United States Patent

Cherry et al.

[15] 3,670,129

[45] June 13, 1972

[54] ELECTRICAL CONTACT MEMBERS

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[21] Appl. No.: **64,362**

[52] **U.S. Cl.** ....**200/166 C**
[51] **Int. Cl.** **H01h 1/02**
[58] **Field of Search**...................200/166 C, 144 B; 29/630 C

[56] **References Cited**

UNITED STATES PATENTS

2,900,476 8/1959 Reece............................200/166 C X

FOREIGN PATENTS OR APPLICATIONS

686,188 5/1964 Canada.............................200/166 C

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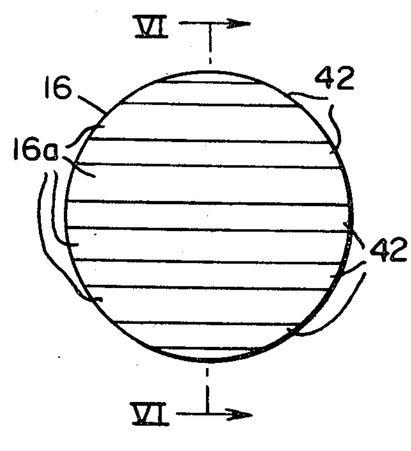
[57] **ABSTRACT**

Electrical make and break contact members for use in a vacuum-type circuit interrupter including a casing forming an evacuated chamber with a pair of separable contacts contained therein and composed of copper (or other similar metal), the contacting surface of each contact having a non-continuous coating of a refractory material, covering the major part of the contact surface and whereby during disengagement of the contacts the welding and high erosion rate of copper caused by an electric arc in a vacuum is minimized by the refractory material coating.

7 Claims, 9 Drawing Figures



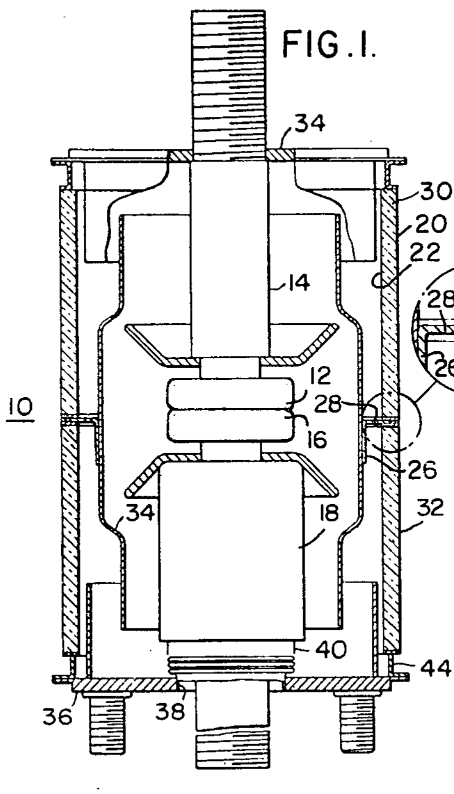


FIG. 1.

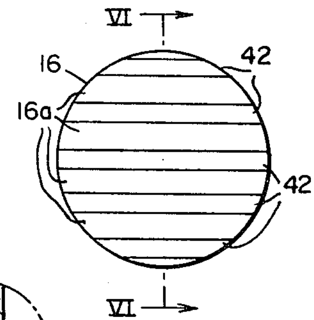


FIG. 2.

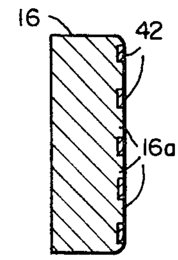


FIG. 6.

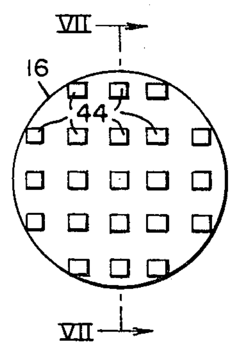


FIG. 3.

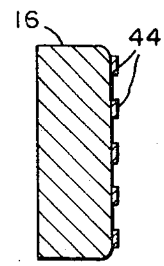


FIG. 7.

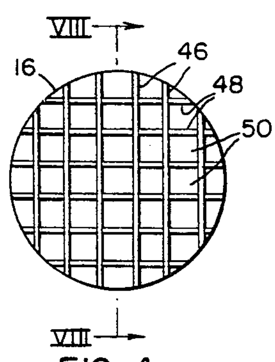


FIG. 4.

