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METHOD OF AND APPARATUS FOR PUNCHING BY TRANSFER MEANS

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Fig. 1.

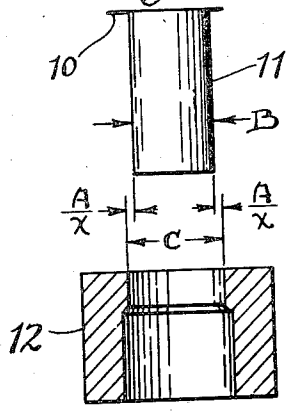


Fig. 2.

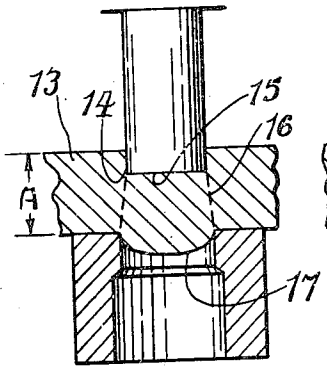
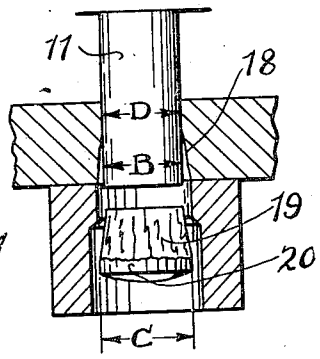


Fig. 3.



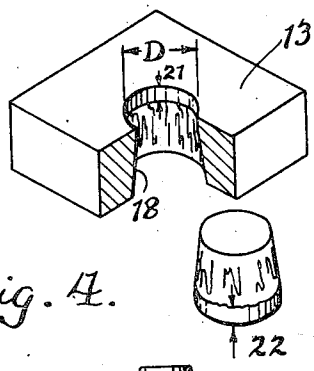


Fig. 4.

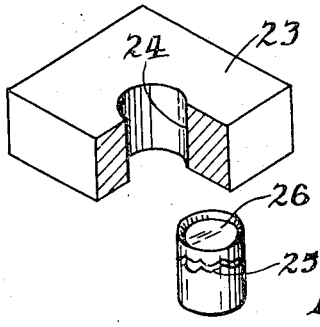


Fig. 5.

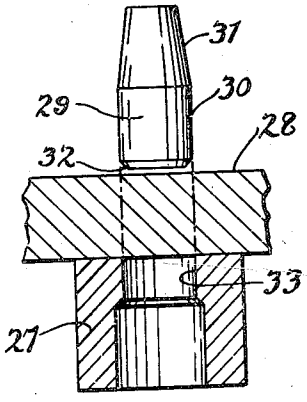


Fig. 6.

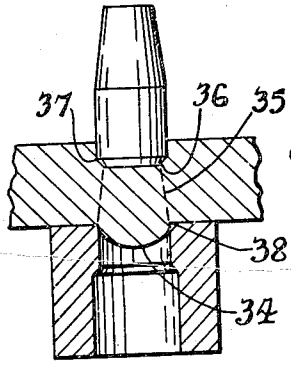


Fig. 7.

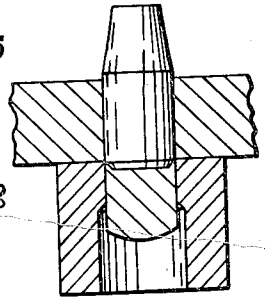


Fig. 8.

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Fig. 9.



Fig. 10.

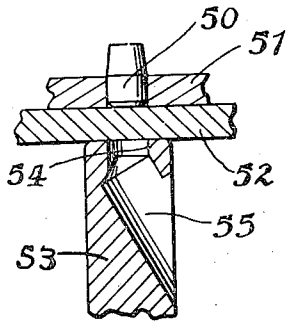


Fig. 11.

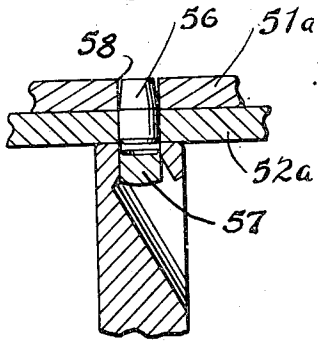
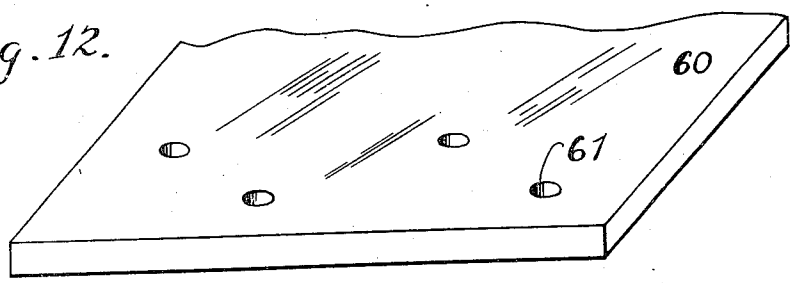


Fig. 12.



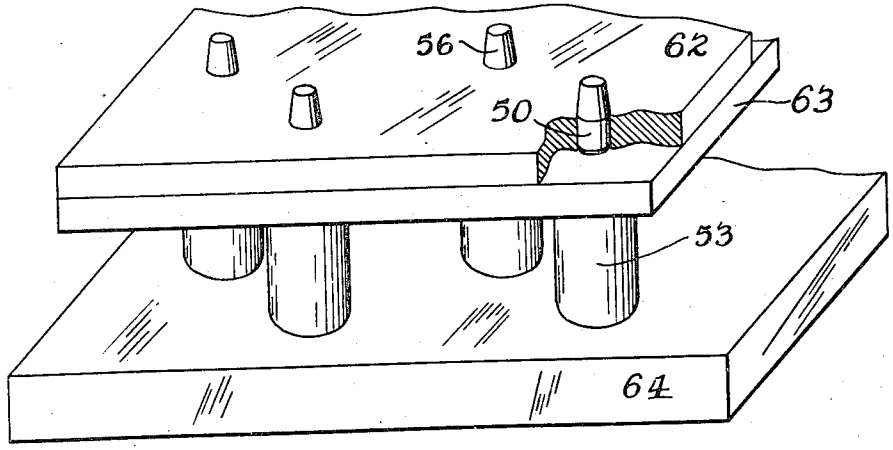


Fig. 13.

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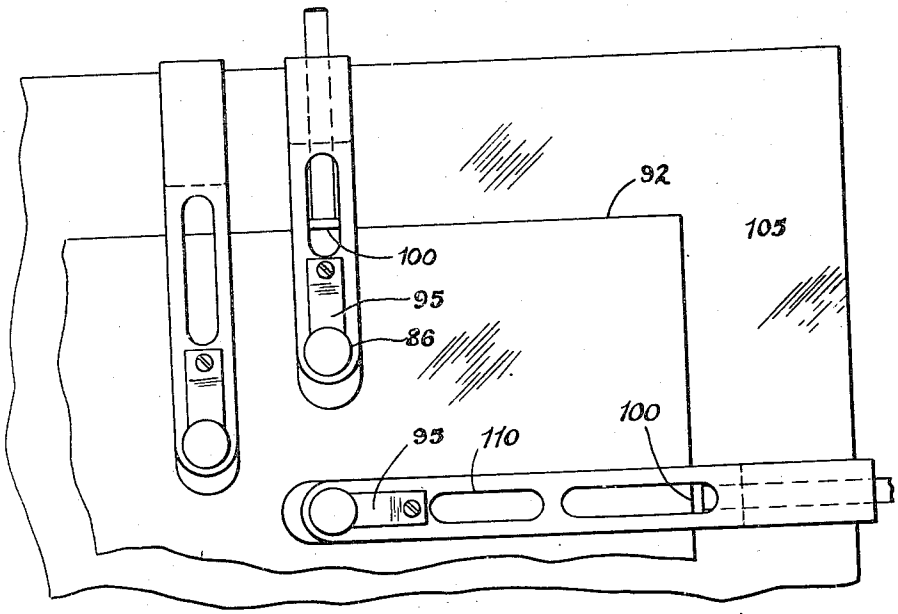


Fig. 14.

