Dec. 23, 1958 W. G. PORTER 2,865,452

PIERCING PUNCH

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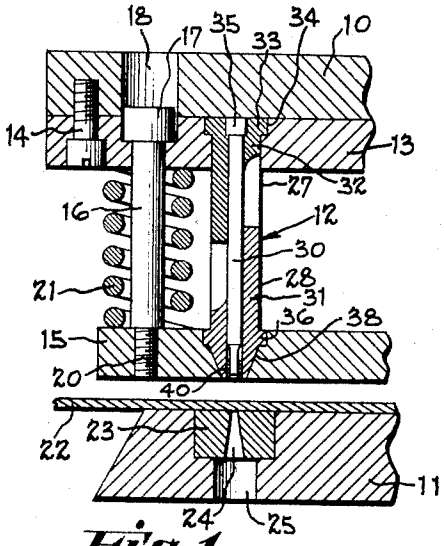


Fig. 1

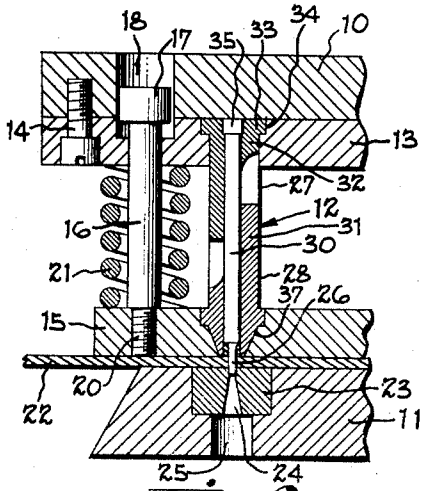


Fig. 2

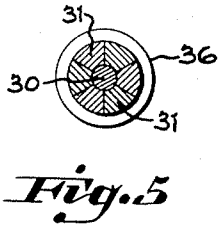


Fig. 5

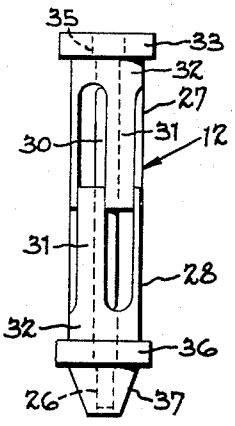


Fig. 3

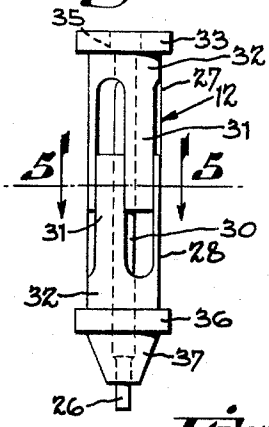


Fig. 4

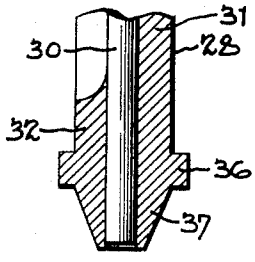


Fig. 6

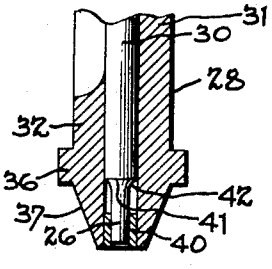


Fig. 7

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PIERCING PUNCH

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This invention relates to die sets for use in punch presses and particularly to an improved piercing punch of the intermeshing sleeve type. The invention also involves improvements in the method of fabricating the punch structure.

An intermeshing sleeve punch of the character embraced by this invention is disclosed in Patent No. 2,108,619 to Jacob A. Smith. The structure disclosed in the patent, consists of a punch body which is reinforced along its length by a pair of extensible sleeve sections having a common axial bore embracing the punch body along its length. The intermeshing sleeves resist the tendency of the punch to buckle or bend under endwise pressure developed during the piercing operation and increase the capacity of the punch.

Prior to the introduction of the interlocking sleeve structure, it was necessary to make the diameter of the punch (and the hole to be pierced) somewhat greater than the thickness of the material to be pierced because the standard plain punch usually fails, or the piercing action is defective, if the metal thickness is equal to or greater than the diameter of the punch. For example, in piercing a given grade of material it may be necessary to use a punch diameter at least 10% greater than the material thickness in order to eliminate punch failure, undue wear, and imperfect holes.

