May 12, 1970 J. SCHMIDT, JR 3,511,953

SILVER RHENIUM ELECTRIC CONTACTS

Filed June 6, 1968

Fig. 1

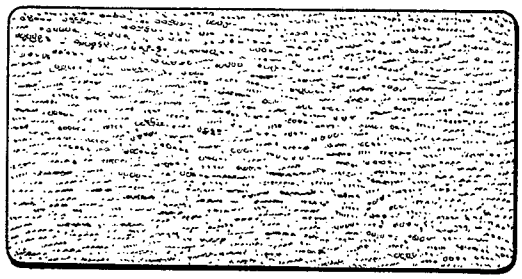


Fig. 4

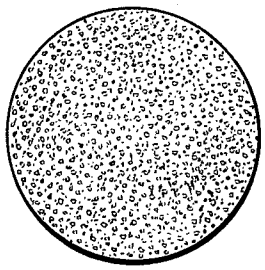


Fig. 2

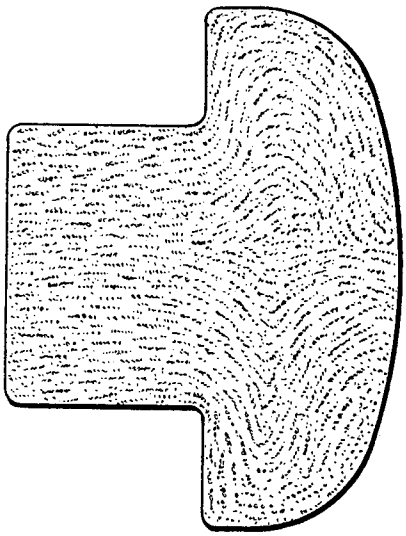
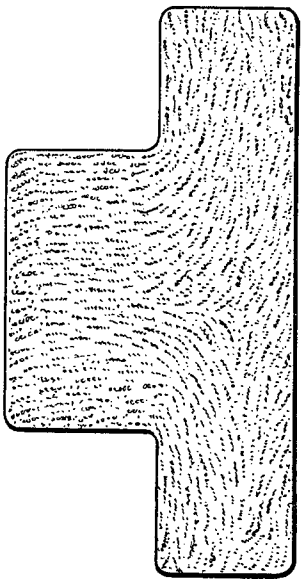


Fig. 3



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SILVER RHENIUM ELECTRIC CONTACTS

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U.S. Cl. 200—166 5 Claims

ABSTRACT OF THE DISCLOSURE

A uniform dispersion of 5–15% by weight rhenium in a silver matrix provides an electric contact which exhibits greatly improved erosion and current carrying characteristics in comparison to prior art pure silver and silver cadmium oxide contacts of like dimension. The diameter of the rhenium particles forming the dispersion varies between 10 and 25 microns, and the particles are uniformly dispersed in the silver matrix.

BACKGROUND OF THE INVENTION

This invention relates to an improved electric contact and, in particular, an electric contact fabricated from a dispersion of rhenium in silver.

Silver has long been recognized as an excellent conductor and consequently a good material for electric contacts especially at low current ratings. However, for higher current ratings, silver contacts erode or fuse when circuits are made and broken. A notable advance in the art of electric contacts was the discovery of silver cadmium oxide as a contact material. Silver cadmium oxide provides excellent current carrying characteristics and is one of the more common high current carrying contact materials.

Other pure metals, alloys and dispersions have been considered as contact materials also. An example of a patentable combination of metals for a contact material is disclosed in U.S. Pat. 2,234,969 issued Mar. 18, 1941 to Hensel et al. There tungsten in combination with various rare earth borides is disclosed as a contact material. Tungsten, alone, is also a well known and durable pure metal contact material. Tungsten is extremely difficult to work however.

Rhenium is still another pure metal which has been considered as a contact metal. For example, U.S. Pat. 2,733,319 issued Jan. 31, 1956 to Ericsson et al. discloses a method of producing an electric contact material made of pure rhenium. Ruskin in U.S. Pat. 2,997,524 issued Aug. 22, 1961 teaches the use of a pure rhenium coating approximately 1 mm. in thickness over a copper conductor base for a contact material. The use of rhenium as a contact material has been very limited, however, because of the great cost of rhenium (approximately $50.00 per ounce) and the difficulty of working the metal.

Thus, while the art of electric contacts has been extensively investigated, an improved contact is desirable. An improved contact should be available at a cost comparable to the cost of present contacts. In addition an improved contact as compared with presently available contacts should be capable of carrying greatly increased loads for increased periods of time without failing. Finally, an improved contact should be capable of being fabricated on currently available equipment using currently known methods.

SUMMARY OF THE INVENTION

In a principal aspect the present invention of an improved contact for electric switches, relays, contactors, etc. consists essentially of approximately 5–15% by weight rhenium dispersed in silver, silver being the matrix. Preferably the rhenium is uniformly dispersed as a particulate, with the particles each being less than 100 microns in diameter. The majority of particles are in the range from 10 to 25 microns in diameter.