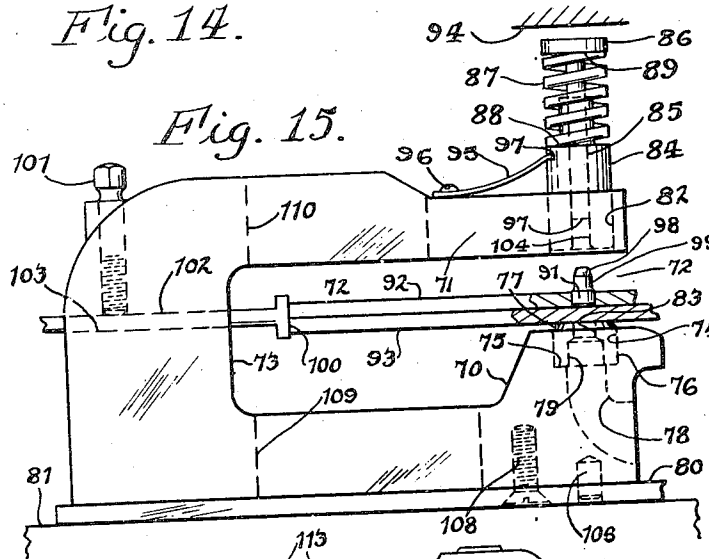


Fig. 15.

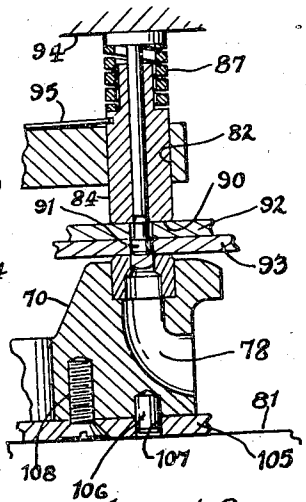


Fig. 16.

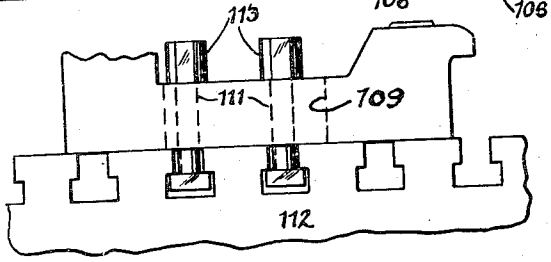


Fig. 17.

INVENTOR.

George F. Wales

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INVENTOR.

George F. Wales.

Patented Apr. 29, 1947

2,419,862

UNITED STATES PATENT OFFICE

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METHOD OF AND APPARATUS FOR PUNCHING BY TRANSFER MEANS

George F. Wales, Kenmore, N. Y.

Application April 29, 1944, Serial No. 533,270

51 Claims. (Cl. 164—94)

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This invention relates to a method and apparatus for punching holes in metal members such as sheets, plates, bars, structural steel shapes, rails and the like, although the same may be used in making holes or openings in any other material to which the method and elements may be adapted.

For the purpose of describing this invention I show in the figures of the drawings the method as applied to flat parts made from sheet metal.

To punch a hole in a piece of metal requires four things, namely a punch to be forced through the metal, a means to force a punch through metal, a companion die into which the slug is pressed as the punch forces it from the metal, and a means for removing the punch from the metal.

To force a punch into the metal is primarily a question of having sufficient power to do it. Other considerations are that the punch must be hardened properly; it must not be too small in diameter in relation to its length; it must not be too small in diameter in relation to the thickness of metal it is to be forced into; it must be supported properly at the working end to prevent bending; and it must be guided in proper concentric relation to the cooperating opening in its companion die.

The prime considerations as far as the die is concerned are that it must be hardened properly; cutting edges must be sharp; escape passage for slugs must be provided; and the diameter of the cutting edge must be greater than the diameter of the punch by a percentage of the thickness of the material to be punched which varies anywhere from 1% to 25% depending on the kind and hardness of the metal.

In punching soft steel for instance it is usual practice among die engineers to allow a difference in diameter of from 5% to 10% of the thickness of the steel. By way of example if a round punch having a diameter of .500" were to punch soft steel ¼" thick the die opening would be made from .512 to .525 in diameter. Whether .512 or .525 depends upon whether or not it is desirable to use less power for forcing the punch into the metal. Most presses have an abundance of power and it is unnecessary to consider this question unless hundreds of holes are to be punched at one time. Cleaner holes, that is, holes free from burrs, will be punched in soft steel if, in the example, the die diameter is .512. To make the die diameter .525 however, has the advantages of making it easier for the punch to penetrate the steel and also easier to withdraw the punch

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from the metal, but a little more burr will be apparent than if the .512 die were used.

When punching a soft steel work-piece the punch penetrates into the metal approximately one-quarter of the thickness before the pressure becomes great enough to shear the slug out and generate the hole. If in the example, the die clearance should be decreased to say .501, various difficulties would result. This would have the effect of trying to force the punch almost into the solid metal and would cause punch breakage, severe wear, and the punch would be gripped so tightly by the work-piece that the relative stripping power required would be enormous. On the other hand, if the die clearance were increased to say .550 the operation would be easier on punching and stripping but too much burr would be present on the die side of the work-piece.

In punching a hard steel work-piece ranging from a carbon content of from .45 to .75 the die clearance may be as high as 30% of the thickness of the steel and good results obtained. This is due to the metal being so hard that the punch does not penetrate it before the shearing takes place. The metal resists such penetration until the pressure becomes so great that the slug breaks out almost completely through the work-piece. A 30% die clearance here makes for easier operation on the punch and die elements, and for easier stripping. Practically no burr results as the metal is too hard to be drawn into the die opening.

The removal of the punch from the work after it has penetrated same is one of the major problems of punching. If soft steel is punched without sufficient clearance, i. e., the difference in diameters of the die opening over the punch, the power required to withdraw the punch out of the metal is relatively enormous. This is made considerably easier by increasing the clearance. Stripping however, is still a problem especially when holes of small size, in relation to the thickness of the work, are punched, because stripping is frequently responsible for broken punches and broken stripping springs. Punches are usually withdrawn from the work by stripping mechanisms actuated by springs or by a solid bridge-type stripper and as these mechanisms are especially designed for each job there are expensive and time consuming problems of designing, building and assembling which are tremendous.

The principal object of this invention is to provide a method of punching a plurality of holes in metal by a process of transferring a multi-

plicity of punch mediums from one work-piece to another, whereby the punch mediums are placed in the first work-piece, then this work-piece is placed in contact with another work-piece which is to be punched, then the two pieces together are placed on die members with the piece to be punched adjacent the die members and then the punch mediums are transferred from the first work-piece to the second under pressure, thereby leaving the first piece with punched openings in it and free to be removed, after which a third work-piece is placed under the second and the transfer process continued.

It is another object to disclose the principle by which a multiplicity of punch bits lodged in a work-piece may be justified for axial alinement with their companion die apertures, as a group, so that when force is applied to the bits to transfer them into a new work-piece, satisfactory slugs will be punched out of the work-piece into the die apertures and the holes will be properly located in the work-piece.