The interlocking sleeve structure of the prior patent, due to the guiding and reinforcing action of the sleeve, makes it possible to pierce materials having thicknesses equal to or even greater than the diameter of the punch. The structure also im proves the shearing action generally and produces clean, accurate holes by virtue of the reinforcing and guiding action of the intermeshing sleeve.

On the other hand, the intermeshing punch units are fairly expensive since they are intricate in construction and must be fabricated to close tolerances. For this reason, they have been manufactured and carried in stock in a series of standard sizes. Accordingly, the punch user has been limited to the standard punch diameters and has had to order special units at added expense if the work required hole sizes other than standard.

One of the primary objects of this invention has been to provide a mechanically improved intermeshing sleeve punch which may be reworked in a simple manner to any required hole diameter; accordingly, the invention eliminates the cost of special or custom built punch units and makes the intermeshing type available for practically any hole diameter.

Another object of the invention has been to carry forward the reinforcing principle of the intermeshing sleeve to increase the piercing capacity of a unit of given size. In other words, the mechanically improved punch is capable of a greater metal thickness (or hardness) for a given punch size and is capable of piercing holes of smaller size than has been possible with the equipment of the past.

The present invention is based upon the concept of improving the punching capacity of the sleeve-type punch

by providing a short piercing nib having a smaller diameter than the punch body, the nib being slidably guided within a short solid bushing at the lower end of the intermeshing sleeve. According to this structure, the long punch body is reinforced against buckling by the intermeshing sleeve, while the small diameter but short piercing nib, which performs the actual piercing operation, is locally reinforced against buckling by its short solid bushing.

In any piercing operation involving a reasonably long punch, the shear resistance of the work builds up heavy compression forces lengthwise of the punch. Penetration of the punch is not gradual; rather it seems to be sudden and explosive. Evidently the forces reach the limit of shear resistance of the work, then the material shears explosively and releases the compressive energy stored in the punch. The explosive action seems to generate a tension force in the punch, acting in the opposite direction. This is demonstrated by the fact that upon failure due to overloading (excessive metal thickness or hardness), the punch body seems to explode and tear loose from the head which is confined in the punch holder.

On the other hand, according to this invention, the diameter of the punch is greater than the piercing nib, and it would be expected that the nib would explode from the end of the punch if overloaded under the above conditions. However, actual experience has demonstrated that this is not the case and even if overloaded under comparable conditions, the nib does not fail. Although the exact reason is not known, it seems possible that the compressive impulses acting within the nib do not travel in a straight line but expand or diffuse laterally into the punch body. It is also possible that the action of the punch body modifies or neutralizes to some extent the forces acting within the nib. At any rate, the combination of the body and nib, both reinforced laterally, has been found to perform successfully in piercing thickness or grades of metal which would almost surely cause failure of the prior interlocking sleeve unit.

In practice, the interlocking sleeves having punch bodies of the standard or nominal diameters may be carried in stock, together with nib bushings having outside diameters suitable to be pressed into the bores of the sleeves. Upon receiving an order for a punch having a specified diameter, the manufacturer selects a punch and sleeve unit one or more sizes greater than the one specified, then machines upon the lower end of the punch body a piercing nib having the specified diameter. A nib bushing of standard size is then machined to provide an internal bore snugly but slidably embracing the nib, and the bushing is then forced into the end of the sleeve to reinforce the nib. By virtue of the localized reinforcement of the nib, combined with the reinforcement imparted to the punch body by the interlocking sleeve, the nib is capable of piercing a given hole size in a greater thickness of metal than is possible with the standard intermeshing sleeve punch.

Briefly therefore, the present improvement makes it possible to extend the advantages of the interlocking sleeve punch to any specified punch diameter at low cost; it makes it possible to pierce a given size hole in a greater thickness of metal than has been possible heretofore; and the structure makes it possible to utilize the piercing technique in operations beyond the capacity of the standard sleeve punch and formerly executed by drilling operations. By the proper selection of punch body and related nib diameters, practically any combination of hole size and metal thickness, within practical limits, can be accommodated by the present improved structure.

Various other advantages of the present invention will be more fully apparent to those skilled in the art from

the following description taken in conjunction with the drawings.

In the drawings:

Figure 1 is a fragmentary vertical section of the piercing punch mounted in a die press, the parts being shown in retracted position with a sheet metal blank in position to be pierced.

Figure 2 is a view similar to Figure 1, showing the parts at the downward limit of the piercing stroke.

