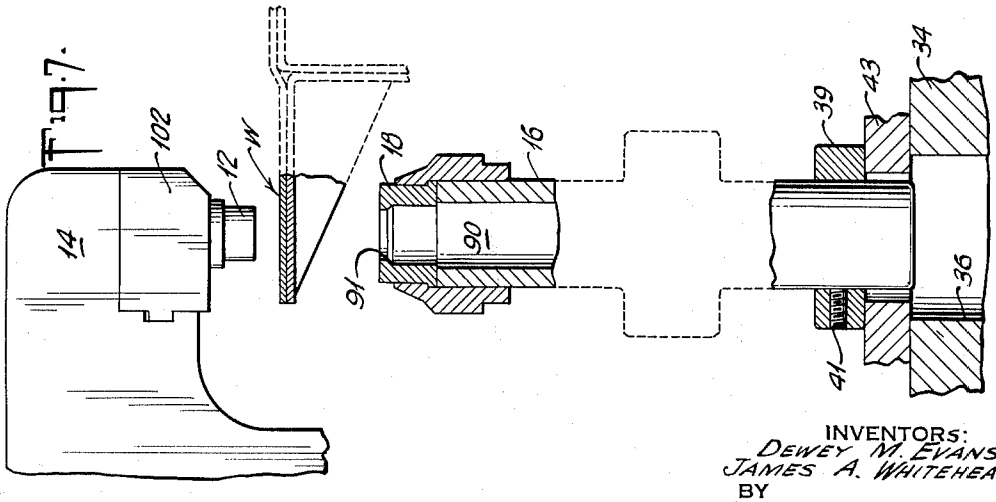



Fig. 7.




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METHOD OF METAL PUNCHING AND STRIPPING AND APPARATUS THEREFOR

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Fig. 12.

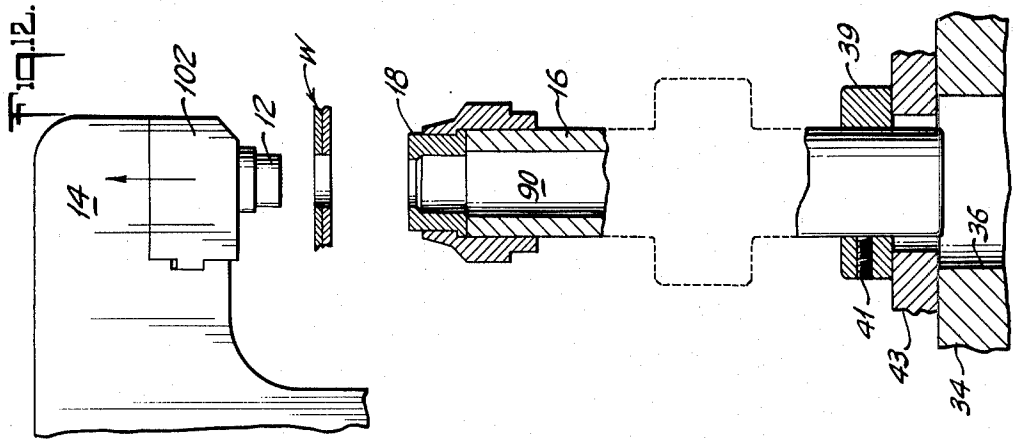



Fig. 11.

