

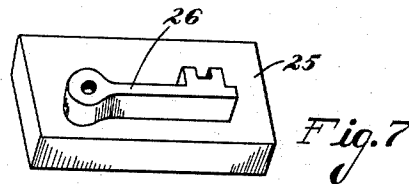
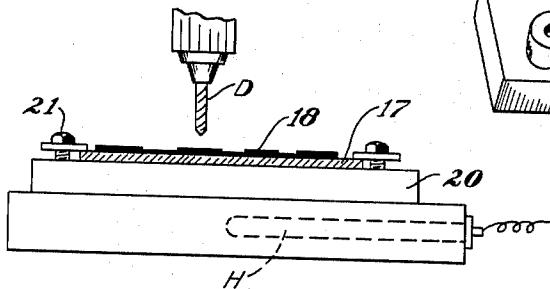
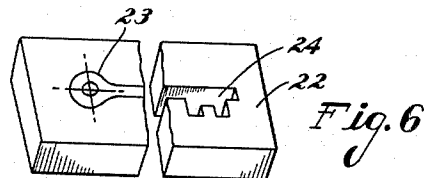
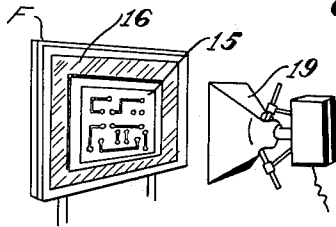
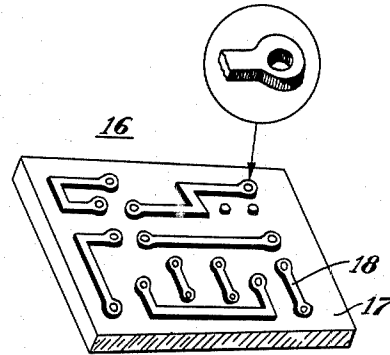
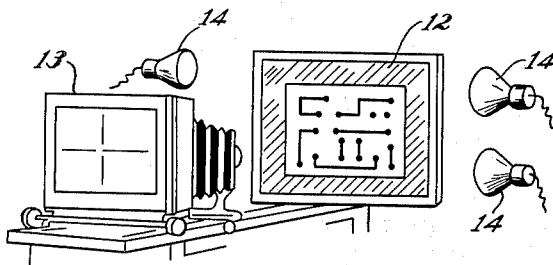
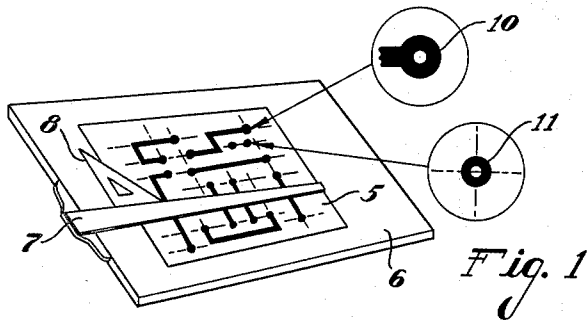
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METHOD OF MAKING TOOLS AND DIES

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2,743,629

METHOD OF MAKING TOOLS AND DIES

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4 Claims. (Cl. 76—107)

This invention relates to the method of making tools, dies and the like.

In the making of tools and dies for use in many fields of manufacturing, much expensive time is required on the part of the toolmaker in laying out the various contours, perforations and perforating punches on the cooperating steel blocks of a tool. This is especially true in the making of tools and dies for finishing printed circuit panels. For example, if a plurality of variously spaced holes are to be made in the cooperating steel blocks forming a set of perforating dies, the toolmaker must compute the desired location on a block surface, of each required hole and then mark this location of the hole by intersecting scriber marks. The block is then drilled at the intersection of the marks with the possibility that the drill might "creep" at the start of the drilling operation, resulting in an inaccurately centered hole. When the perforating dies are to be used in perforating phenolic plastic or like sheets, which must be worked at specified temperatures above room temperatures, the toolmaker must compute the locations of the several perforations in such a manner that the sheet although punched while expanded, due to its elevated temperature, will contract to the accurate, required dimensions when exposed to room temperatures.

It is the purpose of the present invention to provide a method of making tool and die units, which results in greatly reducing the labor and costs of producing such units while materially reducing the possibility of costly errors in the production thereof.

