United States Patent [19]

Cornell

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[54] **TOOL FOR FORMING CRIMP JOINTS**

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[73] Assignee: **Angeles Metal Trim Co.,** Los Angeles, Calif.

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[52] **U.S. Cl.** **72/325;** 29/243.52; 30/366; 72/327

[51] **Int. Cl.** **B21d 31/02**

[58] **Field of Search** 72/325, 326, 327; 29/243.52, 509, 21.1; 30/358, 366, 368; 83/689; 93/1.1

[56] **References Cited**

UNITED STATES PATENTS

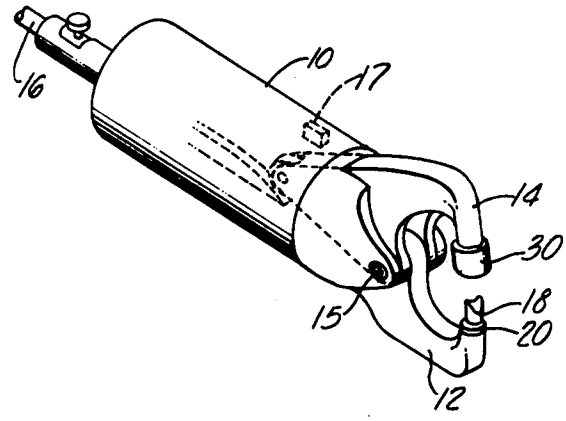
216,912	6/1879	Torrans	29/21.1
345,687	7/1886	Hayes	72/325
2,800,960	7/1957	Cutler	29/21.1
2,874,666	2/1959	Thor	113/114
3,010,199	11/1961	Smith et al.	29/509
3,656,394	4/1972	McCutcheon	83/689

Primary Examiner—C. W. Lanham
Assistant Examiner—James R. Duzan
Attorney, Agent, or Firm—Reed C. Lawlor

[57] **ABSTRACT**

One jaw of a tool actuated by compressed air for joining together two overlapping sheets of metal carries a hollow cup-shaped die with a rim to abut the outer surface of one of the two sheets and a second jaw of the tool carries a novel punch which abuts the outer surface of the other sheet. The punch is cylindrical in configuration, and has one end which is tapered by means of two curved surfaces disposed at acute angles relative to the axis of the cylinder and converging toward each other to form an arcuately curved cutting edge the opposing ends of which define a pair of punch points that coincide with the outer cylindrical surface of the punch. The tool forces the punch through the two sheets into the hollow die, piercing the two sheets and forming tongues on the two sheets respectively which tongues extend away from the two sheets and are nested together in interlocking engagement.

8 Claims, 10 Drawing Figures



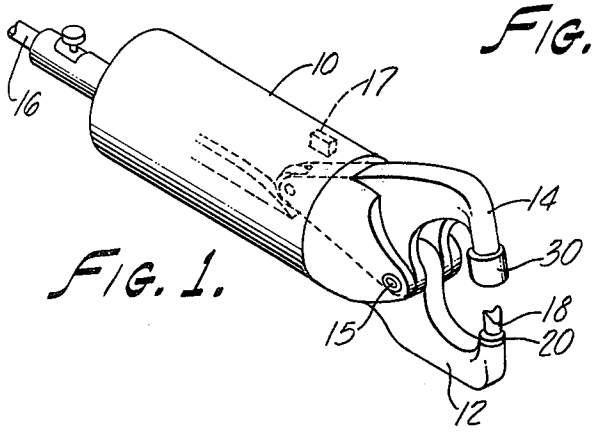
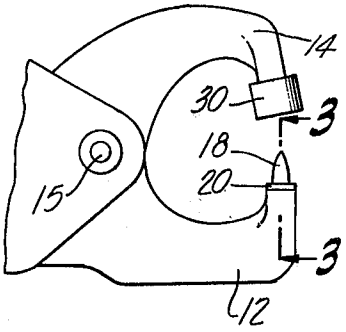


FIG. 1.

FIG. 2.



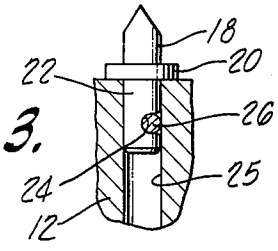


FIG. 3.