Another object of this invention is to provide the work-engaging end of a punch with a taper form for the purpose of presenting a face of reduced area to the work so that, as the end is driven into the work to a fracturing penetration, it first fractures a slug from the work, in cooperation with a die aperture larger than said reduced area, which results in an excess of material being left in the hole ahead of the taper of the punch; then, as the punch is forced to continue through the material, the taper either shaves the excess of material out of the hole, as it is being formed to size by the body of the punch, or presses the excess outwardly into the wall of the hole, depending upon whether the end is provided with an obtuse included angle of taper, for shaving the material out of the hole, or with an acute included angle of taper, for pressing the material by radial dispersement into the wall of the hole.

Further objects of this invention are to provide a method of punching holes in sheet metal members whereby all stripping problems are eliminated; whereby holes of smaller diameter than the thickness of the material may be punched; whereby straight-sided holes (of the same size throughout the thickness of the material) may be punched; whereby punch cost may be reduced to a minimum; whereby bullet-like punch bits may be placed in the punching apparatus and then lodged in the first work-piece to be punched; whereby said bits after being lodged in the first work-piece are successively transferred by force from one work-piece to another thereby leaving the first piece free of said bits but with holes remaining in their stead; whereby a portion of the bit may be used as a pilot or guide to locate or justify the bit in concentric relation with the opening in its cooperating die; whereby a master pattern plate may be used to set up a job where holes are to be punched one at a time by using multiple bits; whereby punch bits may be inserted in the actuating apparatus prior to lodging them in the first work-piece; and whereby pilots on said bits projecting above a work-piece in which they are lodged are used to set up a multiplicity of adjustable operating units.

These objects and the several novel features of the invention are hereinafter more fully described and claimed and the preferred form of construction by which these objects are attained is shown in the accompanying drawings in which:

Fig. 1 is a cross-section partial view of a round punching die element and its cooperating punch as commonly used in metal punches heretofore, showing how clearance is provided between the punch diameter and die opening to punch metal such as mild steel.

Fig. 2 is a cross-section view of the round punch and die shown in Fig. 1, showing how the punch penetrates the work and bulges the under side of the metal into the die opening in the first stage of a punching operation.

Fig. 3 shows how upon continuing the pressure on the punch of Fig. 2 the punch shears and breaks the slug away from the metal and pushes it into the die opening. This view shows how the punched out slug takes a frustum-like shape with the top being the diameter of the punch and the bottom the diameter of the die opening.

Fig. 4 is a partial perspective view of a work-piece as it appears after having been punched by the conventional punch and die shown in Figs. 1 to 3 and also the slug as it appears.

Fig. 5 is a partial perspective view similar to Fig. 4 but of another work-piece showing the punched hole having straight sides as I make it by means of the present invention and also showing the resultant slug.

Fig. 6 is a cross-section view of a round punching die element, a work-piece, and the bullet-like punch bit, which is the essence of this invention, in position above the work-piece to show the action of this method in comparison with the conventional method as shown in Figs. 1, 2 and 3.

Fig. 7 is a view showing the action of the metal as my punch bit is forced into it and showing phantom lines to indicate that by providing my bit with a reduced nose the metal will shear and break in much the same manner as shown in Fig. 2.

Fig. 8 shows the punch bit after it has fully penetrated into the work and how it is held firmly in position by the straight hole it makes.

Fig. 9 is a side elevation of a preferred form of punch bit used in this method, as illustrated in Figs. 10, 11 and 13.

Fig. 10 is a cross-section view showing my punch-bit as it appears before being transferred by force from the top work-piece to the bottom one and showing how this type of punch construction results in a straight-sided straight hole through the work-piece which supports the bit throughout its thickness and thus provides a straight guide to prevent cocking of the bit during its transfer to the under piece. The die element which cooperates with the punch-bit is also shown.

Fig. 11 is a cross-section showing how the parts appear upon completion of the transfer of the punch-bit into the under piece and showing how the punch-bit is reduced at its upper end sufficiently to permit the top work-piece, which is now punched, to be removed and how the punch-bit is now in turn lodged in the straight guide which it has made in the under piece. The under piece in Fig. 11 subsequently becomes the upper piece in Fig. 10.

Fig. 12 is a partial perspective view of a flat element which may represent a template in which a plurality of punchbits are inserted to start the transfer operation or it may represent the top

work-piece after the transfer has been made as shown in Fig. 11.

Fig. 13 is a partial perspective view showing a preferred form of apparatus elements as used in my method showing how die elements are mounted on a carrier base plate—the die elements being like that shown in Fig. 10—and how the work-piece to be punched is interposed between the work-piece carrying the punch bits, and the die elements, with the punch-bits in axial alinement with the die openings.

Fig. 14 is a fragmentary plan view of one corner of the bed of a punch press showing three punch actuating and die assemblages together with a template mounted thereon in accordance with one form of this invention and showing the work-pieces engaged with positioning stops on these assemblages ready to make the transfer of the punch-bits from the upper to the lower work-piece.

Fig. 15 is a side elevation of one of the units of Fig. 14 in position between the bed and ram of a punch press preparatory to perforating the bottom work-piece by lowering the ram and causing the punch actuator to force the punch-bit from its lodging place in the top work-piece into a new one in the bottom work-piece.

Fig. 16 is a fragmentary cross-section view of the apparatus shown in Fig. 15 in its lowermost position with the punch-bit transferred into the lower work-piece.

Fig. 17 is a side elevation showing how the device is mounted on a T-slotted plate for universal adjustment when using these units for multiple punching. This is an alternate method to that shown in Figs. 14, 15 and 16 where the units are mounted on a template.

Fig. 18 illustrates the guide for a punch-bit actuating member containing one type of punch-bit clutching means.

Fig. 19 is the same as Fig. 18 showing the punch-bit clutched in the guide prior to lodging the punch-bit in the first work-piece.

Fig. 20 shows in a modification a type of punch-bit with a flat working end having sharp cutting edges.

Fig. 21 illustrates another type of punch-bit having a flat bottom but with round parting edges.

Fig. 22 illustrates a punch-bit having a round working end.

Fig. 23 illustrates how this method operates when punching thin material showing how the punch-bit is guided by a multiplicity of work-piece and shows the punch-bits in position to penetrate the bottom work-piece and simultaneously free the top work-piece.

Fig. 24 is a fragmentary side elevation partly in cross-section showing an alternative form of apparatus for punching a multiplicity of holes by my method, it being understood that although the die carrying plate and the upper punch actuating unit carrying plate are shown united at the left hand side of the view, that they are also united at righthand ends of these plates and also along the back edges if desired. This view shows the punch-bit actuating and justifying unit in an elevated position and indicates that this unit is not attached to the ram of the press. The work-piece to be perforated rests on the die elements and the work-piece which has just previously had the punch-bits lodged in it, rests on top of the work-piece to be perforated.

Fig. 25 shows the guide in its position of justifying or arranging the punch-bit in axial relation with the aperture in the die element, or in other words, this view shows the punch-bit after the justifier has corrected any misalinement between the unincorporated punch-bit and the die aperture. This is the first stage of action as the ram depresses the punch actuator as illustrated.

Fig. 26 illustrates completion of the operation whereby the punch-bit is forced out of its lodging place in the upper work-piece and into its new lodging place in the bottom work-piece whereby the upper work-piece is perforated and material is removed from the lower work-piece as the punch-bit creates its new lodging place in the lower workpiece.

This method of punching is adapted to be used in connection with any standard punch press or similar machine available which includes among other elements a lower supporting bed which is mounted on the lower part of a stationary main frame and an upper ram which is guided upon the upper part of this main frame and reciprocates vertically toward and from the bed. There are machines in which the lower part reciprocates toward and from a stationary part but in describing this invention I shall limit my remarks to the first type to avoid confusion.

Also in the drawings I confine my illustrations to showing the work-pieces as flat sheets or plates. It is to be understood that this does not limit the scope of this invention to flat work-pieces, however, and that the use of the method and mediums anticipates all other work to which they are applicable.

