

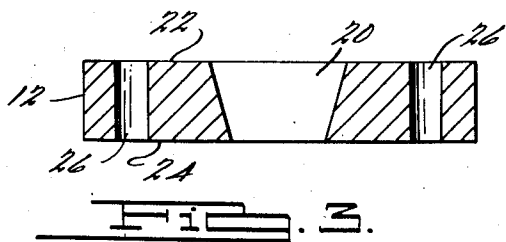
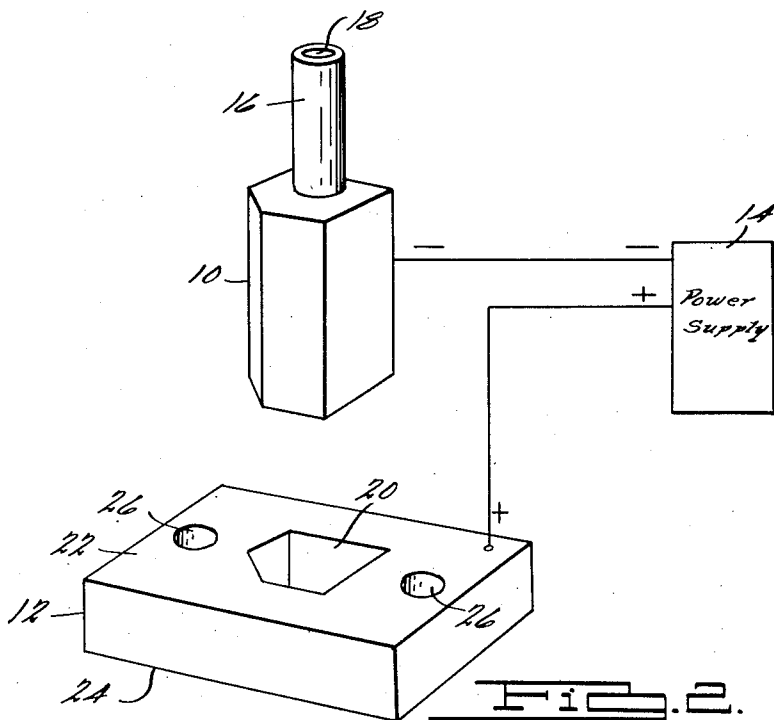
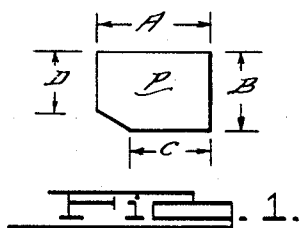
July 23, 1957