Figure 3 is an enlarged side elevation of the sleeve in extended position corresponding to the parts in Figure 1.

Figure 4 is a view similar to Figure 3, showing the sleeve contracted according to the position of the parts in Figure 2.

Figure 5 is a sectional view taken on line 5—5 of Figure 4, detailing the intermeshing portions of the sleeve sections.

Figure 6 is an enlarged sectional view of the lower portion of the extensible sleeve and punch body before the nib is formed on the punch body.

Figure 7 is a view similar to Figure 6, showing the punch body with the nib formed on its lower end, together with the nib bushing pressed into the sleeve and reinforcing the nib. The sleeve and punch body units are carried in stock in the condition shown in Figure 6 and are reworked as shown in Figure 7 to provide a hole diameter specified by the user.

The improved punch is intended to be mounted as part of the die set of a conventional die press, the essential parts of which are shown in Figures 1 and 2. In general, the press consists of a punch holder 10 mounted upon the ram of the press (not shown) for reciprocation relative to the die pad indicated at 11. The die pad is mounted upon the stationary bolster or platen of the press (not shown) below the punch holder. The improved piercing punch, which is indicated generally at 12, is carried in a retainer plate 13 secured by screws 14 to the punch holder 10. A stripper plate 15, spaced below the retainer plate 13, is connected to the retainer plate 13 by keeper screws 16, each screw having a head 17 seated in the end of a counterbore 18 common to the punch holder and retainer plate. The lower end of each keeper screw is threaded into the stripper plate, as indicated at 20. Each keeper screw includes a stripper spring 21 held in compression between retainer plate 13 and stripper plate 15.

The sheet metal workpiece, indicated at 22, rests upon the die pad 11 which includes a die button 23 seated therein with its top surface flush with the surface of the die pad. The die button includes a piercing hole 24 axially aligned with the piercing punch 12, the piercing hole tapering downwardly and outwardly to the slug discharge hole 25. The lower end of the punch includes a piercing nib 26 which fits through the upper end of the piercing hole to create a shearing action during the piercing stroke of the punch. The diameter of the hole to be pierced is governed by the diameter of nib 26, the upper end of the piercing hole being slightly larger than the nib to provide working clearance which varies in accordance with the thickness of the work, the diameter of the pierced hole and other factors.

During the piercing stroke, the ram of the press forces punch holder 10 and retainer plate 13 downwardly as shown in Figure 2, causing the stripper plate to engage the surface of the sheet metal blank in advance of the piercing operation. Overtravel of the punch holder compresses the stripper springs and forces the nib of the punch through the sheet metal blank and into the piercing hole. As the end of the piercing nib penetrates the sheet metal blank, the metal slug, sheared by the edge of the nib, is discharged downwardly through the piercing hole. During the return or stripping stroke, the stripper springs, which were compressed during the piercing stroke, hold the stripper and workpiece down upon the surface of the die pad to permit the punch to be withdrawn from the pierced workpiece.

In most instances, the piercing operation involves the formation of multiple holes located at accurate centers, the holes often having different diameters. Usually therefore, the punches 12 are located at required centers and several keeper screws 16 and springs 21 are located as required by the number and relative positions of the several punches. Pilot pins or dowels (not shown) usually pass upwardly from the stripper plate through the retainer plate and punch holder to hold the parts in registry.

The piercing punch 12 of the invention consists of an extensible sleeve in the form of an upper sleeve section 27 mounted in the retainer plate 13 and a lower sleeve section 28 mounted in the stripper plate 15. The two sections have a common axial bore, the cylindrical punch body 30 being slidably confined in the bore and reinforced against lateral deflection or buckling under endwise pressure by the confining action of sleeve sections.

As best shown in Figures 3 to 5, the companion endwise portion of each sleeve section is slotted longitudinally, the slots delineating three spaced longitudinal prongs 31. As viewed in Figure 5, the slots of each sleeve section are substantially equal in width to the prongs which they delineate, the prongs of each sleeve section slidably interfitting the slots of the companion section. In the perferred construction illustrated in Figure 5, each slot has sides radial to the central axis of the sleeve sections so that the intermeshing prongs embrace the entire circumference of the punch body. The outer end portions of the punch body are completely encircled by the solid metal end portions 32—32 of the sleeve sections. Accordingly, the intermediate length of the punch body, which is most apt to buckle under endwise pressure, is completely encircled by the reinforcing prongs, while the endwise portions, which must be guided accurately during the punching stroke, are completely encircled by the solid metal portions 32 of the sleeve for accurate guidance.