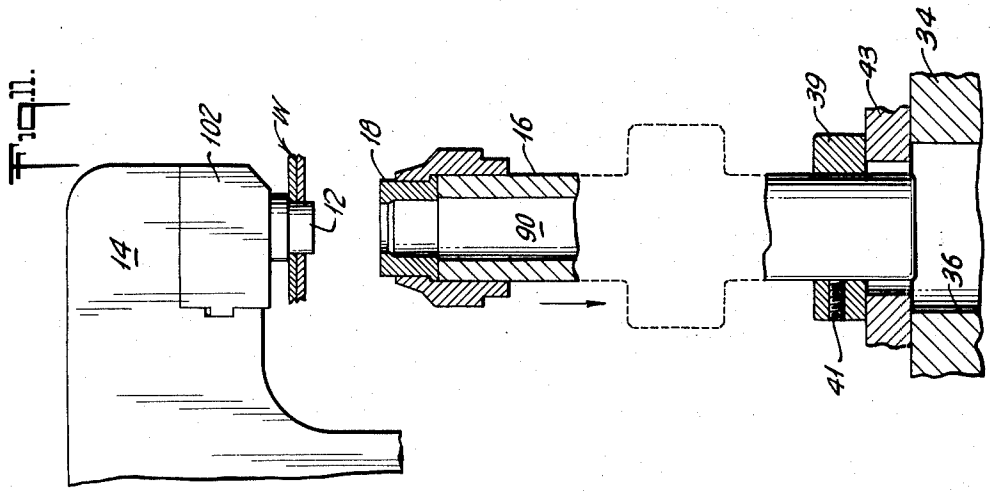
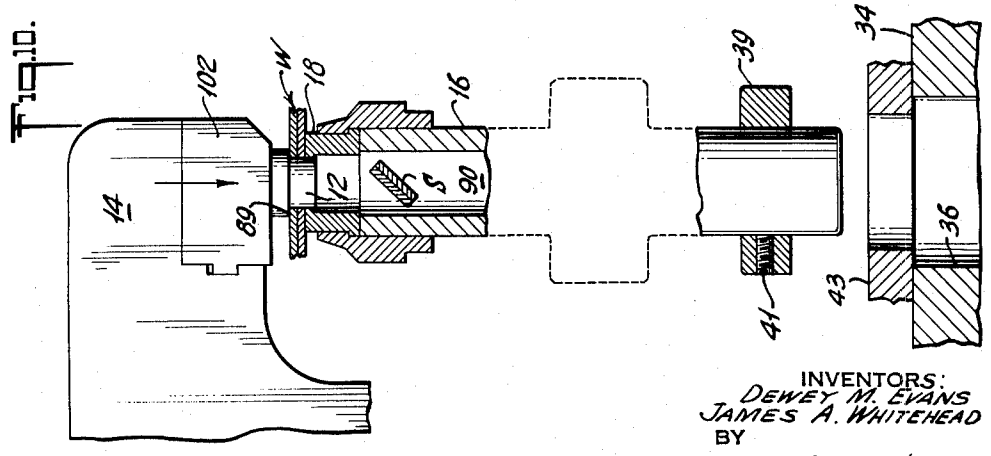



Fig. 10.




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3,227,022

# METHOD OF METAL PUNCHING AND STRIPPING AND APPARATUS THEREFOR

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5 Claims. (Cl. 83—529)

This invention relates to an efficient method of metal punching and stripping and apparatus for reliably performing said method; and more particularly to such method and apapratus wherein positive stripping of the punch and removal of punched metal slugs are assured.

Efficient and reliable punching of metal and stripping of the punch together with positive removal of the slugs are of particular importance in mass-production industries, such as the automotive industry, where metal parts are fabricated on or near a production line and then transferred farther along the production line so as to be assembled into finished composite products. In order that the production lines may continue to move smoothly, it is necessary that the punching and stripping operation be performed in an efficient manner, and thus insure a constant supply of accurately fabricated parts along the production line without the necessity of a large inventory. The fabricated parts must be free of defects and the slugs which are punched out must be positively handled so that the production line will not be affected or jammed up in any way by a defective part or by the slugs.

In many of these production lines several sheets of metal are punched simultaneously and each sheet metal part may have numerous punched holes. As a result there are large quantities of slugs which must be rapidly and continuously displaced from the pierced metal surfaces of the parts. These slugs must be positively removed from each and every part. Hundreds and hundreds of slugs are being handled, and if only a few are accidentally dropped into the machinery, there is a serious danger that they will jam up the production equipment and cause an expensive shut-down of the whole production line.

If a jam-up occurs, the line must be shut down to dislodge the jammed slug from the composite product containing the part. In some cases the slug may find its way into the special machinery used in assembling the composite product, and a costly tie up or breakdown of the apparatus results.

It is generally known that the punching of holes in mass produced sheet metal parts and thin metal plates is more desirable and quicker for mass production than drilling. However, punching is only faster when it is possible to withdraw the punch easily and positively from the fabricated hole and, as stated previously, when the slug is removed positively to a place where it will not cause any trouble.

Accordingly, it is an object of the present invention to provide a metal punching and stripping method and apparatus which is efficient and reliable.

It is a further object to provide apparatus wherein positive removal of the by-product slugs is provided to transfer the slugs to a pre-selected region or depository.

