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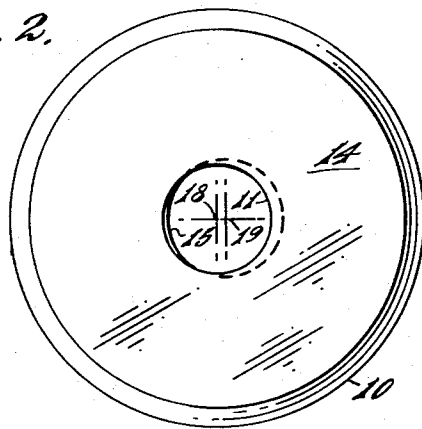
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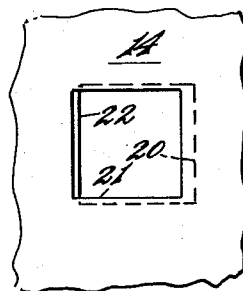
PUNCH DIE HAVING MEANS TO PREVENT RETURN OF SLUGS

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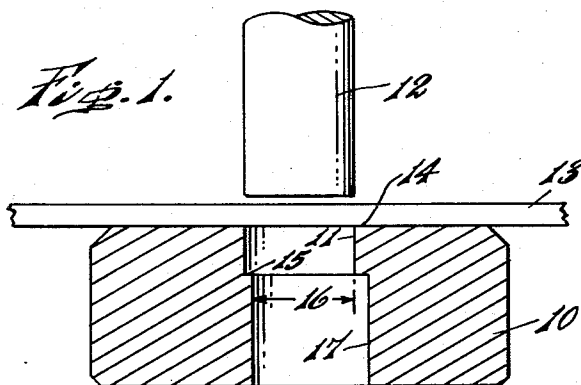
*Fig. 2.*



*Fig. 3.*



*Fig. 1.*



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**PUNCH DIE HAVING MEANS TO PREVENT  
RETURN OF SLUGS**

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**ABSTRACT OF THE DISCLOSURE**

The invention relates to a punch die which has a straight walled entrance aperture adapted to receive the punch, and an offset creating an opening of smaller cross section than the entrance aperture which prevents slugs from retracting with the punch, and compels them to enter a slug chute of larger opening than the aperture.

*Description of the invention*

This invention relates to a tool for punching holes or apertures in a piece of sheet metal and more particularly to an improved construction for the die member of the punching tool.

The primary object of this invention is to provide a die for a punching tool that will eliminate the pick-up of a blank or slug by preventing its return through the slug opening in the die.

A further purpose of this invention is to eliminate the pick-up of slugs in punching tools while maintaining constant die clearance between the punch and the die during punching and after repetitive resharpening of the die.

A further purpose of this invention is to provide a die member for a punching tool that eliminates slug pick-up, that is inexpensive to manufacture, that tends to substantially decrease the generation of heat in punching and that reduces galling and seizing of the punch which thus greatly diminishes time delays due to break downs in the punching operation.

A further purpose of this invention is to provide a straight walled apertured die with an offset or eccentric slug opening in order to shift the slug to prevent its pick-up by the punch.

These and other objects will become more apparent from the following description of the drawings:

FIGURE 1 is a sectional side elevation of the die constructed according to the objects of this invention showing its relationship with respect to a work piece and the punch.

FIGURE 2 is a top plan view of the die of FIGURE 1.

FIGURE 3 is a fragmentary top view of an alternative shape for the aperture of the die.

It is important in a punching operation to prevent a slug or blank that has been punched out of a piece of material, such as metal, from returning through the aperture of the die by adhering to the end of the punch. If the slug or blank is picked up by the punch, it can cause serious damage to the work during the next succeeding punching operation and also to the tool itself. With the increasing use of automated equipment where various operations are to be carried out on a single piece of work, it is essential that all possibilities of potential damage to the work or to the machine be eliminated since human supervision or control is not always available.

Dies with restricted throats or slug openings have been provided in the past in an effort to eliminate this slug pick-up. Reissue Patent No. Re. 23,138 to H. E. Dickerman in 1949, represents a typical example wherein a die is provided with an intermediate restricted portion, the side walls of the die diverging in opposite directions from this restricted portion. The restriction necessarily had to be less than the diameter of the slug in order to prevent its return but tolerances or die clearance had to be close enough to permit the punch to pass by the restricted portion in order to force slugs past it but still narrow enough to trap it. While this die may have prevented slug pick-up, it presented a serious disadvantage which made the die impractical for use in a punching tool. This resulted from the fact that the aperture of the die had to necessarily slope inwardly, creating what is known as negative punching or punching with decreasing clearance as the punch penetrates the aperture. This is inherently bad in punching as it creates galling of the punch and the generation of considerable amounts of heat that burnish and ruin the die.

