Aug. 25, 1964 M. J. ZALESKE 3,145,455

METHOD OF PRODUCING ELECTRIC CONTACT FINGERS

Filed July 10, 1961

Fig. 1.

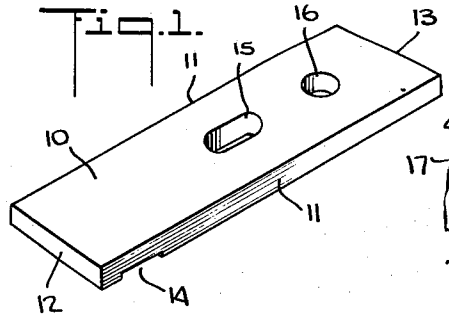


Fig. 3.

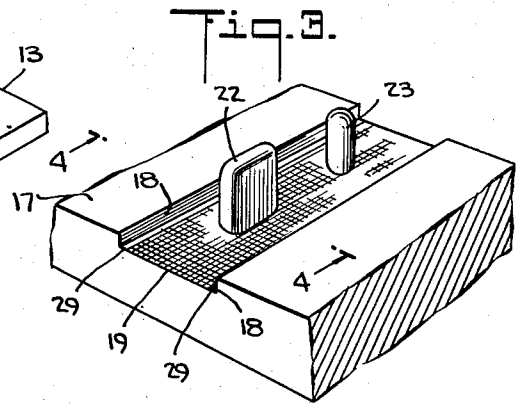


Fig. 2.

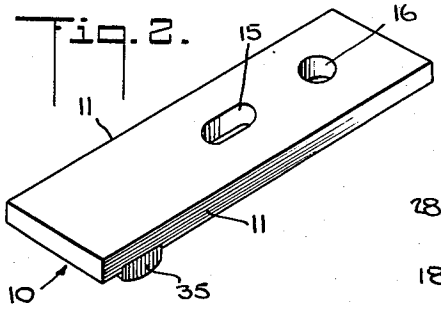


Fig. 4.

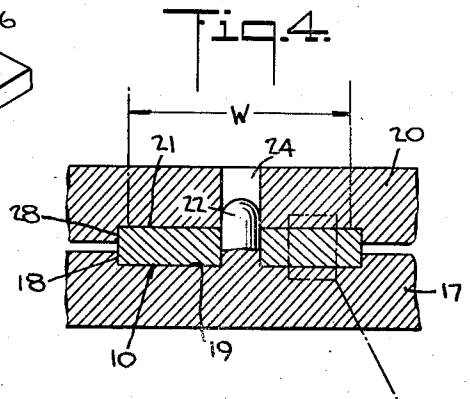


Fig. 6.

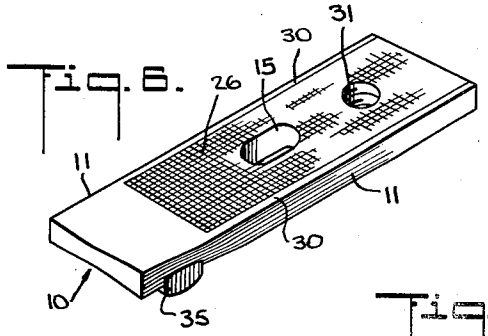
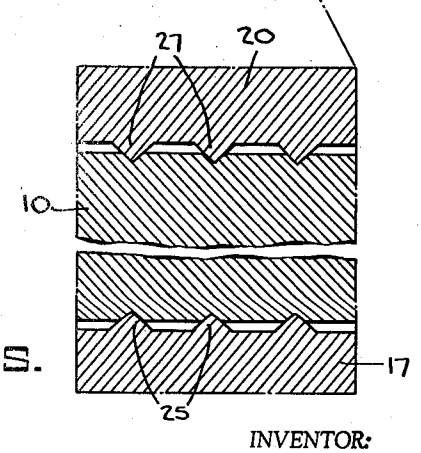


Fig. 5.



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METHOD OF PRODUCING ELECTRIC CONTACT FINGERS

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This invention relates generally to the manufacture of electric contact fingers and similar flat metallic elements, and has particular reference to a method of procedure which imparts adequate hardness and stiffness to the finished product.

A more particular object is to provide an improved method of making an electric contact finger of hard drawn copper or its equivalent, whereby adequate hardness in the contact finger is assured despite the annealing effect of heat engendered during the affixing of the contact button or similar element to the contact finger.

In the production of contact fingers it has often been necessary, heretofore, to employ copper alloys of relatively expensive nature to withstand the annealing effect referred to. The present invention makes it possible to employ less costly alloys, or ordinary commercially-available hard drawn copper.