The upper sleeve section 27 includes a cylindrical head 33 which is larger in diameter than the sleeve section, the head being confined in a counterbore 34 machined in the retainer plate 13, the head being seated against the surface of the punch holder 10. Similarly, the upper end of the punch body includes a head 35 seated in a corresponding counterbore formed in the upper end of the sleeve section 27. The head end of the punch body is seated against the punch holder 10; therefore, downward pressure of the punch holder is imposed upon the head end of the body punch to force it under endwise pressure through the sheet metal blank.

The lower end of the lower sleeve section 28 includes a head 36 and a downwardly tapered cone leader 37. The cone leader is press fitted into a tapered bore 38 in the stripper plate and aligns the lower end of the punch precisely with the piercing hole of the die button.

As best shown in Figure 7, the piercing nib 26 has a diameter substantially less than the diameter of the punch body. The nib is guided in a guide bushing 40 which is pressed into the bore at the lower end of sleeve section 28. The bushing has an inside bore precisely interfitting the nib and providing a snug sliding fit. To provide the piercing stroke, the length of the nib is approximately twice the length of the bushing; also, the length of the nib is more than twice the thickness of the sheet metal to be pierced.

As explained in detail later, the nib diameter is machined to the diameter of the hole to be pierced, the sleeve and punch units being prefabricated and carried in stock in graded standard sizes. The piercing hole 24 of the die button may also be machined in accordance with the specified nib diameter, the die buttons preferably being carried in stock as prefabricated blanks.

As shown in Figure 1, the piercing nib normally resides within the nib bushing. As the ram and punch holder descends, the stripper plate first contacts the work, then the overtravel of the punch holder forces the punch and

nib downwardly by endwise pressure upon the head end of the punch. During this motion, the lower sleeve section and stripper plate remain stationary and the upper sleeve section moves relative to the lower section with the intermeshing prongs embracing the shank of the punch holder. At the same time, the end of the nib contacts the work surface while still embraced for its full length by its bushing.

As outlined earlier, when the nib contacts the work surface, the shear resistance of the work imposes a heavy compressive force upon the nib and punch body before penetration takes place. The compressive force increases to the limit of shear resistance, then the nib shears the slug with an explosive action. The sudden release of compressive energy now reacts in the opposite direction, tending to pull the nib and punch body downwardly from the ram. It has been found that the nib is capable of withstanding the heavy downward tension even though the ratio of metal thickness to nib diameter is of the order which would cause failure of prior structures. Experimental work has indicated that forming a curved fillet at the juncture between the nib and body, further increases the piercing capacity of the unit. Although the exact reason is not known, it is believed that the compressive and tension forces are diffused laterally from the nib and through the fillet to the punch body and in some way are reduced sufficiently to preserve the nib and greatly increase its piercing capacity.

As the nib penetrates the work, the downward movement of the pnuch holder relative to the stripper plate compresses the stripper springs **21**. During the return or upward stroke, the upper sleeve section **27** and punch body **30** are elevated with the retainer plate in which they are anchored, thus withdrawing the piercing nib **26** from the pierced hole. During this motion, the stripper springs hold the stripper plate and work firmly upon the die pad, biasing the pull of the piercing nib.

In practice, the punch body and nib diameters preferably are related (by selection of the proper blank size), to provide substantially equal resistance to forces acting in the nib and body at maximum endwise pressure. This relationship, combined with the reinforcing action of the intermeshing prongs and nib bushing, increases the piercing capacity of he punch unit far beyond that of the interlocking sleeve structure disclosed in the aforesaid patent. In other words, the present structure is capable of piercing a given size hole under adverse conditions (metal thickness or hardness) which would cause failure of the prior interlocking sleeve punches.

In addition to the advantages of providing selective hole diameters and of increasing the metal thickness to be pierced, the nib structure reduces the over-all cost of the punch since the bushing and nib can be precisely interfitted at low cost.

According to the preferred system, the interlocking sleeves and punch bodies are carried in stock by the supplier in unfinished condition, that is, hardened and ground but with the lower end of the punch body in blank as indicated in Figure 6. For example, the punches may be carried in one range of standard sizes, starting at 1/16" punch body diameter, with increments of 1/32" from one diameter to the next. The outside diameter of the sleeve, sleeve head diameter, and sleeve length are varied proportionately from one size to the next.