Among the advantages of the illustrative embodiment of the present invention described herein are those resulting from the fact that the apparatus assures easy and effective withdrawal of the punch from the fabricated hole so that the apparatus may operate at high speed along a production line without causing jamming of the line, and this apparatus is rugged and durable and will withstand heavy punching operations.

It is still a further object to provide a metal punching



apparatus having easily replaceable punches and dies. Also, another object is to provide a method of metal punching and stripping wherein both the punch and the die are sequentially moved to insure rapid and effective metal punching. Among the advantages of this embodiment of the invention is the large convenient clearance opening which is provided between the die and punch to permit easy positioning of the work to be punched.

In the accompanying drawings a preferred embodiment of the present invention in metal punching and stripping apparatus is shown and, together with the method of punching metal, is described in the specification. However, it is to be understood that the drawings are for the purpose of illustrating an example of the invention in order that others skilled in the art may fully understand the invention, its principles and the application thereof for metal fabrication, and that this invention may also be embodied and adapted in numerous other forms each as may be best suited to the requirements of the particular desired usage.

FIGURE 1 is a perspective view of metal punching and stripping apparatus shown as an illustrative embodiment of the present invention;

FIGURE 2 is a side elevational view of the C-frame and hollow piston of the metal punching and stripping apparatus of FIGURE 1, this view being shown on enlarged scale and partially in section;

FIGURE 3 is a side elevational view of a portion of the C-frame and the hollow piston of the apparatus of FIGURES 1 and 2, this view also being drawn partially in section, and being shown on further enlarged scale;

FIGURE 4 is a top sectional view of the punch elements, taken along the line 4—4 of FIGURE 3;

FIGURE 5 is a perspective view of the holder for the punch element;

FIGURE 6 is a fragmentary sectional view taken along the line 6—6 of FIGURE 2, and showing the saddle arrangement for mounting the C-frame; and

FIGURES 7 through 12 are a series of schematic views of the various sequential positions of the punch and die during a punching and stripping operation.

Referring further to the drawings and to FIGURES 1, 2 and 3 in particular, an embodiment of the present invention in metal piercing apparatus is shown. The punching apparatus generally comprises a movable C-frame 10 which has a punch 12 mounted in an upper jaw 14, and a hollow piston 16 and a die 18 mounted in a lower jaw 20. The die 18 is positioned in aligned mating relationship with respect to the punch 12.

As shown most clearly in FIGURES 2 and 6, the C-frame 10 is mounted on a vertical gib 22 and is held in place by a cross piece 23 and by machine screws 24. The gib 22 and the attached C-frame 10 are slidably mounted for vertical movement along a saddle 25. For positioning the punch laterally, the saddle 25 is attached to a horizontal positioning cylinder 26 arranged to move the saddle 25 and a slide platform 27 horizontally along a bed 28. This bed 28 is fixed on a support 30, and an elongated opening 32 is provided in the platform 27 and in the bed 28 so that the lower portion of the hollow piston 16 can project down through this opening. Thus, the hollow piston can discharge the slugs below the surface of platform 27 as explained in detail below.

The support 30 is set on a base 34, and a slot 36 is also provided in the base so that the hollow piston 16 can be further depressed through this slot 36 if desired. An adjustable stop collar 38 surrounds the lower end of the hollow piston 16. This stop 38 can be adjusted up and down along the screw threads 39 and is locked in position by a set screw 41. In operation, this stop collar will engage a stop seat 43 on the base 34 near the

opening 36, thus limiting the extent of the down stroke of piston 16 through the slot 36. Adjustment of the stop 38 determines how far apart the die 18 may be separated from the punch 12. Sufficient spacing between the die 18 and the punch 12 is desirable as it facilitates the positioning of the work in the bight of the die and punch.

The illustrated apparatus functions in a unique manner in actual metal piercing or punching operations so that a maximum punch and die bight is obtained by having both the punch and die movable. Not only is the punch 12 moved towards the die 18, but, contrary to the general punching practice heretofore, the die is also moved towards the punch, each being moved alternately in a series of steps. This combined movement of the punch and die gives greater clearance between them and, thus, affords greater ease for positioning the metal parts to be punched.

The movement of the punch and die is accomplished by a novel method of operation which will be discussed in greater detail hereinafter.

