United States Patent [19]

Sinha et al.

[11] **3,910,138**

[45] **Oct. 7, 1975**

[54] **DIES AND PUNCHES FOR PRODUCING PRESSED COMPONENTS**

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[22] Filed: **Mar. 6, 1974**

[21] Appl. No.: **448,570**

[52] **U.S. Cl.** ..... **76/107 C**

[51] **Int. Cl.**[2] **B21K 5/20**

[58] **Field of Search** ..... 76/101 R, 107 R, 107 C

[56] **References Cited**

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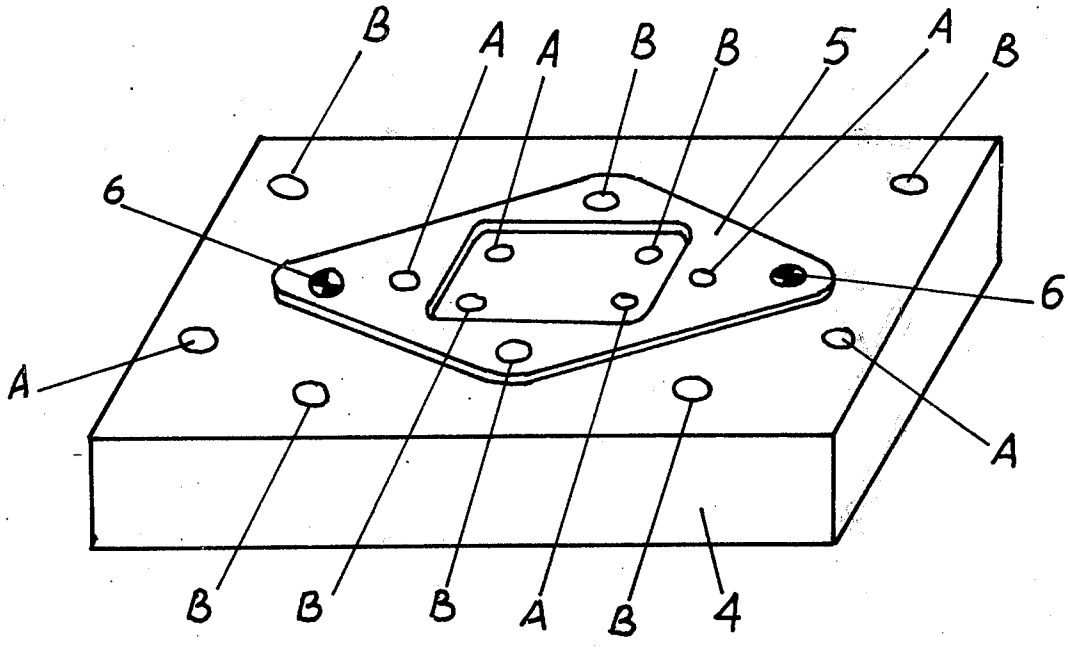
[57] **ABSTRACT**

A method of manufacturing a die or a punch for producing pressed components, wherein a semi-finished metal block is spark-eroded with the help of electrodes comprising a stack of sheared sheets of copper or like conducting material.