Upon receiving an order for a given hole diameter, the end of the punch body is ground or otherwise precision machined to the form of a nib having the specified diameter and a given length, as determined by the thickness of material to be punched. A corresponding nib bushing, also carried in stock in blank form, has an outside diameter to be pressed into the bore of the sleeve. The inside diameter of the bushing is machined to a precision fit with the nib and is pressed into the sleeve bore, as shown in Figure 7. Accordingly, the only machining operation involves the diameter of the nib and corresponding bore of the bushing; these surfaces can be honed or lapped to size at relatively low cost.

As noted earlier, the length of the nib, as indicated in Figure 7, is made approximately twice the length of the bushing in order to provide the required stroke; the length factors may be varied in accordance with the thickness to be pierced. The shoulder **41**, at the junction of nib and punch body, is provided with a fillet **42** for increased strength and breakage resistance as noted earlier.

In supplying the nibbed punch for a specified hole diameter, a standard punch size is selected to provide a given differential between the punch and nib diameters. The differential necessarily is governed by the hole size, thickness, metal hardness, and other factors. For example, for a specified hole diameter of .025" to be pierced in stock 1/32" thick, a standard 1/16" (.062) diameter body may be satisfactory.

On the other hand, by way of example, punching 3/32" diameter holes in stainless steel 1/8" thick presents a more difficult problem. In practice, the standard sleeve units having a punch diameter of 3/32" failed consistently after piercing a few holes, the punches either exploding off or expanding in diameter. In this instance, a sleeve unit having a 1/8" diameter punch was selected, and its piercing end ground to form a 3/32" diameter nib which was fitted into a corresponding bushing. This combination of punch body and nib diameters was found suitable for rapid production of the stainless steel sheets without punch failure. Other difficult hole forming operations, which formerly could not be accomplished by piercing because of punch failure or imperfect holes, have been converted to piercing by utilizing the nibbed punch principle.

Having described my invention I claim:

1. A reinforced piercing punch for forming holes in a metal workpiece comprising, an upper and lower sleeve, each having a plurality of limbs spaced apart radially from one another and projecting endwisely from said sleeves, said limbs slidably intermeshing with one another and providing an extensible reinforcing section intermediate said sleeves, said sleeves having a common axial bore extending therethrough from one end to the opposite end thereof, a cylindrical punch slidably confined in said axial bore, said intermeshing limbs embracing said punch intermediate the length thereof, said upper and lower sleeves reinforcing the cylindrical punch for the full length thereof, a piercing nib formed on an endwise portion of said punch, said nib having a diameter less than the diameter of the punch, said nib having a curved fillet section extending about the periphery thereof which joins the nib to the endwise portion of the punch, means confining the punch within said upper sleeve against endwise movement therein, a nib bushing having an outside diameter substantially equal to the said common axial bore of the sleeves, said bushing being press-fitted into said bore at the outer endwise portion of said lower sleeve, the said endwise portion of the lower sleeve confining the bushing under pressure and reinforcing the bushing against expansive forces, said bushing having an internal bore slidably embracing said nib and reinforcing the nib laterally, said nib having an outer end normally residing within the bore of said bushing, said nib projecting outwardly beyond the end of the bushing upon axial motion of the upper sleeve toward the lower sleeve, whereby upon application of endwise pressure upon the upper end of the punch the piercing nib is forced endwisely from said bushing and through a workpiece supported beneath the nib, the said intermeshing limbs of the sleeves reinforcing the punch against lateral buckling under said endwise pressure, the related diameters of the reinforced piercing nib and punch creating substantially equalized resistance to lateral buckling under endwise pressure, said reinforced nib being capable of piercing a metal workpiece having a thickness greater than the diameter of the nib.

