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Kabayama et al.

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[54] **VACUUM-TYPE CURRENT INTERRUPTER**

[75] Inventors: **Sukeaki Kabayama; Masahiro Kume,** both of Osaka; **Akira Katou,** Kyoto; **Susumu Yamada,** Kyoto; **Masayuki Isei,** Kyoto, all of Japan

[73] Assignees: **Sumitomo Electric Industry Company Ltd.,** Osaka; **Nissin Electric Company, Ltd.,** Kyoto, Japan

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[52] **U.S. Cl.** ..... **200/144 B,** 200/166 C

[51] **Int. Cl.** **H01h 33/66**

[58] **Field of Search** ..... 200/144 B, 166 C

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Primary Examiner—Robert S. Macon

Attorney—Christensen & Sanborn

[57] **ABSTRACT**

Vacuum-type current interrupter having a shield surrounding the contacts so as to block and condense the metallic vapor generated by arcing between the contacts upon separation thereof. The shield is made of partially sintered metallic material to increase the effective surface area to catch and condense the metallic vapor and may be provided on the inner surface thereof with a plurality of generally radially inwardly projecting integral fins to further increase the inner working surface area thereof.

9 Claims, 5 Drawing Figures

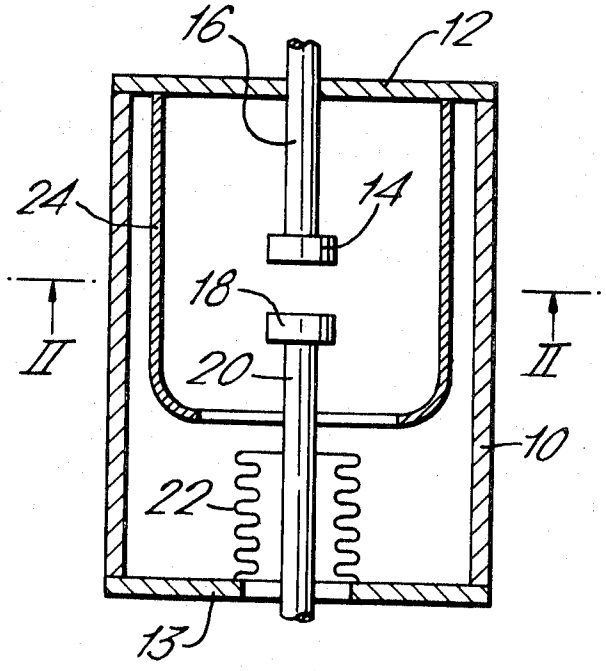


FIG. 1.

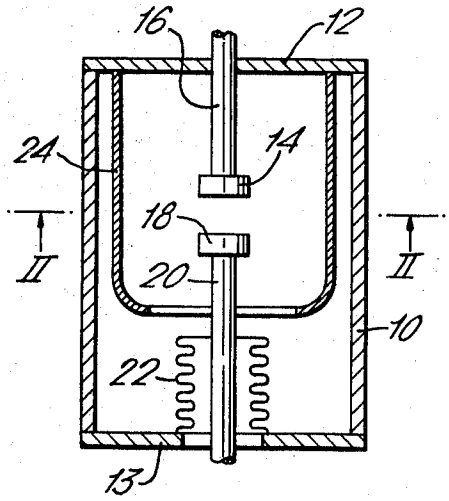


FIG. 3.

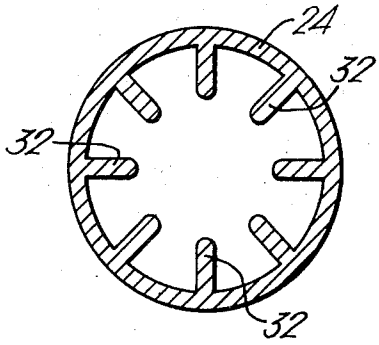


FIG. 2.

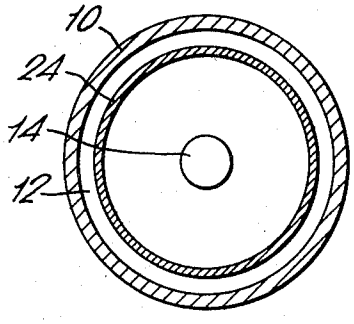
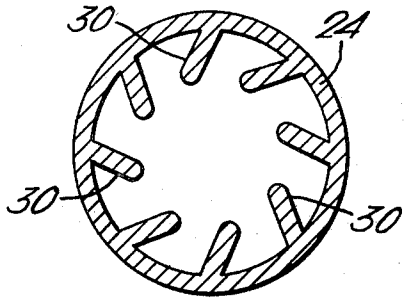


