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(54) Vacuum valve

(57) A vacuum valve having: a vacuum insulating container (1); a pair of contacts (6), (7) that can be freely opened/closed, accommodated in the vacuum insulating container (1); conductive shafts (4), (8) that are fixed to the contacts (6), (7); and an arc shield (11) provided so as to surround the contacts(6), (7), characterized in that a metallic coating (5), (9), (12) made of metallic material of melting point higher than the respective underlying metal thereof is provided on the outside face of the conductive shafts (4), (8) and the inside face of the arc shield (11).

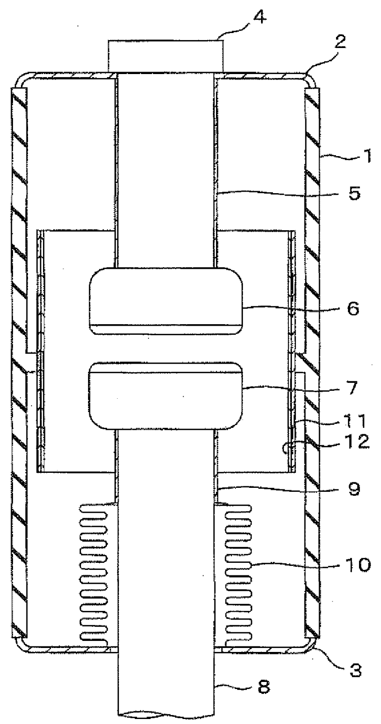

FIG.1

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Description

FIELD

[0001] Embodiments described herein relate generally to a vacuum valve having a pair of contacts that can be freely opened/closed, whereby improved withstand voltage characteristic or performance can be obtained.

BACKGROUND

[0002] Vacuum valves of this type are previously known in which, in order to improved withstand-voltage performance in vacuum, a ceramic diffusion layer is generated at the end of a tubular arc shield that is used for preventing diffusion of metallic vapor. An example is disclosed in Laid-open Japanese Patent Application No. 2007-115599 (hereinafter referred to as Patent Reference 1).

[0003] Vacuum valves are also known in which the withstand-voltage characteristic is improved by reducing the curvature for example at the end of the arc shield. In this case, the so-called area effect in vacuum is utilized and the breakdown field is increased by reducing the area that contributes to insulation breakdown. An example is disclosed in Laid-open Japanese Patent Application No. H10-21802 (hereinafter referred to as Patent Reference 2).

[0004] In the conventional vacuum valves described above, the portion of high electrical field intensity tends to be located at the end of the arc shield and various schemes for improving the withstand voltage are adopted. In contrast, in the case of conductive shafts with contacts fixed thereto, the insulation distance with respect to the arc shield is comparatively securely guaranteed, so the electric field intensity can be restrained. However, between the rod-shaped conductive shafts and the tubular arc shield, the area that contributes to insulation breakdown is much larger than in the case of the end of the arc shield, so, taking into account the "area in vacuum" effect, the breakdown electric field is lowered.

[0005] In particular, in response to the demand for increased capacity and/or reduction in overall size, either the conductive shafts may be made of larger diameter or the insulation distance may be reduced, so the opposing areas are increased, lowering the breakdown electrical field. There is therefore the problem of lowering of the withstand voltage characteristic between the conductive shafts and the arc shield.

[0006] According to an aspect of the present technology, there is provided a vacuum valve which aims to achieve increased capacity and/or smaller overall size by improvement in the withstand voltage characteristic between the conductive shafts and the arc shield.

[0007] In order to achieve the above object, a vacuum valve according to an embodiment is constructed as follows. Specifically, a vacuum valve having:

a vacuum insulating container;
a pair of contacts that can be freely opened/closed, accommodated in said vacuum insulating container;
conductive shafts fixed to aforementioned contacts; and
an arc shield provided so as to surround aforementioned contacts
is characterized in that the outside face of aforementioned conductive shafts and the inside face of aforementioned arc shield are provided with a metallic coating made of metallic material of higher melting point than the underlying metal (the constituent metal in question) thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008]

[Fig. 1] Cross-sectional view showing a vacuum valve according to Embodiment 1 of the present invention;
[Fig. 2] Cross-sectional view showing a vacuum valve according to Embodiment 2 of the present invention; and
[Fig. 3] Cross-sectional view showing a vacuum valve according to Embodiment 3 of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0009] In embodiments of the present invention, the breakdown electrical field in vacuum is increased by employing a metallic coating of high melting point. Embodiments of the present invention are described below with reference to the drawings.