As shown in FIGURE 2, the cylinder piston 16 has a head 40 with a double end and this head is movable by hydraulic pressure within a chamber 42. The chamber 42 is formed by a lower casing 44 and by a bell-shaped upper or guiding casing 50 to which the lower casing 44 is attached. The lower jaw 20 of the C-frame has an opening 46 therein, and the upper guiding casing 50 includes an upper extension 51 fitted within this opening 46 so that the C-frame and the casing form a composite sub-assembly. The casings 50 and 44 also act to provide positive guide means for the piston 16 as well as forming the pressure chamber 42.

The casing 44 includes a lower base portion 48 including a bottom opening 49, and the lower part of the piston 16, which is below the head 40, is movable through this opening 49. At the base of the casing 44, a flanged packing sleeve 52 is provided which fits into an annular cutout 54 in the base portion 48 of the lower casing 44. This packing sleeve 52 surrounds the piston 16 and retains the packing 55 as well as holding a wiper seal 56 which encircles the piston 16. This seal 56 is fixed in a recess 58 in the inner wall of the sleeve 52, thus, the packing 55 and seal 56 create a tight fit and hydraulic seal between the lower casing portion 48, the sleeve 52 and the piston 16.

The adjustable stop 38, which is provided on the lower part of the piston 16, positions the piston 16 with respect to the support 30 and, also, may be adjusted to limit the downward travel of the piston to less than the full length of chamber 42. This stop 38 permits a variation of the positions of the die 18 relative to the work being pierced. When punching heavy work the piston and the die may be withdrawn the full extent allowed by chamber 42. If desired, when thinner or lighter work is being punched, the extent of the downward travel of the die and the piston may be reduced accordingly by adjusting the stop 38.

To insure that the chamber 42 is tightly sealed a cutout portion 60 is provided in the upper casing 50 where it meets the piston 16 and chamber 42, and a flexible ring seal member 62 is fitted into this cutout 60 surrounding the piston 16. As shown in FIGURE 3, in the upper end portion 51 of the casing 50 there is a third seal member 64 held in an annular recess 65. These seal members 62 and 64 cooperate with the lower seal 56 to insure that the piston is tightly, but slidably, contained within the casing 44 and 50. Surrounding the upper casing 50 and above the lower jaw 20 of C-frame 10, there is a ring 66 which is tightened in position by means of a segmented wedge 68. This wedge is bolted to the ring 66 and is tightened against one side of the casing 50 as it pulls the opposite side of the ring into tight contact with the casing 50.

As shown in FIGURE 3, the die 18 is held in tight relationship to the piston 16 by means of a collar 70 which fits about the die 18. This collar 70 has a cutback portion forming a shoulder 72 which sits on a ledge 74 at the lower outer portion of the die 18. The collar 70 extends downwardly and about the upper portion of the cylinder piston 16. An encircling groove 76 is provided in the lower outer portion of the collar 70 and a similar groove 78 is provided in the ring 66. A dirt shield or boot 80 of expansible bellows construction is joined to the collar 70 and the ring 66 by means of snap rings 82 and 83 which are placed about the shield 80 so that the top and bottom ends of the shield 80 are held in the recesses 76 and 78, respectively, by the rings 82 and 83.

The die 18 is held in a non-rotating position on top of the piston 16 by means of a radial pin 84. To further insure that the die 18 will remain in a proper and fixed relationship with the punch 12, guide keys 86 are provided on the inner surface of the upper casing 50. These guide keys 86 are fitted into vertical guideways 88 in the outer wall of the piston cylinder 16. The guide keys 86 are, advantageously, closely fitted into the guideways 88 so that the piston 16 is vertically aligned. Thus, when an irregular shaped hole is to be punched, such as an elongated slot or some specific shape other than a circular form, a satisfactory mating of the punch 12 with the die 18 is assured.

In actual operation of the punch apparatus a novel method of punching is utilized. In this method the die as well as the punch is moved into the space which separates the die and punch when they are in the open position. As shown in FIGURE 7, the work W to be punched is moved into the opening and by any suitable means fixedly positioned between the punch and die. With the work thus positioned, the punch and die are moved in a series of sequential steps which are illustrated in FIGURES 8 through 12.

