United States Patent Office

2,818,633

Patented Jan. 7, 1958

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2,818,633

ELECTRICAL CONTACT

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No Drawing. Application March 2, 1955 Serial No. 491,769

4 Claims. (Cl. 29—182)

My invention relates to a novel electrical contact material and more particularly to a material containing a substantial amount of silver combined with a refractory material such as tungsten, tungsten carbide or molybdenum. More particularly it relates to a contact comprising a refractory metal and silver in which various additives have been added in order to improve the physical and electrical characteristics of such contact material.

In circuit breaker opening operations, the contacts are subjected to severe electrical and mechanical strains. The contacts are normally held against each other with considerable force while in engagement in order to reduce the contact resistance to a minimum.

When the circuit breaker responds to a fault current, this normal contact force is first released. The contact resistance thereupon rises simultaneously with decrease in contact force and considerably increases the I^2R heat generation at the contacts. Although the time involved here is measurable in a portion of a second such as 1/60 of a second, the heat tends to weld the contacts. During the arcing period which immediately follows the first small separation of the contacts, the amount of heat generated raises the temperature of the contacts still further, thereby further increasing the tendency to weld the contacts. Moreover, the potential stresses during arcing tend to flake off and volatilize conducting material. These metal vapors may condense on the insulation portion of the circuit breaker and thus reduce its dielectric strength and may increase the difficulty of extinguishing the arc.

Accordingly, two essential characteristics are required of contacts besides good conducting properties. They must be non-welding at the high temperatures to which they are subjected during circuit failures, and metal vaporization must be kept down by the stresses set up during arcing.

It has long been recognized in the art that contacts comprising silver and a refractory metal, such as tungsten or molybdenum or their carbides, approach these desired characteristics. But, these types of contacts have nevertheless failed to meet the increasing stringent requirements established for contacts as their use has extended into broader fields.

Heretofore contacts of the silver-refractory metal type and more particularly of the silver-molybdenum type were manufactured by pressing the powders of the component metals together, sintering the pressed briquet, repressing, or infiltrating the sintered metal with fine silver. In some cases the refractory metal alone was pressed before any silver was added. The contacts resulting from such methods were often poor from the point of view of their physical properties. The product generally showed varying degrees of porosity which gave inconsistent metallurigical and/or electrical characteristics. Various techniques were employed to overcome this difficulty, such as sintering at high temperatures or a combination of high temperature sintering with high temperature infiltrating over considerably long periods of time. Even when these less economical procedures were followed the physical properties of the resulting contact material was not always satisfactory.

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In accordance with my invention, I have found that the physical and electrical characteristics of silver-refractory metal contacts may be greatly improved by including in the contact composition small amounts of nickel, iron, and lampblack.

Accordingly, it is an object of my invention to provide a silver-refractory metal contact having greatly improved physical properties.

It is another object of my invention to provide a silver-refractory metal contact which will have a greater density, hardness, conductivity and cross breaking strength than those heretofore known to the art.

Still another object of my invention is to add small amounts of nickel, iron and lampblack to a silver-refractory metal contact composition and thereby provide contact material which is readily infiltrated with silver and results in a product of lower porosity and of improved electrical and physical properties.

A still further object of my invention is to add small amounts of nickel, iron and lampblack to a silver-molybdenum metal contact composition and thereby provide a contact material which is readily infiltrated with silver and results in a product of lower porosity and of improved electrical and physical properties.

These and other objects of my invention will be more apparent when taken in connection with the following disclosure.

Essentially my invention involves the addition to a silver-refractory metal composition, commonly used in connection with electrical contacts, of small amounts of nickel, iron and lampblack. The inclusion of these additives in the final contact composition results in a product which is highly uniform and can be relied upon to give consistent metallurgical and/or electrical characteristics. These improved characteristics are due to the fact that a product is obtained which more closely approaches the maximum possible theoretical density. The denser the metal, the less voids it has and, therefore, the better the conductivity, wearing, and hardness characteristics. In practice, densities of at least 97 percent that of theoretical are sought. However, under methods of the prior art the maximum densities secured were of the order of 92 percent.

I have found, however, that particularly in the case of silver-molybdenum compositions, when both nickel and iron along with a small amount of lampblack are added, not only is the density of the contact consistently high, but the hardness, conductivity, and cross breaking strength of the contact material are also consistently improved.

The refractory and silver metal hereinbefore discussed initially take the form of fine powders. The refractory (preferably molybdenum) and silver powders are ordinarily finer than 325 mesh. The additives nickel, iron and lampblack which substantially improve the molybdenum silver compositions have a fineness of between 250 and 325 mesh, preferably about 300 mesh.

The refractory and silver are processed by the usual powdered metallurgy techniques. A typical composition and manufacturing procedure for a molybdenum and silver composition to which various additional agents have been added is as follows: 90 percent molybdenum, 8.95 percent silver, 0.5 percent nickel, 0.25 percent iron and 0.30 percent lampblack are mixed and ball milled for eight hours. The powders are then pressed into electrical contact discs or other desired forms using a pressure of 16 to 18 tons per square inch. The pressed density of the material is approximately 6.5 grams per cc.