Some of the broader phases of the invention are applicable, more generally, to procedures for increasing the hardness of any annealed or hardenable metal bar, whether intended for use as an electric contact finger or not.

The improved procedure is predicated upon the discovery that hardness of the desired magnitude can be imparted to a flat bar of copper or the like by the simple application of perpendicularly-directed pressure in a multiplicity of minute closely adjacent spots, the pressure being of sufficient magnitude to cause deformation of the metal into a pattern of depressions and to cause cold flow into the regions between and directly adjacent to the depressions. Preferably the bar is treated simultaneously on both of its opposite faces.

A feature of the invention resides in confining the opposite side edges of the bar against dimensional change in bar width during the application of the pressure.

Another feature of the invention lies in confining the pattern of depressions to an area that terminates short of the confined edges along lines parallel to such edges. The stiffness of the resultant product has been found to be enhanced when the marginal regions are left undeformed.

In the application of the invention to the production of an electric contact finger composed of hard drawn copper, the preferred procedure resides in first producing through openings in the bar in those particular locations which are prescribed by the mounting upon which the finger is to be supported when in use, then affixing the contact button to a face of the bar, then securing the bar in a rigid holder that snugly confines the opposite side edges and also plugs the openings with rigid unyielding material, and then subjecting at least one face of the bar to the pressure treatment hereinbefore referred to.

One way of practicing the invention is shown by way of illustration in the accompanying drawings, in which—

FIGURE 1 is a perspective view of a flat metal bar in the process of being made into an electric contact finger of the character described;

FIGURE 2 is a similar view, after the contact element has been affixed with consequent annealing;

FIGURE 3 is a fragmentary perspective view of one of the pressure dies by means of which the work piece of FIGURE 2 is subjected to confinement and pressure treatment;

FIGURE 4 is a cross-sectional view, along the line 4—4 of FIGURE 3 showing the work piece interposed between the die of FIGURE 3 and a complementary die;

FIGURE 5 is a greatly magnified fragmentary cross-sectional view of the region designated by dot-and-dash lines in FIGURE 4; and

FIGURE 6 is a perspective view of the finished contact finger.

The bar **10** may have any desired dimensions, depending upon the purpose for which the resultant contact finger is to be employed, and by way of example the bar chosen for illustration is about three inches long, about five-eighths inch wide, and between one-eighth inch and one-fourth inch thick. It is substantially rectangular, having opposite parallel longitudinal sides **11** and front and rear ends **12** and **13**. Near the front end **12** the bar is provided with a shallow recess **14** adapted to accommodate the contact finger or other element **35** (FIGURE 2) and retain it in an accurately predetermined location. The bar is also provided with through openings, such as the elongated opening **15** and the circular opening **16**, in accurate locations prescribed by the mounting (not shown) upon which the finger is ultimately to be supported when in use. One or more of these openings, such as the opening **16**, may be provided with internal threads to cooperate with a correspondingly threaded stud or other fastening element, but at the stage of manufacture depicted in FIGURE 1 the openings are left unthreaded.

In FIGURE 3 there is shown one of a pair of complementary pressure dies between which the work piece **10** of FIGURE 1 is to be supported during the application of the pressure treatment. The die **17** is provided with an elongated recess having opposed side walls **18** and a bottom wall **19**. The distance between the walls **18** is the same as the width of the work piece. The depth of the recess is about one-third the thickness of the work piece. This pressure die cooperates with an opposed die **20** (FIGURE 4) having a similarly arranged and dimensioned recess **21**.

Projecting from the floor **19** are plugs **22** and **23**, composed of rigid unyielding material, and conforming in cross-sectional dimensions, and in relative locations, to the openings **15** and **16** previously formed in the work piece **10**. The opposed die **20** is provided with openings or recesses **24** positioned and shaped to receive the projecting plugs **22** and **23** (and whatever other similar plugs may be provided) when the dies are brought together with the work piece between them, as shown in FIGURE 4.

The floor **19** is provided with a series of closely spaced elevations or projections **25** (see FIGURE 5) shaped to penetrate into the surface of the work piece when the parts are brought together under pressure applied perpendicularly. The projections **25** may have any suitable shape, and it has been found that square pyramids are admirably suited to produce the desired effect when the base of the pyramid has a dimension of about 0.016 inch along each side, and when the altitude of the pyramid is about 0.008 inch. There are preferably between 550 and 600 such pyramidal projections per square inch.

Preferably, but not necessarily, the floor of the corresponding recess in the opposed pressure die **20** is correspondingly provided with a multiplicity of pressure-exerting projections.

