

UNITED STATES PATENT OFFICE

2,669,512

ELECTRIC CONTACT MATERIAL AND
METHOD OF MAKING THE SAME

Earl I. Larsen, Arnold S. Doty, and Donald A. Williams, Indianapolis, Ind., assignors to P. R. Mallory & Co., Inc., Indianapolis, Ind., a corporation of Delaware

No Drawing. Application January 9, 1951,
Serial No. 205,232

1 Claim. (Cl. 75-173)

1

This invention relates to electric contact materials and, more particularly, to electrical make and break contacts and to a method of making such contacts.

Electrical make and break contacts composed of silver and cadmium oxide have been in use for several years and have found wide application on low voltage-high current relays, such as those used in aircraft, as well as in industrial applications, such as motor starting switches, and the like. Contacts of this type have been formed by powder metallurgical procedures from silver and cadmium oxide powders or preferably by internally oxidizing silver-cadmium alloys. As disclosed in the co-pending application of Doty and Lynch, Serial No. 607,676, filed July 28, 1945, now Patent No. 2,539,298, issued January 23, 1951, when a silver-cadmium alloy is heated in air or in an oxidizing atmosphere at a temperature above 300° C. and below the melting point of silver, oxygen is absorbed into the alloy. The oxygen will combine with the cadmium to form cadmium oxide but will not combine with the silver. The resultant product is a mixture of silver and cadmium oxide with the cadmium oxide dispersed throughout the silver matrix in finely divided particles. In general, the silver-cadmium oxide contact materials produced by internal oxidation are characterized by a density, ultimate strength, ductility and resistance to electrical erosion which are considerably higher than those of silver-cadmium oxide contacts of identical composition formed by powder metallurgical procedures.

While silver-cadmium oxide contacts have many excellent qualities as a result of which they have met with wide public acceptance within a short time, they have the disadvantage of relatively low hardness and are thereby subject to considerable amount of wear and deformation, especially in those applications where contact forces are high and where the contacts close under high impact forces.

It is an object of the present invention to improve electrical contacts of the described character.

It is another object of the invention to provide electrical make and break contacts combining the advantages of prior silver-cadmium oxide contacts with the highly desirable characteristic of considerably higher hardness.

The invention also contemplates a method of producing the contact compositions of the invention on a practical and industrial scale at a low cost.

2

Other and further objects and advantages of the invention will become apparent from the following description and from the appended claim.

Broadly stated, we have discovered that an electrical contact composed of silver, cadmium oxide and magnesium oxide provides novel and unexpected advantages. Such contact possesses not only the good contact properties of silver-cadmium oxide, but combines such properties with appreciable hardness, thereby overcoming the objectionable feature of low hardness of prior contact materials composed of silver and cadmium oxide, in the absence of magnesium oxide. We have further found that the most satisfactory method of producing the contacts of the invention is by internally oxidizing an alloy of silver, cadmium and magnesium. This may be accomplished by heating the alloy at a suitable temperature in an oxidizing atmosphere. It appears that during this treatment oxygen is absorbed into the alloy and will combine with the cadmium and the magnesium to form cadmium oxide and magnesium oxide, respectively, but will not combine with the silver. Thus, the resulting product will comprise a silver matrix with the cadmium oxide and magnesium oxide particles uniformly dispersed throughout the said matrix and will be characterized by high hardness and non-annealing characteristics. The non-annealing characteristics of the silver-cadmium oxide-magnesium oxide contacts of the invention make it possible to silver-braze the contacts to a suitable backing and still retain the original high hardness of the material.

The useful range of composition of the silver-cadmium oxide-magnesium oxide contacts of the invention is 1-25% cadmium oxide, 0.05-5% magnesium oxide, balance substantially all silver. The preferred range of composition is 2 to 15% cadmium oxide, 0.1 to 1.0% magnesium oxide, balance silver.

As a specific example, a contact composed of 89.7% silver, 9.82% cadmium oxide and 0.454% magnesium oxide (by analysis) provided excellent results as indicated by the results of the following tests.

The physical properties of this contact composition were the following:

Hardness	68-77.5 Rockwell F.
Ultimate tensile strength	12,000 p. s. i.
Elongation	3.1% in 2" length.
Electrical conductivity	74.6% IACS.

In the aircraft relay tests the contacts having

the above-mentioned specific composition (89.7% Ag, 9.82% CdO, 0.454% MgO) were subjected to the following test procedure:

	v., D. C.	
50 operations at 1000 amps.....	24	5
50 operations at 1500 amps.....	24	
500 operations at 2000 amps.....	24	

Three sets of contacts were tested. The only failures were that one set stuck after 14 operations at 1500 amps. and welded after 19 operations at 1500 amps. The other two sets went through all the above tests with no failure.