In the space between the bed and ram of the press, the apparatus embodying my invention is arranged and adapted to be operated, by the movement of the ram toward the bed, for the purpose of providing the force for transferring the punch-bits from one work-piece to another.

The different features of this method and related apparatus may be variously constructed and still embody the underlying principle of the invention and several examples of the mechanical devices preferred are disclosed herein.

To make the disclosure of this invention clear it is first necessary to show the factors of the heretofore used method upon which improvements have been made and which are the essence of the present patent.

Heretofore the punching of sheet metal has been accomplished by many types of punching devices. The purpose of most of these devices has been to provide better ways of punching sheet metal parts and this includes aims to punch work-pieces faster, easier or with burr free holes as well as to improve the elements of the die assemblage such as the punch, the die, the stripping apparatus, et cetera.

But in all hole punching dies heretofore used, the punch has been considered as an element which was driven by force through the work-piece and which, after the slug had been pressed into the cooperating die opening, had to be withdrawn from the work-piece or "stripped" as the operation is termed in the art. It is the general opinion among die engineers that more small punches are broken in stripping than in punching through the metal.

There have had to be, however, a number of factors considered in designing a punch. First, the working end of a punch had to be as short as possible to provide resistance to bending. A punch ¼" long and ⅛" in diameter would resist bending successfully if pressed into a ¼" plate, whereas a punch 1" long and the same diameter would bend and break shortly after be-

ing placed in operation. Various means have been devised to support long punches. Second, the punch had to be attached securely to the ram or punch carrying device so that the relatively great amount of force used in stripping would be withstood by said attachment as the punch reversed its movement of penetration to one of withdrawal.

In the following descriptions similar characters of reference indicate like parts in the several figures of the drawings.

In Fig. 1 the numeral 10 represents the attaching means by which a conventional round punch 11 is secured to the reciprocating ram of a standard punch press and B represents the diameter of the punch. Numeral 12 represents a die element having opening C for cooperation with punch 11.

Fig. 1 shows the principle of providing die clearance or the amount the opening in the die is made greater than the punch. The reason for different percentages of the thickness of the metal workpiece as translated into die clearance was explained above. By way of example however, if the thickness A of the work-piece 13 should be approximately .375 and of mild steel, judgment might be that an overall clearance between punch 11 and die opening C of 20% of said thickness would give best results. Therefore, as 20% of .375 is .075 then die opening C would equal punch size B+.075. If B were .500 then C would be .575 and the clearance between the periphery of the punch and the periphery of the die aperture, as indicated by the numerals

$$\frac{A}{X}$$

would be one half of .075 or .0375.

There is nothing arbitrary about the exact amount of clearance to allow, but the necessity for providing some clearance is well known in the art and the reason is now explained by reference to Fig. 2.

When the punch, which in this case has a flat bottom 15 and a sharp cutting edge 14 punches through mild steel, the first stage of the operation causes the punch to penetrate the metal as shown, the pressure causing the under side of the work-piece to bulge into the die opening as indicated by numeral 17 until the fracture point is reached. When this point is reached, fracture occurs along the lines 16, and the punch continues through the metal until the slug 19 has been forced out of the work-piece as shown in Fig. 3.

The letter D represents the diameter of the top of the hole formed by punch diameter B. The hole closes around the punch and is characteristically smaller than punch diameter B. This is the cause of the many problems which arise in connection with stripping the work from the punch. In other words, the metal seizes the punch and D is smaller than B by a thousandth of an inch or so and this results in a tight gripping action.

If we were to press punch 11 through the metal as shown in Fig. 3 and leave it there by disconnecting it from its attachment to the ram, then there would be no stripping problem and no mechanism required for stripping. My method of punching in effect does just this.

Before explaining my method, however, by referring to Fig. 4 we see that work-piece 13 does not have a straight sided hole through it. The removed slug 19 is the shape of a frustum except that it has a straight portion 22 caused by the

die element. The hole in the work-piece also has a straight portion 21 caused when the punch enters the metal as shown in Fig. 2 and before the shear strength of the metal is exceeded.

Now if punch 11 were allowed to remain in the work-piece as shown in Fig. 3, the enlargement of the opening as indicated by 18 would not enable the work to support the punch throughout its thickness and this is desirable as will be realized later, although my method will also be successful with this type of hole if it is satisfactory in the finished product. However, I prefer the results and type of punch which I now describe.

In Fig. 5 numeral 23 represents a work-piece having a straight sided hole 24 throughout which is the more desirable type of hole for all purposes. 25 is the slug which has been removed by my method and the depression 26 has been caused by one form of nose on my punch implement as I shall now describe it.

In Figs. 6, 7 and 8 I disclose the fundamental principle of my invention whereby 27 is the die element, 28 the work-piece of mild steel or its equal and 29 the punch-bit which is the essence of my invention. These figures are explanatory rather than to show the elements in operation as this will come later.

In this method I am concerned only with forcing the punch-bit into the work-piece for the present and leaving it there as shown in Fig. 8. Later I shall remove the bit in a novel way and the work-piece will then be punched and have an open hole or holes in it which is, of course, what I am trying to accomplish.

As shown in Fig. 6, punch-bit 29 is in axial alinement with the opening 33 in die element 27 and work-piece 28 is interposed between.

In order to punch a straight sided hole through the work-piece, I provide practically no die clearance and die aperture 33 is therefore substantially the same diameter as the straight portion 30 of the punch-bit. Straight portion 30 of the punch-bit is approximately as long as the work-piece is thick so that it does not project objectionably above the top face of the work-piece when in the position illustrated in Fig. 8.

While conventional punches have heretofore been provided with the sharp cutting edges 14 as shown in Fig. 2 and die clearance has therefore been necessary, I overcome this die clearance need by providing my punch-bit with a chamfer as shown at 32 Fig. 6. As will be seen in Fig. 7 as I force my bit into the work, the under side 34 of the work bulges into the die aperture until the breaking point is reached at which time the break takes place as indicated by line 35 from 36 to 38 and this gives the same effect as if a die clearance as shown in Fig. 2 were provided. As the punch-bit continues downward taper 32 presses and edge 37 shaves the excess material out of the hole when the taper has an obtuse included angle but when the taper has an acute included angle, or the edge rounded, the excess material is pressed outwardly into the wall of the hole. In either case, by the time the bit is pressed into the work a sufficient distance to remove the slug therefrom, as shown in Fig. 8, the bit is tightly held in the work.

Having thus described the fundamental idea upon which my invention depends, I shall now describe how it is used in the production of parts.

In Fig. 9 is shown a punch-bit which is made according to the requirements explained above and which is illustrated in Figs. 10, 11 and 13.

In Fig. 10 the numeral 50 represents the punch-bit, 51 the cover piece in which the punch-bit is lodged, 52 the work-piece to be punched, 53 the die element, 54 the die aperture and 55 the slug clearing passage.

51 may be the first piece of a run and in order to lodge the punch-bit in it as shown in Fig. 10, it may be necessary to drill a hole and press the bit into the hole as shown. Or 51, for the first piece, may be a master template with a hole in it of a size to accommodate the punch-bit. Or as explained later, the punch-bit may be placed in a holder and driven into the position shown in Fig. 8 in the first piece of a run. In Fig. 10 assuming that the hardened punch-bit 50 is lodged in work-piece 51, and that 51 rests on work-piece 52, which in turn rests on die element 53, and assuming that punch-bit 50 is in axial alinement with die aperture 54, then by applying sufficient pressure on the top of the punch-bit, it is forced into the new work-piece as shown in Fig. 11. The operation forces slug 57 into the die aperture and leaves the punch-bit in work-piece 52*a* which is work-piece 52 of Fig. 10 after the punch-bit has been pressed into it. In Fig. 11 the slug is shown lower than in practice for explanation purposes as normally the slug would be in contact with the punch bit. 51*a* represents work-piece 51 of Fig. 10 after the bit has been pressed out of it and it will now be clear that completed piece 51*a* may be removed as the upper portion 56 of the bit is reduced for the purpose of freeing same from the hole 58.

