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CONTACT

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This invention relates to electric contacts.

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

Another object of the invention is to provide a silver base contact material which is corrosion resistant.

A still further object is to provide a silver base contact material which will retain a very low contact resistance.

It is a further object of the invention to provide a new contact material which can be used under severe electrical conditions, without objectionable contact metal transfer.

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

The present invention comprises the combination of elements, 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 zirconium.

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

40	Zirconium	-----	1 to 12%
	Silver	-----	Balance

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

We have found that silver and zirconium can be alloyed by introducing the zirconium in the form of a master alloy. The most successful method in producing such a master alloy was to take silver powder and zirconium hydride and

mix them intimately, in proportions ranging from 20% zirconium, to 75% zirconium. The mixture was then compressed and sintered in hydrogen slightly above the melting point of silver. The zirconium hydride will give off nascent hydrogen and protect the briquette from oxidizing. A master alloy thus prepared, is introduced in the deoxidized silver melt and the material is cast into suitable ingots from which wires, sheet or other forms can be produced, by swaging, rolling, drawing and other suitable operations.

A microscopic examination of the alloys prepared, showed that there is apparently very little solid solubility of zirconium in silver, because even with small percentages of zirconium, two constituents were found to exist, one of which is the silver-zirconium matrix and an irregularly shaped constituent, which appears to be an intermetallic combination of zirconium and silver.

It was found that with increasing the zirconium content, the hardness of the alloys increased very rapidly. For instance, an alloy with 4 3/4% of zirconium, had a Brinell hardness of 65, and an alloy of 6.05% zirconium had a Brinell hardness of 85. By increasing the zirconium content 10%, the hardness was increased to 120 Brinell. An alloy containing 6.05% zirconium, by weight, had a specific resistance of 3.06 microhms per c. c., which is a conductivity of 22.6% of standard annealed copper. The electrical conductivity seems to be a direct function of the amount of zirconium that is present in the alloy, because the zirconium and silver seemed to be present in the form of two separate phases, and not in the form of extended solid solutions.

It was found that with increasing the zirconium content, the manufacture would become more difficult, but alloys containing up to 5% of zirconium, can be readily worked in the form of wrought products.

In a number of contact applications, silver is mixed with refractory materials, taken from the group of tungsten or molybdenum, or their compounds. In many cases, also, iron group metals, which are insoluble in silver, fulfill the purpose of such a refractory material. The metals under consideration for this purpose are particularly nickel, iron and cobalt. These materials are prepared either by mixing the powders together, compressing same, and hot or cold working same into suitable forms from which contacts can be prepared. We have found that the addition of zirconium to the silver base powder, used in such contact applications, is beneficial. The zirconium is preferably to be added in the form of zir-

conium hydride powder, which in sintering will protect the entire mass from oxidizing. Tests have been made on a number of compositions, containing zirconium, such compositions being, for instance:

1.	Copper	10%
	Zirconium	3½%
	Silver	Balance
0 2.	Cadmium	20%
	Zirconium	4%
	Silver	Balance
3.	Magnesium	3½%
	Zirconium	2%
5	Silver	Balance
4.	Gold	2%
	Zirconium	1%
	Silver	Balance
20 5.	Palladium	5%
	Zirconium	1%
	Silver	Balance
6.	Zirconium	4.75%
25	Silver	Balance

The materials of the compositions listed above are characterized by low metal transfer, when compared to standard silver alloys, as indicated by the following values which were obtained on an alloy containing 4.75% zirconium, balance silver. Fine silver transfers to a height of .010", coin silver to a height of 0.11", but the alloy of the above stated composition transferred to a height of only .0015". The conditions of heat under which the above values were obtained, consisted of operating contacts of the stated compositions at a frequency of 470 times per minute, with an impressed voltage of 12 volts D. C., and a contact pressure of 150 grams, the load consisting of a resistive inductive circuit in series with the contacts.

The contact resistance of the alloys of the new invention is very low, as compared to that of other silver base alloys, including fine silver values on the contact resistance being in the neighborhood of 5-2 milliohms, within the range tested. The contact resistance, of course, is a function of the contact pressure, applied voltage, current, frequency of operation, type of circuit, in addition to the composition of the alloy.

When operated on voltage regulators, such as used in the regulation of automotive generators, the material of the present invention will maintain perfect regulation. On applications for standard relay equipment operating on direct current, it has been found that the use of alloys of the type covered by the present invention, will materially reduce transfer, which in turn reduces the tendency to failure by sticking, on account of the relatively high increase in current density, due to the reduction in area which occurs when the material transfers.

The present alloy, with higher percentages of zirconium, provides a relatively hard contact material which will withstand mechanical abrasion very satisfactorily. At the same time, definite sealing 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, of 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 zirconium, in quantities ranging from .1 to 12%.
2. An electrical contact member, consisting of an alloy of .1-12% zirconium, balance substantially all silver.
3. An electric contact member, consisting of a refractory metal base and a silver alloy, containing .1-12% of zirconium.
4. An electric contact member formed of a finely divided refractory material selected from the group consisting of tungsten and molybdenum and their refractory compounds interspersed and bonded with an alloy of .1 to 12% zirconium, balance substantially all silver.

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