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MANUFACTURE OF ELECTRIC CONTACTS

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This invention relates to the manufacture of electric contacts, and more particularly to contact elements for heavy duty, low voltage aircraft and the like relays.

Contacts of cadmium oxide and silver have been used for such purposes, but they have been subject to the disadvantage that they undergo excessive transfer of material, which may result in possible sticking and severe arcing after extended use, say after a few thousand operations, and if an overload occurs on a relay which has undergone severe transfer, the contacts may not break the arc and open the circuit, which may, obviously, defeat the purpose of the relay and have serious consequences. Some specifications call for aviation type relays to undergo 50,000 operations without welding, but it has not been possible to meet this requirement consistently with some types of relays when made by the procedures known prior to this invention.

A primary object of this invention is to provide a method of making electric contact elements composed of contact metal, most suitably silver, and cadmium oxide which is simple, inexpensive and efficacious, which in its preferred embodiment results directly in contacts ready to be united to contact arms by brazing or welding, and which produces contacts that are much more resistant to material transfer and consequently possess a longer and more useful life than similar contacts heretofore available commercially.

Other objects will appear from the following specification.

In accordance with the invention a powdered contact metal and powdered cadmium oxide are mixed intimately, for example in a ball mill, and the mixture is then pressed under high pressure to form compacted bodies, most suitably of the form and general size of the desired contact elements. The compacted and shaped bodies are then baked, or sintered, in an atmosphere of nitrogen.

Silver is preferably used as the contact metal and the pressing, or pilling mixture may contain from about 0.1 to about 20 per cent by weight of cadmium oxide (CdO), although for many purposes we now prefer to use from about 9 to 11 per cent by weight of cadmium oxide and the remainder silver powder.

The compacted bodies formed from such mixtures are baked at a temperature adapted to confer the mechanical strength and electrical properties necessary in such an element. While that temperature may vary, in the preferred practice presently to be described the bodies are heated in a nitrogen atmosphere at a temperature above the boiling point of elemental cadmium and below the melting point of silver. For most purposes we prefer to bake the compacts between about 1200° to 1600° F. for about 1 to 5 minutes. The nitrogen may be, and preferably is, the standard bottled nitrogen of commercial purity.

Difficulties are encountered in uniting contacts of this general type, as by brazing or welding, with contact arms, and various expedients have been employed for providing a metallic face for that purpose. A substantially pure metallic face is provided easily and simply and during the baking operation by supporting the compacts on a carbon surface. A small amount of oxygen will be present in air carried in the pores of the carbon supports, such as boats, and as impurity in the nitrogen used. This oxygen will react with the carbon to form carbon monoxide at the interface between the compact and the carbon surface upon which it rests, and the cadmium oxide will thus be reduced at that face and to a small depth inwardly of the contact, thus forming cadmium metal. By baking at a temperature above the boiling point of cadmium (1430° F.), the cadmium formed by reduction of the oxide is volatilized, leaving a pure silver surface. Some of this vaporized cadmium may be deposited on the other surfaces of the compacts but this does not impair their utility. In this manner there is formed a pure metallic face for connection to a contact arm, and in the preferred practice the face is substantially pure silver. The depth to which the cadmium oxide will be removed will depend in part on the length of the baking step, but it need be sufficient only to provide for adequate welding to the contact arm.

Of particular importance, however, is the fact that by baking in nitrogen we produce compacts that show exceptionally low transfer of material and greatly reduced tendency to weld under overload conditions as compared with contacts of the same composition but baked in other atmospheres, e. g., in air. The contacts produced in accordance with this invention show lower average contact resistance at 200 amperes, and under test meet regularly a specification of 50,000 operations without welding, in comparison with the same contacts baked in air, which show higher average contact resistance and a tendency to weld under overload.

The compacts are then preferably repressed, when they are ready to be welded to the contact arm. Welding as referred to herein and in the appended claims, includes, of course, brazing and related modes of attaching the contact to its arm

to provide a connection that is mechanically strong and of satisfactory electrical properties. The welded assemblies thus provided may then be silver plated, as is common in this art.