In contrast to this, under similar test conditions, two sets of contacts made from a material composed of 90.0% silver and 10.0% cadmium oxide, but containing no magnesium oxide showed the following:

At 1000 amperes, 1 set of contacts stuck 3 times during the first 35 operations and welded on the 47th operation. Another set stuck on the 1st operation, welded on the 47th operation, stuck on the 39th operation and welded on the 52nd operation. Tests were not conducted at higher current due to poor performance at 1000 amps.

The latter (silver and cadmium oxide) material also had a hardness below 57 Rockwell F, actually 74-81 Rockwell H. By conversion, these values are below 0 Rockwell B whereas the values obtained on the silver-cadmium oxide-magnesium oxide contacts of the invention convert to an average of about 30 Rockwell B.

From the foregoing comparative tests it will clearly appear that the contacts of the invention are greatly superior in hardness and in general performance to prior contacts composed of silver and cadmium oxide.

The preferred method of making the contacts of the invention comprises first making an alloy of silver, cadmium and magnesium containing said metals in such proportions that after internal oxidation of the cadmium and magnesium to their respective oxides the resulting product will contain silver, cadmium oxide and magnesium oxide in the desired proportions. The internal oxidation of the alloy is accomplished by heating the alloy in an oxidizing atmosphere, such as oxygen or air, to a temperature higher than 300° C. but lower than the melting point of silver for a suitable period. In general, heating the alloy in air at a temperature between 700 and 850° C. for 24-72 hours provides satisfactory results.

In most cases and particularly when forming contacts of small dimensions, it is advantageous to carry out the internal oxidation after the contacts have been brought substantially into their final shape. In other words, a strip is rolled from the starting alloy of silver, cadmium and magnesium and contacts are blanked from the strip. Finally, the blanked contacts are heated in an oxidizing atmosphere thereby converting them from the silver-cadmium-magnesium alloy into the silver-cadmium oxide-magnesium oxide composition of the invention.

In order that those skilled in the art may have a better understanding of the invention, the following illustrative example may be given:

Example

An alloy of silver-cadmium-magnesium was

made by melting the necessary constituents in a graphite crucible using an Ajax induction furnace. The charge consisted of 1265.8 grams silver, 130 grams cadmium, 4.2 grams magnesium. A charcoal cover was used on the melt. The melt was heated to approximately 1230° C. and poured into a carbon mold $\frac{1}{2} \times 1\frac{1}{2} \times 8\frac{3}{4}$ ". The resulting ingot was scalped and cold rolled to .100" thick. Reduction per pass during cold rolling amounted to approximately 10%. The bar was annealed after each 35-40% reduction. The .100" thick strip was cold rolled to .040" and suitable contact discs blanked from this strip. The contact discs were then heated for 72 hours at 800° C. in an oxidizing atmosphere so as to internally oxidize the cadmium and magnesium to form cadmium oxide and magnesium oxide respectively.

This treatment resulted in a contact disc having the following properties:

Electrical conductivity.....	74.8% IACS.
Hardness.....	30 Rockwell B.

Chemical analysis of these contact discs showed the following composition:

89.9% silver.
8.58% cadmium (9.82% cadmium oxide).
.274% magnesium (.454% magnesium oxide).

What is claimed is:

An electrical make-and-break contact formed of a composition consisting of 2-15% of cadmium oxide, 0.1-1% of magnesium oxide, the balance being substantially all silver, said composition having a microstructure as is obtained by internal oxidation of a cast silver-cadmium-magnesium alloy characterized by a silver matrix and by the presence of particles of cadmium oxide and magnesium oxide uniformly distributed throughout said matrix and being further characterized by high hardness, non-annealing and non-welding properties which are considerably superior to those of contacts consisting of silver and of cadmium oxide in identical proportions in the absence of magnesium oxide.

EARL I. LARSEN.
ARNOLD S. DOTY.
DONALD A. WILLIAMS.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
2,057,604	Zickrick	Oct. 13, 1936
2,145,690	Hensel	Jan. 31, 1939
2,161,575	Hensel et al.	June 6, 1939
2,207,292	Hensel et al.	July 9, 1940
2,396,101	Hensel et al.	Mar. 5, 1946
2,539,298	Doty et al.	Jan. 23, 1951

FOREIGN PATENTS

Number	Country	Date
611,813	Great Britain	Nov. 4, 1948

OTHER REFERENCES

Rhines et al., "Internal Oxidation in Dilute Alloys of Silver . . ." Amer. Inst. of Mining and Met. Engrs., vol. 147, 1942, pages 318-330.