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3,494,168

FORMING TOOL

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U.S. Cl. 72—335 6 Claims

ABSTRACT OF THE DISCLOSURE

This application discloses a forming tool comprised of a punch and cooperating die for forming countersunk openings in sheet material. The punch has a first section that conforms to the shape of the opening to be formed in the sheet material and a second section that conforms to the shape of the countersink for deforming the sheet material around the formed opening. The die is comprised of a first die member having an opening through which the first section of the punch extends when the sheet material is sheared to form the opening. The die further includes a second member that defines a surface against which the sheet material is deformed by the second section of the punch. The first die member is resiliently biased into engagement with the sheet material to facilitate forming of the hole. The biasing means yields after the hole is formed so that the sheet material may be deflected into engagement with the surface of the second member by the second section of the punch.

BACKGROUND OF THE INVENTION

This invention relates to a forming tool and more particularly to a forming tool that is adapted to shear an opening in a piece of sheet material and to permanently deform the segment of the material around the hole.

In many types of forming operations, a hole is formed in a sheet material and the sheet material is subsequently deformed around the hole to form a countersunk depression. This type of operation has been previously performed in two steps, each of which employs a separate punch and die set. Previously it has been attempted to accomplish both of these forming operations with a single punch and die set, but such sets heretofore have been unsatisfactory. In a single step operation with the previously proposed punch and die sets, the slug has not always been completely sheared from the sheet material.

It is, therefore, a principal object of this invention to provide a forming tool that will form an opening in sheet material and provide positive removal of the slug.

It is a further object of this invention to provide an improved punch and die set for forming countersunk openings in sheet material in a single step.

SUMMARY OF THE INVENTION

A forming tool embodying this invention is adapted to pierce a hole in a piece of sheet material and permanently deform the piece around the hole. The forming tool comprises a punch and a co-operating die assembly. The punch is comprised of a first section that is adapted to form an opening in the sheet material and which has a cross section conforming substantially in shape to the shape of the hole to be formed. The punch further comprises a second section for engaging and permanently deforming the sheet material around the hole. The die assembly includes a first member defining an opening that is aligned with the first section of the punch and which is adapted to receive the slug sheared from the sheet material by the first punch section. The first member has a surface surrounding the opening that is adapted to supportingly engage the area of the sheet material around the area in which the hole is to be formed during the shearing of the hole by the first

punch section. The die assembly further includes a second member that defines a surface against which the portion of the sheet material around the formed hole is adapted to be deflected by the second punch section. Biasing means urge the first member and its surface into engagement with the sheet material during the hole forming operation for precluding any substantial engagement between the sheet material and the surface of the second die member. The biasing means yields upon contact of the second punch section with the sheet material for permanent deformation of the material around the formed hole into engagement with the surface of the second die member by the second punch section.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a perspective view, with portions broken away, of a piece of sheet material formed by a forming apparatus embodying this invention.

FIGURES 2 through 4 are cross-sectional views, taken along a vertical plane, through a forming tool embodying this invention and showing the different steps in its sequence of operation.

FIGURE 2 shows the forming tool and the initial stage of contact between the punch and the sheet material being formed.

FIGURE 3 shows the forming tool immediately after a hole has been formed in the sheet material.

FIGURE 4 shows the tool at the completion of the forming cycle.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

A forming tool embodying this invention is shown in detail in FIGURES 2 through 4 and is identified generally by the reference numeral **11**. The forming tool **11** is adapted to form countersunk openings in a piece of short material as identified by the reference numeral **12** and shown in most detail in FIGURE 1. The countersunk openings are comprised of a generally circular aperture **13** around which a section **14** is permanently deformed in the shape of a segment of a cone. The remaining portion of the sheet material **12** may comprise a generally planar surface **15**. It is to be understood that a series of the aforedescribed openings may be formed along the length of the material **12**.

Referring now in detail to FIGURES 2 through 4, the forming tool **11** is comprised of a punch **16** and die assembly **17** that are adapted to be supported in a punch press of any known type or any other like apparatus for reciprocating the punch **16** with respect to the die assembly **17**. The punch **16** is comprised of a first section **18** that is cylindrical in shape or otherwise has the form of the hole **13** to be formed in the sheet material **12** and terminates at its lower end in a sharp cutting edge **19**. The upper end of the section **18** merges into an inclined second surface **21** which is a segment of a cone having an included angle equal to the angle of the countersink **14** with any allowance for spring back which may be required. The upper end of the section **21** merges into a shank **22** that is adapted to be connected to the upper ram of the punch press.

