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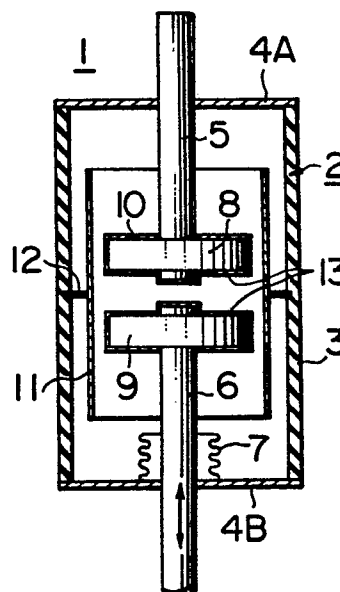
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54 Vacuum circuit breaker.

57 A vacuum circuit breaker has a vacuum vessel (2) in which are disposed a pair of opposing electrodes (8, 9) so as to be moved into and out of contact with each other, each of the electrodes (8, 9) being made of a material consisting essentially of a main component such as Cu, Ag or the like and a low-melting point metal such as Bi, Pb, Te, Se or the like. A film (13) is formed on the surface of each electrode (8, 9) by, for example, evaporating a metal having a melting point equal to or higher than that of the main component of the electrode material.



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VACUUM CIRCUIT BREAKER

1 BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION:

The present invention relates to a vacuum circuit breaker having improved electrodes.

5 DESCRIPTION OF THE PRIOR ART:

Generally, a vacuum circuit breaker has an insulated cylinder both ends of which are closed by end plates so as to form a vacuum vessel in which are disposed a pair of electrodes opposing each other. The electrodes
10 are supported by respective conductor bars which are extended in the axial direction of the vessel so as to project outside the vessel. A bellows is secured at its one end to one of the conductor bars which is axially movable and at its other end to the inner surface of the
15 adjacent end plate so that the conductor bar can move without breaking vacuum in the vessel. When this conductor bar is moved by an actuator, the electrode on this conductor bar is brought into and out of contact with the other electrode, thereby closing and opening an electric
20 circuit.

Each electrode is provided with a contact surface layer' for contact with the other electrode. The contact surface layer is made of a material which contains a metal having a low-melting point. The use of such a material is advantageous in that, since the materials containing

1 low-melting point metals are mechanically brittle, the
actuator can separate the electrodes with small power even
in the event of fusion and welding of two electrodes to
each other as a result of melting thereof by Joule heat
5 produced by, for example, an abnormally large electric
current caused by an accident.

For instance, the specifications of United States
Patent Nos. 2,975,255 and 2,975,256, as well as Japanese
Patent Application Laid-Open Publication No. 9019/82,
10 disclose electrodes materials which contain Bi, Pb, Te,
Se, etc. as the low-melting point metal. Metals such as
Cu, Ag, Co and Cr are used as the main component of these
electrode materials. The low-melting point metals such
as Bi, Pb, etc. mentioned above, however, cannot form any
15 solid solution with these main components and tend to
precipitate in the grain boundaries.

The present inventors have found that, when the
vessel is heated in a vacuum furnace during vacuum brazing
conducted for brazing the electrode to the associated
20 conductor bar or for evacuating the vessel, small projec-
tions are formed in the electrode surface, thereby
deteriorating the withstand voltage property of the
electrode. This is attributable to a fact that, when the
electrode is heated in vacuum, the low-melting point metal
25 such as Bi or Pb existing in the grain boundaries of Cu
grains constituting the main electrode material is molten
and forms projections which project towards the opposing
electrode. When such an electrode is used, the electric

1 field is concentrated locally to such projections,
thereby lowering the withstand voltage property of the
electrode.

On the other hand, other low-melting point metals
5 such as Se, Te, etc. tend to combine with the main elec-
trode material such as Cu, forming intermetallic compounds
such as Cu_2Se , Cu_2Te and so forth. When the electrode
containing such an intermetallic compound is heated in
vacuum, Se or Te having low-melting point existing in the
10 intermetallic compound is evaporated, thereby producing a
force which acts to make the Cu project from the electrode
surface towards the opposing electrode. More specifically,
the intermetallic compound formed by main component such as
Cu and low-melting point metal such as Se or Te exhibits
15 such a specific phenomenon that the main component such as
Cu is freed when the compound is heated to a temperature
between about 250°C and 500°C . The freed main component
projects in the form of whisker, thereby lowering the
withstand voltage property.

20 Thus, the conventional vacuum circuit breakers
have suffered from a problem in that the withstand voltage
property of the electrode itself is not fully utilized.

SUMMARY OF THE INVENTION

Accordingly, an object of the invention is to
25 provide a vacuum circuit breaker which incorporates elec-
trodes having higher withstand voltage property over the
conventional vacuum circuit breakers.

1 To this end, according to the invention, a dense
film of high-melting point metal, which is not reactive
with the low-melting point metal, is formed on the elec-
trode surface so as to prevent any exudation of the low-
5 melting point metal towards the electrode surface and any
whisker of the main component of the electrode material
from being formed.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a sectional side elevational view of a
10 vacuum circuit breaker according to the present invention;
and

Fig. 2 is a sectional side elevational view of
an electrode incorporated in the circuit breaker shown in
Fig. 1.