Before the work piece **10** of FIGURE 1 is subjected to the action of the pressure dies, the contact button or element **35** is affixed to it, as indicated in FIGURE 2. This element is usually composed of silver or other specialized contact material, and its application to the bar **10** is accomplished by brazing. This involves the application of heat which produced an undesirable annealing within the

bar 10. To restore the desired hardness and rigidity, the work piece is now mounted between the pressure dies 17 and 20, as shown in FIGURE 4, and the dies are pressed together under sufficient force to cause the projections 25 to penetrate into the adjacent surface of the work piece, as indicated in FIGURE 5. The degree of penetration should be sufficient to produce a pattern of depressions in the work piece, as indicated at 26 in FIGURE 6, the formation of these depressions being accompanied by cold flow of the metal into the regions between and directly adjacent to the depressions. A force of 25,000 to 30,000 pound is usually sufficient to produce the desired effect.

As hereinbefore stated, this treatment is preferably applied to both surfaces of the work piece, as indicated in FIGURE 5, the projections 27 formed on the element 20 having the same penetrating effect upon the opposite surface of the work piece 10.

This pressure treatment, and the cold flow which it engenders, is carried out while the work piece is accurately confined along its longitudinal edges 11 by the opposed sides 18 and 28 of the recesses in the pressure dies 17 and 20, and while the openings in the work piece, such as those shown at 15 and 16, are similarly confined against dimensional changes by the snugly-fitting plugs that pass through them.

The pattern of projections 25 formed in the floor 19 of the pressure die 17 lie along an area which is narrower than the recess itself. This leaves regions 29 (FIGURE 3), closely adjacent to the opposed sides 18 of the recess, devoid of elevations or projections 25. The pressure is thus effective (see FIGURE 4) along only a width W slightly less than the width of the work piece. As a result, the product shown in FIGURE 6 has undeformed margins 30 adjacent to each of its side edges 11. It has been found in practice that by limiting the area of treatment in this way, a desirable enhanced rigidity is imparted to the contact finger. When the area of pressure treatment extends all the way to the side edges, the hardening of the bar is not as effective.

If any of the holes in the bar are to be threaded it is in this rehardened state that they are now tapped, to produce the desired threads as indicated at 31 in FIGURE 6.

Although the procedure is a relatively simple one, it has been found that contact fingers made of commercially-available copper can be reliably produced, at relatively low cost, without loss of dimensional accuracy, and with a hardness and stiffness adequate for all commercial purposes. Tests have indicated that the pressure treatment causes a doubling of the yield point stress, and increases the modulus of elasticity almost sixfold. This restoration of hardness is highly important in producing contact fingers for use in conventional electromagnetic devices, because the contact deflection in such devices is only a small percentage of the total contact-break distance. This means that any bending that might occur, if the contact finger were not rigid enough, would impair the desired accuracy of making and breaking the electric contact, and would thus lead to excessive heating, faulty operation, and possible complete failure.

It is thought that the unusual hardening effect produced by the present specialized pressure treatment is due to a cold working of the metal. By simultaneously applying pressure in a multiplicity of minutely adjacent spots, a cold flow of metal is produced, effective over the entire area of the pressure treatment. While the penetration of the pressure elements is relatively small, compared to the thickness of the contact member, it is nevertheless entirely adequate for the purpose desired. For any given depth of penetration, the effective increase in hardness is more pronounced in thinner bars.

The pressure-applying projections may be conical, or they may be pyramids having triangular bases. Any form of projection is suitable for the purpose, provided it effects penetration of the material under treatment and restricts cold flow of material from each depression to the immediately adjacent areas.

In general it is to be understood that many of the details herein described and illustrated may be modified by those skilled in the art without necessarily departing from the spirit and scope of the invention as expressed in the appended claims.

What is claimed is:

1. In a method of producing an electric contact finger, the steps which comprise: providing a flat bar of hard drawn copper, producing through openings in the bar in accurate locations prescribed by the mounting upon which the finger is to be supported when in use, brazing a contact button to a face of the bar, the heat of said brazing having an annealing effect upon the copper, securing the bar in a rigid holder that snugly confines opposite side edges and plugs said openings with rigid unyielding material, and then, while so secured against dimensional changes, subjecting at least one face of the bar to simultaneous perpendicularly applied pressure in a multiplicity of minute closely adjacent spots, the pressure being of sufficient magnitude to cause deformation of the metal into a pattern of depressions and to cause cold flow into the regions between and directly adjacent to said depressions, said pressure treatment serving to reharden the copper, confining of the side edges of the bar serving to prevent alteration in the width of the bar as a result of the application of said pressure and to harden said side edges by restraining their normal tendency to expand outwardly.

2. The steps involved in producing a contact finger, as defined in claim 1, in which the pattern of depressions covers an area that terminates short of the confined edges along lines parallel thereto.

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