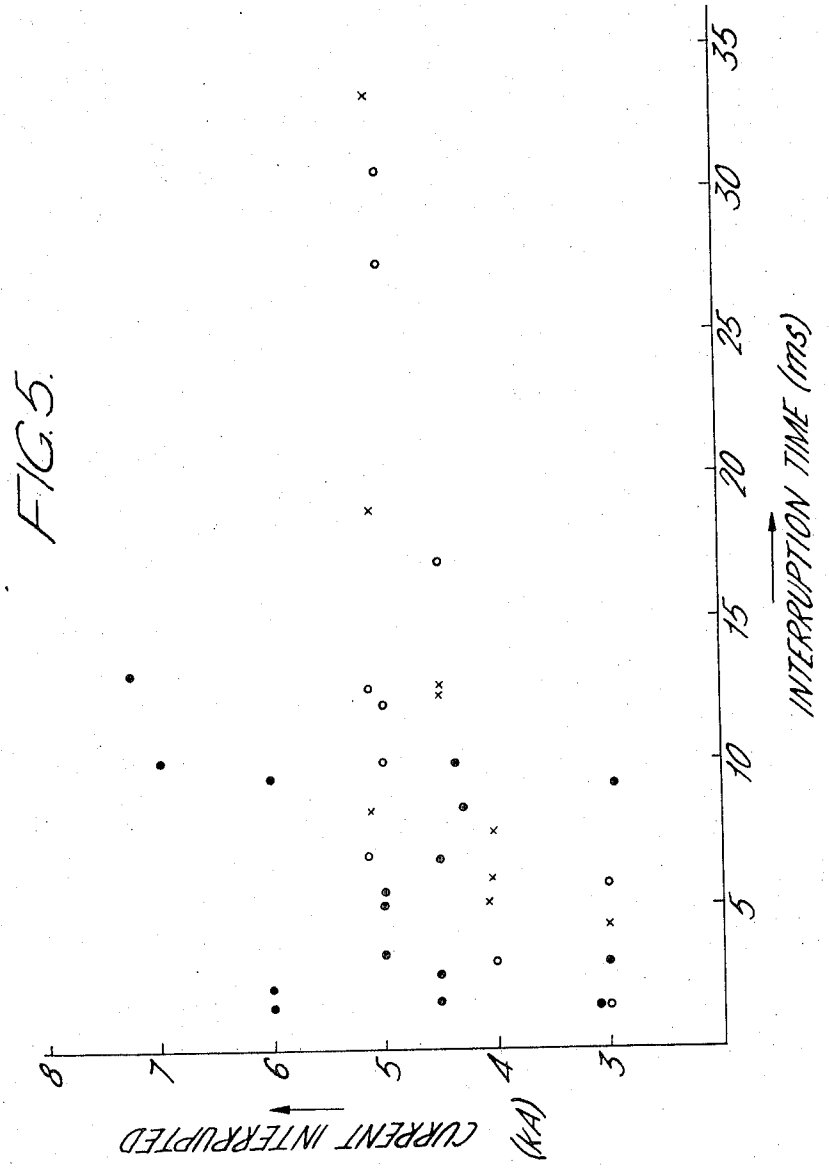
FIG. 4.



INVENTORS
SUNEAKI KABAYAMA
MASASHIRO KUNE
AKIRA KATOU
SUSUMU YAMADA
MASAYUKI ISEI

BY Christensen, Sokoloff & Whitney ATTORNEYS

FIG. 5.



INVENTORS
SUKEAKI KABAYAMA
MASASHIRO KUME
AKIRA KATOU
SUSUMU YAMADA
MASAYUKI ISEI

BY Christensen, Sokoloff & Matthews ATTORNEYS

VACUUM-TYPE CURRENT INTERRUPTER

This invention relates to a vacuum-type current interrupter provided with an improved shield means surrounding the contacts for condensing the metallic vapor generated by arcing between the contacts.

As is well known, a conventional vacuum-type current interrupter comprises a vacuum housing or envelope made of an electrical insulating material and a pair of opposed separable contacts disposed within the housing so that by separating these contacts the current is interrupted. When the contacts are separated, an arcing occurs therebetween and the heat generated vaporizes some of the metallic material of the contacts. If the metallic vapor flies around to strike the inner surface of the housing to be condensed thereon, the insulating resistance of the housing decreases, with resulting occurrence of various undesirable phenomena.

