United States Patent

[11] 3,586,801

[72] Inventors Osamu Saito; Takamasa Saito; Yutaka Iwashima, all of Hitachi-shi, Japan

[21] Appl. No. 5,850

[22] Filed Jan. 26, 1970

[45] Patented June 22, 1971

[73] Assignee Hitachi, Ltd. Tokyo-to, Japan

[32] Priority Jan. 24, 1969

[33] Japan

[31] 44/4751

[54] **VACUUM INTERRUPTER**
10 Claims, 4 Drawing Figs.

[52] U.S. Cl. .... 200/144, 200/168 H

[51] Int. Cl. H01h 33/66

[50] Field of Search .... 200/144 B, 168 H

[56] **References Cited**

UNITED STATES PATENTS

2,892,911	6/1959	Crouch	200/144 B
2,980,782	4/1961	Schneider	200/144 B
3,048,681	8/1962	Polinko, Jr.	200/144 B
3,048,682	8/1962	Yeras	200/144 B

FOREIGN PATENTS

1,411,483	8/1965	France	200/144 B

Primary Examiner—Robert S. Macon
Attorney—Craig, Antonelli, Stewart & Hill

ABSTRACT: A supporting member for the tubular intermediate metallic shield of a vacuum interrupter, which comprises a first metallic strip secured to the outer surface of the shield, second and third metallic strips formed integrally with the first strip and each extending from the respective sides of the first strip at a predetermined angle, one of the side edges of each of the second and third metallic strips engaging with an inclined side of a trapezoidal projection formed along the internal surface of dielectric cylindrical casing which forms the vacuum envelope, the second and third strips being bent so that the folding lines between the main plane of the second and third strips and the main plane of the first strip are generally parallel to the axis of the tubular shield.