The above description explains the basic principle involved in this invention whereby a punch-bit is transferred from one work-piece to another by pressing it always in the same direction rather than having to remove the punch element by pulling it in the opposite direction to strip it from the work-piece as has heretofore been the practice.

I have described above the method as it applies to forming a single hole in a work-piece.

The more important value of this method, however, is in the punching of a multiplicity of holes in a work-piece.

Fig. 12 illustrates a small portion of work-piece 60 having four holes 61 formed in it which is the way work-piece 62 of Fig. 13 will appear when the four punch-bits 50 are pressed out of 62 into 63.

After the punch-bits 50 are transferred from 62 into 63 the finished work-piece is free and may be removed. The punch-bit upper portions are relieved as indicated by numeral 56 so that the punch-bits no longer bind in holes of the plate from which they are transferred.

Fig. 13 is a diagrammatical view which illustrates how a new work-piece 63 is inserted under the work-piece 62 which has just previously received the punch-bits. Work-piece 63 is located above the die apertures properly by gaging means not shown in Fig. 13 and the punch-bits are located in axial alinement with the apertures 54 in die elements 53 by means which are described later.

64 represents a die element holding plate which securely holds the die elements in proper relation to one another. This diagrammatical view is for the purpose of illustrating the principle involved in punching a multiplicity of holes and omits certain details necessary to make it an operable device but these will be disclosed in the following description.

In Fig. 15 the numeral 70 represents the lower

base or shoe and 71 the upper head or horn which form the main parts of a holder whereby the operating parts of the punch actuating and die device of my invention are supported. This base and head are stationary while in use and are separated at their inner opposing ends by an intervening gap 72 while their outer ends are held apart from each other by column 73.

In the outer part of the upper side of the base 70 the same is provided with an upwardly opening seat or socket 74 which is preferably of cylindrical form and terminates at its lower end at a shoulder 75 and in this seat is arranged a perforating die 76 which rests at its lower end on the shoulder 75 and has its upper end preferably projecting slightly above the upper side of the base 70 and tapering upwardly as shown at 77.

In the lower part of the inner edge of the base the same is provided with a discharge chute or slug passage 78 which opens at its upper end into the bottom of seat 74 so as to communicate with the lower end of the die opening 79, while lower end of the chute 78 extends outwardly and terminates at the outer end of the base as shown in Figs. 15 and 16, so that any slugs which are removed from the sheet material downwardly into the opening 79 of the die and discharged from the lower end of the latter, are received by this discharge chute and delivered on the upper side of the template 80 or bed 81.

By extending the die 76 above the base of the holder, the die may be sharpened at the top when the same becomes worn dull.

The outer part of the head 71 of the holder is provided with a vertical guide-way 82 of circular form which is axially in line with the opening 83 in the die. Within this guide opening 82 is arranged a punch actuating unit which is so engaged that the same is capable of sliding vertically in this opening toward and from the die 76 and adapting the same to the upper surface of the work-piece which carries the punch-bit lodged in it, and also to permit of driving said punch-bit downwardly into the lower work-piece, and also to enable this punching device to be removed as a unit from the head of the holder and replaced by one having a different size of punch actuator. The particular organization of this device as shown in Figs. 14, 15 and 16 is constructed as follows:

The numeral 84 represents a tubular punch guide which is preferably cylindrical in shape and which slides in the guide opening 82. Within the punch guide is arranged the punch actuator which has a cylindrical body 85 sliding vertically therein. The upper end of the punch actuator has an enlarged head or anvil 86. The upper part of the punch actuator 85 is surrounded by a pressure element such as helical spring 87, which bears with its lower end against the upper side 88 of the guide 84 while its upper end bears against the under side 89 of punch head 86. This spring 87 tends to lift the punch actuator relative to the punch guide and also serves to cause the bottom of the punch guide 90 to press on the work-piece while punch-bit 91 is transferred from the top work-piece 92 to the bottom work-piece 93 as shown in Fig. 16. The upward movement of the punch actuator away from the punch guide is limited by the free length of spring 87. This punching unit is capable of floating within the guide opening 82 in the head or horn of the holder. When the press is not in operation the ram 94 is not in contact with any portion of the apparatus. When not in operation the punch

guide 84 is held in an upward position so that its lower end 90 is separated by an intervening gap 72 from the top surface of the die 74 to allow for insertion of the work. This lifting action is produced on the punch guide by any suitable means as for instance, a light lifter spring 95 which is of leaf shape and secured at one end to the top of the holder with screw 96 and engaged with its other end in a slot 97 in the punch guide.

The spring 95 is comparatively light and only of sufficient strength to hold the entire punch actuating unit in its elevated position when the press is not in use and thereby retain the under side 90 of the guide 84 approximately flush with the under side of horn 71 so as to permit free introduction and removal of the work-pieces 92 and 93 together with punch-bits 91.

As a means of properly locating the work-pieces with reference to the punching mechanism a gage rod 102 is provided which in this instance is a round bar having a head faced for engagement with the work-pieces as indicated by numeral 100. Gage rod 102 is adjusted horizontally in a bored hole 103 in the rear portion of holder 73, said rod being locked in position by a set screw 101 arranged on the holder. While it is generally necessary to use at least three gage rods to locate the work-pieces properly, it is obvious that as many may be used as desired.

As punch-bit 91 is lodged in work-piece 92, and this assemblage is placed on work-piece 93 which combination is placed on dies 76 as shown in Fig. 15, it is obvious that any means which might locate the work-pieces by engaging their edges, would not assure punch-bit 91 being in axial alinement with die aperture 83. It is essential that the punch-bits and die apertures be in axial alinement and to assure this I provide an adjustment means which I refer to as a "justifying" means. In this means I provide a pilot 99 on the punch-bit having a leading bevel 98 at its uppermost end so that when the punch actuator guide 84 is pressed downwardly, opening 104 engages the guide portion 99 of the punch-bit and corrects any slight mis-positioning which might need correction. Thus it is always necessary that gage faces 100 be slightly further away from the axis of the die than is the requirement, as obviously the corrections cannot be made by requiring the justifying means to shift the material against the gage faces. The shift must be so that binding does not occur between the justifying means and the gages.

In the plan view as shown in Fig. 14, three holders are shown mounted on a template 105 and although only two gage faces 100 are shown, it is usually necessary to use three or more.

Fig. 16 illustrates the device in its lowermost position, which position is reached when the bottom of the punch-bit 91 is approximately flush with the lower face of work-piece 93 although in some cases the bit may extend below if desired. The working diameter of punch-bit 91 is preferably as long as the thickness of the work so that when the punch-bit is forced into work-piece 93 a reduction 99 in the diameter of the punch-bit frees work-piece 92 which is then perforated. To continue production, the punch-bits are now lodged in work-piece 93 which is placed on another work-piece and the process repeated again and again the punch-bits being transferred from one work-piece to another.

To locate the holders on templates 80 as desired, the holders 70 are provided with pilot pins 106 which engage holes 107 bored to a pattern in conformity with which a counterpart is to be punched and the holders are held in position by means of screws 108 as shown in the drawings.

Fig. 17 shows an alternate mounting in which holders are provided with elongated slots 109 through which T-bolts 111 may be inserted into T-slots in plate 112 to provide universal adjustment of these devices when used in multiples. Slot 110 in the upper arm of the holder makes it possible for a wrench to be inserted therethrough for the purpose of tightening nuts 113 when clamping the holder to the T-slotted plate.