13 Claims, 10 Drawing Figures



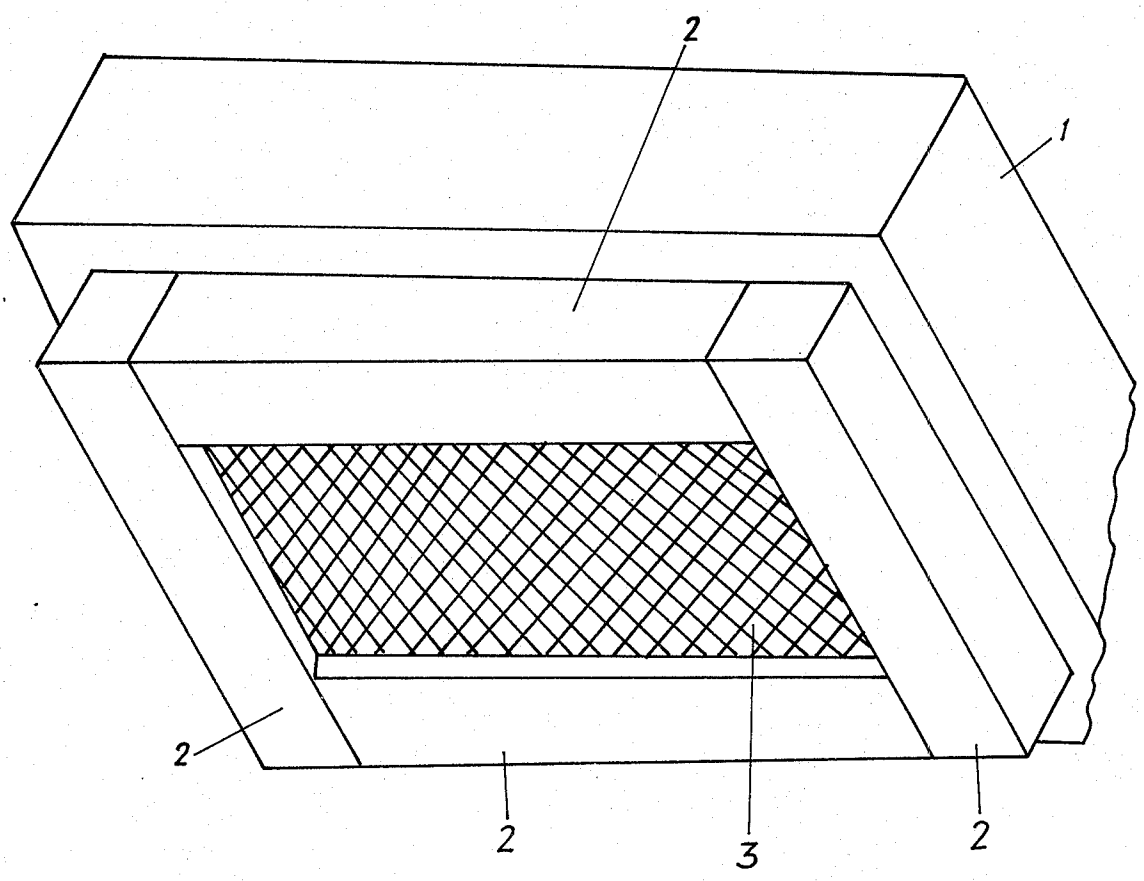


FIG. 1

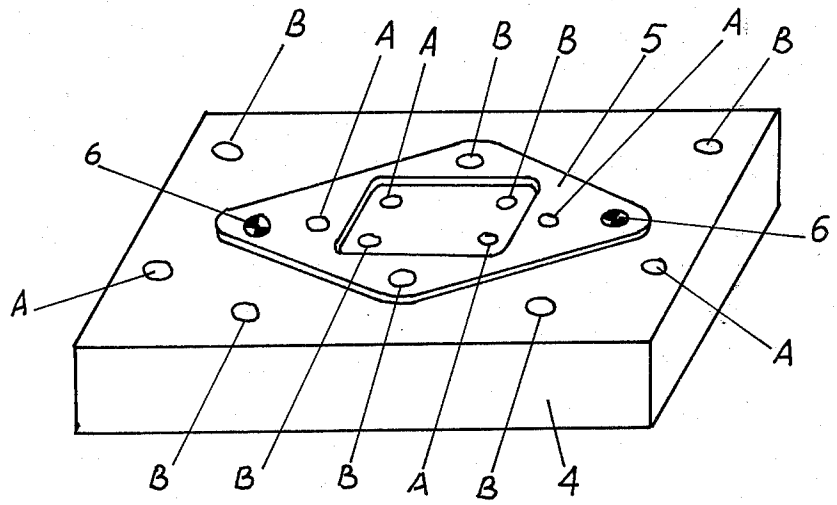


FIG. 2

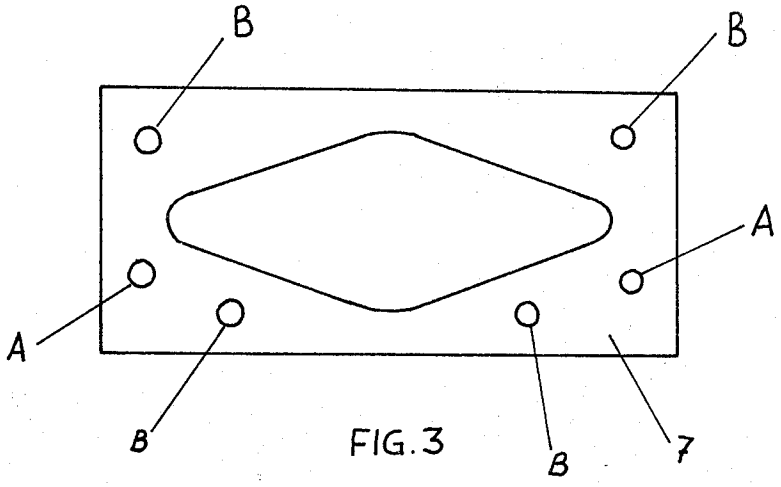


FIG. 3

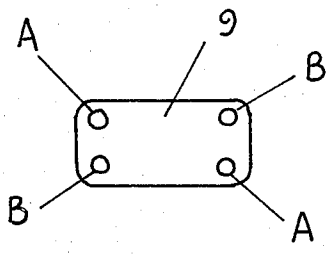


FIG. 5

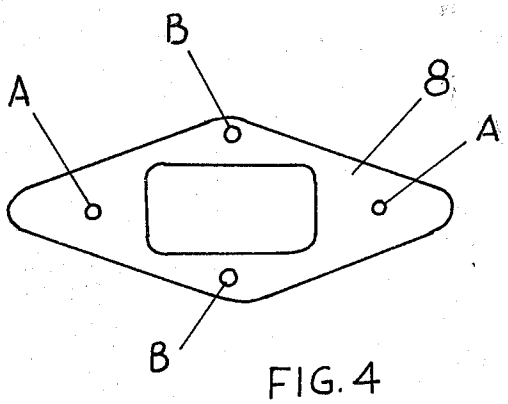


FIG. 4

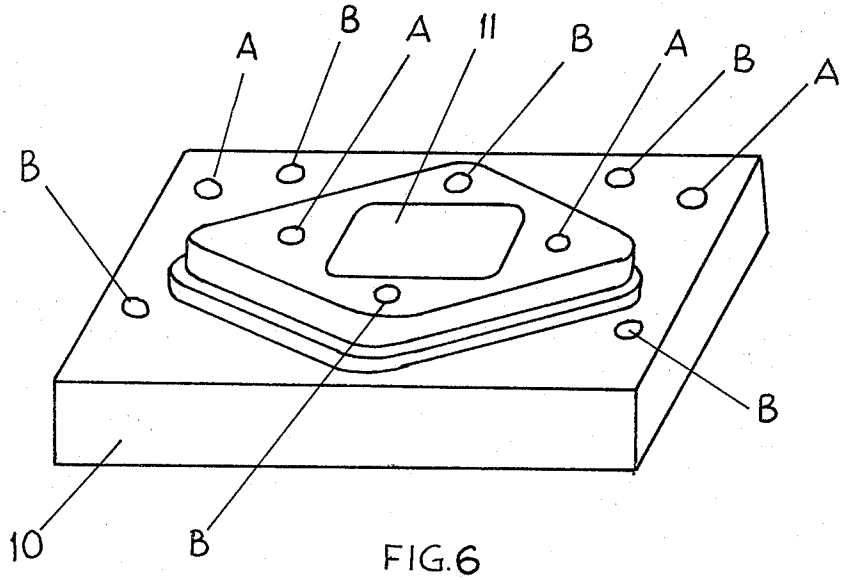


FIG.6

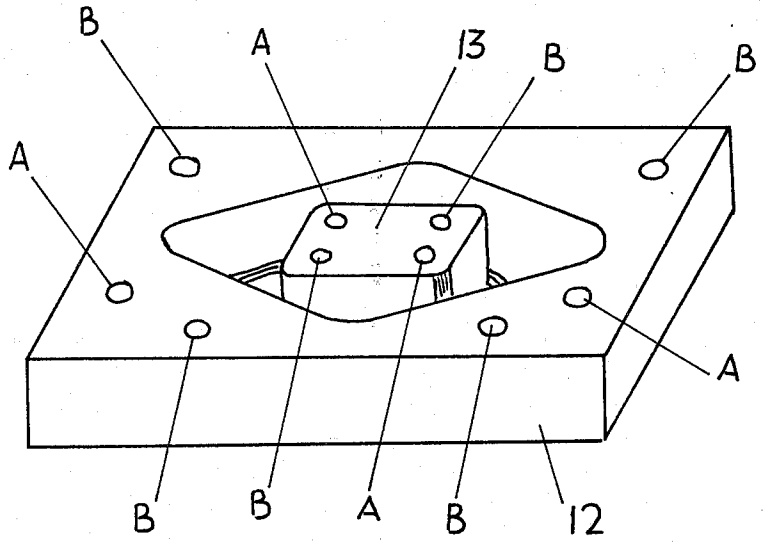


FIG. 7

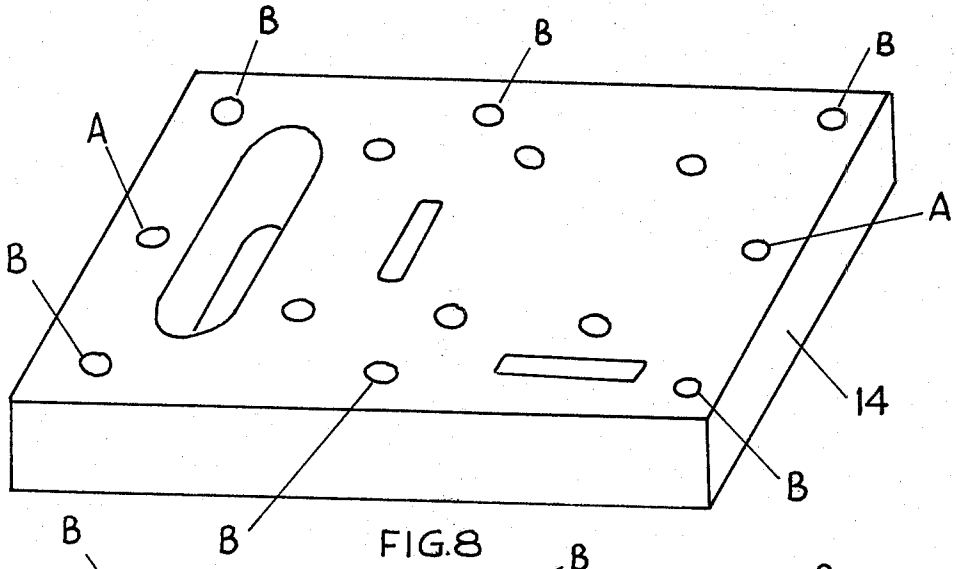


FIG.8

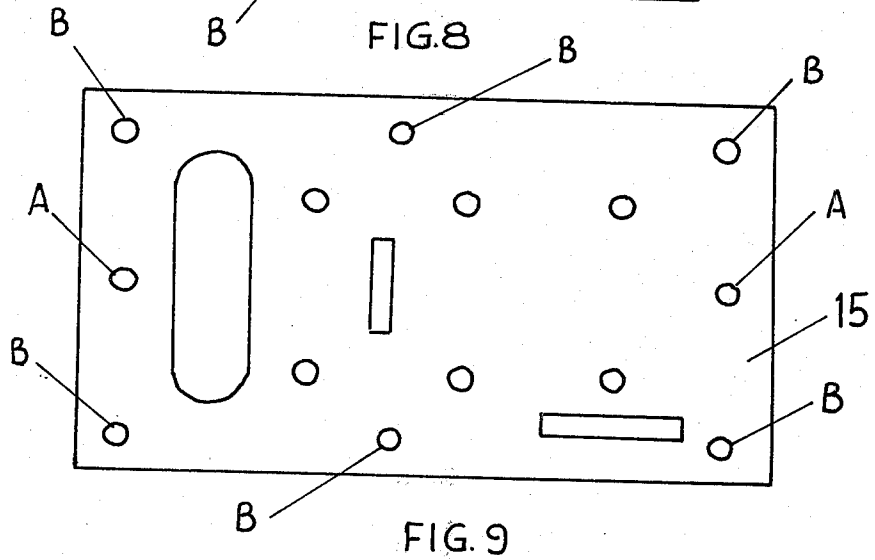


FIG. 9

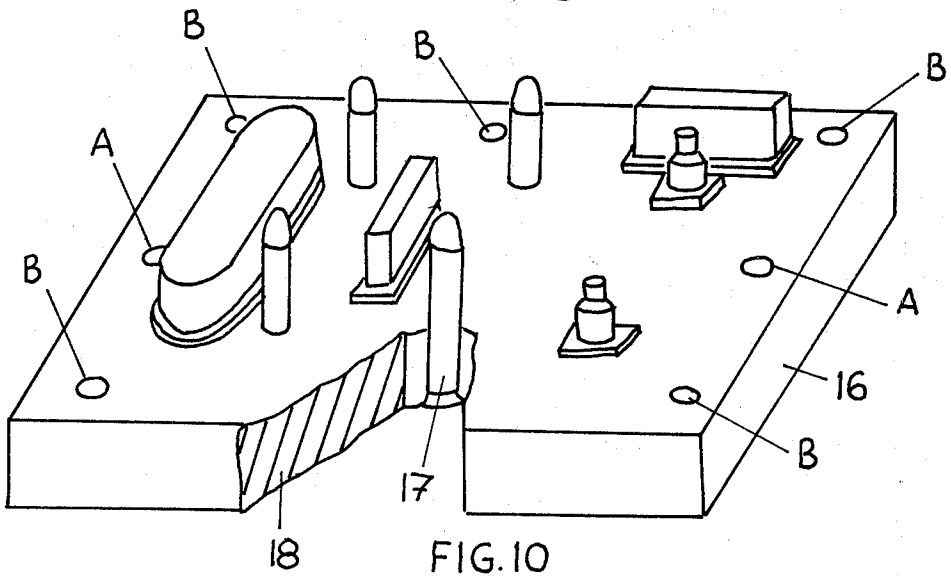


FIG. 10

DIES AND PUNCHES FOR PRODUCING PRESSED COMPONENTS

This invention relates to dies and punches for producing pressed components and to a process for manufacture thereof; more particularly, though not exclusively, this invention relates to the manufacture of integral punches and dies.