As an example of the practice of the invention, a mixture of 10 per cent by weight of cadmium oxide and 90 per cent by weight of silver powder was mixed in a ball mill, and pressed into contact element shapes under a pressure of 25 tons per square inch. The compacts were baked on a carbon plate in an atmosphere of nitrogen of commercial purity at 1550° F. for about one minute. After cooling they were repressed and then welded to copper supporting arms. The assembled elements were then subjected to life tests in which they exhibited substantially no transfer of material in comparison with other contacts of the same composition and made in the same way except that they were not baked in nitrogen. Comparative data follow:

90 Ag—10 CdO contacts
Contact res.
M. V. at 200 a.

	Max.	Min.	Av.	Remarks
Baked in air	82	25	47	Welded at 10,000 operations.
Do	57	21	30	Met 50,000 operation spec.
Do	41	21	27	Welded 2nd overload.
Do	65	17	35	Met 50,000 operation spec.
Baked in N_2	43	17	26	Do.
Do	70	21	35	Do.
Do	100	24	40	Do.
Do	47	17	27	Do.

The consistent superiority of electrodes made according to the invention will be clear from the foregoing data.

The pressure used in repressing after baking will depend upon various factors but generally speaking this may be done at about 20 to 60 or 70 tons per square inch, and 40 tons per square inch is desirable for many purposes.

Although the invention has been described with particular reference to silver-cadmium oxide contacts, other contact metals, of which a variety are known, may be used singly or in combination. For example, copper behaves in a manner similar to silver when mixed with cadmium oxide.

Instead of supporting the compacts on carbon for reduction of CdO to form a metallic surface for welding to a contact arm, the compacts may be supported by non-carbonaceous material, such as ceramic supports, and hydrogen or the like reducing gas passed into contact with one face for the same purpose.

According to the provisions of the patent statutes, we have explained the principle and mode of practicing our invention, and have described what we now consider to represent its best embodiment. However, we desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

We claim:

1. That method of making an electric contact element which comprises pressing an intimate mixture of powdered contact metal and powdered cadmium oxide, and baking the compact in an atmosphere of nitrogen while exposing one face to reducing conditions and thereby reducing the cadmium oxide at that face.

2. A method according to claim 1, said mixture containing about 0.1 to 20 per cent of cadmium oxide.

3. A method according to claim 1, said mixture containing about 9 to 11 per cent of cadmium oxide.

4. That method of making an electric contact element which comprises pressing an intimate mixture of powdered contact metal and powdered cadmium oxide containing from about 0.1 to about 20 per cent by weight of said oxide to form a compact, and heating the compact in an atmosphere of nitrogen while supporting one face on a carbon surface and thereby reducing the cadmium oxide at that face to provide a metallic surface for welding to a contact arm.

5. That method of making a silver-cadmium oxide electric contact element which comprises pressing an intimate mixture of silver powder and powdered cadmium oxide containing from about 0.1 to about 20 per cent by weight of said oxide to form a compact, and heating the compact in an atmosphere of nitrogen while exposing one face to reducing conditions.

6. That method of making a silver-cadmium oxide electric contact element which comprises pressing an intimate mixture of silver powder and powdered cadmium oxide containing from about 0.1 to about 20 per cent by weight of said oxide to form a compact, supporting one face of said compact in contact with carbon and heating in an atmosphere of nitrogen at a temperature above the boiling point of cadmium and below the melting point of silver and reducing cadmium oxide at said face to provide a metallic surface for welding to a contact arm.

7. A method according to claim 6, said mixture containing about 9 to about 11 per cent of cadmium oxide.

8. A method according to claim 6, in which the compact is baked at between about 1200° to 1600° F.

9. That method of making a silver-cadmium oxide electric contact element which comprises pressing an intimate mixture of silver powder and powdered cadmium oxide containing from about 9 to about 11 per cent by weight of said oxide to form the contact body, supporting one face of said body in contact with carbon and heating in an atmosphere of nitrogen at about 1550° F.

10. A method according to claim 4, said atmosphere containing a small amount of oxygen.

11. A method according to claim 5, said atmosphere containing a small amount of oxygen.

12. A method according to claim 9, said atmosphere containing a small amount of oxygen.

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