United States Patent [19]

Backstrom

[11] **3,821,848**

[45] **July 2, 1974**

[54] **COPPER BACKED ELECTRICAL CONTACT AND METHOD OF MAKING THE SAME**

[75] Inventor: **Melvin L. Backstrom,** Murrysville, Pa.

[73] Assignee: **Textron Inc.,** Providence, R.I.

[22] Filed: **June 5, 1973**

[21] Appl. No.: **367,201**

Related U.S. Application Data

[62] Division of Ser. No. 205,273, Dec. 6, 1971, Pat. No. 3,775,067.

[52] **U.S. Cl.** ..... **29/630 C,** 29/497.5, 29/504

[51] **Int. Cl.** **H01r 9/00**

[58] **Field of Search** .. 29/497.5, 504, 195 C, 195 M, 29/199, 630 C; 200/166 C, 166 CM

[56] **References Cited**

UNITED STATES PATENTS

3,355,796	12/1967	Frieling	29/504
3,381,364	5/1968	Winter	29/504
3,381,365	5/1968	Winter	29/504
3,381,366	5/1968	Winter	29/504
3,392,436	7/1968	Winter	29/504
3,392,437	7/1968	Winter	29/504
3,462,827	8/1969	Winter	29/504
3,462,828	8/1969	Winter	29/504
3,545,067	12/1970	Haarbye et al.	29/504
3,616,982	11/1971	Dion	29/504

Primary Examiner—Charles W. Lanham
Assistant Examiner—James R. Duzan
Attorney, Agent, or Firm—Ostrolenk, Faber, Gerb & Soffen

[57] **ABSTRACT**

A copper backing is formed on a silver-cadmium oxide contact by first forming a bimetal strip having a thin layer of substantially pure silver and copper layer. The bimetal strip is secured at at least one end to a billet of the contact material, to retain them together during subsequent operations, with the silver surface of the bimetal strip against a surface of the billet of contact materials. The composite is then rolled to a substantial reduction of thickness, of the order of at least 50 percent, to bond the silver surface of the bimetal to the contact material. This produces a tri-layer contact with the layers fully integrated, consisting of the main contact material section, an intermediate silver layer and a copper backing layer.

6 Claims, No Drawings

COPPER BACKED ELECTRICAL CONTACT AND METHOD OF MAKING THE SAME

This is a divisional application of application Ser. No. 205,273, filed Dec. 6, 1971, and now U.S. Pat. No. 3,775,067.

It has been regarded as impossible to bond a copper backing to a silver-cadmium oxide electrical contact. Because of the affinity of copper for oxygen, heating in an oxidizing atmosphere results in the formation of copper oxide which is an insulator. On the other hand, the kinetics of the silver-cadmium oxide are such that if heated in a neutral or a reducing atmosphere, decomposition occurs. The cadmium oxide decomposes at about 1400°F. and decomposition can occur at temperatures even as low as 500°F. depending on the time of exposure in a reducing atmosphere.

To overcome this apparent incompatibility, the present invention provides a bimetal strip of copper with a fine silver backing. The silver surface of the bimetal is placed in contact with the silver-cadmium oxide and the bondable surfaces are co-rolled to provide a composite electrical contact having a silver-cadmium oxide layer, a fine silver layer not more than 10 percent, and preferably 1–5 percent, of the total thickness of the contact, and the copper backing layer. The copper backing of the tri-lever layer contact can be readily secured to a contact support.

The primary object of this invention is therefore the provision of a tri-level contact element having a layer of contact material such as silver-cadmium oxide, a pure silver intermediate layer, and a copper backing, the silver layer being firmly bonded to the copper backing and also being firmly bonded to the silver-cadmium oxide layer thereby providing a contact structure which can be readily secured to a contact support in a device intended to control an electrical circuit.

Another object is the provision of a method of making the tri-layer contact which includes the steps of providing a bimetal silver-copper member, and securing the silver surface of said bimetal member to a contact material such as silver-cadmium oxide.

Still another object of the invention is the provision of a brazing or soldering surface for a silver-cadmium oxide or other silver based composite which alone is not readily attached by brazing or soldering.

The foregoing and other objects of this invention will become apparent in the following detailed description.

In accordance with the present invention, there is provided an electrical contact material and a bimetal backing strip. The contact material can be silver-cadmium oxide in which the cadmium oxide is generally up to about 50 weight percent. However, the brittleness of the contact material increases with the percentage of the cadmium oxide and it is therefore preferred to employ a material in which about 2.5–15 weight percent is cadmium oxide and the balance is silver.

The bimetal backing strip has a layer of silver and a layer of a material such as copper which is readily soldered or brazed. The silver surface of the bimetal backing strip now provides the means for attaching the bimetal strip to the contact and the copper surface provides the readily brazable or solderable surface which can be used to attach the contact to contact support structures or electrical devices.

The composite silver-copper strip can be formed by any suitable manner as by cold or warm bonding by rolling, by pressure, by plating or other means which will form the bi-metallic strip. A method which is currently employed in the metal industry is hot-roll bonding. In this method, the metals to be joined are preheated and subjected to high localized forces by passing the structure through a rolling mill. As a result of the combination of elevated temperature and rolling pressure, a metallurgical bond is obtained. Any desired thickness of copper and silver can be employed provided that the silver thickness allows a satisfactory bond between the silver and silver-cadmium oxide when the tri-level contact element is mechanically worked.