[Embodiment 1]

[0010] First of all, a vacuum valve according to Embodiment 1 of the present invention will be described with reference to Fig. 1. Fig. 1 is a cross-sectional view showing the construction of a vacuum valve according to Embodiment 1 of the present invention.

[0011] As shown in Fig. 1, a fixed side sealing metal element (metal clasp) 2 and a movable side sealing metal element 3 are sealingly attached at both end apertures of a tubular vacuum insulating container 1 made of alumina ceramics. A fixed side conductive shaft 4 made of electrical copper is fixed by passing through the fixed side sealing metal element 2. On the outside face of the fixed side conductive shaft 4, a fixed side metallic coating 5 of higher melting point than the electrical copper, made of for example chromium, is provided by evaporation or plating. The coating thickness is a few hundred nm. A fixed side contact 6 comprising copper alloy is fixed at the end of the fixed side conductive shaft 4.

[0012] Opposite the fixed side contact 6, a movable side contact 7 comprising copper alloy is fixed to the end of the movable side conductive shaft 8, which is made of electrical copper and which passes through the movable side sealing metal element 3 in freely movable fashion, so that these contacts can be freely opened/closed. On the outside face of the movable side conductive shaft 8, just as in the case of the fixed side, there is provided a movable side metallic coating 9 of higher melting point than the electrical copper.

[0013] One end of a bellows 10 is sealingly attached at the middle section of the movable side conductive shaft 8, in such a way that it can freely extend/contract, the other end thereof being sealingly attached to the movable side sealing metal element 3. In this way, the movable side conductive shaft 8 can be moved in the axial direction while maintaining vacuum within the vacuum insulating container 1. Incidentally, the movable side metallic coating 9 need not be provided on the movable side conductive shaft 8 that is surrounded by the bellows 10.

[0014] Also, a tubular shield 11 made of stainless steel is fixed on the inside face of the vacuum insulating container 1 so as to surround the fixed side contact 6 and the movable side contact 7. A shield side metallic coating 12 made for example of chromium of higher melting point than the stainless steel is provided on the inside face of the arc shield 11 in the same way as in the case of the conductive shafts 4, 8.

[0015] In this way, in the case of the conductive shafts 4, 8, metallic coatings 5, 9 of for example chromium (melting point about 1900°C) that is higher than the melting point of electrical copper (about 1020°C) are provided, and, in the case of the arc shield 11, a metallic coating 12 that is of melting point higher than that of the stainless steel (about 1420°C) is provided: in this way, the withstand-voltage characteristic can be improved. Specifically, although the facing areas are largest within the vacuum valve between the conductive shafts 4, 8 and the arc shield 11, so that there is a tendency for the breakdown electric field to decrease due to the area effect, by providing metallic coatings 5, 9, 12 made of metal of melting point higher than the metal of which the aforementioned members are themselves constituted, the apparent breakdown electrical field can be increased. The metal of which the aforementioned members are constituted is electrical copper in the case of the conductive shafts 4, 8 and stainless steel in the case of the arc shield 11.

[0016] It is believed that this improvement is achieved because minute surface irregularities formed during mechanical processing are smoothed out by the metallic coatings 5, 9, 12, thereby suppressing electron emission by field emission. Also, it is believed that this improvement is achieved because emission of electrons from the aforementioned members themselves is suppressed. Incidentally, titanium (about 3170°C) or molybdenum (about 2620°C) or the like, which are of even higher melting point, could be employed for the metallic coatings 5, 9, 12. Thus the coatings should contain at least one of chromium, titanium, or molybdenum.

[0017] With the vacuum valve according to Embodiment 1 described above, by providing metallic coatings 5, 9, 12, using metallic material of higher melting point than that of the underlying of metal of the aforementioned members, on the outer face of the conductive shafts 4, 8 and arc shield 11, which are of large facing area, the withstand-voltage characteristic can be improved, making it possible to reduce the overall size.

[Embodiment 2]

[0018] Next, the vacuum valve according to Embodiment 2 of the present invention will be described with reference to Fig. 2. Fig. 2 is a cross-sectional view showing the construction of a vacuum valve according to Embodiment 2 of the present invention. The point of difference of this Embodiment 2 from Embodiment 1 is the range over which the metallic coating is provided. In Fig. 2, constituent portions that are the same as in the case of Embodiment 1 are given the same reference symbols and further detailed description thereof is dispensed with.