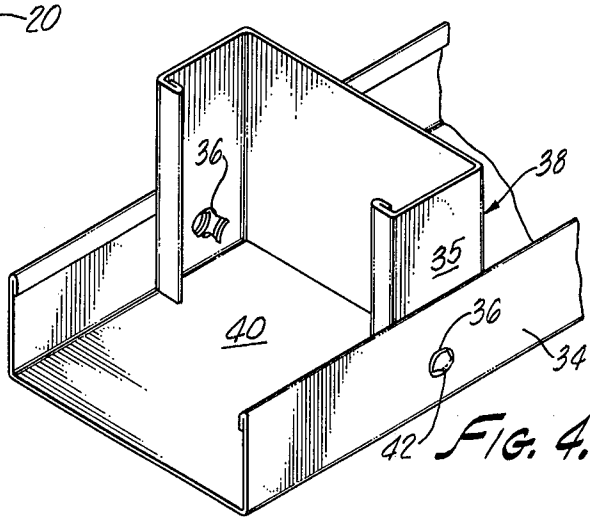


FIG. 4.

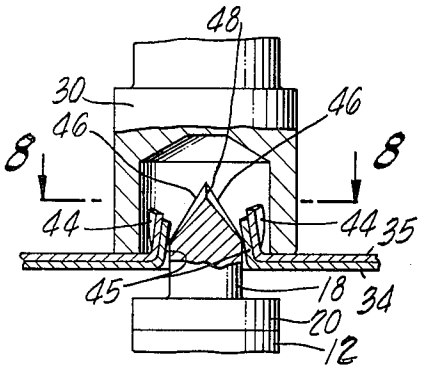
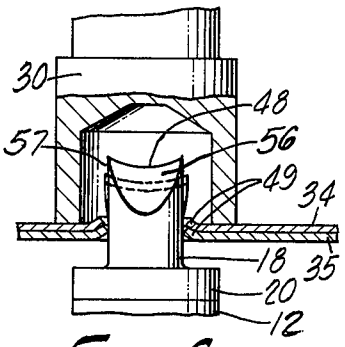


FIG. 5.



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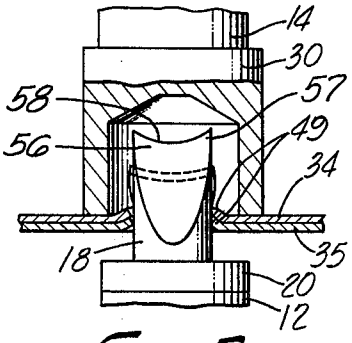

FIG. 7.

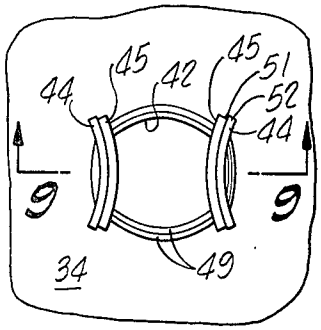

FIG. 8.

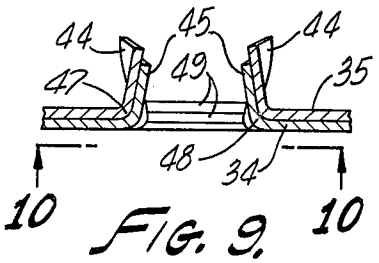

FIG. 9.

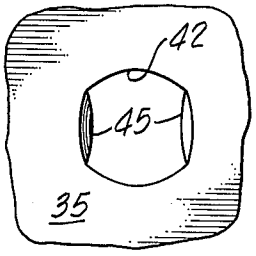

FIG. 10.

TOOL FOR FORMING CRIMP JOINTS

CROSS REFERENCES TO RELATES APPLICATIONS

Patent application Ser. No. 364,295, filed May 29, 1973, now abandoned.

BACKGROUND OF THE INVENTION

Many different hand tools have been developed to interconnect two overlapping sheets of material by forming what may be termed a crimp joint in the two sheets. Such tools are disclosed, for example, in British Pat. No. 145,388 and in the following U.S. Pat. Nos. 2,800,960; 2,865,451; 2,874,666; 3,010,199 and 3,534,466.

