Oct. 25, 1949. M. J. STUMBOCK 2,486,341

ELECTRICAL CONTACT ELEMENT CONTAINING TIN OXIDE

Filed June 30, 1945

Fig. 1

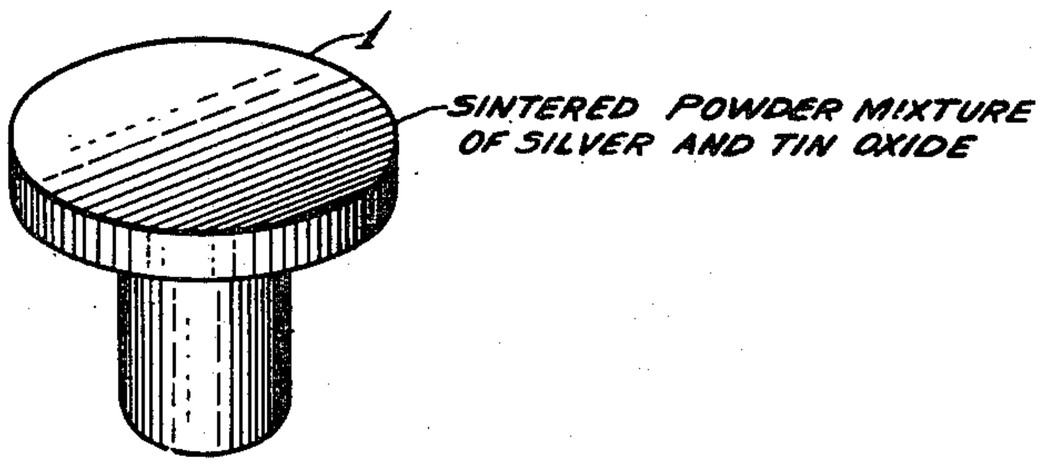


Fig. 2

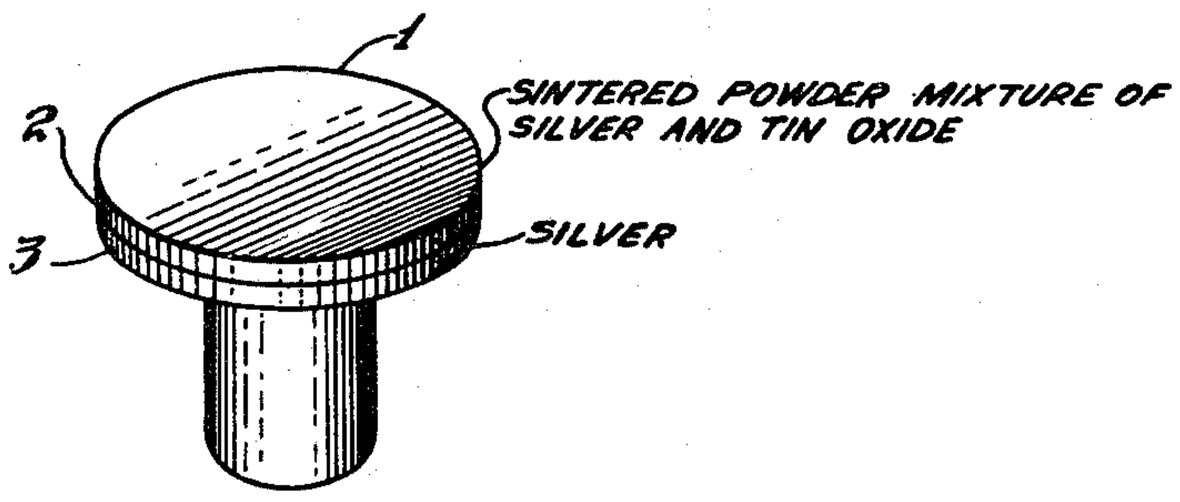
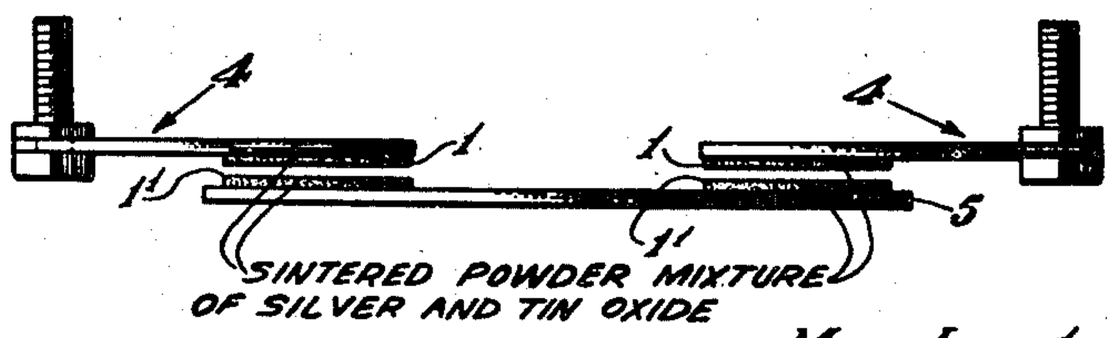


