

UNITED STATES PATENT OFFICE

2,157,933

SILVER-INDIUM CONTACT

Franz R. Hensel and Kenneth L. Emmert, Indianapolis, Ind., assignors to P. R. Mallory & Co., Inc., Indianapolis, Ind., a corporation of Delaware

No Drawing. Application August 6, 1938,
Serial No. 223,507

4 Claims. (Cl. 200—166)

This invention relates to electric contacts.

An object of the invention is to improve the characteristics of electric contact elements containing silver.

Another object of the invention is to provide a silver base contact material which is highly resistant to tarnishing and therefore will not form a layer of high contact resistance.

A still further object is to provide a new contact material which can be used under severe electrical conditions, without welding.

It is a further object of the invention to provide a contact capable of operating on high frequency at heavy current values, without objectionable contact metal transfer.

Other objects of the invention will be apparent from the following description taken in connection with the appended claims.

The present invention relates to an electric contact and the combination of elements thereof, methods of manufacture and the product thereof, brought out and exemplified in the disclosure hereinafter set forth, the scope of the invention being indicated in the appended claims.

While a preferred embodiment of the invention is described herein, it is contemplated that considerable variation may be made in the method of procedure, and the combination of elements, without departing from the spirit of the invention.

The present invention comprises an improvement in silver electric contact elements, and especially in contact elements formed of at least 70% of silver. According to the invention, the contacts are improved by the addition of indium.

The contacts may be composed of silver and indium, accordingly. The ingredients may be present in approximately the following proportions:

Indium	0.1 to 21%
Silver	Balance

It is likewise possible to improve the characteristics of silver alloys containing additional ingredients, by the addition of indium; thus silver alloys containing beryllium, magnesium, zinc, cadmium, copper, gold, nickel, manganese, palladium group elements, platinum group elements, silicon, titanium and zirconium can be improved by the addition of indium in substantially the proportions indicated above.

We have found that silver and indium, up to 21% indium, alloy very readily and the cast ingots have an extremely clean surface. The alloys can be readily swaged and drawn to wires from

which contacts may be prepared by a screw machine operation or by cold heading. Silver-indium alloys may also be rolled in the form of sheet, and contacts may be punched from sheets. Silver-indium alloys lend themselves very readily to be prepared in the form of contact bimetal, in which one side consists of a base metal, such as an alloy of iron, nickel or a copper base material, and silver-indium material on the other side. The nature of the alloy is such as to lend itself readily to the formation of electrical contacts by "beading" or fusing the alloy directly to the surface of a base metal blank, such as a rivet, screw or disc, etc. The ease with which these materials can be rolled has reduced greatly scrap losses and produced smooth surfaces which are ideally suitable for the manufacture of electric contacts.

In a number of contact applications, silver is mixed with refractory materials, taken from the group of tungsten and molybdenum, or their compounds. These materials are prepared either by mixing the powders together, pressing same and hot and cold working same into suitable forms from which contacts can be prepared. We have found that the addition of indium to the silver base used in such contact combination, is extremely beneficial for several reasons. Indium improves the fluidity of molten silver, and when such contact materials are produced by an impregnating process the presence of indium in percentages up to 21%, will improve the "alloying or impregnating" action of the liquid silver base. Therefore, a structure is obtained which is much more uniform and homogeneous, and at the same time it is possible to produce pieces of much larger cross section by substituting a silver-indium alloy for fine silver. Indium has the definite advantage, furthermore, of having a very low melting point of 155 degrees C., but a very high boiling point of 1450 degrees C. If, therefore, mixtures are being prepared by using powders of the elements incorporated into the final mixture, sintering temperatures can be used which are comparatively high, without fearing the loss of any indium, due to vaporization.

It is possible also to produce a much stronger mixture that way, because the materials can be prepared by having a liquid phase present, which will cement not only the silver particles, but also the refractory particles, much better.

We have limited ourselves in the indium content to 21%, because we have found that the most desirable contacts can be prepared from an alpha solid solution of indium in silver. The solid

solubility of indium in silver at room temperatures, is approximately 20.4%, while at 693 degrees C., it is 21%.

When operated on voltage regulators, such as used in regulation of automotive generators, the material of the present invention, operating against a high silver alloy of a different composition, such as a silver-palladium alloy, maintained perfect regulation. This operation at frequencies between 50 and 400 cycles, for periods of in excess of 500 hours, gave contact resistance values of extremely low order, 0.4 to 0.5 milliohms. After continuous operation exceeding 750 hours, our resistance value is in the order of $\frac{1}{2}$ of that normally encountered on alloys previously adopted for this type of service.

On applications for standard relay equipment, operating on a direct current, it has been found that the use of alloys of the type covered by the present combination, will increase the critical current value or value of failure current, between 80 and 100% over other commercial alloys at present available. The material does not transfer as readily, which reduces the tendency to failure by sticking, because by relatively high increases in current density, due to reduction in area.

The present alloy has been found to appreciably harden on cold working, which eliminates some of the difficulties encountered on other types of materials, due to rapid penetration of transferred material into the opposite or mating con-

tact. At the same time, definite "seating" of the contacts is effected with extremely small dimensional displacements, so that it is possible to accurately maintain the shape and placing of the contacts where such factors materially affect the operation of the equipment on which the contacts are a part.

While the present invention, as to its objects and advantages has been described herein, as carried out in specific embodiments thereof, it is not desired to be limited thereby, but it is intended to cover the invention broadly, within the spirit and scope of the appended claims.

What is claimed is:

1. An electric contact member containing as an essential ingredient, silver to which has been added indium, in quantities ranging from 0.1 to 21%.
2. An electric contact, consisting of an alloy of 0.1 to 21% indium, balance substantially all silver.
3. An electric contact member composed of a refractory metal base and a silver alloy containing 0.1 to 21% indium.
4. An electric contact member formed of a bonded mass of refractory metal powders selected from the group consisting of tungsten and molybdenum together with a silver alloy containing 0.1 to 21% indium.

FRANZ R. HENSEL,
KENNETH L. EMMERT.