United States Patent

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[54] **ELECTRICAL CONTACT SURFACE PLATE HAVING A MERCURY AMALGAM**
4 Claims, 2 Drawing Figs.

[52] **U.S. Cl.** **200/166**
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[50] **Field of Search** ..... 204/37, 40, 38.3, 35; 29/199; 117/131; 200/166 (C)

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ABSTRACT: An electrical contact surface is prepared by forming a thin nickel or cobalt plate over a conductive substrate, coating the nickel plate with a thin silver plate, and thereafter coating the silver surface with mercury and causing the mercury to amalgamate into the lower nickel and silver plates. The silver layer may be further coated with a layer of gold or a layer of one or more of the platinum group family metals before the application of the mercury surface. Cadmium may be applied over the mercury layer before amalgamating the mercury into the silver layer.

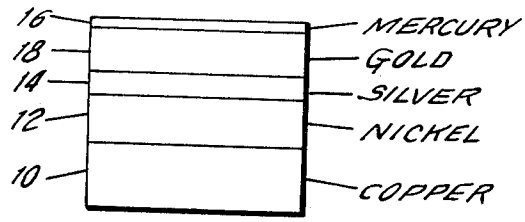


FIG. 1

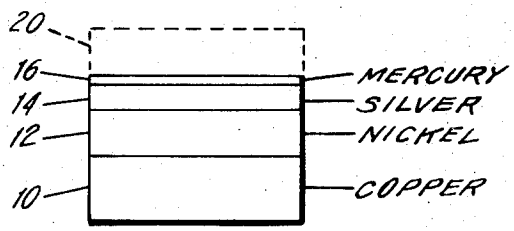
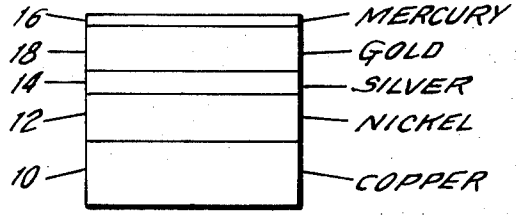


FIG. 2



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ELECTRICAL CONTACT SURFACE PLATE HAVING A MERCURY AMALGAM

This invention relates to electrical contact structures and methods of making such structures, and more particularly relates to a novel plated contact.

Electrical contacts are commonly formed by plating a silver or silver alloy layer over a conductive substrate such as a brass rivet, brass or copper plate, or the like, which is to cooperate with another contact. Similarly, surfaces which are to receive sliding contact engagement are commonly silver plated to reduce contact resistance and mechanical friction.

Platings or cladding used in the past have exhibited relatively high rises in contact resistance or unexpected changes in contact resistance, due in part from localized electrolytic action between the plating and the substrate. Moreover, relatively soft platings such as silver are subject to flow under pressure, leading to inadvertent open or closed circuits between the plated contact surface and its cooperating contact (which may also be a plated contact).

A principle object of the present invention is to provide a contact surface layer for a conductive substrate which has a relatively consistent resistance drop.

Another object of this invention is to provide an electrical contact surface having a low resistance drop which is smooth and hard.

A further object of this invention is to provide a novel contact surface layer structure which is relatively inexpensive.

These and other objects of this invention will become more apparent from the following description and examples of carrying out the invention, reference being made to FIGS. 1 and 2 of the drawings showing alternative embodiments thereof, though not necessarily to scale.

EXAMPLE 1

A copper plate **10** (FIG. 1) which is the conductive substrate to be clad is first cleaned in the manner well known for preparing a surface for a nickel plate. Thereafter, a nickel plating **12** is applied to the surface to be clad to a thickness of at least 0.0001 inches. This nickel layer can be applied by any desired process such as mistplating, vacuum plating, electroplating or electroless plating. Thereafter a layer of silver **14** is plated over the nickel plate to a thickness of at least 0.00005 inches.

The upper surface **14** of the silver surface is then wet with mercury **16** and the substrate and mercury are tumbled or agitated until the silver surface is coated uniformly with a mercury coating having a thickness of at least 0.00001 inches.