V. E. MATULAITIS
PRECISION PUNCH AND DIE SET

2,800,566

Filed Dec. 8, 1954

3 Sheets-Sheet 1



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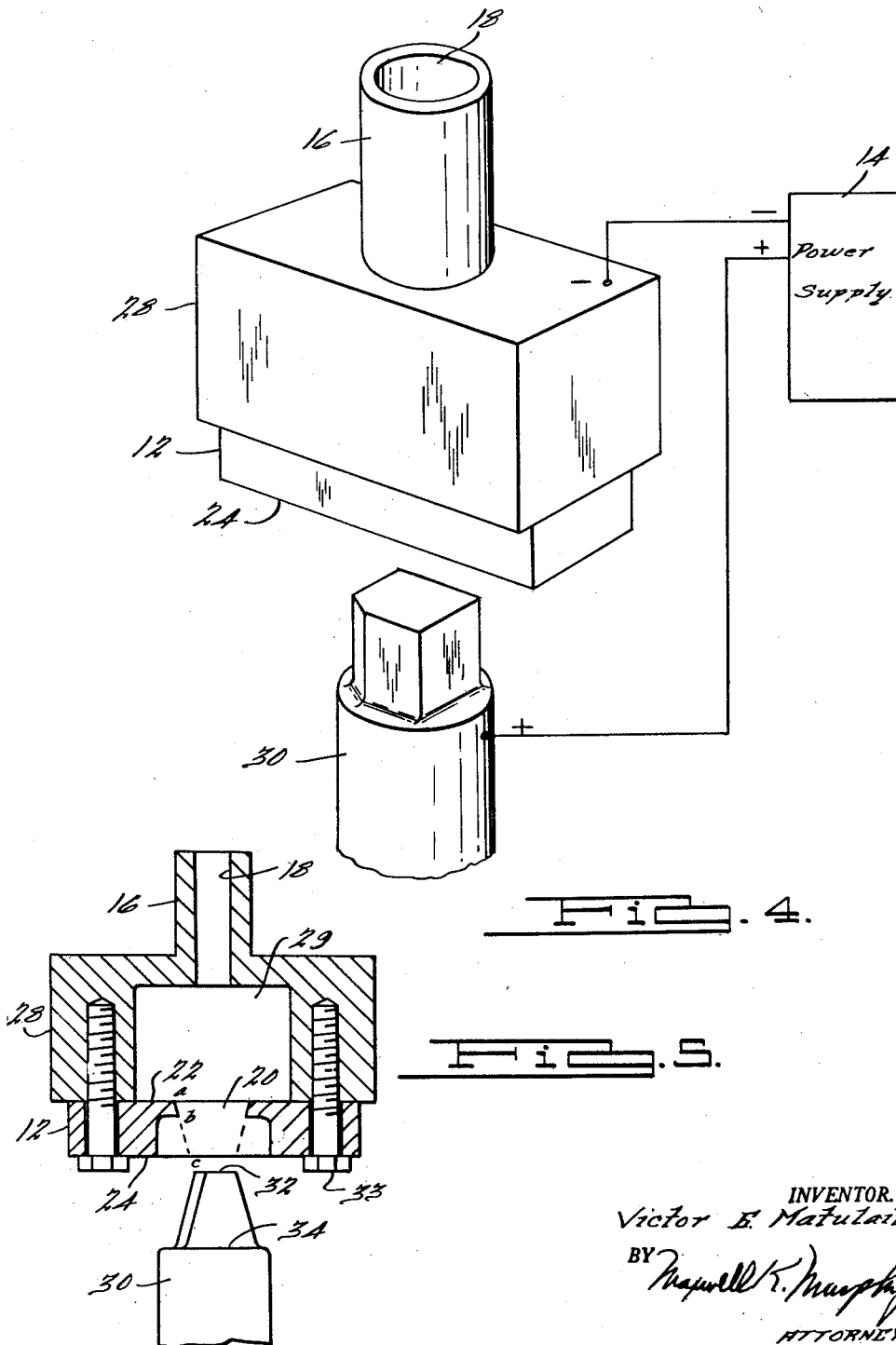
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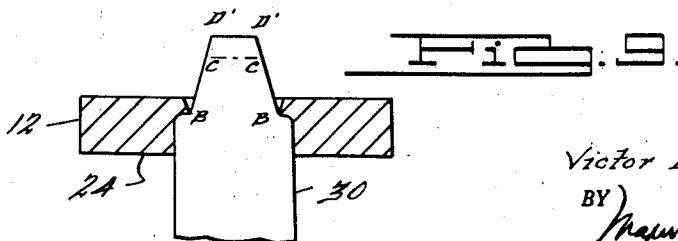
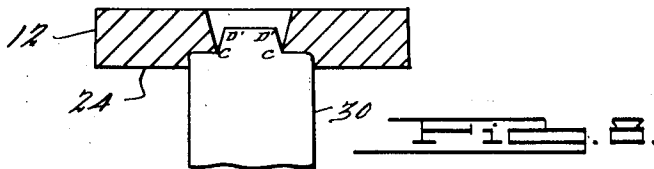
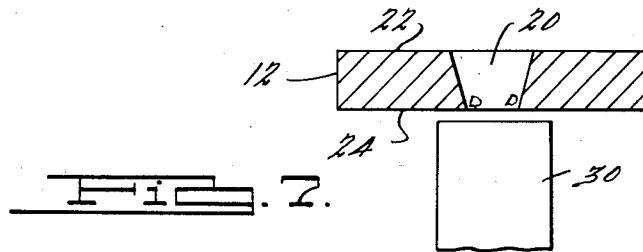
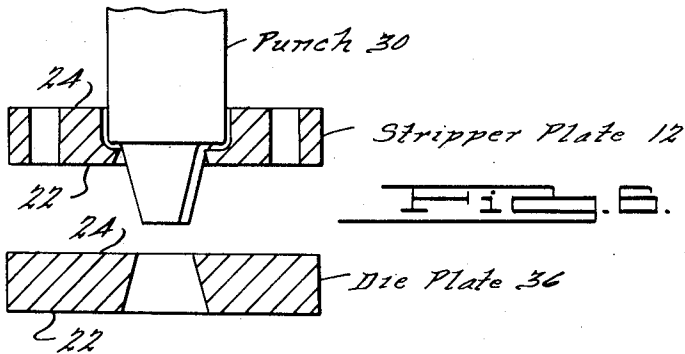
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3 Sheets-Sheet 3



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PRECISION PUNCH AND DIE SET

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Application December 8, 1954, Serial No. 473,971

1 Claim. (Cl. 219—69)

This invention relates generally to an improved method of making punch and die sets and particularly to a method and means for making punch and die sets by "arc-machining" or, as it is sometimes called, "spark-machining," "electrical-discharge-machining" or "metal disin-tegration."