The various features and advantages of the invention will appear from the following detailed description and claims when taken with the drawings in which:

Fig. 1 is a perspective view of an enlarged master drawing of a printed circuit or tool layout shown on a drawing board;

Fig. 2 is a perspective view illustrating how the enlarged master drawing is photographically printed on a negative in a size reduced to the exact final dimensions;

Fig. 3 is a perspective view showing how the drawing, in reduced size on the negative, is copied exactly on a surface of a metal sheet which has been mounted on a suitable support, the metal surface having first been coated with photo-sensitized photoengraver's resist;

Fig. 4 is a perspective view showing the resulting layout after the metal sheet or foil while still mounted on the support has been selectively etched as determined by the resist, down to the surface of the support;

Fig. 5 is a side elevation illustrating how a die element or like tool unit can be made by using the layout of Fig. 4; and

Figs. 6 and 7 are respectively perspective views of cooperating female and male die sections of intricate outline, such as a key for a lock, made in accordance with the present invention, the left hand fragment of the female section illustrating the block before any metal has been cut away and the right hand fragment thereof showing

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the block after the metal has been cut away in accordance with a photograph thereon.

Referring to the drawings, a master drawing of a printed circuit or tool layout is drawn to close tolerances on a sheet 5 of good quality paper such as Bristol board. As shown in Fig. 1, the sheet 5 is mounted on a drawing board 6, together with T-square 7 and triangle 8 used in making the master drawing. This drawing should be made to accurate dimensions which are preferably twice the scale of the actual required size, in order to minimize the effect of imperfections in the master when photographically reduced. Where extreme accuracy is required in the final product, the master drawing should be made to a scale five or more times the actual size of the product. It should be noted that any holes in the elements of the layout, should be drawn on the master drawing, as shown enlarged at 10 and 11 in Fig. 1.

The master drawing on the sheet 5 is then mounted on a suitable board 12 in the field of a well-known copying camera 13 where it is properly illuminated by the lights 14. The copying camera has placed therein, in the usual manner, a photosensitive plate (not shown) which comprises a photographic emulsion coated on a non-shrinking transparent support such as a glass plate or a vinyl base which is .007 to .010 of an inch in thickness. The master drawing is photographed in the camera to actual size, on the photosensitive plate which is then developed in the usual manner, to provide a negative of the master drawing.

The finished negative 15 (Fig. 3) is photographically printed on a panel 16 in a well known manner. This panel may comprise a self-supporting sheet 17 (Fig. 4) of plastic material having specified characteristics including a predetermined coefficient of expansion. The sheet 17 has a layer of metal such as copper, aluminum or other metal foil 18 secured to one surface thereof. The outer surface of the foil is photosensitized with a photoengraver's resist, such as "Cold Top Enamels." As shown in Fig. 3, the negative is printed on the panel 16 by placing it in superimposed relation in a printing frame F, with the negative placed against the photosensitized, resist surface which is exposed through the negative, to light from the lamp 19. After a given exposure time, the exposed sensitized resist on the panel is developed to render the resist selectively removable in accordance with the image thereon. Then the metal layer 18 is etched away to reproduce the image in the form of metal on the panel, the etching being preferably down to the plastic base or sheet 17. The etching leaves a relief image of the circuit or tool layout as shown in Fig. 4. As the centers 10 and 11 in Fig. 1 are etched away, they leave a depression similar to a centerpunched hole (Fig. 4). These spots are exactly positioned since they are photographic reproductions through a non-shrinking negative 15.

If the tool is to punch material in its cool state, the etched circuit or tool layout is clamped to a block of tool steel 20 (Fig. 5) and all holes are drilled using the etched centers as guides.

If, however, the plastic material 17 to be worked on, must be heated in order to render it workable, the etched circuit or tool layout is held on the block 20 of tool steel (Fig. 5), and this in turn is placed on a heating element H. The temperature of the material 17 should be raised to the working value recommended by the supplier. This will cause the plastic material to expand.

When the plastic material 17 has fully expanded, it is clamped to the block by clamps 21. All holes are spotted and drilled into the steel block by a drill D, using the plastic material 17 with the layout thereon, as a template. These holes are then finished in the usual manner to provide a female die section. A second block

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(not shown), is similarly drilled with holes likewise using the material 17 as a template. Thereafter punches are mounted in the resulting holes, to provide a male die section which is finished in the usual manner.

This method automatically computes the amount that a tool has to be enlarged to allow for contraction of the plastic upon cooling.