The mercury coated plate is then placed in a suitable oven and heated to a temperature greater than 100° C., but less than 300° C., until the mercury coating **16** amalgamates into the lower silver layer **14**, and, to a lesser extent, the nickel layer **12**.

The completed contact surface formed in the above manner has been found to exhibit a very stable resistance rise and has a hard, smooth finish which will not cold flow or deform easily.

EXAMPLE 2

Thin nickel **12** and silver **14** layers were first applied to a conductive substrate **10**, as described in Example **1**. Thereafter, and prior to application of the mercury layer **16**, a thin layer of gold **18** (FIG. 2) having a thickness of about 0.0001 inches was plated atop the silver **14**. Mercury **16** was then coated atop the gold layer **18** and amalgamated into the three lower layers by heating as described above.

EXAMPLE 3

The process of Example 2 was repeated where the gold layer **18** was replaced by a layer of one or more of the platinum group family metals including palladium, osmium, rhodium, platinum, and ruthenium.

EXAMPLE 4

The process of Example 1 was repeated to the point of spreading mercury **16** over the lower silver layer **14**. Before amalgamating the mercury, a thin cadmium layer **20** (FIG. 1, in phantom) was plated over the mercury **16** to a thickness of about 0.0001 inches. The platings were then heated to force the amalgamation or diffusion of the mercury into the silver layer and partly into the bottom nickel layer.

EXAMPLE 5

The process of Example 1 was repeated with the nickel layer **12** replaced by cobalt. It was found that the cobalt performed in a manner similar to nickel in its cooperation with the mercury after amalgamation of the mercury.

It has been shown through electrical and/or electrochemical life tests that the addition of and incorporation of mercury in the cladding prevents or sufficiently ameliorates the electrolytic or so-called battery actions often existing between the individual members of a contact assembly under humid or liquid operational conditions, so that the resultant two or multilayer cladding is not subject thereto. This is particularly important for the contact requirements of dry circuitry, of television tuner circuits etc., and for low impressed voltage contact requirements. It is well known in the art that such electrolytic actions can markedly affect the direction and degree of current flow under low voltage and low current flow conditions.

These tests have further shown that the millivolt drop (surface resistance rise) across single or mating contacts prepared according to this invention remains consistently lower than for parts similarly plated, but not containing mercury. Furthermore, these tests have also shown that to obtain optimum results both the nickel clad surface and the diffused or amalgamated mercury are necessary components or constituents. Although not as yet fully determined as to its nature, there is a resultant definite advantageous synergistic action obtained through the mutual inclusion and use of the nickel or cobalt and the mercury.

Furthermore sliding frictional value tests have shown that the incorporation of mercury appreciably lowers the overall drag or frictional resistance over the same materials not containing mercury. This is somewhat surprising, since the overall (surface) hardness is also greater for the contacts incorporating mercury than for those not containing mercury.

Although this invention has been described with respect to its preferred embodiments, it should be understood that many variations and modifications will now be obvious to those skilled in the art, and it is preferred, therefore, that the scope of the invention be limited not by the specific disclosure herein, but only by the appended claims.

The embodiments of the invention in which an exclusive privilege or property is claimed are defined as follows:

I claim:

1. An electrical contact structure comprising a conductive substrate, a thin first layer of material selected from the group consisting of nickel and cobalt extending across at least a portion of a surface of said substrate, a thin silver layer extending across the upper surface of said thin first layer, and mercury amalgamated into said silver layer and, to a lesser extent, into said first layer.

2. The contact structure as set forth in claim 1 which includes a further layer of cadmium plated atop said silver layer.

3. The contact structure of claim 1 which further includes a third layer of material selected from the group consisting of gold and the platinum group family metals plated across said silver layer; and mercury amalgamated into said third layer.

4. The contact structure of claim 1 wherein said first layer has a thickness of at least 0.0001 inches and said silver layer has a thickness of at least 0.00005 inches.