[0019] As shown in Fig. 2, a fixed side electrode metallic coating 13 and movable side electrode metallic coating 14 like the metallic coatings 5, 9 are provided also on the peripheral sections of the fixed side contact 6 and movable side contact 7. The fixed side contact 6 and movable side contact 7 are constituted by for example a coil electrode and contactor that generate for example a longitudinal magnetic field: the electrical field at the outer face of the coil electrode is comparatively high. Thus the metallic coatings 13, 14 are provided on the outside face of these coil electrodes. Also, an end metallic coating 15 like the shield-side metallic coating 12 is provided at the end of the arc shield 11.

[0020] Specifically, metallic coatings 13, 14, 15 are also provided in portions where the electric field is high. Preferably, these metallic coatings 13, 14, 15 have greater film thickness than the metallic coatings 5, 9, 12 provided on faces where the electric field intensity is low, so that their surfaces can be made smoother. Film thickness of a few μm to a few tens of μm can be achieved by employing ion plating. It should be noted that, taking into account electrical conductivity, the coil electrode is made of electrical copper.

[0021] With the vacuum valve according to the above Embodiment 2, since metallic coatings 13, 14, 15 made of metallic material of high melting point are provided in portions of high electric field intensity, apart from the beneficial effects of Embodiment 1, the withstand voltage characteristic or performance can be further improved.

[Embodiment 3]

[0022] Next, a vacuum valve according to Embodiment 3 of the present invention will be described with reference to Fig. 3.

[0023] Fig. 3 is a cross-sectional view showing the construction of a vacuum valve according to Embodiment 3 of the present invention. The aspect in which this Embodiment 3 differs from Embodiment 2 is the provision of an insulating film at the periphery of the vacuum insulating container. In Fig. 3, structural portions that are the same as in the case of Embodiment 2 are given the same reference symbols and further detailed description thereof is dispensed with.

[0024] As shown in Fig. 3, an insulating layer 16 that is formed by molding epoxy resin is provided at the periphery of the vacuum insulating container 1.

[0025] With the vacuum valve according to Embodiment 3, in addition to the beneficial effects of embodiment 2, insulation reinforcement of the insulation along the surface of the outside of the vacuum insulating container 1 can be achieved by the insulating layer 16, thereby making it possible to further reduce the overall size of the vacuum valve.

[0026] With the embodiments described above, by providing a metallic coating made of metallic material of higher melting point than electrical copper on the conductive shafts, or by providing a metallic coating made of metallic material of higher melting point than stainless steel on the arc shield, the withstand-voltage characteristic can be improved.

[0027] While various embodiments have been described above, these embodiments are merely given by way of example and are not intended to restrict the scope of the present invention. In fact, the novel device that is described herein could be realized in various other modes and various omissions, substitutions or alterations could be performed in the form of the device described herein without departing from the gist or spirit of the present invention. The appended claims and equivalents thereof are intended to include modes or modifications such as fall within the scope of the present invention and the gist or spirit thereof.

Claims

1. A vacuum valve comprising:

   a vacuum insulating container;
   a pair of contacts that can be freely opened/closed, accommodated in said vacuum insulating container;
   conductive shafts that are fixed to said contacts, and
   an arc shield provided so as to surround said contacts;
   characterized in that a metallic coating made of metallic material of melting point higher than an underlying metal thereof is provided on an outside face of said conductive shafts and an inside face of said arc shield.

2. The vacuum valve according to claim 1, **characterized in that** said contacts comprise contactors capable of being opened/closed; and coil electrodes that generate a magnetic field and are fixed to said contactors,
   wherein a metallic coating made of metallic material of higher melting point than said underlying metal is provided on the outside face of said coil electrodes.

3. The vacuum valve according to claim 1 or claim 2, **characterized in that** a metallic coating made of metal of higher melting point than said underlying metal is provided at an end of said arc shield.

4. The vacuum valve according to any of claims 1 to 3, **characterized in that** said metallic coating contains at least one of chromium, titanium, or molybdenum.

5. The vacuum valve according to any of claims 1 to 4, **characterized in that** said metallic coating is provided by ion plating.

