



"ELECTRICAL CONTACTS"

This invention relates to electrical contacts, especially for electric breakers.

There are provided strict standards for electrical contacts which are to be used with electric breakers, since they are greatly concerned with safety. Those standards such as Japanese Industrial Standard: C8370 have a first requirement that contacts should have a low contact resistance and endure various tests preceding a short circuit test, without causing welding, and also a second requirement that they have high refractoriness and low consumption characteristics so that they can reliably perform opening and closing cycles after the short circuit test. Although it has been desired to provide electrical contacts for electric breakers with such two requirements, none of the known contacts has thus proved satisfactory.

The present invention aims to provide electrical contacts especially for electric breakers which meet the above described requirements.

The present invention provides an electrical contact, comprising a base made from a silver alloy containing tin and indium, and a thin layer clad over

the base made from either a silver alloy containing cadmium, or from a silver alloy containing tin and bismuth, the said silver alloys having been internally oxidized.

Since internally oxidized silver alloys having dispersed in their matrices tin and indium oxides, precipitated by means of internal oxidation, meet the above-mentioned second requirement, they are advantageously utilized in this invention as a base of electrical contacts for breakers.

On the other hand, since internally oxidized silver alloys, which contain dispersed therein cadmium oxides or tin and bismuth oxides, meet the above-mentioned first requirement, they are clad over the base.

In such electrical contacts for electric breakers having the above constructions in which a base of an internally oxidized silver alloy containing Sn and In is clad at its upper surface with a thin layer of another internally oxidized silver alloy containing Cd or Sn and Bi, the thin layer of said silver alloy in which oxidized particles of Cd or Sn and Bi are dispersedly precipitated effectively meets a series of tests precedent to a short circuit test. Also, after the short circuit test, the base of the electrical contact, that is the silver alloy in matrices of which particles of Sn and In oxides are dispersedly precipitated, effectively meets an opening and closing circuit test.

The electrical contacts in accordance with this invention exhibit good operation and results as electric breakers.

Sn preferably in an amount of more than 4.5 weight % contained in Ag-Sn-In system alloys which constitute the base of electrical contacts in accordance with this invention, is successfully internally oxidized on account of the existence of In, and becomes precipitated and dispersed as Sn oxides in the alloy matrices.

Nevertheless, Sn oxides do not disperse uniformly, but tend to be segregated particularly about outer surfaces of the alloys.

However, in this invention, the segregation of Sn oxides scarcely occurs, because a thin layer of Ag-Cd or Ag-Sn-Bi alloy acts, in the course of internal oxidation, to partially screen oxygen and allow it to pass moderately into the base of the electrical contact. Such moderate and gradual penetration of oxygen into the Ag-Sn-In alloy prevents Sn from segregate oxidation.

It shall be noted that while the primary solute metal in the base of contact materials of this invention is Sn, and In is essential for completely internally oxidizing Sn when said Sn is present in an amount of more than 4.5 weight %, other metal elements can be added to the materials. Likewise, it is a matter of course that elements other than Cd, Sn and Bi can be

added to the alloy cladding over the base of the contact material.

When a base clad with a Ag-Cd system alloy is internally oxidized, and then punched out into contacts of a desired configuration, the remnants of the base and cladding can be utilized as a starting material of the base by remelting them. In this instance, a trace amount of Cd will inevitably be contained in the Ag-Sn-In alloy which constitutes the base of the contact material. It is therefore to be understood that Ag-Sn-In system alloys comprising the base of the contact materials may contain a trace or small amount of cadmium.

Reference is made to the accompanying drawing, which is a section of an electrical contact in accordance with the invention for electric breakers, in which numeral 1 represents a base of the contact, and numeral 2 a cladding thereof.

The invention will be further described with reference to the following illustrative Examples.

Ag-Sn 8 wt-In 5 wt	Ag-alloy (1)
Ag-Cd 15 wt-Sn 3 wt-In 1 wt	Ag-alloy (2)
Ag-Sn 8 wt-Bi 0.1 wt	Ag-alloy (3)

By employing the above Ag-alloys (1), (2) and (3), electrical contacts of this invention having the following combinations were made.