In the first phase as shown in FIGURE 8, the punch 12 is lowered into contact with the work W. Next, as illustrated in FIGURE 9, the piston 16 with the die 18 attached is moved upwardly so that the die 18 also contacts the work W opposite the punch 12. The punch 12 is then forced further downwardly through the work W and into the opening of the die 18 to the position shown in FIGURE 10 in which a shoulder 89 on the punch rests against the work and the end of the punch has passed completely through the opening of the die 18. Thus, the slug S stamped from the work W by the punch 12 falls downwardly within the hollow center 90 of the piston 16 which advantageously has a greater cross-sectional area than the die opening. It will be noted that the opening in the die 18 is undercut at 91 so as to provide the enlarged slug passageway 90.

The work W having been punched, the die 18 is retracted from its mating position with the punch 12 by withdrawing the piston 16 to the position shown in FIGURE 11. The punch 12 is then withdrawn from the work W and raised to its fully open position as shown in FIGURE 12. The work W may then be removed and the next piece inserted into the opening between the punch and die.

This unique method of sequential steps in metal punching is preferably carried out by the apparatus in the illustrated embodiment which utilizes a combination of hydraulic pressure and the gravity fall of the various components of the apparatus to achieve positive punching and slug removal. The normal or fully open position of the punch 12 and die 18 is shown in FIGURE 2. With apparatus in this position, hydraulic pressure is introduced into the chamber 42 through an upper inlet passage 92 which is connected with a hydraulic pressure line 94, which is connected to a controlled source of hydraulic pressure, as indicated at 95. The hydraulic pressure may be provided by any of the various well-known means, as will be understood.

Because the hydraulic pressure is being supplied by

the line 94 to the chamber 42, the C-frame 10 is forced upwardly, and the piston 16 is driven downwardly to its lowermost position, for the pressure being supplied by line 94 acts on the upper face of the piston head 40. Thus the die 18 is carried downwardly to its lowermost position, as set by the adjustment of the stop collar 38.

To move the punch 12 and the die 18 into mating relationship, the pressure in line 94 is released, and pressure is supplied through another hydraulic pressure line 96 which communicates with a lower passage 98 in the bottom of the chamber 42. With the pressure released from the upper line 94 and pressure now being exerted through the lower line 96, the dead weight of the C-frame 10 and the initial pressure through the lower pressure line 96 causes the C-frame 10 to move downwardly and to carry the punch 12 to the position shown in FIGURE 8. At this moment the punch 12 encounters the surface of the work and so it temporarily arrests any further downward movement of the C-frame and punch.

As the pressure from the lower line 96 builds up in the lower end of the chamber 42 and is exerted against the lower face 100 of the piston head 40, the piston 16 is driven upwardly so that the die 18 strikes the work W as shown in FIGURE 9. A further increase in pressure in chamber 42 from the lower line 96 acts up against the bottom 100 of the piston head 40 and also acts down against the lower portion 48 of the casing 46. As a result, the punch 12 is driven toward the opening in the die 18 while the die is pressed up against the lower surface of the work W. The punch 12 is driven through the work W forming the slug S as shown in FIGURE 10. This slug S falls through the hollow center 90 of the piston 16 and falls through the opening 36 where it is safely conveyed to a predetermined depository.

As soon as the work W has been punched, the pressure in the lower hydraulic line 96 is released, and pressure is again exerted through the upper line 94. Again there is an advantageous combination of the initial pressure force and the force of gravity. The weight of the piston 16 and the initial pressure against the upper face of the piston head 40 causes the piston 16 to fall downwardly to a position as shown in FIGURE 11. As further pressure is exerted through line 94 and against surface 102 of the upper casing 50, the C-frame 10 is carried upwardly as shown in FIGURE 12 to its normal or open position.

In order to insure that maximum utilization is made of the hydraulic pressure exerted in the chamber 42, the piston head 40 is provided with a series of rings 103 which engage and slide against the inner wall of the lower casing 44.

Another feature of the illustrated embodiment in metal punching apparatus is the ease and rapidity with which a punch may be removed and replaced. As shown in FIGURES 3, 4 and 5 in particular, the punch 12 is set into a block 104. This block 104 is in turn fitted onto the inside end portion of the upper jaw 14 of the C-frame 10. The block 104 is firmly held in place by a pair of mounting screws 105 which permit easy removal of the block 104 when necessary. On the rear side of the block 104 a lug 106 is provided which fits into a cutout portion 108 in the upper jaw 14, and this lug 106 serves as a shear key during punching operations, especially when the punch is stripped from the work piece.