In the conventional method, punches are manufactured individually and held accurately on a punch plate. When necessary, these punches are guided either by a fixed stripper plate or a spring-loaded stripper plate. The dies, depending on their complexities, are made either of one-piece construction, or made in small individual segments which are assembled like a jigsaw puzzle.

The said conventional method has the following drawbacks:-

a. making of individual punches are time consuming and holding them on punch plates accurately involves lot of work and trouble;

b. invariably, cumulative errors occur whenever the stripper and dies are made in segments. Such errors cause misalignment which ultimately reduces the working life of the dies;

c. wear and tear of the stripper plate and the flexibility of the punch plate causes deflection and misalignment of the punch with respect to the die. This leads to either punch failure, reduced working life of the die or production of components having heavy burrs.

An object of this invention is to provide a method of manufacturing dies and punches whereby the aforesaid disadvantages are obviated.

Accordingly, this invention broadly provides a method of manufacturing a die or a punch for producing pressed components, comprising shearing under application of pressure one or more thin sheets of copper or like conducting material sandwiched between a top press-plate having a resilient contact face and a bottom press-plate provided with a plurality of locating holes and fixing holes, so that the profiles of the sheared cut pieces of copper or like conducting material are faithful reproductions of the profiles of the cutting edges of the bottom press-plate and of the locating holes and the fixing holes; stacking the cut pieces of copper or like conducting material to form electrodes and spark-eroding a semi-finished metal block with the help of said electrodes to produce a die or a punch.

The aforesaid method may be utilized for the manufacture of either punches or dies of conventional type or integral punches or integral dies. It should be understood that the expression "integral punch" refers to a punch in which the punch projections are integrally formed on what is conventionally described as a punch plate and the expression "integral die" refers basically to a one-piece die having projections integrally formed thereon which act as a punch for performing piercing operations.

The semi-finished block mentioned above may be made of steel and provided with hard metal inserts or hard metal welding or any suitably heat-treated alloy-steel.