6. The vacuum valve according to any of claim 1 to claim 5, **characterized in that** an insulating layer is provided around said vacuum insulating container.

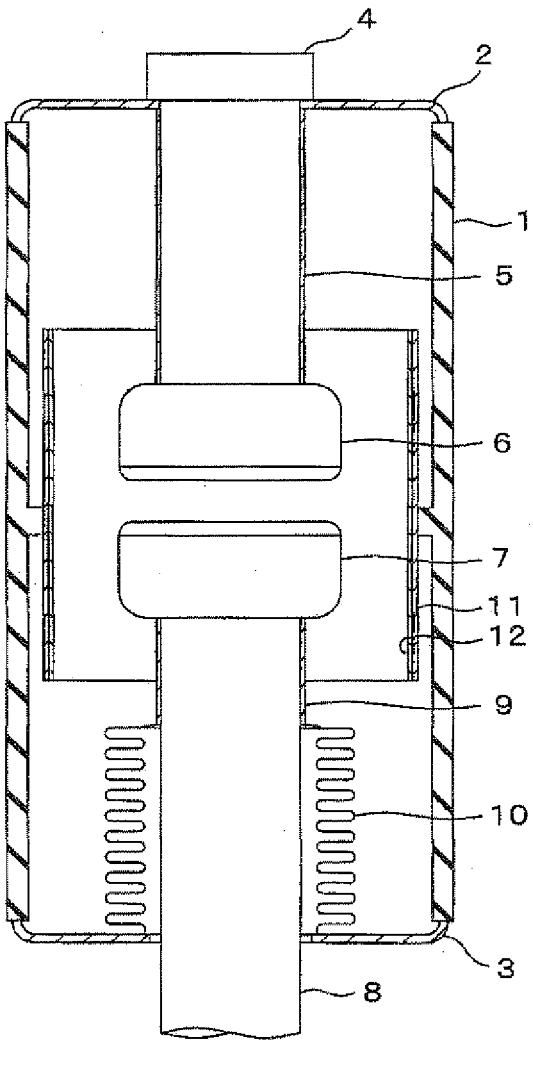

FIG.1

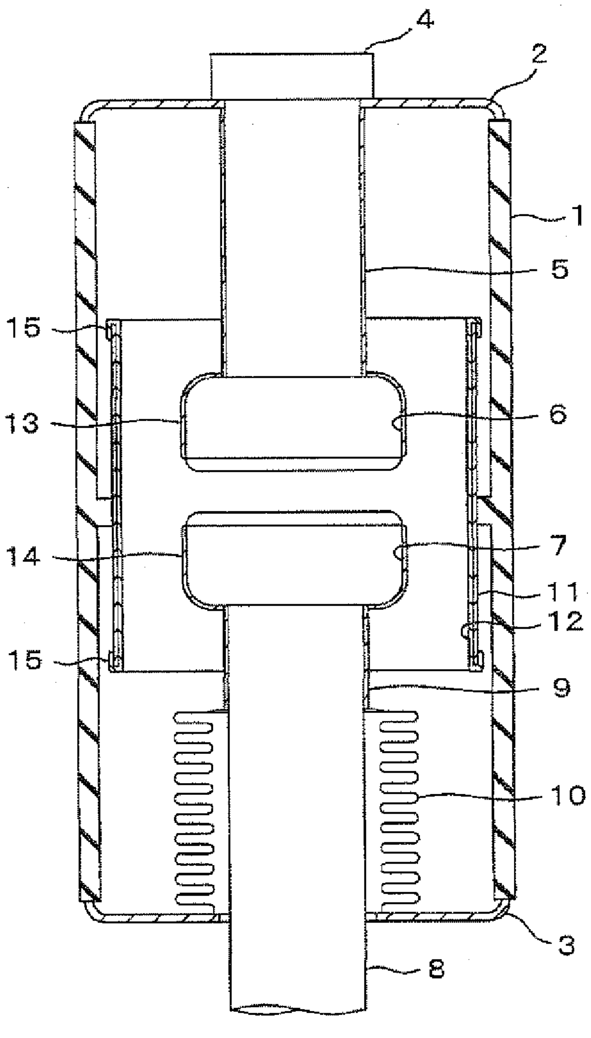

FIG.2

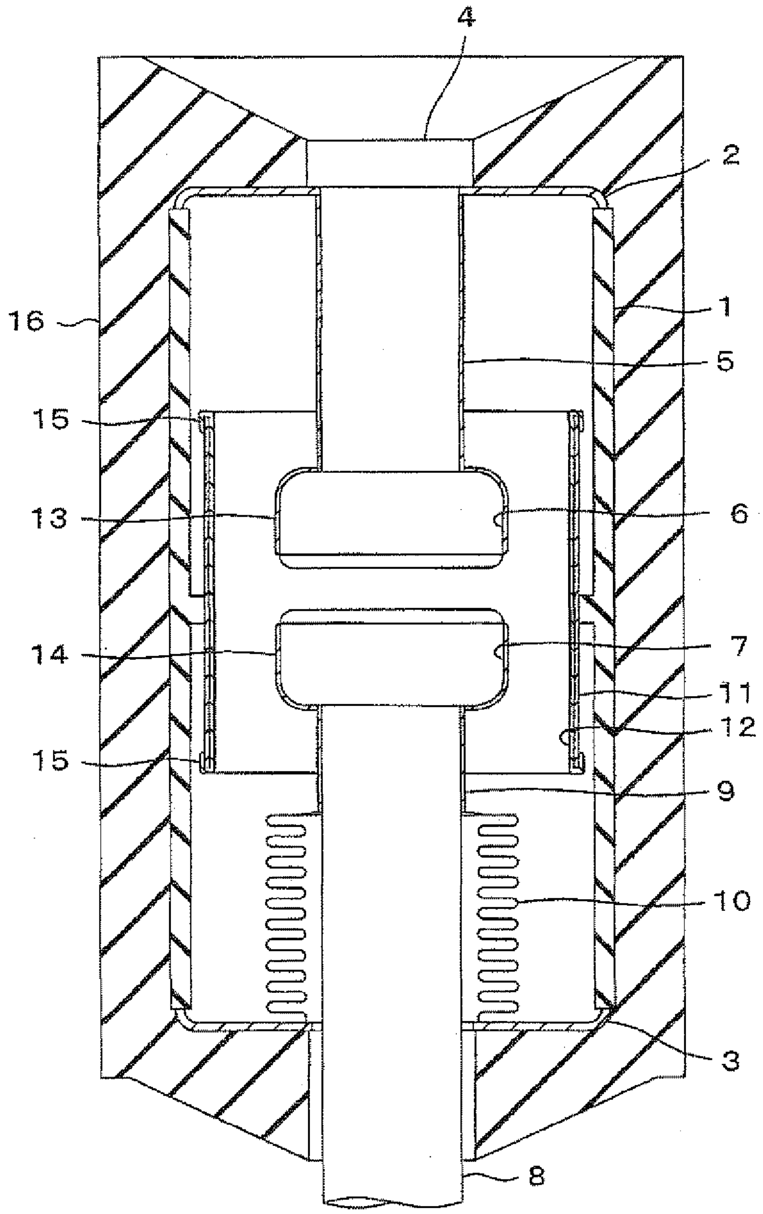

FIG.3

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EUROPEAN SEARCH REPORT

Application Number
EP 11 17 3237

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X Y	WO 2007/031202 A1 (ABB TECHNOLOGY AG [CH]; DULLNI EDGAR [DE]; GENTSCH DIETMAR [DE]; KALTE) 22 March 2007 (2007-03-22) * page 1 - page 5; figure 1 * -----	1,3,4 2,5,6	INV. H01H33/662
Y	GB 2 061 010 A (MEIDENSHA ELECTRIC MFG CO LTD; GEMVAC KK) 7 May 1981 (1981-05-07) * page 1, line 94 - page 4, line 19; figures 1-6 * -----	2	
Y	EP 0 286 335 A1 (TOSHIBA KK [JP]) 12 October 1988 (1988-10-12) * column 6, line 34 - column 16, line 50; figures 1-11 * -----	5	
Y	EP 1 501 101 A2 (TOSHIBA KK [JP]) 26 January 2005 (2005-01-26) * paragraph [0020]; figure 2 * -----	6	
A	WO 2006/032522 A1 (ABB TECHNOLOGY AG [CH]; UMICORE AG & CO KG [DE]; GENTSCH DIETMAR [DE];) 30 March 2006 (2006-03-30) * page 1 - page 5 * -----	1	TECHNICAL FIELDS SEARCHED (IPC) H01H

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	29 September 2011	Nieto, José Miguel

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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