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(54) MULTIFINGER CONTACT MEMBERS

(71) We, ILLINOIS TOOL WORKS INC., a corporation organized under the laws of the State of Delaware, United States of America, of 8501 West Higgins Road, Chicago, Illinois 60631, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates generally to multifinger electrical contact members, such as those used in potentiometers.

One commonly used method of producing multifinger contacts of the type used in potentiometers is to wind conductive wire about a drum, plate the wound wire with conductive material, and selectively remove the plating to produce a plurality of severable brush blanks, each having a plated portion serving as a base interconnecting individual finger portions. This practice necessarily involves several complicated and expensive steps.

Another approach used to produce multifinger contacts is to cut slots into one edge of a sheet of conductive material and so provide a plurality of individual contact fingers separated by relatively large spaces between adjacent edges. Understandably, this method does not produce a dense arrangement of individually flexible fingers as is required for microminiature environments, such as in potentiometers.

Simple shearing of fingers from one another has been found to produce unacceptable contact members, because the fingers will not flex independently since they will remain in substantial lateral contact with each other.

According to the present invention, an electrical contact member comprises a base portion and a plurality of elongate resilient contact fingers emanating integrally from one edge of the base portion and arranged side by side, each of the fingers having a cross-sectional outline of which the portions closest to adjacent fingers are curved and convex towards the respective adjacent finger, and each of the fingers being slightly spaced from the adjacent fingers.

In such a contact member the fingers are in a dense arrangement, i.e. very close together, but are able to flex independently of each other.

The accompanying drawings show one example of a contact member embodying the present invention, and illustrate how it can be made. In these drawings:—

Figure 1 is a fragmentary plan view showing a series of deformations effected along a metal strip;

Figure 2 is a cross-sectional view of opposing tool faces in mating condition at four successive forming stations, which relate to the four successive deformed portions of the strip in Figure 1;

Figure 3 is a cross-sectional view of the strip along the line 3—3 of Figure 1, showing the condition of the strip as a result of the second working station;

Figure 4 is a cross-sectional view of the deformed strip taken along the line 4—4 of Figure 1, showing the condition of the strip after the third working station;

Figure 5 is a cross-sectional view of the fully formed fingers taken along the line 5—5 of Figure 1, showing the condition of the strip after the fourth working station;

Figure 6 is a perspective view of a contact element cut from the strip; and

Figure 7 is a side view of the contact element shown in Figure 6.

The method illustrated by Figures 1 to 5 involves advancing a strip of material through a plurality of work stations which

progressively deform portions of the strip. Figures 1 and 2 represent respectively the general configuration of the strip material as a result of the operations at each particular work station, and the associated work stations producing such a configuration. It will be seen that there are four successive work stations.

The various successive work stations each include a die set having mating opposing working faces. These faces are configured to produce a plurality of slender contact fingers integrally connected to a base portion. As stated above, one of the common problems in producing an integral multifinger contact of an extremely small size is the fact that conventional shearing operations will not allow independent flexing of the fingers. In contrast, the work stations shown in Figure 2 will form fingers which will not tend to hang up or interfere with the independent flexing of one another. The work stations 22 and 24 compress and diminish the width of the individual fingers as well as severing the fingers from one another. A subsequent station 26 totally confines each individual finger along its length and also accurately sizes and forms adjacent edge surfaces of the fingers into configurations which will provide essentially no interference to independent flexing.

An example of the size of contact members which may be produced as embodiments of this invention is a multifinger integral contact member having individual fingers with an individual width of approximately .005" and length of .075".

Turning now to Figure 2, the details of the various successive work stations will be presented with particular reference to the results of the deformation accomplished at each station.

The first work station serves to initially define elongated portions 12 which subsequently become fingers. The definition and location of the portions 12 is accomplished by a pair of opposing tools with working faces aligned so that opposing slender elongated die cavities 32 and 34, as well as thin wall portions 36 and 38 in upper and lower tool portions 28 and 30 respectively, will be accurately aligned. The station is designed so that the edges of the wall portions will not abut, so the edges will serve to score but not completely penetrate the strip 10.