It was stated above in describing Fig. 6 that means would be described whereby the punch-bit 30 as shown in Fig. 6 would be accurately positioned in axial relation to die aperture 33.

One way of accomplishing this is as shown in Figs. 18 and 19 wherein 120 represents a guide for punch actuator 121, and 122 an expansion spring or ring which contracts sufficiently to hold punch-bit 30 in the muzzle of said guide. As this method consists in transferring the punch-bit from one work-piece to another it is, of course, necessary to place the multiplicity of punch-bits properly in their relative locations in a first work-piece before the transfer to another work-piece can commence. These punch-bits may be put into position in the first work-piece by any means such as by drilling and pressing the bits into the drilled hole. However, I prefer to place a punch-bit in each of the actuator guides as shown in Fig. 19 so that by placing only the first work-piece to rest on the die elements, the device is actuated and the punch-bits remain lodged in the work-piece after the stroke of the ram. From then on the operation proceeds as explained above or as shown in Figs. 24, 25 and 26 with the bottom piece of Fig. 26 of each operation becoming the top piece of Fig. 24 and repeating this procedure until all the required number of work-pieces have been perforated.

At the completion of the run, the punch-bits may be pressed out of the last work-piece by placing any one of the finished work-pieces on top of the punch actuators 135 so that when the ram makes its final stroke it pushes the punch-bits out of the final work-piece after which the punch-bits may be removed from the die apertures and be ready for use in another set-up.

I prefer, however, to allow the punch-bits to remain lodged in the last work-piece of a run and then to store the final piece and punch-bit combination so that when an additional run of counterparts is to be made, it will only be necessary to draw the plate from its storeroom and either set up the adjustable individual units previously described and shown in Figs. 15 and 17, or to use any other type of device such, for example, as that shown in Fig. 24.

In Fig. 19 the numeral 123 represents a space between the bottom face 124 of the actuator and the upper face of the punch-bit. I prefer to provide this gap so that spring 125 in Figs. 24 to 26 will press upon guide 120 which in turn will apply pressure on the work-pieces before the punch-bit starts to move. This principle is shown in Fig. 25 as it relates to the transferring of punch-bit 30 from work-piece 62 to work-piece 63 and shows how the pressure is applied in this case.

As shown in Fig. 24 numeral 126 represents the upper plate which carries the punch actuating and justifying unit, 127 represents the lower plate which carries die elements 53, and 128 represents one of a number of spacer bars which tie 126 and 127 together by means of screws 129 or

any other means. 130 represents one of a multiplicity of gage pins against which work-pieces 62 and 63 are positioned so that the holes will be in their proper locations in relation to the edges of the work-pieces. In practice, the edges of work-pieces are never quite accurately made, principally because of burrs which result from shearing and blanking operations. These burrs do not occur the same on any two blanks and although usually slight, it would be sufficient to cause the punch-bits 30 to be slightly out of axial relation with their die apertures 33 if location of the work-pieces by edges were attempted. I therefore position these gage pins 130 slightly further away from their exact position so that the work-piece carrying the punch-bits may be free to move slightly in any direction as required by the justifying device which is described as used in Figs. 24 and 25 as follows.

The lower portion of the guide 120 is provided with an opening 131 which is in axial alinement with die aperture 33. Punch-bits 30 are provided with tapering frustum-like tail pieces 31. The upper diameters 132 are sufficiently smaller in diameter than the openings 131 so that when guides 120 are depressed by ram 133, openings 131 will engage the tail pieces 31 of the punch-bit and cause the entire upper work-piece 62 to shift slightly so that the punch-bits will be in axial alinement with the die openings. In order to accomplish this, of course, the diameter of the hole 131 in guide 120 must be the same diameter as the straight diameter of the punch-bit and in order to assure proper justifying, I prefer to allow the straight diameter of punch-bit 30 to remain slightly above the upper face of work-piece 62 so that diameter 131 will engage a full diameter of punch-bit 30.

Fig. 25 shows a work-piece 62 after the punch-bits have been justified and just before the punch actuators 121 engage the punch-bits.

Before ram 133 contacts the upper face 135 of the punch-bit actuator, it will be seen in Fig. 24 that the punch actuating and justifying units are held in an elevated position in relation to carrying plate 126, this being accomplished by means of light lifter springs 136 which surround guides 120 and are attached thereto by means of hooks 137 which engage holes in said guides.

After the punch-bits have been justified as shown in Fig. 25 ram 133 continues its downward motion and forces the punch-bits into lower work-piece 63 forcing slug 138 into the die aperture whence it is pressed from the die element 53, by other slugs not shown, and escapes by means of a suitable passageway similar to 139.

After the punch-bits are transferred into the lower work-piece, the ram ascends and the punch actuating units rise to the position as illustrated in Fig. 24, after which the upper piece which is now completely perforated, is removed and another piece inserted under the remaining work-piece which now carries the punch-bits and the operation is repeated as many times as there are work-pieces to be run.

It is to be noted that lifter springs 136 are of light weight in order that little downward pressure be exerted on upper plate 126 as the ram depresses the units, but that springs 125 are much stronger as they must exert considerable pressure on sleeve 121 to enable it to perform its justifying function and also to put pressure on the work-pieces to hold them steady while the operation is being performed.

When punching holes in work-pieces which are thinner than the main diameter of the punch-bit is long, then I prepare a sufficient number of work-pieces 140 to carry the punch-bit as shown in Fig. 23. I then place this multiplicity of sheets and the multiplicity of punch-bits on the work-piece 141 and then place this combination in the punch actuating and justifying devices, after which the punch-bits are pressed only through the one work-piece 141 which action frees the upper work-piece 140 and the process is repeated until the number of workpieces are completed.

As it is obvious slight changes may be made in the shapes and contours of the various punch-bits, it is to be understood that this invention anticipates all of them and in Figs. 20 to 23 inclusive, I show four variations wherein numeral 141 shows the sharp cutting edge as used in the conventional punch of Fig. 1. 142 represents a rounded parting edge which causes the metal to break as shown in Fig. 7 and in some metals may be required to burnish the hole. 143 is a round bottomed punch which may be required for punching of soft materials and burnishing the hole.

Having thus described my invention disclosing a method of punching holes in materials it is to be understood that the method may be adapted to large holes or irregular shapes of blanks and the like and this invention applies to anything wherein a punch medium is lodged in one member and then transferred under pressure from said member to a counterpart.

Although the forms shown in the drawings represent practical embodiments of the operating devices for my invention it is also to be understood that the same may vary as to details and still contain the essence of my improvements as summed up in the following claims.

I claim:

1. A method of manufacture consisting of transferring a plurality of punch mediums by pressure from their lodging places in one work-piece into lodging places which they form in a second work-piece.

2. A method of punching consisting in lodging a plurality of traveler punch-bits in a first work-piece, then forceably transferring said bits from one work-piece to another whereby a multiplicity of holes are left in each work-piece from which said punch bits travel.

3. A method of punching a multiplicity of holes consisting in lodging a plurality of traveler punch-bits in a first work-piece then forceably transferring said bits from one work-piece to another whereby a multiplicity of holes are left in each work-piece from which said punch-bits travel, and whereby said last work-piece of a run receives said punch-bits and retains them in readiness for the start of a subsequent run.

4. In a method of manufacture consisting in transferring a plurality of tool mediums from their lodging place in one work-piece to a second work-piece, the step of causing said mediums to form lodging places for themselves in said second work-piece by forcing material out of it and into receiving mediums.

5. A method of multiple punching consisting in lodging a plurality of punches in a work-piece, placing said work-piece and lodged punches on a second work-piece, placing said work-pieces including said punches on a plurality of die elements with said punches in axial relation to said die element apertures and with said second work-piece interposed between said punch and die elements and then applying pressure on said

punches whereby same are transferred from their lodging places in the first work-piece to the second work-piece while simultaneously removing material from said second work-piece and forcing said material into said die apertures to form lodging places in said second work-piece and thereby form holes in said first work-piece.