Electrical Contact A = Ag-alloy (2) as surface cladding (in the drawing, numeral 2) + Ag-alloy (1) as base (in the drawing, numeral 1)

Electrical Contact B = Ag-alloy (3) as surface
05 cladding + Ag-alloy (1) as base

The following conventional contacts were also made for comparison:

Electrical Contact C = wholly made of Ag-alloy (2)

Electrical Contact D = wholly made of Ag-alloy (3)

10 Electrical Contact E = wholly made of Ag-alloy (1)

The electrical contact A was made by temporarily fixing a thin layer of the Ag-alloy (2) to a surface of the Ag-alloy (1) by means of hot pressing. This was hot-rolled at a temperature of 600-700°C, annealed, and
15 then cold-rolled. The thus rolled plate was punched out to obtain movable contacts (1.2 mm x 4 mm x 7 mm) for electric breakers and stationary contacts (1mm x 5 mm x 5 mm). The thickness of the thin layer 2 of the Ag-alloy (2) became 0.1 mm.

20 The contacts thus obtained were internally oxidized for 48 hours under a pressure of 10 atm. and a temperature of 700°C. No segregation of oxides about the top surfaces of the bases 1 was observed.

Electrical contacts B were made similarly to the
25 electrical contacts A.

Electrical contacts C, D and E were also made by

rolling the corresponding contact materials, viz., Ag-alloy (2), Ag-alloy (3), and Ag-alloy (1), punching the materials to the above-mentioned dimensions, and internally oxidizing them.

- 05 The electrical contacts A, B, C, D and E thus prepared were subjected to the following tests.

Testing conditions (Frame 50):

Nominal electric current 50A

Nominal electric voltage 220V

- 10 a) Overload Test: 220V 300A

Manual closing and manual breaking 35 times

Manual closing and automatic breaking 15 times

Total 50 times

frequency 240 times/hour

- 15 power factor 0.45-0.5

- b) Temperature Rise Test:

at terminals - to be less than 50 deg.

(temperature rise degree higher than room temperature)

- 20 at contacts - to be less than 100 deg.

- c) Endurance Test: 220V 50A

power factor 0.75-0.85

charged 6000 times

discharged 4000 times

- 25 frequency 360 times/hour

- d) Insulation Resistance Test:

Measurement of insulation resistances between each terminal and between charging parts and earth by means of an insulation resistance tester of 500V, the measured amount being more than $5M\Omega$.

05 e) Short Circuit Test:

220V 2.5KA pf = 0.7-0.8

1P O 2 minutes CO

3P O CO

f) Judgement Standards for Short Circuit Test:

10 (i) After the test, breakers shall be able to make O and CO under 220V, 50A without any hindrance, and

15 (ii) Insulation resistances between each terminal and between charging parts and earth measured by an insulation resistance meter of 500V 15 minutes after the test shall respectively be more than $0.5M\Omega$.

The test results were as shown in the following table.

Table

	contact <u>A</u>	<u>B</u>	<u>C</u>	<u>D</u>	<u>E</u>
Test a)	OK	OK	OK	OK	OK
Test b) (at terminals)	42deg	48deg	42deg	48deg	52deg
Test c)	OK	OK	OK	OK	OK
Test d)	OK (more than $5M\Omega$)	OK	OK	OK	OK
Test e) (1P O CO) (3P O CO)	OK OK	OK OK	OK OK	OK OK	OK OK
Test f)(ii)	$2M\Omega$	$1M\Omega$	$0.4M\Omega$	$0.3M\Omega$	$3M\Omega$
Contact consumption	small	medium	large	large	small

As apparent from the above test results, the electrical contacts of this invention are excellent particularly when they are for electric breakers. That is, in the initial stage of tests, viz., the above tests 05 a to e, the cladding 2 performed very effectively, and then the cladding 2 disappeared or decomposed by the test e whereby the base 1 came to the front, while the base 1 performed well the making and breaking thereafter, with a small amount of consumption.

CLAIMS

1. An electrical contact, comprising a base made from a silver alloy containing tin and indium, and a thin layer clad over the base made from either a silver alloy containing cadmium, or from a silver alloy containing tin and bismuth, the said silver alloys having been internally oxidized.

2. An electrical contact as claimed in claim 1, in which the silver alloy of the base contains tin in an amount of more than 4.5 weight %.

3. An electrical contact as claimed in claim 1, in which the silver alloy of the base contains tin in an amount of more than 4.5 weight %, the said tin having been precipitated as oxide(s) substantially without segregation.

4. An electrical contact as claimed in any of claims 1 to 3, in which the silver alloy of the base further contains cadmium.

5. An electrical contact according to claim 1, substantially as herein described in any of the foregoing Examples.