The surface of the contact material which is to be secured to the bimetal strip and the silver surface of the bimetal strip are thoroughly cleaned in a manner well known in the art. The bimetal strip and contact material are contacted in a manner to provide continued alignment during processing. This can be accomplished by mechanically forming the bimetal so as to provide a physically locked total configuration, by spot-weld tacking, or otherwise mechanically fixing the bimetal backing to the silver-cadmium oxide before initiating the bonding.

The bonding of the bimetal backing strip and the silver-cadmium oxide contact material is effected by mechanically working the opposing faces together. Because silver-cadmium oxide cannot be heated in a reducing or neutral atmosphere and copper cannot be heated in an oxidizing atmosphere, it is preferable to perform the initial bonding operation by rolling the composite structure to obtain a reduction in thickness at ambient temperature. The structure is rolled to a reduction of not less than 50 percent taking as many passes as necessary, although it is possible to obtain this reduction in one pass. The purpose of the rolling operation is to enable a complete metallurgical bond and it has been found that a good metallurgical bond can only be achieved if an initial reduction of at least 30% is effected by the first pass through the rolls.

If desired, a preliminary heating operation can be performed to increase the ductility of the contact material and insure that during the rolling operation which takes place immediately thereafter, the materials will not separate and no thin spots will occur. A temperature of 500°–750° F. for a period of time selected so as to avoid substantial decomposition of the heated materials is usually employed. If the contact material is silver-cadmium oxide, the heating operation can take place in air. If the contact material is of other structure (such as silver tungsten) the heating operation can take place in a reducing atmosphere such as hydrogen.

A typical copper backed electrical contact of the present invention is prepared as follows. Slabs of a composition having 90 percent silver and 10 percent cadmium oxide were cut into ½ × 1-¾ × 6 inch sections. A commercially available bimetal strip of cold-bonded fine oxygen-free, high conductivity silver-copper having a total thickness of 0.060 inch and a fine silver layer of 0.006 inch was cut to size and mechanically bent to form a V-shape. The contact material and bimetal strip were mechanically cleaned by sanding and mechanically affixed together. The total thickness was 0.560 inch. The composite was fed with the aid of roll guides into 14 inch diameter work rolls set to pro-

vide an opening between rolls of 0.250 inch. The rolling speed was 150 feet per minute and the contact angle was approximately 4°. After the first pass through the rolls, a strip approximately 1-¾ wide by 11-½ inch long with a thickness of 0.256 inch was obtained.

The resulting strip was evaluated for bond strength and brazing characteristics. A section of the strip was placed in a vice and bent into a 90 degree bend which resulted in the breaking of the silver-cadmium oxide section but the integrity of the bond was sufficient to resist peeling of the backing member from the main structure. Subsequent chiseling at the interface resulted in breaking the silver-cadmium oxide but not in destroying the bond. The brazing test was conducted by cutting several contact sections ½ × ½ × 0.256 inch and brazing the sections to a backing member by induction heating. A commercial brazing alloy known as Sil-Fos was employed as the brazing media. No separation of the interfaces resulted from the heat applied during brazing. Metallographic examinations were made and verified the integrity of the multiple bonded cross-section.

The tri-level contact was then rolled to form better cross-sections. The initially bonded strips were placed in an air atmosphere furnace and heated to about 750° F. for 15 minutes. The rolls of the rolling mill were preheated to about 100° F. Some oxidation of the copper occurred but the bonded areas had sufficient integrity to prevent deterioration of the bond surfaces. The rolls were set to provide a 20 percent reduction for the pass at the same rolling speed as the initial pass. The rolled material had a thickness of 0.202 inch. Subsequent passes were made through the rolling mill using the same heating cycle but the individual reductions were reduced to about 10 percent per pass to eliminate the possibility of exceeding the maximum tensile strength of the silver-cadmium oxide. The final thickness of the tri-level composite was 0.050 inch of which 0.006 inch was the copper backing and 0.001 inch was the fine silver intermediate layer.

Various changes and modifications can be made in the process and product of this invention without departing from the spirit and the scope thereof. The various embodiments disclosed herein serve to further illustrate the invention but were not intended to limit it.

I claim:

1. A process for forming a solderable copper backing for silver-cadmium oxide electrical contacts comprising the steps of providing a bimetal strip having a silver surface and an opposite copper surface, securing a portion of said strip to a silver-cadmium oxide contact material with the silver surface adjacent a surface of the contact material, and rolling the composite structure at ambient temperature to a reduction of at least about 50 percent to decrease the thickness of the composite and metallurgically bond the silver surface of the silver-copper bimetal to the surface of the contact material, the initial rolling effecting a reduction of at least 30 percent.

2. The process of claim **1** wherein the bimetal strip is welded at one end to the contact material prior to rolling.

3. The process of claim **1** wherein the cadmium oxide in the silver-cadmium oxide is up to about 50 weight percent.

4. The process of claim **3** wherein the cadmium oxide is about 2.5–15 weight percent of the contact material.

5. The process of claim **1** wherein the silver of the silver-copper bimetal is not more than 10 percent of the total thickness of the composite structure.

6. The process of claim **5** wherein the silver is 1–5 percent of the thickness of the composite structure.

* * * * *