To avoid this, it is customary to provide a shield between the contacts and the inner surface of the housing. The shield generally comprises a tubular member made of glass or metal such as stainless steel. The metallic vopor flying from the contacts are blocked by the inner surface of the shield to be cooled and condensed thereon so as not to reach the wall of the housing. However, if the current to be interrupted is large, a large amount of metallic vapor is generated, so that in some cases all of the vapor generated cannot be caught by the shield, but some of the vapor will fly as far as the housing wall to be reflected thereby back to the gap between the separated contacts. Prior art shields have a smooth inner surface having a high reflectivity of the metallic vapor or particles, and the presence of the reflected metallic vapor or particles in the gap between the separated contacts impairs the insulation therebetween and consequently the current-interrupting ability of the interrupter.

One way to increase the current-interrupting ability is to make the interrupter itself a large size. Another way is to catch as much of the arc-generated metallic vapor from the contacts as possible by by means of a shield and, if there is any vapor left uncaught, to prevent it from flying back to the space around the contacts. To this end it has been proposed to form the inner surface of the shield into a wave shape or provide indentations on the inner surface of the shield by inserting thereinto several rings spaced along the length thereof. With such arrangements, the inner working surface area of the shield increases with a resulting increase in the vapor catching and condensing ability thereof. However, manufacture of such structures requires much work and yet the surface of the indentations or the wave-shaped wall is so smooth as to be unable to prevent the metallic vapor or particles from rebounding from the surface. Even if the metallic vapor has attached to the inner surface of such a shield as a thin metallic film, the smoothness of the surface and the vibrations of the interrupter caused by opening or closing of the contacts will cause the film to be stripped off from the inner surface of the shield.

Accordingly, the primary object of the invention is to provide a vacuum-type current interrupter having a shield means which has a greater ability than the prior art shields to catch and condense the metallic vapor generated upon separation of the contacts and to prevent the vapor from being reflected by the shield to fly back to the space about the contacts.

The shield constructed in accordance with the invention is made of sintered metallic material. Such a material has a large number of microscopic holes or recesses in the surface thereof, so that the effective surface area of the shield increases with a resulting increase in the ability to catch and condense the metallic vapor from the contacts of the interrupter. When the minute metallic particles constituting the vapor generated by arcing between the contacts hit on the surface of the shield, they enter the minute holes to settle therein. Even when they are reflected by the inner surface of the holes, they continue to be irregularly reflected in the holes and have little or no chance to come out therefrom, so that they are finally attached to the inside surface of the holes. This means a great reduction of the rate of the metallic particles caught by the surface of the shield to those reflected thereby to fly back around the contacts. The metallic particles will irregularly settle inside the holes, so that the surface of the shield will not be deteriorated and the original vapor condensing or particle catching ability and the small reflectivity thereof will be maintained scarsely changed.

The inner surface condition of the shield, that is, the diameter of the holes thereon, is determined by the grading of the metallic particles used to make the shield. A mixture of large and small particles at a suitable rate produces a shield material having a great mechanical strength and a rugged surface.

The material suitable to form the shield is a simple metal such as iron, cobalt, nickel, copper, silver, aluminum, tungsten or molybdenum, or their compounds metals, or stainless steel, bronze, brass or other alloys. The grading of the particles or powder of the material is 20 to 325 mesh. In molding of the powdered material, a binder or other additional medicines such as camphor, zinc stearate may be used, the amount to be added being 0.5 to 4 percent by weight. A molding pressure of 0.5 to 3 t/cm^2 may be employed, but no such pressure need always be applied.

Since the shield of the present invention is formed by sintering the above-mentioned metallic materials, it can be easily formed into any desired shape. In order to increase the effective working surface area of the shield, it may be provided with a plurality of integral fins on the inner surface thereof.

The invention, with its objects, features and advantages, will be better understood by reading the following description of some preferred embodiments thereof with reference to the accompanying drawings, wherein:

FIG. 1 is a longitudinal cross-section of a vacuum-type current interrupter constructed in accordance with the invention;

FIG. 2 is a sectional view taken along line II — II of FIG. 1;

FIG. 3 is a transverse section of a second form of the shield means;

FIG. 4 is a view similar to FIG. 3 but showing a third form of the shield means; and

FIG. 5 is a graph showing the interruption characteristic of the interrupter of the invention in comparison with that of the prior art interrupter.

Referring to FIG. 1, there is shown a housing or envelope 10 made of an electrical insulating material such

as ceramic or glass. The housing **10** has its opposite end openings tightly closed by end plates **12** and **13**, and a vacuum is generated inside the housing. The housing **10** encloses therein a fixed contact **14** supported on the inner end of a fixed electrode **16** secured to the end plate **12** and a movable contact **18** supported on the inner end of a movable electrode **20** inserted loosely through the other end plate **13**, with a bellows **22** provided between the electrode **20** and the end plate **13** for sealing while permitting relative movement of the electrode **20** to the plate **13**. The electrodes **16** and **20** are aligned coinciding with the axis of the housing **10**. By moving the electrode **20** by means of a suitable driving means, not shown, the contacts **14** and **18** are opened and closed.