It is thus an object of the present invention to provide an improved electric contact.

It is a further object of the present invention to provide a silver rhenium electric contact having improved electric characteristics in comparison to prior art contacts.

Still another object of the present invention is to provide an electric contact which reduces contact size requirements as compared to prior art contacts and at the same time carries current loads equal to or greater than those carried by prior art contacts.

One further object of the present invention is to provide a contact which may be provided at a cost competitive with presently available contacts having the same current carrying characteristics.

Still another object is to provide a contact which may be fabricated with presently available contact fabrication equipment and methods.

These and other objects, advantages and features of the present invention will be set forth in greater detail in the description which follows.

Brief description of the drawing

In the detailed description which follows, reference will be made to the drawing comprised of the following figs.:

FIG. 1 is a pictorial representation of a photomicrograph of a longitudinal axis cross section of a wire having a dispersion of rhenium in the range 5–15% by weight in a silver matrix;

FIG. 2 is a pictorial representation of a photomicrograph of a longitudinal axis cross section of a round head electric contact made from wire of the type shown in FIG. 1;

FIG. 3 is a pictorial representation of a photomicrograph of a longitudinal axis cross section of a flat head contact made from wire of the type shown in FIG. 1; and

FIG. 4 is a pictorial representation of a photomicrograph of a cross section transverse to the longitudinal axis of the wire shown in FIG. 1.

Description of the preferred embodiments

The contacts of the present invention are prepared by standard powder metallurgy techniques. Thus, rhenium powder is supplied having a particle size equal to the final desired size of particles in the dispersion. The metal powders are thoroughly mixed and then fabricated into billets, wire or rod in a manner similar to that used for fabricating powdered tungsten into various useful structural shapes. In mixing and fabricating the sintered material, composition is maintained within 1%, e.g. 10%±1% rhenium in silver.

Thus, the mixed powder is first pressed by hydraulic means, for example, into a billet. The billet is then sintered at a relatively low temperature so that the silver and rhenium particles comprising the billet collease and provide some structural strength to the billet. The sintering operation preferably takes place in an inert atmosphere furnace.

Next, the low temperature sintered billet, is sintered at an elevated temperature below the melting point of silver. This may be done, for example, by electrical resistance means in a protective atmosphere. During the second sintering operation, the density of the silver-rhenium dispersion is greatly increased. This is facilitated by the wetting action of the silver which tends to flow about the rhenium particles and fill the interstices be-

tween the rhenium particles. The finished product is a uniformly dispersed particulate of rhenium in a silver matrix. The density of the mixture should be in excess of 90% of the theoretical weight per unit of volume for the combination of silver and rhenium.

The billet is then worked by various methods such as forging, swaging or drawing to reduce it to proper size rod or wire. Rod or wire is, of course, the structural shape from which electric contacts are most commonly made. The swaging operation and other working operations require annealing steps between each operation. This results because the dispersion work hardens. Pure rhenium work hardens also to a much greater degree than the dispersion of the present invention. For this reason pure rhenium is almost impossible to cold work. By contrast, the material of the present invention may be cold worked for at least one pass without adverse effects to tools or the like.

Following preparation of wire or rod of sufficient size for the desired contact, the wire or rod is formed into a contact. The methods for fabricating contacts are well known to those in the art. For example, "cold heading" of pre-annealed silver-rhenium wire may be practiced using conventional tools and equipment. Another procedure by which contacts may be formed from the present material is the well known "coining" method.

Referring now to FIGS. 1, 2, 3 and 4 there is shown pictorial representations of a dispersion in the range 5–15% by weight rhenium in a silver matrix. The rhenium is depicted by the dark ink within the outline of the wire or contact. First FIG. 1 shows a pictorial view of a typical photomicrographed longitudinal cross section of the rhenium silver wire of the present invention. FIGS. 2 and 3 illustrate photomicrographs of round head and flat head contacts respectively fabricated from rhenium-silver wire of the type shown in FIG. 1. The longitudinal axes of the wire in FIG. 1 and the contacts in FIGS. 2 and 3 are aligned in the same directions for the purposes of comparison. FIG. 4 illustrates a typical cross sectional view of a photomicrograph of the the wire shown in FIG. 1. FIG. 4 may also be considered a cross sectional view of the contacts shown in FIGS. 2 and 3 since photomicrographs of cross sections of the contacts are substantially identical to photomicrographs of the wire cross section.

As illustrated in the figures, the rhenium particulate is uniformly dispersed in the silver matrix. In addition the silver matrix tends to wet and adhere to the particles of

rhenium. The rhenium particle sizes are normally less than 100 microns in diameter with the mean range of distribution being 10 to 25 microns in diameter. No clumping of the particles is observed. Moreover, it is believed that clumping is undesirable.