The conventional method of making a punching die set which usually includes a punch, a die and a stripper plate, comprises machining each element separately from tool steel, hard alloy, tungsten carbide or the like. If the material is hard, like hardened alloy or carbide, the machining is difficult and time consuming and consequently expensive. If the die set is machined before the material is hardened, lapping and "barbering" must be performed after heat treating and this is expensive and time consuming.

It is the main object of my invention to provide a method and means for making a die set quickly and cheaply, which die set will be capable of precision work.

Another object is to provide a method of making die sets having relatively greater perfection of fit between the punch and the die whereby parts produced by the die set will be to closer tolerances than those produced by die sets made by conventional methods.

Still another object is to provide a method of making a complete punch, die and stripper plate set by arc-machining with the use of only one electrode.

Other objects and advantages of my invention will become apparent from the following description and discussion. In the drawings accompanying the description, in which reference characters have been used to designate like parts referred to herein,

Fig. 1 is a plan view of a typical part produced by a die set of the type herein mentioned;

Fig. 2 is a pictorial representation of the electrode and workpiece as they appear during the arc-machining operation for producing the die or the stripper plate;

Fig. 3 is a sectional view of the finished die plate made as shown in Fig. 2;

Fig. 4 is a pictorial representation of the electrode and workpiece as they appear during the arc-machining operation for producing the punch;

Fig. 5 is a part-sectional view of the parts shown in Fig. 4;

Fig. 6 is a view, with the die plate and stripper plate shown in section, of a complete die set made in accordance with the invention; and

Figs. 7, 8 and 9 illustrate successive stages in the machining of a punch blank.

Referring to the figures, it may be seen that the part P, shown in Fig. 1, is of simple form, such as may be employed in an automobile door latch assembly or the like. It is typical of the type of part produced in large quantities by a stamping operation and has been chosen for illustrative purposes, but it is desired to emphasize that the method herein disclosed is not limited to making die sets for simple parts. Indeed, it is when dies are required for

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manufacture of complex parts that my invention shows its greatest advantage because of the tremendous saving in time and cost.

A typical part like that shown in Fig. 1 might have the following dimensions: A— $\frac{3}{4}$ inch, B— $\frac{1}{2}$ inch, C— $\frac{1}{16}$ inch, and D— $\frac{3}{8}$ inch. The machining specification on the blueprint for the part would probably carry the notation, "All fractional dimensions $\pm$ or $- .010$," in accordance with normal machine shop practice. This latitude in dimension or "tolerance" as it is commonly called is appreciable, but the tolerance permitted in the manufacture of the die set itself is much closer as will be apparent from the following explanation.

In the conventional method of making the die set, the allowable tolerance may be totally or substantially expended in the making of the die plate. The punch then must be made to exact or near exact size with practically a tolerance of zero. Conversely, if the punch is made first and the allowable tolerance used up there, the die plate must be made to precision standards in order to obtain proper coordination of the punch and die and to secure proper dimensional tolerance on the finished part. In either case, a considerable amount of lapping and barbering is necessary by a skilled die man when the punch and die are "sheared in" in order to provide the clearances required for good stamping work.

It is standard practice to provide a radial clearance between the punch and die equal to 5% of the thickness of the stock to be punched. For example, if the part P is to be punched from stock .060 inch thick, a radial clearance or gap of .003 inch between the punch and die must be provided, and in conventional practice this clearance is obtained by grinding and lapping, the labor being done by skilled die makers. In other words, it is necessary for the die maker to work to a tolerance of .003 inch despite the fact that the finished part carries a generous tolerance of .020 inch.

Obviously the manufacture of die sets by conventional means is time consuming and expensive because of the necessity for precision work on the part of highly skilled operators as outlined above. In the manufacture of die sets in accordance with the teachings of my invention, the need for such precision entirely disappears; consequently the time required for making a precision die set is very substantially reduced with corresponding reduction in cost.