The present invention relates to a hand tool that has special utility for forming crimp joints in a prefabricated sheet metal wall module for incorporation in a building wall. Such a sheet metal wall module is commonly made of 26-gauge galvanized metal and in some instances, sheets as thick as 20-gauge. The wall module comprises vertical studs, each having a main web and two parallel longitudinal side flanges, an upper horizontal member in the form of a cap member having a main web and two opposed depending longitudinal side flanges and a lower horizontal member in the form of a track member having a main web and two upstanding longitudinal side flanges. The upper end of each stud telescopes into the cap member between its depending side flanges and the lower end telescopes into the track member between its upstanding side flanges. The metal studs normally simulate wooden 2×4 units, thus having webs about 3-⅝ inches wide and flanges about 1-⅝ inches wide. The studs are preferably of C-shaped though they may be of other non-planar configuration. The cap members and track members also normally simulate 2×4 wooden members, thus also having web with widths of about 3-⅝ inches and flanges having widths of about 1-⅝ inches. The cap and track members, however, are normally of U-shape.

In a conventional sheet metal wall module of this character, the longitudinal side flanges of the stud are attached to the side flanges of the upper and lower horizontal members by rivets or screws. But it would be economical and otherwise advantageous to substitute crimp joints for rivets if the crimp joints were strong enough to withstand the stresses involved in handling and transporting the wall modules and the stresses involved in maneuvering the wall modules into their final assembled positions in a building structure.

Crimp joints having the same form as that produced with the punch of the present invention have heretofore been used for joining together the webs of two parallel channel members. Such a crimp joint has been made heretofore by means of a tool consisting of a prior art punch mounted on a punch press opposite a large hole in a plate on the punch press for piercing a pair of sheet metal members to form the crimp joint. The prior art punch is in the form of a two-tine rod-shaped member in which the leading faces of the two tines are formed substantially entirely by two pairs of planar surfaces disposed in planes that intersect at a point on the axis of the punch. The convergence of the four leading faces at a single point results in a leading edge which, as viewed in profile or side elevation, is reentrant and is thus divided into two radial halves forming a sharp valley or inverted vertex.

Attempts have been made to utilize such a prior art punch in combination with a hollow die mounted in opposing relation thereto on two relatively movable jaws respectively of a pneumatic hand tool. While the resultant crimps and the resultant prefabricated wall modules were generally satisfactory, the punch itself deteriorates rapidly with repeated use resulting in a short service life because of fracture and thus requiring frequent replacement of worn punches.

SUMMARY OF THE INVENTION

The object of the present invention is to provide a hand tool that incorporates an improved punch of the general character described, which tool may be given heavy usage over an extended service period without excessive deterioration of the punch and without undue loss of time to replace punches.

The hand tool of the present invention has an elongated body that serves as a handle and has two jaws on the leading end of the body which are shaped and dimensioned to straddle the overlapping side flanges at the juncture of a stud and a horizontal member. One of the two jaws is a fixed longitudinal extension of the elongated body of the tool and carries a hollow die that forms a cavity. The other jaw is pivoted on the body to swing in an arc, and carries a punch which is substantially smaller in cross-sectional area than the cavity of the die. To form a crimp joint between a flange of a stud and an overlapping flange of a horizontal member, the pivoted jaw with the hollow die is positioned inside the wall stud with the rim of the die contacting the inner surface of the side flange of the stud. The other jaw, which is fixed on the body of the hand tool, is positioned outside of the stud, and the tool is actuated to cause the punch on the pivoted jaw to advance against the outer surface of the flange of the horizontal member and toward the die cavity with consequent piercing of the two layers of metal and the formation of inwardly extending interlocking tongues on the two layers of metal. The tool is provided with a stop to limit the movement of the punch into the cavity of the die and hence to prevent impacting of the punch against the inner end of the cavity.

The improved punch is in the form of a solid cylindrical rod having two tines at the cutting end thereof. The two tines are interconnected by a concave arcuate cutting edge that extends from one side of the punch to the other. The tines and the cutting edge are formed by two cylindrically curved surfaces formed on opposite sides respectively of the cylindrical rod. These surfaces have radii approximately equal to that of the rod and the axes of these two cylindrical surfaces are angularly inclined in opposite directions relative to the axis of the rod at acute angles, thereby forming crescent-shaped curved surfaces that terminate in a sharp arcuate cutting edge having the aforementioned two tines at the opposing ends. The various features and advantages of the invention may be understood by reference to the following detailed description and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings, which are to be regarded as merely illustrative:

FIG. 1 is a perspective view of a power-actuated hand tool utilizing the invention;

FIG. 2 is a fragmentary side elevation of the two jaws with the hollow die and the punch mounted on the two jaws respectively;

FIG. 3 is a fragmentary section along the line 3—3 of FIG. 2, showing how the punch is mounted on the pivoted jaw of the tool;

FIG. 4 is a fragmentary perspective view showing how a pair of opposite crimp joints connect the lower end of the sheet metal wall flange to the horizontal sheet metal track member;

FIG. 5 is an enlarged sectional view showing how the punch cooperates with the hollow die to form a crimp joint;

FIG. 6 is a sectional view like FIG. 5 taken at 90° relative thereto;

FIG. 7 is a sectional view like FIG. 6 of a tool employing an alternative form of the punch of this invention.

FIG. 8 is a face view of a crimp joint produced by the tool as seen along the lines 8—8 of FIG. 5;

FIG. 9 is a sectional view of the crimp joint as seen along the line 9—9 of FIG. 8; and

FIG. 10 is a view of the crimp joint as seen along the line 10—10 of FIG. 9.

DESCRIPTION OF THE PREFERRED EMBODIMENT OF THE INVENTION

FIG. 1 shows a tool having a body 10 that is elongated to serve as a handle. A fixed jaw 12 extends longitudinally from the leading end of the body 10 and movable jaw 14 is mounted on a pivot 15 at the leading end of the body. The tool comprises an improved punch 18 and a hollow die 30 which are mounted respectively on the jaws 14 and 12.

The movable jaw 14 is actuated by compressed air and for this purpose the body 10 of the tool is adapted at its trailing end for releasable connection to an air hose 16. A suitable mechanism for actuating the pivoted jaw 14 is driven by an air-actuated piston (not shown) inside the body 10.

The tool per se, shown in FIG. 1, is manufactured by Chicago Pneumatic Tool Company, New York, N.Y., and is known as an alligator yoke riveter CF-214-P. A model with a single piston in the body 10 may be used for forming crimp joints in 26-gauge sheet metal but for heavier gauges a model may be employed that has two pistons acting in tandem. In this invention, the tool is used as a staking tool rather than as a riveter. The staking is accomplished by means of a special punch and a hollow die.

As shown in FIG. 3, the punch 18 of this invention has a radial flange 20 at its base and a shank 22 that is formed with a transverse groove 24 of semi-circular cross section. The shank 22 of the punch fits into a bore 25 of the fixed jaw 12 with the radial flange 20 of the punch backed against the rim of the bore. The shank 22 is releasably retained in the bore 25 by suitable means, for example, by means of a cross pin 26 that fits in the groove 24. The pivoted jaw 14 carries a hollow die 30 which may be mounted in the same manner. As may be seen in FIGS. 6 and 7, the hollow die 30 has a cylindrical wall 32 which may be of substantially the same outside diameter as the radial flange 20 of the punch 18.

The stop (shown schematically at 17) on the interior of the tool 10 limits the movement of the pivoted jaw 14 toward the stationary jaw 12, thus limiting the movement of the punch 18 into the die 30 and preventing the tines of the punch from striking the inside end of the well or bore 25 in the hollow die 30.

FIG. 4 indicates how two crimp joints 36 formed in the staking process connect a sheet metal stud 38 to a floor track member 40. Each crimp joint 36 connects and outer layer 34 in the form of a side flange of the track member to an inner layer 35 in the form of a side flange or the stud 38. In making a crimp joint 36, the punch 18 forms an aperture 42 in the two sheets of metal with a pair of interlocking tongues on each of two opposite sides of the aperture, one tongue of each pair being a tongue 44 of the inner layer of metal 35, the other tongue of each pair being a tongue 45 of the outer layer 34. As may be seen in FIGS. 8 and 9, the two tongues of each pair are arcuate in cross-sectional configuration with the two tongues nested together in interlocking engagement.

The apertures 42 formed in each of the two layers of sheet metal 34 and 35, are non-circular. The rims of the apertures are formed with shallow round rim flanges 49 along the edges of the apertures between the tongues 44 and 45. The tongues 44 and 45 are nearly straight at their roots 47 and 48 where the tongues join the two layers of metal. The tongues are bent more and more toward their outer ends about axes that extend transversely of the two layers of sheet metal and the projection of the outermost corners 51 and 52 of the tongues on the metal sheets lie outside the apertures. Because of the shape and size of the tongues and their orientation relative to the apertures, the two layers of sheet metal are firmly locked together and become, for all practical purposes; almost impossible to pull apart without destroying the tongues.