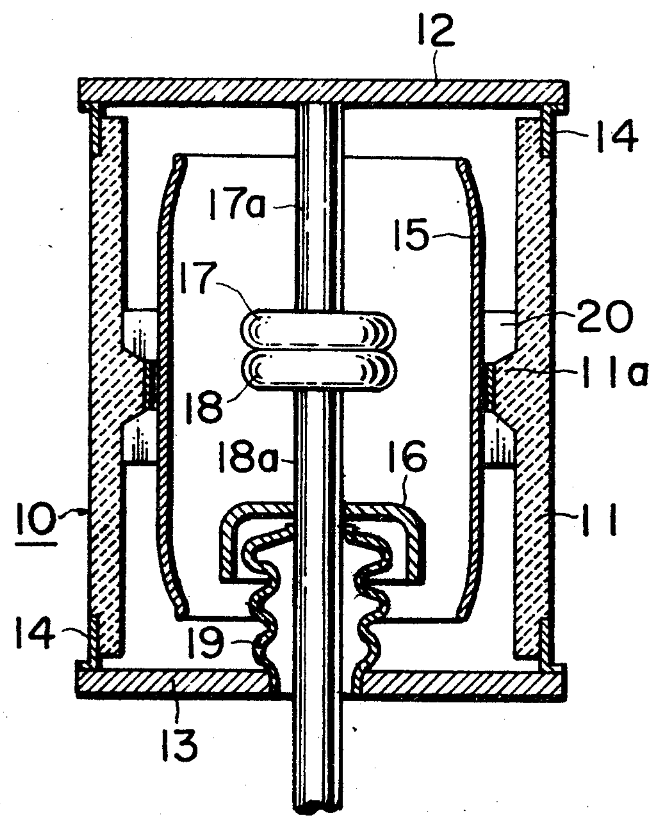


FIG. 2

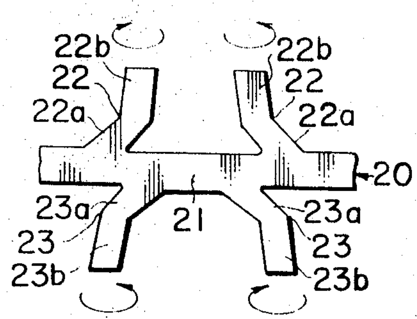


FIG. 1

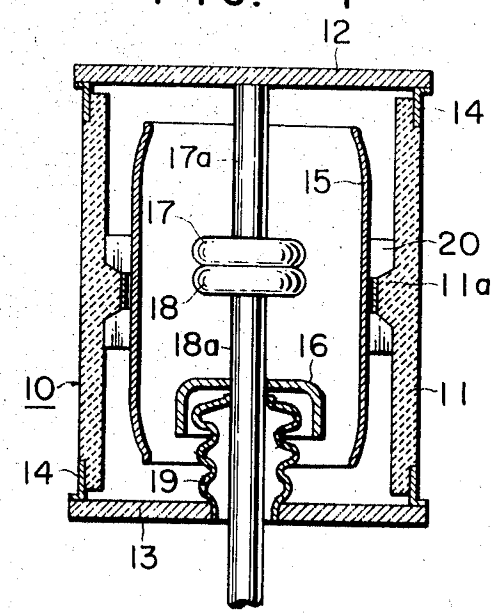


FIG. 3

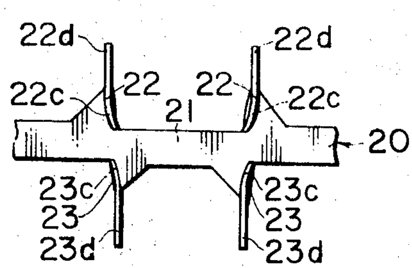
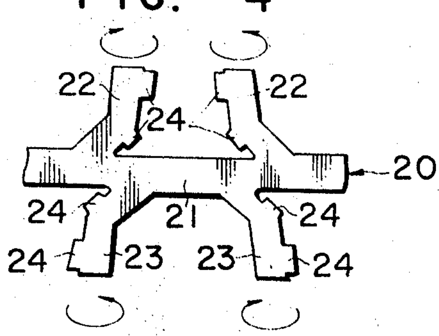


FIG. 4



INVENTORS
OSAMU SAITO, TAKAMASA SAITO and
YUTAKA IWASHIMA
BY Craig, Antonelli, Stewart & Hill
ATTORNEYS

VACUUM INTERRUPTER

BACKGROUND OF THE INVENTION

This invention relates to a vacuum interrupter and more particularly relates to a supporting member for the tubular intermediate metallic shield of a vacuum interrupter.

A vacuum interrupter comprises a highly evacuated envelope consisting generally of a dielectric cylindrical casing, e.g. made of glass or ceramics, with a pair of metallic end caps closing off the ends of the casing, a pair of separable contacts or electrodes disposed within the envelope, and a tubular metallic shield disposed between the casing and the electrodes and encircling the electrodes to prevent vapors dispersed from the contacts upon contact separation from producing condensation of arc-generated metallic particles on the internal surface of the casing.

This shield is called an intermediate shield by reason of the fact that the shield is isolated from both electrodes so as to improve the electric field distribution in the envelope.

Supporting members for the intermediate shield of a vacuum interrupter which have been proposed prior to this invention are as follows:

One type of supporting member is constructed so as that the intermediate shield is supported by engaging metal fittings, which form one part of the supporting member, secured integrally in the dielectric casing during the production thereof, with another part of the supporting member being secured to the outer surface of the intermediate shield. However, this known supporting member has the disadvantage that it reduces the mechanical strength of the casing and causes air creepage into the envelope to decrease the degree of vacuum of it. Further, in case the casing is made of a ceramic or similar material, it is very difficult to secure the metal fittings integrally in the ceramic body during the production thereof.

Another known supporting member is constructed so as that the intermediate shield is supported by engaging metal fittings, which form one part of the supporting member, adhered to the internal surface of the casing after the production thereof by metallizing the surface thereof, with another part of the supporting member being secured to the outer surface of the intermediate shield. This supporting member has the disadvantage that it requires so much time for metallizing the internal surface of the casing and adhering the metal fittings to the portion thereof that it is not applicable to mass production techniques by which the vacuum interrupter may be economically manufactured. Further, adhesion between the metal fittings and the internal surface of the casing is generally insufficient because of the differences in the coefficient of thermal expansion between the metal fittings and the casing.

Still another known supporting member is constructed so that the intermediate shield is supported by engaging rectangular metallic plates, which are secured at their center part around the predetermined position of the outer surface of the intermediate shield by means of spot welding and so forth, with the inclined plane of a trapezoidal projection formed along the internal surface of the casing, by bending both parts of the rectangular plate divided by the welded portion so as to position the main plane of the plate in contact with the inclined plane of the trapezoidal projection and to hold the projection therebetween. That is, rectangular plates are bent so that the folding lines between the main plane of the plate and the plane of the intermediate shield are perpendicular to the axis of the tubular intermediate shield.

Although the time required for fixing this third supporting member to the intermediate shield and the casing is extremely short as compared to the above-mentioned supporting member; the ability of this element to provide dependable support is less than satisfactory. After the structural elements of the vacuum interrupter are assembled, it is necessary to heat up the vacuum interrupter in a furnace at a temperature between 400° C. and 500° C. to free the interrupter of gases absorbed internally of the contact body and other materials in the envelope so as to preclude evolution of these gases during current interruption. Accordingly, the tenacity of the rectangular metallic plates decreases and the brittleness of them increases due to this heat treatment process. The result is that the engagement between the rectangular metallic plates and the trapezoidal projection of the casing becomes incomplete after the heating up operation.

Therefore an object of the present invention is directed to the improvement of the above-explained third supporting member for the intermediate shield of a vacuum interrupter.

One object of the invention is to provide a vacuum interrupter having a supporting member which firmly fixes the tubular intermediate shield to the casing of the envelope.

Another object of the invention is to provide a vacuum interrupter having a supporting member which can be fixed to the tubular intermediate shield and the casing in an extremely reduced time.