The second station 22 includes a pair of opposing tools 40 and 42. The working faces of these tools include a series of alternately arranged die cavities 44 and punches 46 in the upper tool 40, and a series of die cavities 48 and punches 50 in the lower tool 42. The punches 46 in the upper tool are aligned with the die cavities 48, and likewise the punches 50 are aligned with the cavities 44, and will thus mate so that the punches may extend a limited distance within the cavities. It will be noted that the cavities 48 and 44 decrease in width from the mouth of the cavity to the bottommost portion of the cavity and the bottommost portion of the cavity is of an arcuate shape. The mating punches 46 and 50 increase in width from the working face to the base of the punch.

Figure 3 represents the condition of the strip as a result of the work performed at station 22. It will be seen that the punches 46 will deform alternate finger portions 12 out of the plane of the remaining finger portions. As the tool portions 40 and 42 are mated, each individual finger portion 12 will be compressed into a cavity 44 and 48 and, since the cavity is of decreasing width, the finger portion resulting will likewise be of a decreasing width. The finger portions 12 remain interconnected along their length through webs 13 following the operation at this station.

At the third station 24, co-operating upper and lower tools 52 and 54 are provided having working faces substantially identical to the preceding station 22. However, it is to be noted that the relative positions of the die cavities 56 and punches 58 on the upper tool 52 are reversed from the positionment of die cavities 44 and punches 46 in the preceding upper tool 40. Likewise, the relative positions of die cavities 60 and punches 62 in the lower tool 54 are reversed from the positions of die cavities 48 and punches 50 in the preceding lower tool 42. It will be apparent, therefore, that the alternate fingers 12 that were deformed in one direction in station 22 will now be deformed in the opposite direction in station 24. This is shown by comparing the configuration of the stock in Figure 4 with the configuration of the stock in Figure 3. Since the die cavities 56 and 60 in station 24 are also of decreasing width towards the bottom of the cavities, the resulting fingers will likewise be decreased in width during this operation as well as in the preceding station. The two directions of deformations performed successively by stations 22 and 24 will allow the deformation at station 24 to completely sever adjacent fingers 12 from one another. Any burrs or irregularities along the length of the fingers caused by the shearing will tend to be eliminated in the deformation process of station 24. As shown in the appropriate portion of Figure 1 as well as Figure 4, the adjacent fingers 12 will be slightly spaced from one another as a result of the compression into die cavities of decreasing width and following the severing at station 24.

The final work station 26 includes upper and lower tools 64 and 66. The working

face of the upper tool 64 includes a plurality of closely adjacent shallow die cavities 68 separated by thin wall portions 79. The tool face of the lower tool 66 includes shallow elongate die cavities 72 separated by thin wall portions 74. The die cavities 68 and 72 as well as the wall portions 70 and 74 are aligned so that the edges of the wall portions will abut when the tools are in mating condition. The die cavities 68 and 72 are substantially identical and are of an arcuate configuration so that the mating tool faces will provide a generally oval-shaped cavity. It will be particularly noted that the abutting edges of the walls 70 and 74 will totally confine adjacent finger portions 12 from one another. Due to the continuously arcuate configuration presented by the opposing die cavities, the resulting fingers will have opposing side edges 82 (Figure 5) which are curved, convex to one another, as well as being slightly spaced, as at 80 in Figure 5, as a result of previous compression steps and the confinement step in the station 26. The plurality of finger portions 12 may be returned to a position coplanar with each other as well as with the associated base portion 14 either at the station 26 or at a separate work station interposed between stations 24 and 26.

Following a final deformation step at station 26, the strip may be selectively severed to produce a plurality of integral multi-finger contact members such as that shown in Figure 6. Each contact member includes a base portion 14 and a plurality of densely arranged fingers 12 emanating therefrom. The fingers have curved surfaces at opposing sides, to substantially minimise the potential binding or interfering lateral contact between adjacent fingers.

The various compression and forming steps may serve to work-harden each finger, as well as providing the slight spacing between each finger.

WHAT WE CLAIM IS:—

1. An electrical contact member comprising a base portion and a plurality of elongate resilient contact fingers emanating integrally from one edge of the base portion and arranged side by side, each of the fingers having a cross-sectional outline of which the portions closest to adjacent fingers are curved and convex towards the respective adjacent finger, and each of the fingers being slightly spaced from the adjacent fingers.

2. An electrical contact member according to claim 1, in which the cross-sectional outline of each finger is continuously curved.

3. A contact member according to claim 1, substantially as described with reference to Figures 5 to 7 of the accompanying drawings.

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