In order to form a crimp having the shape described without requiring excessively frequent replacement, the punch is formed with curved faces 46 of cylindrical configuration having a diameter about equal to that of the punch. The leading end of the punch 18 is tapered with the two opposite leading faces 56 converging to form a leading sharp cutting edge 58 that extends diametrically across the leading end of the punch and terminating in points 57. Each of the faces 56 is of arcuate concave curvature in transverse cross section, with the consequence that the leading edge 58 is also of smooth concave curvature in profile as may be seen in FIGS. 6 and 7 and forms two points or tines 57 at its opposite ends respectively. The two tines 57 coincide with the outer cylindrical surface of the punch. The two converging cylindrically curved surfaces that form the arcuate cutting edge, are formed in the punch by a grinding process using a wheel having a circular, as distinguished from a flat, outer peripheral grinding surface. The two cylindrical surfaces 56 are symmetrically located on opposite sides of the punch and are formed therein with their respective axes intersecting the axis of the punch and inclined at acute angels of about 40°–50° relative to the axis of the punch. The two cylindrical surfaces 56 thus form crescent-shaped faces on opposite sides of the punch.

The radii of the cylindrically curved surfaces 56 that form the cutting edge of the punch, are about the same as the radius of the punch itself, so that the faces 56 are of substantially uniform curvature from one edge thereof to the other, instead of being formed by two predominantly flat surfaces joined by a sharp curve as in the punch that was previously employed. For best effect, the radii of curvature of the two arcuately shaped

cylindrical surfaces are equal to at least three-fourths of the radius of the punch. More particularly, the radius of curvature of the two arcuately shaped faces is about equal to the radius of the punch and that is between about three-fourths and about one and one-half times the radius of the punch.

The tines **57** of the punch lie on a line that is parallel to the axis of the pivot **15**, so that both points **57** contact the outer layer **34** of sheet metal simultaneously, as the punch approaches the metal sheets that are to be crimped together. This orientation of the leading edge of the punch, which is maintained by the cross pin **26**, adds to the life of the punch and facilitates fabricating a crimped joint which is of symmetrical configuration. This particular configuration of the punch, results in a relatively long service life for the punch and produces the pairs of tongues of the configuration shown in FIGS. **5–9**.

If the punch **18** is too large in diameter, the resulting apertures **42** in the sheet metal are of too great cross-sectional area with consequent excessive weakening of the side flanges of the stud **38** and the side flanges of corresponding horizontal members. On the other hand, if the punch **18** is too small in diameter, the resulting crimp joint is too weak to withstand the stress resulting from handling, transporting, and setting up a sheet metal wall module. It has been found that the diameter of the punch may be in the range of 3/16 to 5/16 inch and the cross-sectional curvatures of the two leading faces **46** may be the same as the cross-sectional radius of curvature of the punch. In one specific form of the invention, the diameter of the punch **18** is approximately 1/4 inch and the inside diameter of the cylindrical wall **32** of the die **30** is approximately 15/16 inch.

In the best mode of practicing the invention, the edges at the ends of the studs **38** are formed accurately perpendicular to the length of the stud in order to permit the studs to engage the main web of the cap member or the floor member at the end of the module snugly. In forming the crimp, the cap member and track member are held under pressure against the opposite ends of the stud and the crimps are formed at points adjacent the centers of the overlapping flanges so that the resultant crimp joints are located about one inch from the end of the stud as well as from the sides of the crimped flange.

It is apparent that the described tool can be used to form crimp joints in rapid succession to reduce the cost of a prefabricated sheet metal wall module. A further advantage, of course, is that the tool is light enough to be readily handled and the tool may be employed on a building site as well as in the shop. One advantage of employing compressed air to actuate the two jaws, is that the two jaws, in closing together as shown in FIGS. **5** and **6** and **7** accommodate themselves to the particular combined thicknesses of the two layers of sheet metal **34, 35**. The squeezing force applied to the two layers of sheet metal is determined by the pressure of the compressed air and is not of sufficient magnitude to impair the sheet metal around the joint by excessive compression. Another advantage of using compressed air is that the magnitude of the squeezing force is not substantially affected by variation in the combined thicknesses of the two sheets of metal.