The aforesaid bottom press-plate may be a template substantially similar to the press component to be produced mounted on a base plate for the manufacture of a punch or a die; alternatively, it may comprise a completed die or a punch for the manufacture of a punch or a die, respectively.

The aforesaid cut sheets of copper or like conducting material when stacked may be used as finishing electrodes as well as a roughing electrode; the latter being modified versions of the finishing electrodes for allowing a higher spark gap. According to the invention some of the finishing electrodes may be converted into roughing electrodes by opening out the inside profile and reducing the outer profile of the finishing electrodes in any known manner such as, for example, filing, drilling or milling. Alternatively, the roughing electrodes may be obtained directly by stacking cut sheets of copper or like conducting material which have been sheared between a top press-plate and the non-working face of a completed die. Preferably, such roughing electrodes may be used for spark-eroding the semi-finished block prior to effecting spark-erosion with the finishing electrodes so as to obtain rapid material removal.

Preferably, the stacked cut sheets of copper or like conducting material may be bonded, in known manner, to facilitate handling.

Preferably, thin copper sheets may be used for the manufacture of roughing electrodes and finishing electrodes. Alternatively, any conducting material such as, for example, aluminum, brass, silver or their alloys may be used.

Preferably, locating holes may be provided in known manner on the semi-finished block prior to spark-erosion, said locating holes having identical center-distances as existing on the bottom press-plate so as to facilitate locating the electrodes prior to spark-erosion and also to assist in the alignment of the punch and the die during assembly.

In an embodiment of the invention, a bottom press-plate comprising a template, made of steel or like metal and having a cutting edge profile substantially similar to the pressed components to be produced, mounted on a base plate may be used, said plurality of locating holes and fixing holes being provided on both said template and said base plate, and wherein the identical cut pieces of copper are stacked to form finishing electrodes.

Preferably, if the sizes of the cut pieces of copper or like conducting material are so small that locating holes cannot be accommodated in them, openings in the punch or the die may be made with a solid electrode located by means of an appropriate cut sheet of copper or like conducting material prior to spark-erosion operation.

Preferably, said resilient contact face of the top press-plate may be a rubber pad.

It should be understood that the expression "semi-finished block" refers to a steel piece which has been rough machined leaving 2–3 mm machining allowance all round the cutting edges.

A punch may also be made from a conventional die and in a method according to this invention, the bottom press-plate comprising a die may be used, said locating holes and fixing holes being provided on said die so that the profiles of the sheared or cut pieces of copper or like conducting material are faithful reproductions of the profiles of the cutting edges and the locating holes and fixing holes of said die and the finishing electrodes made by stacking the said cut pieces of copper or like

material and subsequently used for spark-eroding a semi-finished metal block to produce a punch.

This invention also applies to a method of manufacturing a die from a punch; in this method, a punch is used as the bottom press-plate so that the profiles of the cut pieces of copper are faithful reproductions of the cutting edges of the punch and holes whatever is existing on the punch face and wherein the stacked and bonded cut sheets of copper or like conducting material form finishing electrodes which are used for spark-eroding a semi-finished metal block to produce a die.

The punch forming the bottom press-plate may be suitably held to facilitate shearing of the copper sheets.

Embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings in which:

FIG. **1** shows a bottom perspective view of a top press-plate provided with a rubber pad for shearing copper sheets,

FIG. **2** shows a bottom plate with a template mounted thereon,

FIGS. **3, 4** and **5** show respectively an outer piece, a middle piece and an inner piece cut from a copper sheet,

FIG. **6** is a perspective view of a punch according to an embodiment of the invention,

FIG. **7** is a perspective view of an integral die corresponding to the punch shown in FIG. **6,**

FIG. **8** is a perspective view of a conventional die,

FIG. **9** shows a copper sheet cut by the die shown in FIG. **8** according to another embodiment of the invention, and

FIG. **10** is a perspective top view of an integral punch manufactured with the aid of the cut copper sheet shown in FIG. **9.**

Referring to FIGS. **1–7** of the drawings, a method for manufacturing a punch (FIG. **6**) and a die (FIG. **7**) comprises first manufacturing a steel template **5** approximately 1mm thick having a cutting edge profile similar to the pressed component to be manufactured except for such tight tolerance dimensions for which a spark gap allowance has to be made. This template **5** is held on a bottom plate **4** (FIG. **2**) with two dowels **6.** The bottom plate **4** and the template **5** both are provided with a plurality of locating holes A and fixing holes B. The number and location of these holes is determined by the number of cut copper pieces (FIGS. **3,** 4 and **5**) required to be made. Due precaution is taken to ensure that the center distances of the locating holes A in the bottom plate **4** and in the template **5** are identical to the holes provided in semifinished blocks which are subsequently converted into die plate **12** (FIG. **7**) and the punch **10** (FIG. **6**).