The pressed powders are then sintered at 1800° to 1900° F. for one half hour in a reducing atmosphere. The sintered material is then infiltrated with fine silver of a precalculated weight at a temperature of 2000° to 2100° F. for 15 to 25 minutes in a reducing atmosphere. The infiltration process is accomplished, for example, by placing the fine silver, generally in the form of a slug, onto the sintered material which in turn rests on a graphite boat. The whole assembly, as such, is placed directly into the furnace wherein the internal and interconnected pores of the sintered material are filled with the infiltrating silver.

The nickel and iron powders which are used are rounded particles made by the carbonyl process and have a fineness of about 300 mesh. Almost any pure form of unadulterated lampblack is suitable as an additive for this composition.

A typical final composition obtained by virtue of processing the mixture hereinabove described is as follows: 59.3 percent molybdenum, 40 percent silver, 0.33 percent nickel, 0.17 percent iron and 0.20 percent lampblack. This composition is of course only typical of one suitable molybdenum base electrical contact element. It should be pointed out that reasonable variations of the amounts of nickel, iron and lampblack added will not materially change the properties of the end product but will effect primarily the shrinkage and distortion characteristics of the composition.

Preferably a final composition will contain between 40 to 75 percent molybdenum, 25 to 60 percent silver, 0.1 to 0.5 percent nickel and small amounts up to 0.5 percent of iron and lampblack. The nickel and iron allow the molybdenum to absorb larger quantities of silver and thereby increase the density of the resulting contact composition. Although the amount of nickel and iron is usually kept below 0.5 percent, and this is my preferred embodiment, it is also within the scope of the present invention to add amounts of nickel and iron up to 1 percent. It has been found that the higher percentages are advantageous from the standpoint of giving better structure, homogeneity, strength and hardness. However, such higher percentages are undesirable from the standpoint that they induce higher shrinkage than that desired, and the highly undesirable distortion which accompanies large shrinkage. Obviously electrical conductivity of the resulting product will decrease with greater amounts of additives.

The lampblack primarily performs the functions of purification and deoxidation. The combination of the lampblack plus the nickel and iron possesses the unique characteristics of deoxidizing and, at the same time, effecting good adhesion between the molybdenum and silver powder particles. This is probably accomplished by virtue of the fact that nickel and iron act as wetting and cementing agents between the molybdenum and silver. The result is that the strength, structure, and homogeneity of the material are substantially improved over the older methods of producing molybdenum and silver or refractory and silver compositions. Moreover, this mechanism appears to improve the interconnection of the pores during the sintering operation so that the infiltrating silver can reach into and fill all of the pores.

Some of the properties obtained from the typical combination given earlier in this disclosure are as follows:

	60% Mo, 40% Ag (no additions)	60% Mo, 40% Ag (Nickel+Iron+Lampblack)
Percent Theo. Density Range	95.0–96.0	97–98
Hardness R_B	70–80	80–90
Conductivity, percent I. A. C. S.	47.0	50–55
Cross Breaking Strength, p. s. i.	115,000	150,000–160,000

It should be pointed out that the proportions of the ingredients may be varied within the limits suitable for the manufacture of refractory silver contacts and preferably are maintained within the limits hereinabove referred to.

In the foregoing, I have described my invention only in connection with preferred embodiments thereof. Many variations and modifications of the principles of my invention within the scope of the description herein are obvious. Accordingly, I prefer to be bound not by the specific disclosure herein, but only by the appending claims.

I claim:

1. An electrical contact comprising the pressed and sintered powders of molybdenum, silver, nickel, iron, and lampblack and consisting essentially of 40 percent to 75 percent molybdenum, 25 percent to 60 percent silver, 0.1 percent to 1 percent nickel, iron in an amount up to 1 percent and lampblack in an amount up to 0.5 percent.

2. An electrical contact comprising the pressed and sintered powders of molybdenum, silver, nickel, iron, and lampblack and consisting essentially of 40 percent to 75 percent molybdenum, 25 percent to 60 percent silver, 0.1 percent to 0.5 percent nickel, iron in an amount up to 0.5 percent, and lampblack in an amount up to 0.5 percent.

3. An electrical contact comprising the pressed and sintered powders of molybdenum, silver, nickel, iron, and lampblack, the molybdenum and silver powders being finer than 325 mesh, the other powders having a fineness of between 250 and 325 mesh, and consisting essentially of 40 percent to 75 percent molybdenum, 25 percent to 60 percent silver, 0.1 percent to 0.5 percent nickel, iron in an amount up to 0.5 percent, and lampblack in an amount up to 0.5 percent.

4. An electrical contact comprising the pressed and sintered powders of a refractory metal, silver, nickel, iron, and lampblack and consisting essentially of 40 percent to 75 percent of said refractory metal, 25 percent to 60 percent silver, 0.1 percent to 1 percent nickel, iron in an amount up to 1 percent, and lampblack in an amount up to 0.5 percent.

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