In practice, it has been found that when the reduced end of the punch completely penetrates the two metal sheets as shown in FIG. **6**, a tearing action sometimes occurs at the roots **47** and **48**, especially for heavier gauge sheet metal, such as **20** gauge sheet metal. Such tearing action is avoided by arranging the stop **17** within the tool to limit the piercing action so that the curved faces **46** of the punch do not penetrate the sheets completely during the staking, but come to a halt while they are still in the planes of the surfaces of the metal sheets. One way to accomplish this result with a given stop involves forming the curved surfaces of the punch with faces **46** that extend over a greater length of the punch. In a staking operation employing such a punch, the cutting pressure is is distributed more evenly than otherwise over the bends at the roots **47** and **48**. Even though there may be some tendency for breakage at the bends **48** and **50**, this does no harm so long as the crimps are sufficiently strong to hold the studs **38** and **40** together until the resulting wall modules are assembled to form a wall of a building and the wallboard has been secured to them in place.

The increased life of the punch of this invention over that of the prior art, has its origin in the fact that the faces **56** and **46** forming the cutting edge of the punch are of large radius, compared with the very sharp radius formed at the junction of flat surfaces of previous punches used in such a tool. The increased tool life results in a substantial reduction in the cost of manufacture of the prefabricated sheet metal wall modules.

The foregoing description in specific detail of the selected embodiment of the invention, will suggest various changes, substitutions and other departures from the disclosure within the spirit and scope of the appended claims.

The invention claimed is:

1. In a crimping tool of the type comprising a cylindrical punch and a cooperating die having a cylindrical cavity, and wherein said die and punch are mounted for pivotal movement relative to one another to cause said punch to enter said cavity in coaxial relation thereto to crimp together a pair of superposed metal sheets previously disposed between said punch and die, the improvement wherein:

spaced diametrically opposing side portions of said punch adjacent the end of the punch facing said cavity are shaped to define a pair of arcuately curved surfaces,

said pair of arcuately curved surfaces each being inclined at an acute angle relative to the axis of said punch and relative to an axis perpendicular to said first mentioned axis, said surfaces converging toward one another to intersect one another at an arcuate cutting edge, each said surface being of crescent shape,

the opposing ends of said arcuate cutting edge terminating at the outer cylindrical periphery of said punch to define a pair of spaced punch points disposed respectively at the extremities of said arcuate cutting edge, said arcuate cutting edge being concavely curved substantially the entire length thereof from one said punch point to the other.

2. In a tool as defined in claim **1** wherein the radii of curvature of said two arcuately curved surfaces are equal to at least three-fourths the radius of said punch.

3. In a tool as defined in claim **1** wherein the radii of curvature of said arcuately curved surfaces are about equal to the radius of said punch.

4. In a tool to form a crimped joint in two overlapping sheets of metal, wherein the tool has two relatively

pivotable jaws with a hollow die on one jaw and cooperating punch on the other jaw,

the improvement wherein said punch comprises a solid cylinder having a tapered leading end forming a curved cutting edge across a diameter of the punch,

said cutting edge of the punch being of shallow concave curvature in profile and having two tines at the opposite ends respectively of said cutting edge, the cutting edge being concavely curved throughout substantially the entire distance from one end thereof to the other, the cutting edge being tangential to a plane that is perpendicular to the axis of said punch.

5. The improvement of claim **4**

in which the jaw that carries said punch is pivoted to swing about a pivot axis;

and in which a straight line connecting said two tines is parallel to said pivot axis.

6. A punch adapted to cooperate with a hollow die to form a crimped joint in two overlapping sheets of metal,

said punch being beveled at its leading end and having two leading faces that converge to form a diametrical cutting edge,

each of said two faces being arcuately concave in cross section about an axis inclined to both the axis of the punch and an axis perpendicular thereto whereby said cutting edge is arcuately concave in profile.

7. The punch of claim **6** in which each of said leading faces is of cylindrical curvature in cross section.

8. The punch of claim **7** in which the body of the punch is a solid cylinder, and the radius of curvature of each of said leading faces is equal to about the radius of the cylindrical surface of the body of said punch.

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