The next operation in the manufacture of dies and punches involves cutting thin copper sheets either collectively or individually for making roughing electrodes and finishing electrodes. For this operation, a top press-plate such as shown in FIG. **1** is used along with the template **5** and the bottom plate **4** in FIG. **2.** The top press-plate consists of a plate **1** on which strips **2** are welded together to define a rectangular recess in which a rubber pad **3** snugly fits; this recess is preferable though not essential. The thin copper sheets approximately 0.1 mm thick are sandwiched between this rubber pad **3** and the bottom plate **4,** with the template **5** mounted thereon by the dowels **6,** and cut or sheared under pressure. In the particular embodiment shown, the copper sheet or sheets are cut into three pieces; an outer piece **7,** (FIG. **3**), a middle piece **8** (FIG. **4**) and an inner piece **9** (FIG. **5**). The profile of the cut copper pieces obtained in this manner are found to be faithful reproductions of the profile of the template and of the locating holes A and fixing holes B and can, therefore, be used, as explained hereinbelow, for accurately manufacturing the dies and punches. It is quite likely that in a particular case the cut pieces may be too small for accommodating locating holes, thereon; in such an event, the necessary holes may be made in the punch or the die by using solid electrodes and for this purpose one of the cut copper sheets may be effectively utilized for locating a solid electrode prior to a spark erosion operation. Preferably, each of the cut copper pieces **7,** 8 and **9** should have at least two locating holes A and one or more fixing holes B so that locating holes A assist in the alignment of the individual cut copper pieces during stacking and also in the alignment of stacked copper sheets during spark erosion.

With the assistance of the bottom plate **4** and suitable locating pins (not shown), identical sets of the thin cut copper sheets **7, 8** and **9** are independently stacked and bonded to form stacks measuring approximately 2 mm which serve as roughing electrodes and finishing electrodes. The operation of the roughing electrodes and the finishing electrodes is explained hereinbelow and it will suffice to mention here that for efficient operation, the inside profile of the cutting edge of the roughing electrode is opened out while the outside profile, is reduced, for example, by filing; this adjustment in the profile of the roughing electrode is made to allow for a suitable spark gap which enables rapid material removal.

The next operation in the method involves selecting a suitable block which is to be subsequently made into a punch or a die and removing the bulk of the material from it by conventional machining methods so as to leave a margin of about 2–3 mm all around the cutting edges. The punch **10** (FIG. **6**) is finally obtained from this semi-finished block by hardening it and subsequently spark-eroding it with the assistance of the roughing electrodes which are made from the outer piece (FIG. **3**) and the inner piece (FIG. **5**) and the finishing electrodes.

To manufacture the die shown in FIG. **7,** similarly a block is machined in the conventional manner leaving a margin of 3–4 mm of material all around the cutting edges and hardened and spark-eroded in a manner similar to that followed during the manufacture of the punch except that the roughing electrode and the finishing electrode employed are made from the middle piece (FIG. **4**) of the cut copper sheets.

Punches can also be manufactured directly from a die which has been manufactured by a conventional method instead of from a template as described above. In this method, a die is first completed in any known manner. The completed die **14** (FIG. **8**) is used as a bottom press plate and thin copper sheets cut or sheared therebetween and the rubber pad **3** of the top press-plate (FIG. **1**) under application of pressure. The holes in the cut copper sheets will thus be faithful reproductions of those existing in the completed die. Very often, for proper cutting action the holes and opening of the die are filled up with suitable filler material such as for instance epoxy, rubber, etc. leaving an unfilled depth of 1 mm. A number of such cut copper

sheets are stacked with the help of locating pins (not shown) and bonded together to form roughing electrodes and finishing electrodes as mentioned above. A punch is then made by machining, hardening and spark-eroding a block as described above with the assistance of the roughing electrode and finishing electrode made out of cut copper pieces such as shown in FIG. 9.