2. A reinforced piercing punch for forming holes in a metal workpiece comprising, an upper and lower sleeve,

each having a plurality of limbs spaced apart radially from one another and projecting endwisely from said sleeves, said limbs slidably intermeshing with one another and providing an extensible reinforcing section intermediate said sleeves, said sleeves having a common axial bore extending therethrough from one end to an opposite end thereof, a cylindrical punch slidably confined in said axial bore, said intermeshing limbs embracing said punch intermediate the length thereof, said upper and lower sleeves reinforcing the punch laterally for the full length thereof, a piercing nib formed on the endwise portion of said punch, said nib having a fillet section extending about the periphery thereof which joins the nib to the endwise portion of said punch, said nib having a diameter not greater than two-thirds the diameter of the punch, the upper end of said punch having an enlarged head formed thereon, the end of said upper sleeve having an enlarged counterbore formed therein, said head being seated in said counter bore and thereby confining the punch endwisely in said upper sleeve, a nib bushing having an outside diameter substantially equal to the said common axial bore of the sleeves, said bushing being press-fitted into said bore at the outer endwise portion of said lower sleeve, the said endwise portion of the lower sleeve confining the bushing under pressure and reinforcing the bushing against expansive forces, said bushing having an internal bore slidably embracing said nib and reinforcing the nib laterally, said nib being substantially twice the length of said bushing and having an outer end normally residing within the bore of said bushing, said nib projecting outwardly beyond the end of the bushing upon axial motion of the upper sleeve toward the lower sleeve, whereby upon application of endwise pressure upon the head of the punch the piercing nib is forced endwisely from said bushing and through a workpiece supported beneath the nib, the said intermeshing limbs of the sleeves reinforcing the punch against lateral buckling under said endwise pressure, the related diameters of the reinforced piercing nib and punch creating substantially equalized resistance to lateral buckling under endwise pressure, said reinforced piercing nib being capable of piercing a metal workpiece having a thickness greater than the diameter of the nib.

3. A reinforced piercing punch for forming holes in a metal workpiece comprising, an upper and lower sleeve, each having a plurality of limbs spaced apart radially from one another and projecting endwisely from said sleeves, said limbs slidably intermeshing with one another and providing an extensible reinforcing section intermediate said sleeves, said sleeves having a common axial bore extending therethrough from one end to the opposite end thereof, a cylindrical punch slidably confined in said axial bore, means confining the punch endwisely within said upper sleeve, said intermeshing sleeves embracing said punch intermediate the length thereof, said upper and lower sleeves reinforcing the punch laterally for the full length thereof, a piercing nib formed on an endwise portion of said punch, said nib having a fillet section extending about the periphery thereof which joins the nib to the endwise portion of said punch, said nib having a diameter less than the diameter of the punch, said nib having a length not less than the diameter of said punch, a nib bushing having an outside diameter substantially equal to the said common axial bore of the sleeve sections, said bushing being press-fitted into the end portion of said lower sleeve, said end portion of the lower sleeve confining the bushing under pressure and resisting outward expansion thereof, said bushing having an internal bore slidably embracing said nib, said nib being substantially twice the length of said bushing and having an outer end normally residing within the bore of said bushing, said nib projecting outwardly beyond the end of the bushing upon axial motion of the upper sleeve toward the lower sleeve, whereby upon application of endwise pressure upon the upper end of the punch the piercing nib is forced endwisely from said bushing and through the workpiece supported beneath the nib, the said intermeshing limbs of the sleeves reinforcing the punch against lateral buckling under said endwise pressure, the related diameters of the reinforced piercing nib and punch creating substantially equalized resistance to lateral buckling under endwise pressure, the reinforced piercing nib being capable of piercing a metal workpiece having a thickness greater than the diameter of the nib.

4. In a reinforced piercing punch for forming a hole in a metal workpiece of a thickness appreciably greater than the diameter of the hole, the combination of an upper sleeve and a lower sleeve, each of said sleeves having a plurality of spaced limbs, the limbs of the lower sleeve telescopically interengaging the limbs of the upper sleeve, whereby said sleeves can move axially relative to one another, said sleeves having a common axial bore extending therethrough defining an elongated punch receiving opening, a cylindrical punch slidably disposed within said opening, said cylindrical punch including a cylindrical body portion, said body portion being completely confined within said axial bore in the sleeves, a piercing nib formed on the lowermost portion of said punch, said piercing nib having a diameter substantially less than the diameter of said body portion, the length of said nib being substantially greater than the diameter of said nib, said nib having a fillet section of gradually increasing diameter which joins the upper portion of the nib to the body of said punch, whereby the relative diameters of the nib and body provide substantially equalized resistance to deformation under endwise pressure and said nib is effective to pierce a metal workpiece having a thickness appreciably in excess of the diameter of the nib, said lower sleeve being provided at the lower portion of said punch receiving opening with a support for said nib.

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