Die edges need to be periodically resharpened as they become rounded with use. This sharpening is accomplished by grinding down the face of the die in order to maintain a sharp corner between the face and the aperture of the die. When the walls of a die aperture converge, this resharpening will continuously decrease the initial opening of the die and since the size of the punch remains constant, the die clearance will also continuously decrease.

Die clearance is an important factor in punching for it is the balance between the effective life of the punch, the die, and the hole perfection. In general, the greater the clearance, the longer the punch will last, but the rougher will be the hole that is punched, whereas the smaller the clearance, the straighter and more burnished the hole, but the shorter will be the punch life. With relatively large die clearances, the material tends to break away on its exit side, thus creating a rough hole in the material, having a larger opening on one side than on the other. Hence an optimum die clearance strikes the proper balance between these two factors, but in a die with converging sides, the proper balance between die life and hole perfection will only be achieved when the die is new, as the necessary resharpening of dies will continuously alter this clearance.

These disadvantages have been eliminated according to the objects of this invention by providing a straight walled aperture for the die, with an offset or eccentric protrusion in the aperture positioned below the opening of the die. This provides an eccentric slug opening for the die that still permits the die to maintain a constant die clearance through the length of the die and optimum die clearance even after repetitive resharpenings.

With reference to the drawings and in particular to FIGURE 1 there is shown a die block 10 having an aperture 11 therein adapted to cooperate with a punch 12. A piece of metal or other material is represented by 13 disposed between the die and the punch. The punch may be suitably attached to a press apparatus, either manual or automatic, that forces the punch through the piece of material. The optimum die clearance can be readily determined, as is well known to a punch operator

as a factor of the die life and hole perfection as above described.

The side walls of the aperture 11 are straight extending from the opening on the face 14 of the die to an offset or eccentric portion 15. In FIGURE 1 the aperture is circular and hence the offset will be eccentric as seen in FIGURE 2 but the applicant does not intend to be limited thereby as the aperture and the offset may be of any shape desired such as square, rectangular, triangular, oval or any other desired shape to which the objects of this invention may be readily applied. For the sake of convenience, however, the invention will be discussed with respect to a circular die having an eccentric offset.

This offset must extend in the aperture 11 of the die a distance greater than the clearance between the die and a slug or blank that has been punched out by the punch. In other words the slug opening 16 at the bottom of the aperture 11 must have a smaller diameter than the diameter of the slug so that the offset will cause a slug to jam between it and the opposite wall of the aperture and will deflect it away from the aperture to prevent its return. The offset, however, must not be so large as to prevent slugs from being pushed by it with force in order to avoid a pile up of slugs within the aperture. It has been determined experimentally that the offset should reduce the effective diameter of the slug opening as compared to the diameter of the aperture 11 by a factor of from around 1 to 3%. Hence at an aperture diameter of around .4 inch, for example, the offset should protrude into the aperture approximately .005 inch. Below the slug opening 16 is a slug chute 17 preferably of greater diameter than the diameter of the slug and the aperture in order to provide a relatively free passage for the ultimate removal of the slug from the working area. Hence the center 19 of the slug chute 17 should preferably be greater than .005 inch away from the center 18 of the aperture 11 so that a larger slug chute will be provided. The large chute permits the slug to fall clear of the punch after it has been deflected by the offset and is clear of the slug opening 16.

In the operation of the punch tool, the punch must penetrate the die at least as far as the depth of the offset 15 minus the thickness of the material that is to be punched. If the punch is designed to penetrate the aperture of the die at least this distance, but not as far as the depth of the offset, the slug will necessarily be jammed into the slug opening 16 by the punch and will not return with it on its return stroke. In this case the clearance between the punch and the die may be low, as the punch need not penetrate beyond the offset and hence it may have a greater diameter than the diameter of the slug opening. The next slug that is punched will then force the jammed slug out of the opening, the offset deflecting it down the chute, jamming itself in turn into the slug opening and so forth, thus preventing slug pick-up.

Alternatively the die clearance can be of a size that permits the punch to pass the offset, but the slug opening must still be smaller than the slug. In this case the punch will force the slug past the opening, the offset deflecting it to the right into the expanded area of the chute where it will fall clear from the work.