The outer face of the block 104 is provided with a socket 110 into which the punch 12 is fitted. There is a flange 112 on the upper portion of the punch 12 and this flange 112 is seated on a shoulder 114 which is provided within the socket 110. The face of the block 104 at a point 116 at the rear of the socket 110 is curved to conform with the curvature of the punch 12 which is fitted within this socket. To hold the punch 12 tightly in place, a twist pin 118 is inserted through a pair of holes 120 at opposite sides of the socket 110. This twist pin 118 is fitted with a lock at one end which is engaged by twisting the pin into place after it has been inserted into the holes 120. The center surface portion of the pin 118 is preferably cut away so that a face 122 of substantially mating curvature with the punch 12 is provided. The face 122 is comprised of a series of arcs which are almost tangential with the curvature of the punch 12. By twisting the pin 118 into a locked position, the punch 12 is tightly wedged in place between the pin 118 and the rear wall 116 of the socket, and yet, the punch is easily and rapidly removed when necessary.

If desired, a shock absorbing washer 124 of resilient material may be inserted between the shoulder 114 and the punch flange 112, and thus, reduce the impact forces on the lug 106 which acts as a shear key during stripping operations.

Referring to FIGURES 2 and 6 in particular, the entire C-frame unit may also be readily removed by releasing the cross piece 23. This permits the entire unit to be removed. It will be noted that a locator key 128 is also provided at the rear of the C-frame so that a replacement unit may be readily set in the proper position and, thus, reduce changeover time to a minimum.

It is to be understood that this upper casing 50 and the ring 66 may be eliminated if desired. If this is done, the lower arm 20 of the C-frame 10 is integrally constructed so that it has a bell-like opening which serves as the upper portion of the chamber 42.

From the foregoing description it will be appreciated that the present invention provides a method of punching metal and apparatus for the same which insures complete and efficient slug removal. It will thus be appreciated that the present invention accomplishes the aforementioned and other advantageous objects.

What is claimed is:

1. Apparatus for punching a hole in material whereby a slug of waste material is formed, said apparatus generally comprising a punch and a mating die, a piston for carrying said die, a piston casing having a chamber therein, a C-frame having upper and lower jaws, a frame for mounting said C-frame slidably thereon, and hydraulic means for actuating the C-frame and the piston, the punch being mounted on said upper arm and the piston casing being mounted on said lower arm, the piston being slidably mounted in said casing and the die being fixed on the upper end of said piston whereby the die and the punch are in opposed aligned relationship, the lower end of said piston extending through said casing and away from the punch, and an adjustable stop mechanism near said lower end of the piston for limiting the extent of downward travel of the piston away from the punch.

2. Apparatus for punching a hole in material as set forth in claim 1 wherein said piston has a longitudinal opening extending downwardly therethrough greater than and communicating with the opening in said die.

3. Punching apparatus including a base, a cylindrical punch having a flange at one end, a first carrier mounted on said base and adapted to carry said punch, a socket block for said punch secured to said first carrier and having a shouldered recess therein, the flange on said punch engaging in said shouldered recess, said socket block having a pair of aligned holes on opposite sides of said shouldered recess, a locking pin extending through said holes for locking a punch in place in said socket block, a die, a second carrier for said die, and a hydraulically operated cylinder and piston for driving said punch and die together.

4. Punching apparatus for punching a hole in material whereby a slug of waste material is formed and conveniently removed comprising a base, a punch, a carrier for said punch movably mounted on said base, a hollow die, a double-headed piston having a passage extending therethrough, said hollow die being secured to one end of said piston in alignment with said passage, a cylinder surrounding said piston and being secured to said punch carrier, and fluid conducting means for conducting fluid into said cylinder on opposite sides of said double-headed piston.

5. Apparatus for hole punching generally comprising a punch and mating die, a double-headed hollow piston, a piston casing having means for applying hydraulic pressure therein at either head of said piston, a movable C-frame having upper and lower arms, said punch being carried on said upper arm, said casing being carried on said lower arm, said piston carrying said die at its upper end and having stop means at its lower end, whereby applying pressure between said casing and one of said piston heads moves said C-frame downwardly until said punch engages a work piece, then moves said piston upwardly until said die engages said work, and moves said punch and die into mating relation with the slug thereby punched being discharged downwardly through said hollow piston.


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