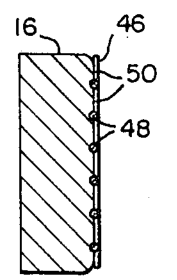


FIG. 8.

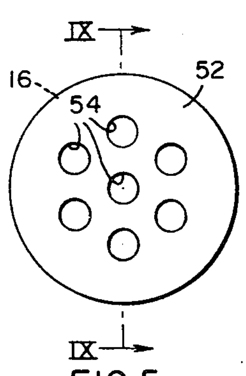


FIG. 5.

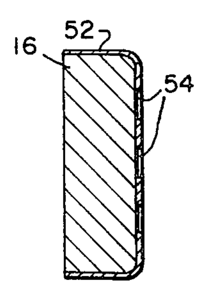


FIG. 9.

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ELECTRICAL CONTACT MEMBERS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to vacuum-type circuit interrupters and it particularly pertains to the structure of contacts for such an interrupter.

2. Description of the Prior Art

Contact materials presently used for vacuum interrupters rates at 15 KV for 6,000 amperes and higher are primarily copper base alloys. A disadvantage of this material is that its rate of erosion is so high (explosive at times) that not only are the contacts badly eroded, but material is scattered throughout the interrupter, leading to high field points which may result in voltage breakdown between elements of the interrupter.

One solution to the problem of excessive erosion has been to use certain refractory material such as tungsten which continuously cover the contacting surfaces. However, some refractory materials such as tungsten have a current interrupting ability for 15 KV which is less than for copper alloys. To overcome this disadvantage a composite contact made up of copper (or silver) in a tungsten (or other refractory metal) matrix may be used. While this material has a lower chopping current than either the usual refractory metal alone or the copper alloy, it does not approach the copper alloy in current interrupting capacity. Such a composite contact is limited to less than 6,000 amperes compared to copper alloys which have been interrupted as high as 50,000 amperes. One reason for the inability of the tungsten-copper composite contact to match the current interrupting capability of the copper alloy contact is that the thermionic emission from the refractory metal is so high that the arc reignites when the inverse voltage appears across the open contacts. One way of lowering the thermionic emission is to use a refractory material with a high work function.

Moreover, presently-used devices have not completely cured other problems such as creation of strong welds between contacts, or re-establishment of an arc when the polarity is reversed. An attempted solution to these problems is that disclosed in U.S. Pat. Nos. 2,234,834 and 2,294,783 in which contacts composed of laminations of a refractory metal and a good conducting metal as well as a contact member having a plurality of elongated strands or wires of refractory metal imbedded in a matrix of a good electrical conducting metal, with the wires or refractory metal extending substantially perpendicular to the contacting surfaces of the contacts. Such contact constructions have not provided adequate bonding between the wires and the matrix of good conducting metal to obtain satisfactory heat exchange therebetween during operation of the contacts.

Still another prior art contact includes a veneer or layer of refractory metal that completely covers the surface of contact of good conducting metal such as copper. Such a structure is unsatisfactory for most vacuum type circuit interrupters because the coating of most refractory metals overheats and emits electrons which, when the polarity reverses, re-establishes the arc between the contacts.

SUMMARY OF THE INVENTION

In accordance with this invention, is has been found that the foregoing problems may be overcome by providing a vacuum type circuit interrupter having contacts composed of a metal body having a high coefficient of electrical conductivity, the facing surfaces of the contacts being provided with a thin layer of refractory material covering from about 60 percent to 95 percent of the area exposed contact surface, which layer is discontinuous with respect to the surfaces of the body of the contacts, whereby spaced surface portions of the layer and of the body of one contact are exposed to the corresponding portions on the other contact.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a representative view of a vacuum type circuit interrupter constructed in accordance with the present invention;

FIG. **2** is a plan view of the configuration of the interrupter contacts;

FIGS. **2–5** are plan views of other embodiments of the interrupter contacts; and

FIGS. **6–9** are sectional views taken through the several plan views of FIGS. **2–5**.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Though the device of the present invention is described for use in a vacuum type circuit interrupter, it is also useful in other vacuum type devices such as circuit breaker envelopes, gas discharge tubes, and the like. In FIG. **1** a vacuum type circuit interrupter is generally indicated at **10** and comprises a stationary contact **12** having a stationary stem portion **14**, a movable contact **16** engageable with contact **12** and mounted on a stem portion **18**, and the contacts being enclosed within a housing **20** forming an evacuated chamber **22**.