If the slug sill remains adhered to the end of the punch, it will be pulled off by the restricted slug opening on its return stroke and thus prevented from further interfering with the work.

As stated above, the invention is not only applicable to circular or round dies, including oval shape, but also to square dies as shown in FIGURE 3, rectangular, triangular or any polygonal shape so desired. The slug chute 20, in FIGURE 3, would hence be larger than the aperture 21 of the die, the chute being offset so as to produce a land or offset portion 22 that deflects a slug into the chute again, protruding preferably around 1 to 3% into the aperture, thus creating a slug opening of

smaller size than the size of the aperture. The offset has been slightly exaggerated in the view for purposes of clarity. The offset may extend from more than one side of the aperture be it circular or polygonal, but not from all sides as at least one side of the aperture and preferably at least one half of the aperture should be free so that the slug may be deflected into the chute.

The invention can be readily applied to a wide range of die sizes, the size of the offset being a function of the die clearance as this controls the size of the slug that is ultimately to be punched out and jammed or restricted in the slug opening.

In an actual working example, a die having an aperture diameter of .416 inch plus or minus .001 inch and a slug chute diameter of .466 inch plus or minus .001 inch, offset by .031 inch from the center line of the aperture, was used, wherein the die had an eccentric offset protruding a maximum of .006 inch into the interior of the aperture. The slug opening 16 thus had a restricted size that was eccentric in shape, having a diameter as small as .410 inch, the offset being positioned at a depth of approximately .20 inch below the face of the die. The punch had a diameter of approximately .350 inch, creating a die clearance of around 16% and penetrated the die a distance of .225 inch thus passing the offset. The material used in the example was 20 gage mild steel having a thickness of approximately .020 inch. The results of the test showed that after 700 hits, or punches, no slug pick-up occurred.

Using the same die with 16 and 12 gage steel sheets and using die clearances of 9% and 5% respectively, no slug pick-up was encountered after making 300 successive punches on the 16 gage steel and after 500 punches on the 12 gage sample.

The offset or eccentric portion of the die hence prevents substantial slug pick-up while maintaining the normal die life as in conventional straight walled dies without restricted openings and also permits punching without the necessity of using a continuously changing negative clearance in order to prevent slug pick-up.

In view of my invention and disclosure variations and modifications to meet individual whim or particular need will doubtless become evident to others skilled in the art, to obtain all or part of the benefits of my invention without copying the structure shown, and I therefore claim all such insofar as they fall within the reasonable spirit and scope of my invention.

Having thus described my invention what I claim as new and desire to secure by Letters Patent is:

1. For use with a punch for punching a hole in a work piece, and thus creating a slug, the invention which consists in a die having a series of openings extending therethrough, comprising a straight walled entrance aperture adapted to receive the punch, with clearance between the punch and the wall of the aperture, extending from one end of the die to a point within the die, a slug chute of larger cross section than the aperture, extending from a location near said point within the die at which the aperture terminates to the other end of the die, and being misaligned with respect to the aperture, and an offset extending inwardly from the side of the aperture but from less than all of the sides of the aperture, fixed in the wall of the die between the aperture and the slug chute, the cross section of the opening through the die opposite the offset being smaller than the cross section of the aperture.

2. A die according to claim 1, wherein the offset is disposed at a depth up to but no greater than the depth of penetration of the punch plus the thickness of the work piece.

3. A die according to claim 2, wherein the offset is disposed at a depth less than the penetration of the punch.

4. A die according to claim 2, wherein the offset is disposed at a depth greater than the depth of penetration

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of the punch, but less than the depth of penetration of the punch plus the thickness of the work piece.

5. A die according to claim 1, wherein the offset extends inwardly from only one side of the aperture approximately 1 to 3% of the width of the aperture.

6. A die according to claim 1, wherein the punch and aperture are circular, the offset forming an eccentric opening for the die.

7. A die according to claim 7, in which the slug chute is also circular.

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10 JAMES M. MEISTER, *Primary Examiner.*

UNITED STATES PATENT OFFICE  
CERTIFICATE OF CORRECTION

Patent No. 3,358,538

December 19, 1967

Joseph G. Maceyka

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 5, line 9, for the claim reference numeral "7" read -- 6 --.

Signed and sealed this 1st day of April 1969.

(SEAL)

Attest:

Edward M. Fletcher, Jr.

Attesting Officer

EDWARD J. BRENNER

Commissioner of Patents