In my method of making die sets, I utilize arc-machining apparatus of the type described and claimed in McKechnie Patent 2,501,954, and detailed description thereof will be omitted herein in the interest of brevity. In arc-machining, an electrode of cross-sectioned form substantially identical to that of the part being machined is used in connection with a power supply to machine the workpiece by means of electrical discharges between the electrode and the workpiece in the presence of suitable coolant fluid.

In Fig. 2, I have illustrated in pictorial form the machining setup used for making the die plate and the stripper plate in accordance with my invention. The electrode 10 is, in most instances, the only tool that need be constructed. It is preferably made of free-machining brass to the tolerance permitted by the finished part. The electrode has a portion 16 adapted to be held in a collet of an arc-cutting machine and a passage 18 for the passage of coolant through the electrode to the arc zone.

The workpiece 12 which may be either the die plate or the stripper plate, is in this instance the stripper plate and is of hard, electrically conductive material such as alloy steel, tungsten carbide or the like. The holes 26 for accommodating fastening bolts may be machined in the piece 12 by another arc-machining operation either

before or after that being described. The hole 20 which is cut in the plate 12 by electrical-discharge between the electrode 10 and the plate is the hole through which the punch passes in the punching of the part P. In the case when the plate is the die, the hole 20 is the opening through which the part P is punched by the punch in actual manufacture of the part.

A power supply 14 having the required characteristics is connected to the electrode and workpiece as shown in accordance with the teachings of the aforesaid McKechnie patent.

In the arc-machining process, the chips eroded from the workpiece when a hole such as 20 is being cut are flushed out of the hole around the outside of the electrode by the coolant which enters through the electrode passage 18 under pump pressure. As these chips in their suspended state pass out through the extremely small clearance space between the electrode and the side of the hole in the workpiece, conductive bridges are formed which causes "side-arc-ing" between the side of the electrode and the side of the hole. As the hole is machined, the upper portion thereof is naturally exposed to the side-arc-ing effect for a longer period of time than lower portions thereof; consequently, erosion of the hole around the electrode occurs progressively as the operation proceeds. The hole then acquires a taper, shown in greatly exaggerated form in Fig. 3. This taper is necessary in the finished die as a "relief" to permit the punched part to drop out of the die, and in the conventional method of making dies is the cause of painstaking and laborious work as above mentioned. In my improved die-making method, the desired taper is obtained automatically as the hole is cut. The punch must necessarily have a corresponding taper, and this is obtained automatically as will be explained.

As above mentioned, the plate 12 of Figs. 2 and 3, is actually the stripper plate and it may be of the same hard material of the punch and die or if desired it may be of softer and cheaper stock. In either instance the method of making the die set in accordance with the teachings of my invention is the same.

After the stripper plate is finished, the die plate 36 (Fig. 6) may be machined, and this is done in identical manner as described for the stripper plate.

In cases where the stripper plate is of relatively soft material, it is sometimes desirable to make several stripper plates, and this can be accomplished by the method described and all of the plates will be substantially identical.

In instances where the punch is relatively long, several "phantom plates" may be machined of soft stock and these used as electrodes for machining the punch and then discarded.

The punch is made by using the phantom plate or stripper plate (preferably the latter) as the electrode, or as just mentioned, one or several phantom plates may be used as the electrode.

The plate 12, now the electrode, is secured by screws 33 to an electrode holder 28 having a coolant passage 18 opening into an enlarged opening 29 for accommodating the increased area necessary to accommodate the punch. The negative terminal of the power supply 14 is connected to the holder 28, and the positive terminal is connected to the punch blank, which in this case is the workpiece (see Fig. 4). The punch blank is usually of the same hard material as the die plate.

As shown in Fig. 5, the plate 12 when used as an electrode for cutting the punch is mounted so that the surface 24 faces the punch blank 30. This assures that the surface 32 of the punch will be identical in shape and size to the electrode 10 and to the piece P. As the electrode plate 12 is fed toward the punch, the desired punch length will be machined on the blank and the electrode will be eroded because of normal electrode wear.

Figs. 7, 8 and 9, show successive stages during machining of the punch blank, and reference to these figures will clarify the procedure. In these figures, the plate 12 may be the plate that is ultimately used as the stripper plate or it may be a phantom plate which is discarded after the punch is machined.