The particular type of interrupter **10** illustrated in FIG. **1** is provided with a condensing shield **24** which is composed of a metal such as copper for the purpose of condensing thereon any metallic vapor discharged from the contacts **12** and **16** during interruption. A number of mounting tabs **26** are provided at spaced intervals around the shield **24** which tabs are an integral part of an annular flange **28**, the outer peripheral portion of which is seated in and hermetically sealed to the housing **20** which is composed of upper and lower housing portions **30** and **32**. The upper end of the housing **20** is closed by an end plate **34** and the lower end is closed by an end plate **36**. The stem portion **14** of the stationary contact **12** is mounted in the upper end plate **34** in a conventional manner such as by brazing. The stem portion **18** of the movable contact **16** extends through an opening **38** in the lower end plate **36** and the assembly of the end plate **36** and the stem portion **18** is sealed in an air tight manner by the provision of a flexible corrugated metallic bellows **40**.

The contacts **12** and **16** are comprised of a main body of a metal having a high coefficient of thermal conductivity and good electrical conductivity, the preferred metals are copper, silver, gold and base alloys thereof. Other metals of lesser electrical conductivity are not as desirable, but may be used for some low amperage applications, such as nickel, iron, and chromium. The good conducting metal, copper for example, may contain from 0.01 to 2 percent of bismuth to improve its properties in a vacuum. Other minor additives to copper are such as are disclosed in U.S. Pat. No. 3,246,979. The alloy is preferably vacuum melted and degassed thoroughly before being made into a contact.

As shown more particularly in FIGS. **2** to **9**, each contact **12** and **16**, is provided with a thin veneer or discontinuous surface layer of a refractory material which layer is composed of spaced apart portions to provide a discontinuous cover between which portions of the contact are disposed. Thus, for example, in FIG. **2**, the contact **16** is provided with a plurality of spaced stripes **42** of a refractory material with surface portions **16*a*** disposed between said stripes.

In FIG. **3** layers **44** of refractory material are provided on the surface of the contact in the form of islands disposed at spaced intervals across the surface thereof.

Another form of the invention is shown in FIG. **4** and comprises a grid **46** composed of horizontal wire-like members **48** and vertical wire-like members **50**. The members **48** and **50** are composed of a refractory material.

Still another form of the invention is that shown in FIGS. **5** and **9** in which one of the contacts **12** and **16**, such as contact **16**, is provided with a layer **52** disposed upon the surface of the contact and which layer is provided with a plurality of spaced apertures **54** through which the surface of the good conducting metal of contact **16** is exposed. As shown in FIG. **9** the layer 52 may be disposed over the outer peripheral portion of the contact 16 as well as on the top surface thereof. The layer 52 is composed of a refractory material. The distance from any part of an exposed copper area at the contact surface, to the nearest refractory material should be less than 0.1 inch.

The several layers including the stripes 42, the island-like layers 44, the grid 46, and the layer 52 are composed of refractory materials and particularly refractory metals such as chromium, molybdenum, rhenium, iridium, tungsten and alloys thereof. Other suitable refractory materials including some carbides, borides and nitrides such as tantalum carbide, tungsten carbide, boron carbide, vanadium carbide, tungsten boride, and boron nitride, and similar other refractory compounds having low emission characteristics.

The layers of refractory material may be applied in any one of a variety of methods such as evaporation, chemical vapor deposition, and ion sputtering. The stripes 42, the layers 44, and the layer 52 are preferably applied by evaporation with the provision of masks on the contacts to provide the areas which are not covered by the refractory material. Where the layers, such as the layers 44 (FIG. 3), are applied by evaporation, they are disposed above the surface of the contact 16 as shown in FIG. 7. Thus, the layers 44 protrude from the surface of the contact 16. In a similar manner the exposed surface areas of the contact 16 (FIG. 9) are recessed within the apertures 54 in the layer 52 of the embodiment of the invention shown in FIGS. 5 and 9.

The layers 42 (FIGS. 2 and 6) may also be applied to the surface by forming the refractory material into stripes 42 of the desired thickness and then casting the good conducting material into the body of the contact 16 therearound. In that manner, the stripes 42 are embedded in the surface of the contact 16 with surface portion 16*a* disposed between the stripes 42.

The layers of refractory material may also be applied in another manner. The grid 46 (FIGS. 4 and 8) comprising the horizontal and vertical members 48 and 50 may be rolled into the contacting surface of the contact 16 whereby portions of the horizontal and vertical members are partially embedded in the surface.