Fig. 3



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ELECTRICAL CONTACT ELEMENT CONTAINING TIN OXIDE

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2 Claims. (Cl. 75—22)

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This invention relates to electrical contact elements suitable for use in making and breaking electric current and is concerned in particular with the improvement of electrical contacts of silver or the like.

Electrical contacts of silver have found the widest general use, as silver has excellent electric current carrying capacity and is relatively cheap, compared with other contact materials, such as platinum and the like. However, silver contacts, including fine silver contacts, suffer from the disadvantages of welding or sticking, coning and cratering as well as metal transfer from one contact to the other, and such disadvantages are magnified when heavy electric currents are employed, thus limiting the field of usefulness of such contacts both with respect to the life and the number of possible uses and applications thereof. Attempts have, therefore, been made to improve silver and the like contacts, primarily by incorporation of other metals, in one form or another, with a view to modifying the properties of such contacts and decreasing such shortcomings. Some notable success has been achieved in one direction or another but further improvements are desirable in order to expand the usefulness of electrical contacts of silver or the like into the field of heavy electric currents and in order to increase the useful life of electrical contact elements.

It is, therefore, one prime object of the present invention to improve silver contacts. It is another object of the invention to provide silver contacts having a longer useful life than has heretofore been associated with silver contacts. It is a further object of the invention to provide such silver contacts which shall have, throughout their useful life, a high degree of reliability in operation, substantially free from welding or sticking, deformation and metal transfer. Other objects and advantages of the electrical contacts of the invention will appear from the description thereof hereinafter following.

I have found that silver contacts can be improved substantially, and the objects of the invention achieved, by incorporating therein tin oxide, SnO_2, in finely divided form. Such contacts consisting of a mixture of silver and tin oxide are best manufactured by methods of powder metallurgy. Electrical contacts made from a compressed and sintered mixture containing a substantial portion of silver and another portion of tin oxide, with or without the admixture of other suitable metals, exhibit superior properties in that while they retain the high current carrying capacity characteristic of silver contacts, they have practically no tendency to weld or stick, or to become deformed by the formation of cones and craters, and are useful even with heavy currents. Furthermore, I have found that these contacts do not show recrystallization of the silver at normal annealing and soldering temperatures and that they possess, therefore, a high degree of hardness not only initially but also after annealing or soldering, whereas other silver contacts suffer from recrystallization on heating, thus lowering part of their initial hardness. Thus no difficulties are experienced in hard soldering electrical contacts of the invention; in fact a perfect bond is obtained without deleteriously affecting the hardness of the silver contacts of the invention.

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For purposes of illustrating the contact of the invention I have shown two forms of contacts in the accompanying drawing in which:

Fig. 1 is a perspective view of one type of contact and

Fig. 2 is a perspective view of another type of contact, and

Fig. 3 represents a sectional view of a contact system in a solenoid operated breaker relay.

The contacts shown in the drawing comprise the contact element 1 which in Fig. 1 consists of a single disc of compressed sintered powder mixture in accordance with the invention and which in Fig. 2 consists of a surface layer 2 of compressed sintered powder mixture in accordance with the invention and a backing layer 3 of silver or other conductive material. In Fig. 3 I have shown a contact system comprising contacts 1 positioned on a stationary contact arm 4 and cooperating contacts 1′ positioned on a solenoid operated breaker relay 5.

It might be noted that the components silver and tin oxide are initially in finely divided form. For instance 97% of the tin oxide particles have a particle size of between 4.6 and 13 microns and 72% of the particles have a particle size of approximately 6.5 microns. In providing the mixture of silver and tin oxide I may employ any suitable proportions of silver and tin oxide. The compressed and sintered contacts may contain as little as 0.1% or as much as 50% tin oxide, by weight, the particular percentage usually depending on the specific use for which the contacts are designed, but in general an incorporation of 2% to 10% tin oxide will satisfy most uses. Many of the powder mixtures, after pressing and sintering, are advantageously swaged, rolled, drawn or otherwise formed, as desired, while in other cases pressing and sintering, with or without repressing and resintering, is sufficient.