15 DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring first to Fig. 1, a vacuum circuit
breaker according to the present invention is generally
designated at a reference numeral 1. The vacuum circuit
breaker 1 has a vacuum vessel 2 which is composed of an
20 insulating cylinder 3 and both end plates 4A and 4B.
A pair of conductor bars 5 and 6 are disposed in the vacuum
vessel so as to oppose each other. The other ends of the
conductor bars are extended to the outside of the vacuum
vessel. A bellows 7 is secured at its one end to one 6
25 of the conductor bars and at its other end to the inner
surface of the end plate 4. The conductor bar 6 is adapted

1 to be moved by an actuator (not shown) towards and away
from the other conductor bar 5 as indicated by arrows.
Electrodes 8 and 9 are attached by vacuum brazing to the
inner opposing ends of the conductor bars 5 and 6. The
5 electrode 9 carried by the conductor bar 6 is adapted to
be brought into and out of contact with the other elec-
trode 8. Arc is generated between two electrodes when the
electrode 9 is just going to contact the other electrode
8 or be separated from the same. In order to prevent
10 metal dusts produced during arcing from attaching to the
inner surface of the insulating cylinder 3, an intermediate
shield 11 is disposed between the insulating cylinder 3
and the electrodes 8,9. The intermediate shield 11 is
secured to the inner surface of the insulating cylinder
15 through brackets 12. Since both electrodes 8,9 have an
identical construction, only one of the electrodes repre-
sented by a numeral 10 will be described with reference
to Fig. 2.

An alloy such as Co-Ag-Se alloy, Co-Cu-Te alloy
20 or the like is used as the material of the electrode 10.
Alternatively, the electrode 10 may be made of a material
containing a main component such as Cu or Ag with addition
of a low-melting point metal such as Bi, Pb or the like.
A film 13 is formed on the surface of the electrode 10
25 made of the material mentioned above. The film 13 is
formed by evaporating Cr onto the electrode surface. The
film 13, however, may be made from other materials such
as metals belonging to iron group e.g., Co, Ni, Fe, etc.,

1 as well as refractory metals such as Ta, Mo, W, etc.

All what is required for the film material is that the melting point of such film material is equal to or higher than that of the main component of the electrode material.

5 The electrodes 9,10 incorporated in the vacuum circuit breaker of the invention is covered with the film 13 of, for example, Cr which is not reactive with Co, Ag and Se even at an elevated temperature of, for example, 1000°C at which the vacuum brazing is conducted in the
10 course of fabrication of the vacuum circuit breaker, so that the undesirable projection of whisker of, for example, Ag in the Co-Ag-Se alloy is prevented by the dense film of Cr on the electrode surface. This in turn avoids any tendency of local concentration of the electric
15 field, thereby ensuring improved withstand voltage property of the electrode. On the other hand, it may appear that the wetting of the electrode surfaces by the melting of the low-melting point metal, which is necessary for attaining an easy contact and separation of two electrodes, is
20 impaired by the presence of the film 13 on the electrode surfaces. The film 13, however, is easily broken by a tensile force which is generated when both electrodes are separated from each other, i.e., when the circuit is opened, so that the electrode surfaces are sufficiently
25 wetted to ensure an easy separation of two electrodes.

Although the film in the described embodiment is formed by evaporation, this is not exclusive and the film may be formed by another method such as plating.

1 As has been described, the vacuum circuit breaker
of the invention features a film of a high-melting point
metal formed on the surface of each electrode made of a
material containing a low-melting point metal. The film
5 effectively prevents exudation of the low-melting point
metal and formation of whisker of main component of the
electrode material during heating of the electrode under
a vacuum in the course of fabrication of the vacuum circuit
breaker. It is thus possible to obtain a vacuum circuit
10 breaker capable of withstanding high voltages.

WHAT IS CLAIMED IS:

1. A vacuum circuit breaker having a vacuum vessel (2) in which are disposed at least one pair of opposing electrodes (8, 9) so as to be moved into and out of contact with each other, each of said electrodes (8,9) being made of a material consisting essentially of a main component such as Cu, Ag or the like and a low-melting point metal such as Bi, Pb, Te, Se or the like, characterised in that a film (13) is formed on the surface of each electrode (8,9) from a metal having a melting point equal to or higher than that of said main component of the electrode material.
2. A vacuum circuit breaker according to claim 1, wherein said film (13) formed on the electrode surface is made of any one metal selected from a group consisting of Co, Fe, Ni, Cr, Mn, Ta, Mo and W.
3. A vacuum circuit breaker according to either one of claims 1 or 2, wherein said film (13) is formed by a method selected from a group consisting of evaporation, sputtering and plating.

FIG. 1

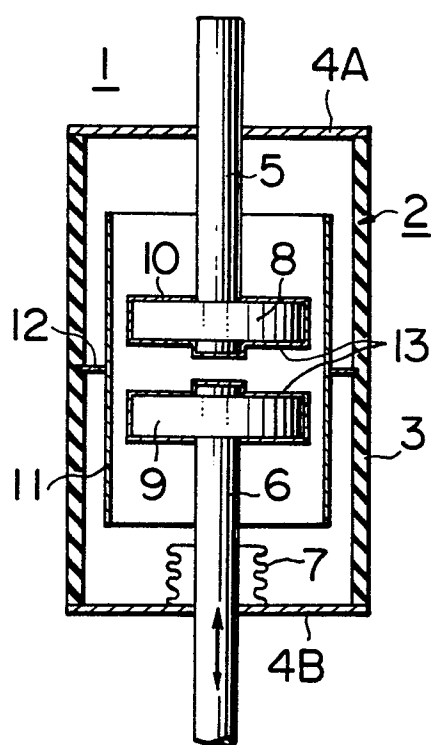


FIG. 2