As evidenced by reference FIG. 1, the swaging and wire drawing operations used to fabricate the wire, tend to cause the rhenium particles to align themselves along flow lines coincident with the longitudinal or draw axis of the wire. After the contacts are formed by the cold heading operation as illustrated in FIGS. 2 and 3, the flow lines of the material indicate the manner in which the metal is deformed when cold heading, which is a forging operation.

The contacts are used in electric switches. "Switches" as called for in the claims, include any electric device which utilizes contacts or contact material to make and break electric circuits. For example, relays and contactors are switches within the scope of the claims.

Various tests were conducted with contacts of the present invention. The results were compared to the results of similar tests conducted with pure silver and silver cadmium oxide contacts, a well known high current carrying contact material. Where possible comparison data with pure rhenium is supplied. In many instances, however, such data is unavailable or almost impossible to determine because rhenium is very hard and extremely difficult to work. Moreover, the electrical characteristics of rhenium make it impossible to run many of the tests outlined below. These tests are well known in the art and form part of most military specifications for relays, switches, etc. In the tests, all of the contacts were approximately equal in size and were examined under substantially identical conditions.

Test results

One double headed, rounded or radius faced contact with a diameter of approximately 0.125 inch and a thickness of approximately 0.031 inch and a flat faced contact of similar dimensions were tested for current interrupting ability *a*. Initial contact resistance *b*, minimum current switching *c* and maximum load carrying *d* were tested with 0.187 inch diameter, 0.038 inch thick contacts. These contacts were attached to copper alloy blades of such dimensions to permit a nominal rating of the composite assembly of 10 amperes. The results were compared with results from similar tests on equally sized silver, silver cadmium oxide and, where possible, rhenuim contacts.

	Silver	Rhenium	90% silver, 10% rhenium	85% silver, 15% cadimum oxide
Test (a).—Current Interrupting Ability. In this test a high current circuit is interrupted. The amount of current and the number of interruptions or making and breaking of a circuit under load are maximized:				
Spacing between contacts ins	0.022	----------	0.022	0.022
Load in amperes	50	(1)	100	50
Number of operations	(1)	----------	At least [2] 50	50 max.
Test (b).—Initial Contact Resistance. In this test the voltage drop for a given current through the contacts is determined. Preferably a low voltage drop is observed:				
Current in ma	500	500	500	500
Voltage drop in mv	0.30–0.40	(3)	0.60–0.75	0.55–9.70
Test (c).—Minimum Current Switching. Change in millivolt drop for a 100 milliamp load following 100,000 switching cycles: [4]				
Initial reading in millivolts	1.0–1.5	----------	1.5–2.0	2.0–2.5
Final reading in millivolts	1.0–1.5	----------	2.0–3.0	6.0–7.0
Charge in millivolts	0	(5)	0.5–1.5	3.5–5.0
Test (d).—Maximum Load Test. The maximum current in amperes resulting in failure of the contacts	~200	(5)	250	~220

[1] Not tested.
[2] After fifty (50) interruptions the test was halted. No appreciable erosion of the contacts was noted and it is believed that innumerable interruptions may be made.
[3] The voltage drop for rhenium is a variable and can reasonably be expected to be 10–20 times that of silver.
[4] The normal maximum allowed change is 7.0 mv.
[5] This data is impractical to obtain.

Similar tests carried out on a 97% by weight silver-3% by weight rhenium dispersion produced no significant improvement over silver cadmium oxide or silver. However, the 3% rhenium dispersion as tested was not as uniform as 10% dispersion. Nevertheless, it is believed that the differences cannot be attributed entirely to the difference in uniformity of dispersion and particle size that was observed. For this reason it is believed that rhenium dispersion in the range 5–15% by weight provides a substantial improvement in contact characteristics not heretofore observed and that the improvement is related, among other factors, to the amount of rhenium in the dispersion. Besides having the ability to carry larger loads and interrupt a wider range of loads, the contacts of the present invention compare favorably in cost with prior art contacts and also may be fabricated using standard contact manufacturing methods and equipment.

What is claimed is:

1. In an electric switch the improvement comprising at least one electric contact consisting essentially of rhenium in the range of 5–15% by weight and the remainder silver, said silver comprising a matrix in which said rhenium is dispersed.

2. The improved contact of claim 1 wherein said rhenium is approximately 10% by weight of said contact and said silver is approximately 90% by weight of said contact.

3. The improved contact of claim 1 wherein said rhenium is substantially uniformly dispersed in said matrix.

4. The improved contact of claim 1 wherein said rhenium is a particulate with the diameter of each of said rhenium particles being less than 100 microns.

5. The improved contact of claim 1 wherein said rhenium is a particulate with the diameter of each of said rhenium particles being in the range of 10–25 microns.

References Cited

UNITED STATES PATENTS

2,234,969	3/1941	Henel et al.
2,733,319	1/1956	Ericsson et al.
2,861,155	11/1958	Farnham et al.
2,914,640	11/1959	Grattidge.
2,997,524	8/1961	Ruskin et al.

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