The following example will illustrate the method of making electrical contacts according to the invention:

Example

A 5 ounce bar composition was made by mixing 0.5 ounce SnO_2 and 4.5 ounces fine silver powder, 300 mesh size, for 12 hours. The bar was pressed in a ⅝″ x ⅝″ x 4″ die under a pressure of 20 tons per square inch. Sintering took place for 1 hour at 850° C. in an inert atmosphere. The bar was then reduced in 5% passes with regular an-

neals in between; on rolling the hardness increased to Rockwell F 85, dropping to F 80 at 470° C., F 75 at 620° C., and F 64 at 900° C. The sheet was rolled to 0.075'' and electrical contact discs were blanked out.

Electrical contacts made in accordance with the above example and containing various quantities of tin oxide were tested under various electrical operating conditions. For purposes of illustrating the suitability of these contacts under severe operating conditions, where contacts of fine silver as such would fail, I have summarized in the following tables test results in the heavy current field and using direct current. In the tests thus reported I use standard solenoid operated, plunger type relay breakers, at 75 amps. and 30 v. D. C. in Table 1 and at 200 amps and 30 v. in Table 2. The contact pressure was 300 grams in the experiments reported in Table 1 and 1400 to 1800 grams in the experiments reported in Table 2. The experiments reported involve 50,000 cycles of makes and breaks, 68 cycles per minute in the experiments of Table 1 and 60 cycles per minute in the experiments of Table 2, followed by 50 to 1000 cycles under 125 amps. overload in case of Table 1 and by 50 cycles under 800 amps. overload in case of Table 2. In the experiments reported in Table 2 there are furthermore included 1000 cycles under a 22'' vacuum.

Contact	Cycles	Load	Millivolts across contacts at end of test
		Amps.	
98% Ag—2% SnO_2	50,000	75	43–50
	50	125	50
97.5% Ag—2.5% SnO_2	50,000	75	43–69
	1,000	125	69
95% Ag—5% SnO_2	50,000	75	31–75
	1,000	125	53
98% Ag—1% Ru—1% SnO_2	50,000	75	60–62
	50	125	62

TABLE 1

TABLE 2

95% Ag—5% SnO_2	50,000	200	50
	50	800	
97.5% Ag—2.5% SnO_2	50,000	200	60
	50	800	

The operation of the electrical contacts during the lengthy test performed under the unusually severe conditions specified was excellent and showed complete absence of sticking throughout the period tested. The condition of the electrical contacts upon the termination of the tests showed the absence of any cones, craters or the like in the tests reported in Table 1; in the tests reported in Table 2 there was observed a slight roughening of the surface at the end of the test period but the contacts were free from cones and craters.

The contacts of the invention may also contain admixtures of other metals, such as noble metals, for instance platinum group metals, as mentioned for instance in the case of one contact reported in Table 1 which contained 1% ruthenium, or suitable base metals such as copper, nickel, etc. Also the incorporation of tin oxide, as specified, is applicable to electrical contacts of materials other than fine silver, such for example as copper, nickel, noble metals, or refractory metals.

The exact functioning of the tin oxide, as distinguished from other admixtures, in bringing about the improvements hereinabove described has not yet been fully ascertained. It might be noted, however, that the improvements described are observed only upon the admixture of tin oxide and are entirely absent in case of incorporation of tin itself or other compounds of tin.

As previously stated the electrical contacts of the invention may be used as such or in the form of composite structures consisting of a surface layer of silver tin oxide mixture which is then molded or soldered onto a layer of dissimilar material such as silver. It is thus possible, in the case of composite contact structures, to obtain various modifications of the overall properties of the contact, for instance, to produce a contact with a contact face of silver tin oxide mixture and a backing of the highly conductive silver, or copper, thereby endowing the contact with greater overall conductivity similar to that of fine silver or copper contacts, possessing freedom from pitting, sticking, etc., or by using a backing of higher electrical resistance to facilitate resistance welding of the composite contact.

The electrical contacts of the invention may be used either in pairs or as one contact element of a pair in which the other electrical contact consists of a dissimilar material such for example as palladium silver alloy, silver ruthenium alloy, compressed and sintered mixture of silver and carbonyl iron, fine silver, etc.

What I claim is:

1. An electrical contact for making and breaking electric current formed of compressed and sintered silver powder containing distributed therethrough tin oxide constituting from 0.1% to 10% by weight of the whole.

2. An electrical contact for making and breaking electric current, formed of a compressed and sintered metal powder taken from the group consisting of silver and copper and containing distributed therethrough tin oxide constituting from 0.1% to 10% of the whole.

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