6. A method of punching a multiplicity of holes in a member consisting in placing a traveler punch-bit in each of a plurality of retainers resiliently suspended above said member, driving said punch-bits into said member, driving the slugs formed by said punch-bits into companion die apertures, whereby said punch-bits remain in said member until subsequently removed by transferring them to a receiving medium whereby holes are left in said member.

7. A method of punching a multiplicity of holes in a member consisting in placing a traveler punch-bit in each of a plurality of retainers, driving said punch-bits into said member, driving the slugs formed by said punch-bits into companion die apertures, whereby said punch-bits remain in said member until subsequently removed by driving them from said member and lodging them in another member whereby holes remain in said first member.

8. A method of manufacture consisting in transferring a punch medium by pressure from its lodging place in one work-piece into a lodging place which it forms in a second work-piece.

9. A method of punching consisting in lodging a punch-bit in a first work-piece, then forceably transferring said bit from one work-piece to another whereby a hole is left in each work-piece from which said punch-bit is transferred.

10. A method of punching consisting in lodging a punch-bit in a first work-piece, then forceably transferring said bit from one work-piece to another whereby a hole is left in each work-piece from which said punch-bit is transferred, and whereby said last work-piece receives said punch-bit and retains it in readiness for a future continuation of use.

11. In a method of manufacture consisting in transferring a tool medium from its lodging place in one work-piece to a second work-piece, the step of causing said medium to form a lodging place for itself in said second work-piece by forcing material out of it and into a receiving medium.

12. A method of punching consisting in lodging a punch in a work-piece, placing said work-piece and lodged punch on a second work-piece, placing said work-pieces including said punch on a die element with said punch in axial relation to said die element aperture and with said second work-piece interposed between said punch and die elements and then applying pressure on said punch whereby same is transferred from its lodging in the first work-piece to the second work-piece while simultaneously removing material from said second work-piece and forcing said material into said die aperture to form a lodging for said punch.

13. A method of punching consisting in placing a punch-bit detachably in a reciprocatory retainer, driving said punch-bit into a work-piece, driving the slug formed by said punch-bit into a die, whereby said punch-bit remains in said work-piece until subsequently removed by transferring it to a receiving medium whereby a hole is formed in said work-piece.

14. A method of punching consisting in placing a punch-bit detachably in a retainer, driving said punch-bit into a work-piece, driving the slug formed by said punch-bit into a die, whereby said punch-bit remains in said work-piece until subsequently removed by driving it from said work-piece and embedding it in another like work-piece, thereby leaving a hole in said first work-piece.

15. A method of punching an opening in a sheet of material whereby a punch-bit is transferred under pressure from one sheet to another.

16. A method of punching openings in sheets of material whereby punch-bits are transferred under pressure from one sheet to another remaining in the second sheet and being cleared from the first sheet.

17. A method of punching consisting in providing a short punch-bit, embedding said bit in a first piece of material placing said material and bit in contact with a counterpart, then pressing said bit through said first piece into said counterpart whereby said first piece is punched and said counterpart has the punch-bit embedded in it.

18. A method of punching consisting in pressing a reduced work-engaging end of a punch implement against a member positioned on a companion implement, having a die aperture, until said punch implement end causes material to fracture from said member into said aperture after which the punch implement end, formed for the purpose to an acute included angle of taper merging into the periphery at a distance less than the thickness of the member, displaces any excess material remaining within the opening caused by said fracture, by radial dispersement.

19. A perforating punch for passing through work, said punch having its pressing and breaking end shaped to present a face of reduced area to the work in advance of the unreduced periphery, said end being of frusto-conical form merging into said unreduced periphery at a distance less than the thickness of the work and said periphery being of the proper size to form the hole to the desired dimension.

20. A punch-bit comprising a straight parallel-sided center section, a trunco-conical working end and a trunco-conical anvil end.

21. In a press having a stationary bed and reciprocating ram a sheet material perforating apparatus comprising a holder having a lower base and an upper head, a perforating die mounted on said base, a punch-bit interposed between said die and upper head and a punch-bit locating and actuating device mounted and guided on said head said holder being mounted on said bed and said device being actuated by said ram.

22. A sheet material perforating apparatus comprising a holder having a lower base and an upper head, a perforating die mounted on said base, a punch-bit lodged in a work-piece interposed between said die and upper head and a punch-bit locating and actuating device mounted and guided on said head in such manner that with the application of force on said device said punch-bit is transferred into a second work-piece interposed between said first work-piece and said die.

23. A sheet material perforating apparatus comprising a holder having a lower base and an upper head, a perforating die mounted on said base, a punch-bit lodged in a work-piece and positioned on a second work-piece with both of said work-pieces interposed between said die and upper head and a punch-bit justifying and ac-

tuating device mounted and guided on said head.

24. A sheet material perforating apparatus comprising a holder having a lower base and an upper head, a perforating die mounted on said base, a punch-bit lodged in a first work-piece and positioned on a second work-piece with both of said work-pieces interposed between said die and upper head, a punch-bit justifying means for arranging same in axial alinement with a cooperating aperture in said die and means for pressing said punch-bit from its lodging place in said first work-piece and into a new lodging place in said second work-piece whereby a hole is left in said first work-piece.

25. A sheet material perforating apparatus for use between the bed and ram of a press, comprising a holder having a lower base and an upper head, a perforating die mounted on said base, and a punch actuating device mounted and guided on said head as a unit, which unit is capable of being freely assembled with said head and removed therefrom and is also capable of floating freely on said head and including a punch actuator cooperating with a punch element which cooperates with said die and a spring lifting means for lifting said device above said sheet.

26. A sheet material perforating apparatus for use between the bed and ram of a press comprising a unitary holder having a lower base and upper head, a perforating die mounted on said base and a punching device movably mounted and guided on said head as a unit and including a punch-bit actuator adapted to force an independent punch-bit into cooperation with said die and a pressure device for holding said material and justifying said punch bit into coaxial relation with said die.

27. A sheet material perforating apparatus for use between the bed and ram of a press comprising a holder having a lower base and upper head, a perforating die mounted on said base and a punching device removably mounted and guided on said head as a unit and including a tubular punch-bit justifying member slidably mounted in a vertical guideway in said upper head, a punch-bit actuator arranged lengthwise in said member and having an outer head, a pressure spring interposed between said head and member and an elevating device to maintain said unit in an elevated position.

28. A sheet material perforating apparatus for use between the bed and ram of a press comprising a holder having a lower base and upper head, perforating die mounted on said base and punching device movably mounted and guided on said head as a unit and including a tubular punch-bit justifying member slidably mounted in a vertical guideway in said upper head, a punch actuator arranged lengthwise in said member and having an outer head, a pressure spring interposed between said head and member and an elevating device to maintain said unit in an elevated position, said member being provided at its lower end with an accurately formed internal opening which engages with an upwardly extending part of a punch-bit to adjust said punch-bit into coaxial alinement with the cooperating aperture in said die.

29. A sheet material perforating apparatus according to claim 28 in which the holder is provided with an adjustable work-piece stop arranged at a distance slightly more remote from the axis of said die aperture than the distance desired between the stop engaging part of the work-piece and the axis of the opening to be made so that when justifying the punch-bit the work-piece moves away from said stop.

30. A sheet material perforating apparatus according to claim 28 and means for adjustably connecting each holder with the bed of the press comprising clamping bolts passing through said holder and engaging their heads with T-shaped grooves in the bed and provided with nuts engaging the clamping surface on said holder.