The several embodiments of the layers including the stripes 42, the layers 44, the grid 46 and the layer 52 have a thickness of any suitable dimension and preferably up to 0.030 inch. The several embodiments of the contacts 12 and 16 are preferably identical for both. The contacts are adapted to operate in vacuums of down to an absolute pressure of 10^{-4} mm of Hg and lower. Currents of up to about 10,000 amperes AC may be used.

The total surface area of the contact body covered by the layers of the refractory material in the several embodiments comprises between from about 60 percent to about 95 percent with a preferred area of about 90 percent. If greater areas of copper are exposed, the copper welds. There must be sufficient copper exposed to assure the occurrence of only small amounts of vapor from copper as well as an adequate amount of copper to carry the amperages required.

The advantage of the surface construction for the contacts 12 and 16 as shown in the several embodiments of FIGS. 2 to 9, is that surface portions of both the contact such as copper and the veneer of refractory material such as tungsten, are brought into operation during separation of the contacts. The veneers of refractory material must be bonded or in otherwise positive contact with the substrate or body of the contact 16. By providing exposed areas of the contact, some copper vapor is generated during separation of the contacts and the veneer or layers prevent extension erosion of the copper surfaces. Thus, the presence of copper has the desired effect of forming a metallic vapor on arcing to the extent necessary to prevent other undesirable results such as strong welds occurring between the contacts 12 and 16 which often occur where no layer of refractory metal is present.

On the other hand, when a continuous layer of refractory material is provided over the entire surface of the contact, local areas of the refractory metal will overheat and emit electrons which, upon reversal of polarity, re-establishes the arc. By providing spaced areas of exposed copper, a limited amount of copper metal vapor is generated and defeats the counterdevelopment of electrons of the refractory metal.

Once the arc is broken, the metal vapor generated condenses very rapidly on the condensing shield 24.

The benefit of a refractory material such as tungsten is that it has a very high melting point and therefore a low vapor pressure, i.e., substantially less than that of the metal forming the contact 16, such as copper. The contacts of this invention have current interrupting capacity of from about 6,000 to 50,000 amperes depending upon the refractory material used with tungsten giving the lower value and chromium the higher value.

Accordingly, the vacuum interrupter of the present invention satisfies the objectives and overcomes the disadvantages of prior known constructions. As has been shown, the presence of a discontinuous layer or veneer of discrete areas of refractory material on the surface of the contacts of a vacuum interrupter avoids the deteriorating effects of extension erosion of the contact body metal. The provision of a discontinuous layer of refractory material on the contact overcomes the disadvantages of the prior art constructions in which the layer was continuous over the entire surface of the contact, which disadvantage arose due to the development of thermionic electrons of the refractory material which electrons served to prevent the breakdown of the arc by re-establishing the arc upon reversal of polarity of the current. The contact construction of the present invention avoids the prior art difficulties and is conducive to a satisfactory termination of the arc between the contacts.

Although the best known embodiments of the invention have been illustrated and described in detail, it is understood that the invention is not limited thereto or thereby.

What is claimed is:

1. In a vacuum-type circuit interrupter including wall means defining an outer evacuated cylindrical casing, a pair of contacts disposed within the casing and separable from each other whereby to interrupt an electrical circuit and each having a contact surface whereon an electrical arc can form during such interruption, the improvement comprising at least one of the contacts comprises a body of good electrical conducting metal and a discontinuous layer on the contact surface of the contact, said layer being composed of at least one refractory material selected from a group consisting of chromium, iridium, molybdenum, rhenium, tungsten, and base alloys thereof, and the refractory borides, carbides and nitrides of these elements, and which layer covers from about 60 percent to about 95 percent of the area of the contact surface.

2. The device of claim 1 wherein the contact body of good electrically conducting metal is selected from a group consisting of copper, silver, and gold, and base alloys thereof.

3. The device of claim 1 wherein the discontinuous layer is a perforated sheet-like member.

4. The device of claim 3 wherein each layer includes at least one opening through which the good conducting metal is exposed to the other contact.

5. The device of claim 1 wherein the discontinuous layer is tungsten.

6. The device of claim 1 wherein the discontinuous layer has a thickness of up to about 0.03 inch.

7. The device of claim 1 wherein the discontinuous layer consists of spaced discrete portions between surface portions of the good conducting metal of the contact.

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