A tubular shield **24** has its one end securely supported by the end plate **12**, and is interposed between the inner surface of the housing **10** and the contacts so as to surround the latter. The shield **24** is made of a sintered metallic material. Powder of one or more of the previously mentioned metallic materials is loosely packed into a mold of a desired shape and sintered with or without a pressure of 0.5 to 3 t/cm^2. The holes formed in the surface of the shield may be independent from each other or continuous. The working surface of the shield is formed as rugged as possible, but the more rugged is the surface, the less becomes the mechanical strength of the shield. Therefore, the grading of the material of the shield must be determined in accordance with the field in which the interrupter is to be used.

The rugged surface of the shield of the invention easily catches more of the metallic vapor flying around upon separation of the contacts than without such a rugged surface. This means that the vapor condensing or particle catching ability of the shield has increased. Indeed, the metallic particles entering the holes on the shield surface may be reflected by the inner surface of the holes, but they have little or no chance to fly out of the holes but are repeatedly reflected inside the holes to finally settle therein. The shield of the invention can thus avoid deterioration of the insulation about the separated contacts which would otherwise be caused by the metallic particles rebounding from the inner surface of the shield. In other words, the current-interrupting ability of the interrupter is much increased by provision of the shield of the invention.

The shield **24** may be of a simple tubular or hollow cylindrical shape as shown in FIG. **2**. To increase the inner working surface area of the shield, a plurality of radially inwardly projecting fins **32** may be formed integral with the tubular body of the shield **24** as shown in FIG. **3**. The fins may be formed so as to be inclined a certain angle relative to the radial direction as shown at **30** in FIG. **4**. The shield with such fins can be easily formed by preparing correspondingly shaped molds.

FIG. **5** shows the interruption characteristic of the interrupter constructed in accordance with the invention in comparison with that of a prior art interrupter. The shield of the invention is made of **100** mesh powder of iron sintered at 1,130° C. The prior art shield is made of stainless steel. The current (kA) to be interrupted is taken on the ordinate and the interruption time (ms), on the abscissa. The black dots show the interruption times resulting from the shield of the invention, while the white circles and crosses, those resulting from the prior art shield. The voltage used is 7.2kV and the frequency is 60 cycles, one cycle being about 16.6 ms. As shown, with the current to be interrupted being about 4 kA, interruption is achieved in about 8 ms by both the interrupters of the invention and the prior art. Above 4.5 kA, however, the time required for interruption is from maximum 13 to minimum 1.6 ms, while it is from maximum 33.2 to minimum 6.8 ms with the prior art interrupter. As is clearly shown, as the current to be interrupted becomes higher, the interrupter of the invention becomes more effective than the prior art device. In most cases, interruption is achieved in three-fourths of one cycle by the interrupter of the invention.

What we claim is:

1. In a vacuum-type current interrupter, an electrically insulative housing adapted to have a vacuum generated therein, a pair of separable contacts disposed within the housing, and means defining a shield which is disposed in the housing so as to surround the contacts and contain the metallic vapor which is generated by arcing between the contacts when they separate in use, the inner peripheral surface portion of which shield, around the perimeter thereof, consists essentially of a metal particulate material which is sintered to a rugged, mechanically strong condition in which the surface thereof has a multitude of microscopic recesses for receiving and condensing the metallic vapor therein.

2. The vacuum-type current interrupter according to claim **1** wherein the shield consists essentially of the sintered metal particulate material.

3. The vacuum-type current interrupter according to claim **1** wherein the metal particulate material is iron, cobalt, nickel, copper, silver, aluminum, tungsten, molybdenum, or a compound metal thereof, or stainless steel, bronze, or brass.

4. The vacuum-type current interrupter according to claim **1** wherein the inner peripheral surface portion of the shield also comprises about 0.5 – 4.0 percent by weight of a binder for the metal particulate material.

5. The vacuum-type current interrupter according to claim **1** wherein the metal particulate material is of about 20 – 325 mesh in particle size.

6. The vacuum-type current interrupter according to claim **5** wherein the particles are a mixture of relatively large and small particles.

7. The vacuum-type current interrupter according to claim **1** wherein the inner peripheral surface of the shield has one or more inwardly projecting fins thereon, which are integral with the surface portion of the shield and likewise consist essentially of the sintered metal particulate material.

8. The vacuum-type current interrupter according to claim **1** wherein the shield is interposed between the contacts and the housing, in spaced relationship thereto.

9. The vacuum-type current interrupter according to claim **1** wherein the inner peripheral surface of the shield is cylindrical in configuration.

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