31. A sheet material perforating apparatus for use between bed and ram of a press comprising a plurality of perforating devices adapted to rest on said bed and each having a lower die and an upper punch-bit actuating and justifying device cooperating with a punch-bit and its respective die, a template connected with each holder in alinement with the axis of the respective die thereof, and means for retaining the several holders in a definite position relatively to each other and gauging the sheet to be perforated.

32. A sheet material perforating apparatus for use between the bed and ram of a press, comprising a plurality of punch-bit actuating device holders each of which is provided with a die and a punch-bit actuator cooperating with a punch-bit separate from said device, and a template for definitely locating the several holders relatively to each other so that the die and punch-bit actuator of each holder registers with one of the punch-bits lodged in a work-piece in one of the places where said punch-bit is to be transferred into a work-sheet.

33. A sheet material perforating apparatus according to claim 32 in which the multiplicity of punch-bits in a work-piece are justified in relation to their respective die apertures by causing the entire work-piece to shift and result in mass justification of all of said punch-bits.

34. A perforating apparatus according to claim 32 in which said template is secured to the underside of the several holders and provided with a plurality of pilot openings each of which receives a pilot pin arranged on the underside of each holder in axial alinement with the die and punch actuator thereof.

35. A perforating device comprising a holder having a lower base and an upper head which are separated to form a gap for the reception of a pair of work-pieces, one of which has a punch-bit lodged in it, the other is to have said punch-bit transferred into it, a die element mounted on said base, and a punch-bit justifying element and actuator mounted on said head and cooperating to produce a hole in one of said work-pieces by forcing said punch-bit from it and lodging said bit in the other of said work-pieces arranged within said gap.

36. A multiple hole perforating device comprising a plurality of holders each having a lower base and an upper head which are separated to form a gap for the reception of a pair of work-pieces, one of which has a plurality of punch-bits lodged in it, the other is to have said punch-bits transferred into it, a die element mounted in each base and a punch-bit justifying element and actuator mounted on each head and cooperating to produce holes in one of said work-pieces by forcing said punch-bits from it and lodging them in the other of said work-pieces arranged within said gap.

37. A method of perforating work which includes simultaneously forming holes in a pair of plates while secured in spaced relation to one another, the holes being arranged according to

a pattern with which a counterpart is to be punched, then placing die units tightly into the holes of one plate and punch-bit actuating units into the holes in the other plate, then placing the assemblage into a press and positioning a pair of work-pieces between said plates, one of said work-pieces having punch-bits lodged in it according to said pattern and the other resting on said die units then moving the actuating units relative to their plate toward the units of the other plate by means of the ram of the press to transfer said punch-bits from the one work-piece into the other.

38. A method of perforating work according to claim 37 in which the punch-bits are justified into coaxial relation with their die apertures prior to the transfer of said bits.

39. A perforating apparatus for use in a press having a stationary bed and a ram movable toward and from the bed and including a pair of flat plates spaced apart and held in fixed relation to each other and having holes therein, die elements arranged in the holes of one of said plates and punch-bit justifying and actuating units in the holes of the other plate, each punch-bit justifying means being in axial alinement with a die element, said units being slidable in the holes of their plate toward and from said die elements to arrange punch-bits lodged in one work-piece into axial alinement with their companion die elements and to actuate said punch-bits to transfer them into another work-piece interposed between said punch-bits and die elements.

40. A justifying means for a perforating device wherein a punch member which is not in axial alinement with its cooperating die member is arranged in axial alinement before the punch member is actuated to penetrate the work including a movable sleeve guided to move in axial relation to said die member and having an aperture which engages said punch to cause said alinement.

41. A punch-bit comprising a straight parallel-sided center section, a working end formed to first present to the work a portion smaller than said center section, and an anvil end having a body smaller than said center section.

42. A method of punching consisting in lodging a punch-bit in a plurality of work-pieces until the thickness of the stack equals the length of the parallel sides of the punch-bit, placing said stack and lodged punch-bit on another work-piece, placing said stack and work-piece on a die element with said punch-bit in axial relation to said die element aperture and with said other work-piece interposed between said punch and die elements and then applying pressure on said punch-bit whereby same is pressed into said other sheet while a counterpart on the opposite side of the stack is freed from said punch-bit thereby leaving an opening in said counterpart.

43. A method of punching consisting in lodging a multiplicity of punch-bits in a plurality of work-pieces until the thickness of the stack equals the length of the parallel sides of the punch-bits placing said stack and lodged punch-bits on another work-piece, placing said stack and work-piece on a multiplicity of die elements with said punch-bits in axial relation to said die element apertures and with said other work-piece interposed between said punch and die elements and then applying pressure on said punch-bits whereby same are pressed into said other sheet while a counterpart on the opposite side of the stack is freed from said punch-bits thereby leaving openings in said counterpart.

44. An apparatus for locating a punch-bit, prelodged in a work-piece and projecting therefrom, into operable position with a companion die aperture, comprising a frame having both a base, on which the die is mounted, and an overhanging head, a sleeve having an aperture for engaging said projecting punch-bit mounted on said head, for movement toward and from said die, in such manenr that when moved into engagement with said punch-bit the sleeve aperture adjusts the position of said bit into operable alinement with said die aperture.

45. A sheet material perforating apparatus for use between the bed and ram of a press, comprising a plurality of holders each having a lower base and upper head, a perforating die mounted in each base and a punching device mounted and guided on each head, each device including a tubular punch-bit justifying member slidably mounted in a vertical guideway in said upper head, a punch actuator arranged lengthwise in each of said members and having an outer head, a pressure spring interposed between said head and member and an elevating means to maintain each of said devices in an elevated position, said members being provided at their lower ends with accurately formed internal openings which engage the upwardly extending parts of individual punch-bits lodged in a work-piece to shift said work-piece so that each of said bits is positioned in co-axial alinement with their co-operating apertures in said dies.

46. A sheet material perforating apparatus according to claim 45 in which a plurality of work-piece stops are arranged at a distance slightly more remote from the actual position desired in relation to the axes of the justifying members so that when justifying the punch-bits into axial alinement with their cooperating die apertures the work-piece moves away from said stops.

47. In a method of punching a hole in metal whereby a punch, having its working end taper formed to provide an acute included angle of taper merging into the periphery of the punch at a distance less than the thickness of the work to thereby present a face of reduced area to the work, is pressed into the work in such manner as to cause a slug to break into a cooperating die aperture larger than said reduced area, the subsequent step whereby the movement of the punch through the work causes its formed end to displace the excess of metal into the wall of the hole.

48. In a method of punching a pole in material whereby a punch, having its working end taper formed to provide an obtuse included angle of taper merging into its periphery to thereby present a face of reduced area to the material, is pressed into the material in such manner as to cause a slug to break into a cooperating die aperture larger than said reduced area, the subsequent step whereby the movement of the punch through the material causes the formed end to displace the excess of material by shaving same from the hole.

49. A method of punching consisting in pressing a reduced work engaging end of a punch implement against a member positioned on a companion implement, having a die aperture, until said punch implement end causes material to fracture from said member into said aperture after which the punch implement end, formed for the purpose to an obtuse included angle of

taper merging into the periphery, displaces any excess material remaining within the opening caused by said fracture by shaving same from the opening.

50. A method of producing a uniform parallel walled opening in a member whereby a punch having its work-engaging end taper formed at a distance less than the thickness of the member and merging into the periphery to present a face of reduced area to the work, is pressed into the work to cause a slug to break into a cooperating die aperture larger than said reduced area, after which continued pressure causes the face of the punch, between said reduced area and the outer periphery, to press the resultant excess material from within said opening.

51. A method of producing a uniform parallel walled opening in a member according to claim 50 in which the excess material is pressed outwardly by radial dispersement into the wall of said opening.

GEORGE F. WALES.

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