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ELECTRICAL CONTACT MATERIAL

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The present invention deals with an electrical contact and, more particularly, with a ductile electrical contact alloy characterized by improved electrical performance.

The prior art indicates that electrical contacts of fine silver can be improved by the addition thereto of various oxides such as tin oxide, cadmium oxide, indium oxide, etc., introduced to the silver component by powder metallurgical methods. Further improvements were attempted by providing an alloy of, for example, silver and cadmium and internally oxidizing the cadmium component to provide useful contacts. The silver-cadmium oxide contacts, although useful for some purposes, did not appear to perform as well as desired, and efforts have been made to still further improve such contacts. In view of the above, tin and indium additions were studied and applied. Other experiments included the addition of aluminum, beryllium, magnesium, etc. It was found that tin or indium actually improves the electrical performance, apart from the fact that all of these additions introduced an undesirable hardness to the oxidized material to the point of brittleness, which precluded the use thereof in the manufacture of certain contact assemblies. Some electrical contacts are flat, round, or square members soldered onto screws or brackets, where some brittleness may be tolerated. However, in other cases, where the contacts are preferred in the form of the rivets with or without hollow shanks, ductility is of critical significance, and the oxidized contact alloys heretofore proposed do not lend themselves to sufficient plastic deformation without fracture for desirable application in such form.

It is an object of the present invention to provide an electrical contact alloy, which upon oxidation provides for improved electrical performance and suitable ductility, permitting plastic deformation without fracture. It is another object of the present invention to provide an electrical contact element in the form of a rivet, and composed of a material having improved electrical performance together with suitable ductility permitting the attaching of said rivets to a contact arm or other support therefor by staking or spinning of the shank. Other objects of the present invention will become apparent from the description hereinafter following.

The present invention relates to an electrical contact alloy consisting of silver-cadmium-tin, which retains desirable electrical properties and ductility when the tin content is maintained below a critical maximum content, whereby, upon internal oxidation of the cadmium and tin, the tin oxide content is below a critical maximum content, and the excellent electrical properties of tin oxides are maintained without rendering the composite contact material disadvantageously hard, whereby the material is amenable to plastic deformation essential in the manufacture of electrical contacts in the form of rivets with shanks deformable without fracture.

The alloy of the present invention is composed of from 0.1% to 15% cadmium oxide, 0.01% to 0.2% tin oxide, the balance being silver, and preferably of an alloy of 88% silver, 11.85% cadmium, and 0.15% tin, whereby

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upon oxidation the material consists of 86.5% silver, 13.31% cadmium oxide, and 0.19% tin oxide. As soon as the addition of tin oxide is increased to over 0.2%, and cadmium oxide over 15%, a deterioration of the physical properties is noticeable, and the hardness of the material is sufficient to prevent plastic deformation without cracking. According to this invention, it is found that indium behaves substantially identically to tin, and, therefore, the use of indium as a substitute for tin, in the identical amount as tin, is contemplated within the scope of the invention.

Both indium and tin may be incorporated into the contact material so long as the combined amounts do not exceed 0.2%.

The contact material of this invention can be rolled and formed after oxidation to a remarkable degree, and, in view of the ductility, additional work hardness may be introduced if required.

In order to obtain the advantages of this invention, it is not necessary to completely oxidize the alloy throughout, so long as the electrically operating surface provided by oxidation shows a substantial layer of oxidized alloy.

Example

An alloy composed of 88 oz. fine silver, 11.85 oz. cadmium, and 0.15 oz. of tin was melted in a graphite crucible under a charcoal cover. The alloy was suitably liquified at about 1700° F. and cast at 1850° F. into an upright wire mold. After cooling, the bar was scalped on a lathe and cold rolled with 60% reductions and anneals at 1200° F. in between. Part of the bar was drawn into round wire and part was flattened into strip. The wire was cut and headed into a rivet form having .312" head diameter and .125" shank diameter, and into another rivet having .125" head diameter and 0.625" shank diameter. The strip was cut and stamped into a disc having a diameter of .250" diameter and .032" thickness. Also, a square of .375" x .375" with a thickness of .050" was cut and stamped from the strip. The samples were then oxidized in an electrically heated furnace with a slight circulation of fresh air at between 800° C. to 850° C. The samples appeared to oxidize easier than many similar compositions with less cadmium or with no tin constituents. The disc was oxidized for 7½ hours, the square for 23 hours, the heavier rivet for 38 hours, and the other rivet for 12 hours.

The oxidation time left only about 5% of the total volume as only partially oxidized in the sample centers.

Although the above example is specific, it is thought that the reductions with anneals can be advantageously carried up to 80% of the cross-sectional area. By increasing the time of oxidation, the oxidation can be conveniently carried to a depth of .0625" from the surface.

The physical properties of this alloy are:

	Annealed Unoxi- dized	4 No. hard Un- oxidized	Oxidized	Oxidized and Worked 20%
Rock. hard., T 15.....	27	82	61	80
Ult. Tensile Str., p. s. i.	28,000	43,000	36,000	38,000
Elong., percent in 2".....	55	10	28	7
Elec. Res. Ohms cm ² /10 ⁻⁶	5.1	5.5	2.3	3.5

The hardness of my oxidized alloy (R. 15T-61) is the same as the hardness of an oxidized alloy 88% silver-12% cadmium. Therefore, while ductility has been at least maintained in spite of the tin oxide content, the electrical performance of the new alloy is superior, as follows:

Electrical tests were made on a 220 v. A. C. breaker with 450 grams' pressure.

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A. Commercially available oxidized material with no tin oxide (rivets $\frac{3}{8}$ " diameter):

200 amps., 100 operations—5 sticks (no weld)
 250 amps., 100 operations—6 sticks (3 welds)
 250 amps., 100 operations—7 sticks (3 welds)
 83 amps., 7000 operations—1 stick (no weld)

B. 88% silver, 11.85% cadmium, 0.15% tin, oxidized (rivets $\frac{3}{8}$ " diameter—Rock. 15T-61):

200 amps., 100 operations—no sticks
 250 amps., 100 operations—no sticks
 300 amps., 100 operations—1 stick (no weld)
 83 amps., 15000 operations—1 stick (no weld)

From the above, it is apparent that the alloy herein contemplated constitutes an unexpected improvement over similar alloys, so long as the cadmium oxide does not exceed 15% and the tin oxide does not exceed 0.2%. It is further contemplated to provide an electrical contact of conventional form incorporating the alloy hereinabove set forth. For example, a bimetal sheet or strip with one layer constituting the alloy and the other layer

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a base metal or silver solder; an inlay or overlay strip of the alloy of the invention on a base metal support; composite brackets or arms with the contact alloy soldered thereto; and contact springs with rivets attached by staking, double heading, or spinning, which rivets are composed of the oxidized alloy of this invention.

What I claim is:

1. An electrical contact material composed of from 0.1% to 15% cadmium oxide, from 0.01% to 0.2% of an oxide taken from the group consisting of tin oxide, and indium oxide, the balance being silver.
2. An electrical contact material composed of from 0.1% to less than 15% cadmium oxide, from 0.01% to less than 0.2% tin oxide, the balance being silver.

References Cited in the file of this patent

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