The present invention can also be used in the making of tool sections of intricate outline as illustrated in Figs. 6 and 7. In the making of such sections, a master drawing of the layout of the outline of the desired tool, preferably on an enlarged scale, is made in the manner indicated in Fig. 1. This layout is copied in a copying camera, in reduced form to the final desired dimensions to produce a photographic negative, in the manner shown in Fig. 2.

The image on the negative constituting the intricate pattern, is photographically copied on one surface of a first block 22 of tool steel or the like (as in Fig. 3) the surface having first been coated with a photosensitive material. This material may be a colored photo-engraver's resist which is developed in the well known manner to make visible on the surface of the block, the image 23 of the tool pattern (at the left of Fig. 6). The toolmaker can use the image to guide him in removing metal from the block, as at 24, to make a female die section. In making a cooperating male section, there is provided a second block 25 of the tool steel or the like with one surface thereof coated with a photosensitive material as in the case of block 22. The image on the negative is photographically copied in reverse on the coated surface of the second block. This is effected in the known manner by reversing the surface of the negative in engagement with surface of the block 25, with respect to the surface of the negative which was in engagement with the block 22. The image on the block 22 is rendered visible by the usual developing operation. The visible image on the surface of this block shows what portion thereof must be removed to provide the punch 26 of the male die section.

The present disclosure is given by way of example and is not to be construed in a limiting sense except as specifically set forth in the appended claims.

What we claim is:

1. The method of making tools such as dies and the like which comprises preparing a master drawing of a tool layout, photographically copying the drawing to the final scale desired, in a light sensitive emulsion carried on a substantially rigid transparent support, developing the image in the emulsion while on the support to provide a photographic negative, photographically printing the negative image on a metal sheet carried on a self-supporting sheet of plastic material and coated with a photolithographic resist, developing the image in the resist to render the resist selectively removable by etching in accordance with the image thereon, etching the metal layer substantially down to the plastic sheet as determined by the solubility of the resist, superimposing the sheet on a metal block and using the sheet as a template to drill holes through the sheet and into the metal block.

2. The method of making tools such as dies and the like which comprises preparing a master drawing of a tool layout on an enlarged scale, photographically copying the drawing reduced to the final scale desired, in a

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light sensitive emulsion carried on a substantially rigid transparent support, developing the image in the emulsion while on the support to provide a photographic negative, photographically printing the negative image on a metal layer carried on a self-supporting sheet of plastic material workable at a temperature other than room temperature, said metal layer being coated with a photolithographic resist, developing the image in the resist to render the resist selectively removable in accordance with the image thereon, etching the metal layer substantially down to the plastic sheet as determined by the solubility of the resist, superimposing the plastic sheet with the etched metal sheet thereon on a metal block, bringing the temperature of the plastic sheet to its workable temperature, and using the sheet as a template to drill holes through the sheet and into the metal block.

3. The method of making tools such as dies and the like which comprises preparing a master drawing of a tool layout on an enlarged scale, photographically copying the drawing reduced to the final scale desired, in a light sensitive emulsion carried on a substantially rigid transparent support, developing the image in the emulsion while on the support to provide a photographic negative, photographically printing the negative image on a metal layer carried on a self-supporting sheet of plastic material workable at a temperature higher than room temperature, said metal layer being coated with a photolithographic resist, developing the image in the resist to render the resist selectively removable in accordance with the image thereon, etching the metal layer substantially down to the plastic sheet as determined by the solubility of the resist, heating the plastic sheet to its workable temperature, superimposing the heated plastic sheet with the etched metal sheet thereon on a metal block, and using the sheet as a template to drill holes through the sheet and into the metal block.

4. The method of making tools such as dies and the like which comprises preparing a master drawing of a printed circuit layout in which the illustrations of terminal openings for the circuits are represented with relatively wide borders, photographically copying the drawing including the wide-bordered terminal openings, to the final scale desired, in a light sensitive emulsion carried on a substantially rigid transparent support, developing the image in the emulsion while on the support to provide a photographic negative, photographically printing the negative image on a metal sheet carried on a self-supporting sheet of plastic material and coated with a photolithographic resist, developing the image in the resist to render the resist selectively removable by etching in accordance with the image thereon, etching the metal layer substantially down to the plastic sheet as determined by the solubility of the resist to developed countersunk recesses at the desired terminal openings, superimposing the sheet on a metal block and using the sheet with its countersunk recesses as a template to drill holes through the sheet and into the metal block.

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