The aforesaid roughing electrodes and finishing electrodes are made in the present method by using the non-working face and the working face of the completed die respectively. Since the openings in the completed die are tapered, the cut copper sheets made out from the non-working of the die face having larger openings and, therefore, do not require opening out operations as was necessary earlier. In case a longer projection of punch is needed such as for forming or for piloting, a suitable hole is spark eroded in the integral punch by a solid electrode taking its location from the cut copper sheet. A suitable pilot pin 17 (FIG. 10) is then inserted in this hole and held in conventional manner. The lead and heeling provided on such forming punches and pilot pin take care of certain amount of flexibility which is likely to be present in such an assembly.

We claim :

1. A method of manufacturing a die or a punch for producing pressed components, said method comprising shearing under application of pressure thin sheets of conducting material between a top press-plate having a resilient contact face and a bottom press-plate provided with a plurality of locating holes and fixing holes, so that the profiles of the sheared pieces of conducting material are faithful reproductions of the profiles of the cutting edges of the bottom press-plate and of the locating holes and the fixing holes; stacking a plurality of said cut pieces of conducting material to form electrodes and spark-eroding a semi-finished metal block by said electrodes to produce a die or a punch.

2. A method as claimed in claim 1, wherein locating holes are formed in the semi-finished block prior to spark erosion, said locating holes having identical center distances as existing on the bottom press-plate so as to facilitate locating the electrodes prior to spark-erosion and so as to assist in the alignment of the punch and the die during assembly.

3. A method of manufacturing a die or a punch as claimed in claim 2, wherein the bottom press-plate comprises a template made of hard material and having a cutting edge profile substantially similar to the pressed components to be produced, mounted on a base plate, said plurality of locating holes and fixing holes being provided on both said template and said base plate, and wherein the identical cut pieces are stacked to form finishing electrodes.

4. A method as claimed in claim 1, wherein if the sizes of any of the cut pieces of conducting material are so small that locating holes cannot be accommodated in them, openings in the punch or the die are made with a solid electrode located by means of an appropriate cut sheet of conducting material prior to the spark-eroding operation.

5. A method as claimed in claim 3 comprising converting some of the finishing electrodes into roughing electrodes by opening out the inside profile and reducing the outer profile of the finishing electrodes, and spark-eroding the semi-finished block with said roughing electrodes prior to spark-eroding with the finishing electrodes.

6. A method of manufacturing a punch according to claim 1, wherein the bottom press-plate comprises a die, said locating holes and fixing holes being provided in said die so that the profiles of the sheared pieces of conducting material are faithful reproductions of the profiles of the cutting edges and the locating holes and finishing holes of said die, and wherein the finishing electrodes are formed by stacking identical sets of cut pieces of conducting material and are used for spark-eroding a semi-finished metal block to produce a punch.

7. A method as claimed in claim 6, wherein the sheets of conducting material are so sheared by application of pressure between the working face of the die and the top press-plate that the cut pieces on stacking form finishing electrodes.

8. A method as claimed in claim 6, wherein the sheets of conducting material are so sheared by application of pressure between the non-working face of the completed die and the top press-plate that the cut pieces on stacking form roughing electrodes.

9. A method as claimed in claim 7, wherein some of the finishing electrodes are converted into roughing electrodes by opening out the inside profile of the finishing electrodes and wherein the semi-finished metal block is spark-eroded with said roughing electrodes prior to effecting spark-erosion with said finishing electrodes.

10. A method of manufacturing a die as claimed in claim 1, wherein a punch is used as the bottom press-plate so that the profiles of the cut-pieces of conductive material are faithful reproductions of the cutting edges of the punch and wherein the stacked and bonded cut sheets of conducting material form finishing electrodes which are used for spark-eroding a semi-finished metal block to produce a die.

11. A method as claimed in claim 1 comprising bonding the cut pieces of conducting material to form the electrodes.

12. A method as claimed in claim 1 wherein a plurality of said sheets are sheared simultaneously.

13. A method as claimed in claim 1 wherein said conducting material is copper.

* * * * *