The die assembly **17** is comprised of an outer cylindrical member **23** that is adapted to be supportingly received in a complementary cavity **24** formed in a base plate **25**. The base plate **25** may be a portion of the punch press or may be a separate element that is affixed to the bed of the press. The member **23** has a generally planar upper surface **26** that is adapted to supportingly engage the underside of the sheet material **12** and particularly the area around which the hole **13** is to be formed. An inclined surface **27** is formed centrally in the surface **26**

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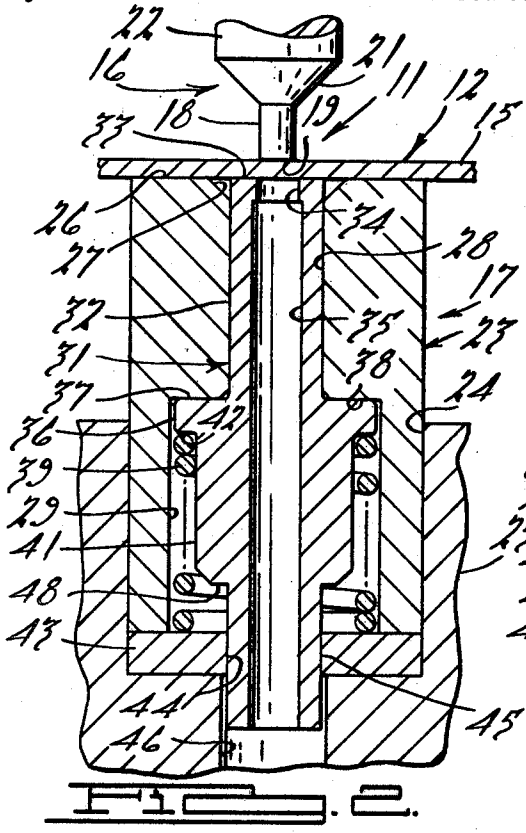


FIG. 2.

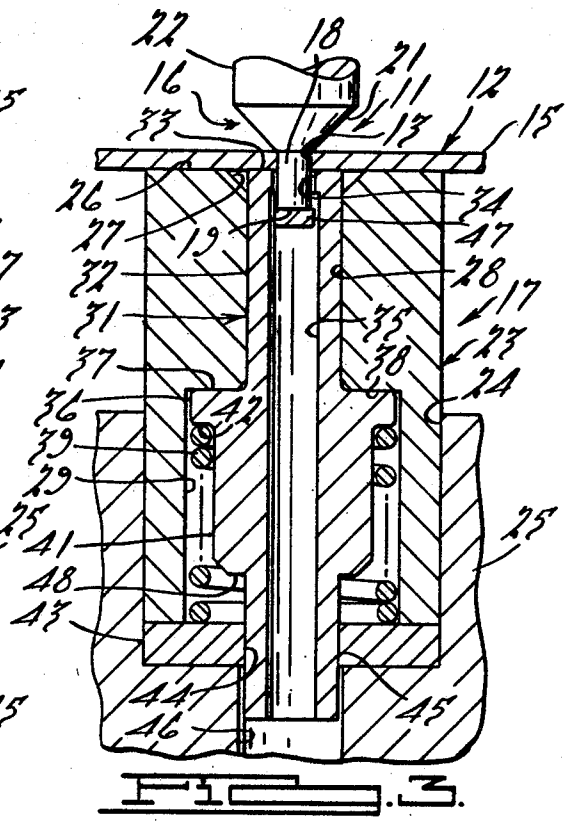


FIG. 3.

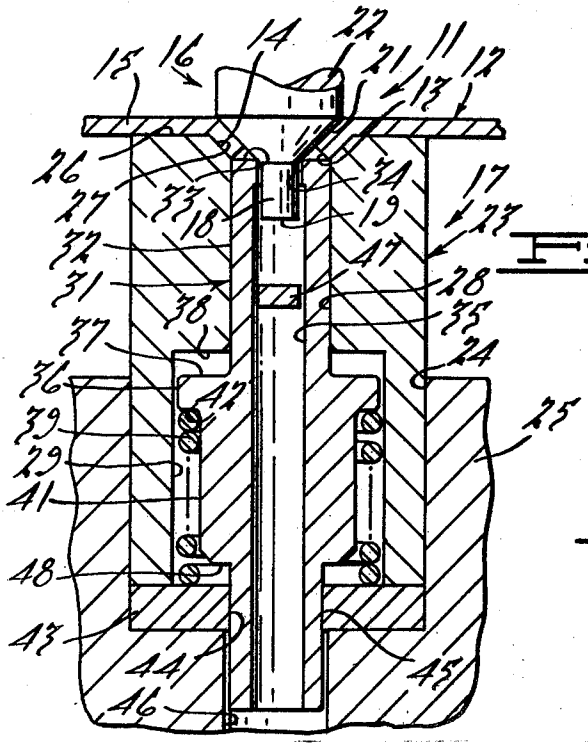


FIG. 4.

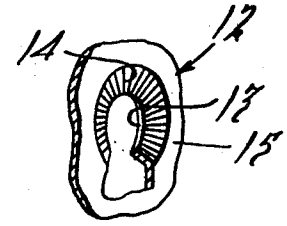


FIG. 1.

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ond die member supported within said first die member, said second die member having a first cylindrical portion slidably received in said first cylindrical opening of said first die member, said second die member further having a second larger diameter cylindrical portion received in said second cylindrical opening of said first die member, said first cylindrical portion of said second die member having a planar upper surface, a hole extending through said second die member from said planar surface, and biasing means for urging said second die member upwardly with respect to said first die member for disposing said planar surface of said second die member in substantially coplanar relationship with said planar surface of said first die member.

6. A die assembly as set forth in claim 5 wherein the biasing means is disposed within the second cylindrical opening of the first die member and wherein the hole in the second die member is comprised of a smaller diameter portion adjacent the planar upper surface of the second die member and a larger diameter portion extending through the remainder of said second die member.

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