The plate 12, as it is fed toward the punch blank 30 will erode the latter as shown in Figs. 8 and 9. As the electrode approaches the blank, the area of the blank embraced by the opening 20 will, of course, not be eroded. The machining operation will therefore start cutting the blank at the plane D—D (Fig. 7) and will produce a surface D'—D' (Figs. 8 and 9) on the punch blank. As the punch blank feeds into the opening 20, the blank will be machined as shown in Figs. 8 and 9 and there will be an accompanying change in the size of the opening 20 at the plane D—D and at parallel planes such as C—C, etc., because of natural electrode wear. Because of the reverse taper of hole 20, there is very little, if any, side-arc-ing between the electrode and the workpiece as the machining progresses. It is clear then that the surface at plane D'—D' will remain substantially the size originally cut, but as the blank is fed into the electrode hole, a taper will be machined on the blank as the electrode wears away at planes D—D, C—C, etc. Fig. 8 illustrates an intermediate stage in the cutting of the punch, and Fig. 9 shows the condition of the parts at the end of the operation as normally conducted.

The wear of the electrode in its relation to the length of punch machined can be calculated and thus, by proper correlation of the materials and factors involved, the punch can be given the desired amount of taper. If the material of the plate 12 is the same as that of the punch (for example, tungsten carbide), the electrode will wear away at the plane of the bottom of opening 20 at about two-thirds of the rate of erosion of the workpiece. This electrode wear is not particularly objectionable if the plate 12 is to be used as the stripper for the die set or if the plate is to be discarded. If the plate is to be used as a stripper, it is, of course, necessary that the machining of the punch be discontinued before the blank 30 passes entirely through the plate 12; otherwise, there would be no stock left around the opening 20 to provide stripper action. Fig. 9 shows the plate 12 and punch blank at the conclusion of the machining operation of the punch.

In instances where an unusually long punch is required or no stripper plate is wanted, brass or other inexpensive material may be used for the plate 12. The brass, when used as an electrode, will wear much faster than harder material; consequently, several plate electrodes are necessary to maintain the proper dimensions on the punch. If several plates are used to make one punch, care must be exercised in making the plates to insure absolute accuracy in the size, shape and location of the hole 20 in each plate.

In instances where a relatively long punch is required, it has been found to be economical to first make a number of brass "phantom plates" and one plate of tool steel or hard carbide. The hard plate is then used for the last machining operation on the punch blank and is then available for use as a stripper if required.

A single thick brass plate is not usually satisfactory for machining a long punch because the brass wears away so fast that the taper of the punch is increased beyond allowable tolerances. The use of several thinner plates avoids this.

It will be observed that the parts of a matched die set made as outlined herein will have complementary taper but this taper will not be detrimental in any way. When the parts require sharpening, the punch and die may be ground simultaneously and thus, proper clearance will be maintained throughout their useful life.

If it is desired to produce a die set without taper but with proper clearance between the parts, application of the teachings of my copending application Serial No. 693,774

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may be resorted to. Proper clearance between the die parts is readily obtainable with arc-machining apparatus utilizing modern power circuits. With such circuits, such as those shown in my copending application Serial No. 459,704, almost any desired practical gap size can be obtained, say through the range of .0004 inch to .004 inch, and this clearance range is suitable for the great majority of commercially produced stampings.

If greater or less clearances are required, corresponding arc-gap lengths may be obtained through the control of electrode size, as will be explained in my copending application Serial No. 666,076, filed June 17, 1957.

I claim:

A method of forming a punch for a die set having a cross sectional shape which conforms at the free end to the shape and dimensions of an article to be punched which comprises, providing a plate having a tapered opening therethrough having a cross sectional shape and dimensions at a first face corresponding to the shape and dimensions of the article to be punched with the sides of said opening diverging in proceeding to the second

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face of the plate, arranging said first face of the plate with said opening adjacent the end of an elongated metal punch blank, supplying electrical current to the punch blank and the plate while there is relative movement of the punch blank and the plate towards each other, supplying a coolant through the opening in the plate for flushing eroded metal from the periphery of the punch blank and the boundary of the opening, continuing said relative movement of the punch blank and the plate to arc machine the punch blank with the side surfaces of the punch blank diverging from each other in proceeding from a free end of the punch blank whereby the shape and cross sectional dimensions at the free end of the punch blank correspond to the shape and dimensions of the opening in said plate at the first face.

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