SUMMARY OF THE INVENTION

In carrying out the present invention in one form, there is provided a vacuum interrupter which comprises a highly evacuated envelope consisting of a dielectric cylindrical casing and a pair of metallic end caps closing off the ends of the casing; a pair of separable electrodes disposed within the envelope; a tubular metallic shield disposed between the casing and the electrodes and encircling the electrodes; a trapezoidal projection formed along the circumference of the internal surface of the casing substantially at its center portion; a supporting member secured to the outer surface of the tubular metallic shield and engaging with the trapezoid projection for supporting the tubular metallic shield, said supporting members having at least two first metallic strips secured to the outer surface of the tubular metallic shield, at least one second metallic strip formed integrally with each of the first metallic strips and extending from one side of the first metallic strip and at least one third metallic strip formed integrally with each of the first metallic strips and extending from the other side of the first metallic strip, said second and third metallic strips each consisting of a first portion extending immediately from the first metallic strip and a second portion extending from the first portion, each second and third metallic strip being bent so that the folding or bending lines between the main plane of the second and third metallic strips and the main plane of the first metallic strip are generally parallel to the axis of the tubular metallic shield, the directions of the bending of the second and third strips being opposite to each other. One side plane of the each first portion engages with a respective inclined surface of the trapezoid projection, one side edge of each second portion contacting the internal surface of the casing and another side edge of each second portion contacting the outer surface of the tubular metallic shield. In other words, each first portion of the second and third metallic strips of the supporting member of this invention engages with each inclined surface of the trapezoidal projection by a side edge thereof, not by the main plane thereof. The moment of inertia of each first portion becomes extremely larger than the above-explained third supporting member, accordingly the flexural rigidity of the supporting member is maintained at a high value, not withstanding the decrease of the tenacity of the supporting member and the increase of the brittleness of it after the heating up operation of the vacuum interrupter.

BRIEF DESCRIPTION OF THE DRAWING

For a better understanding of our invention, reference may be had to the following description taken in conjunction with the accompanying drawings, wherein;

FIG. 1 is a cross-sectional view of a vacuum interrupter embodying one form of our invention.

FIG. 2 is a plane view of a part of a metal fitting which is not yet formed into a supporting member used in the interrupter of FIG. 1.

FIG. 3 is a plane view of a part of a supporting member into which the metal fitting shown in FIG. 2 has been formed.

FIG. 4 illustrates a modified embodiment of metal fitting shown in FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the interrupter of FIG. 1, there is shown a highly evacuated envelope **10** comprising a cylindrical casing **11** of suitable insulating material, such as a ceramic, and a pair of metallic end caps **12** and **13** closing off the end of the casing. Suitable seals **14** are provided between the end caps and the casing to render the envelope vacuum tight. The normal pressure within the envelope **10** under static condition is lower than 10^{-4} mm. of mercury, so that a reasonable assurance is had that the mean free path for electrons will be longer than the potential breakdown paths in the envelope.

Located within the envelope **10** is a pair of relatively movable disc-shaped contacts, or electrodes, **17** and **18** shown in their contacted or closed-circuit position. The upper contact is a stationary contact suitably secured to a conductive rod **17***a*, which at its upper end is united to the upper end cap **12**. The lower contact **18** is movable contact joined to a conductive operating rod **18***a*, which is suitably mounted for vertical movement. The operating rod **18***a* projects through an opening in the lower end cap **13**. And a flexible metallic bellows **19** provides a seal about the rod **18***a* to allow for vertical movement of the rod without impairing the vacuum inside the envelope **10**. As shown in FIG. **1**, the bellows **19** is secured in sealed relationship at its respective opposite ends to the operating rod **18***a* and the end cap **13**.

Coupled to the lower end of the operating rod **18***a*, suitable actuating means (not shown) of any conventional configuration is provided for driving the movable contact **18** downwardly out of engagement with the stationary contact **17** so as to open the interrupter. The actuating means is also capable of returning the contact **18** to its illustrated position so as to close the interrupter.

The arc that is established across the gap between the electrodes upon contact-separation vaporizes some of the contact material, and these vapors are dispersed from the arcing gap toward the envelope. In the illustrated interrupter, the internal insulating surfaces of the casing **11** are protected from the condensation of arc-generated metallic particles thereon by means of a tubular metallic shield **15** supported on a trapezoid projection **11***a* formed along the internal surface of the casing through a supporting assembly **20** which will soon be explained in great detail. This shield acts to intercept and condense arc-generated metallic vapor before they can reach the internal surface of the casing **11**. To prevent the vapor from condensing on the metallic bellows **19**, shield **16** is provided on the operating rod **18***a* so as to encircle the metallic bellows **19**.

Referring now to the FIG. **2**, the metal fitting **20** is formed by stamping out a metallic plate made of a material which has less absorbed gases therein and/or a lower vapor pressure, e.g., stainless steel. The thickness of the metal fitting **20** is determined by the weight of the intermediate shield **15** which is supported on the trapezoidal projection **11***a* of the casing **11**. Metal fitting **20** comprises a first metallic strip **21** and second and third metallic strips **22** and **23** formed integrally with the first strip and each extending from respective sides of the first metallic strip **21**. Each of the second and third metallic strips **22** and **23** consist of a first portion **22***a* and **23***a* extending immediately from the first metallic strip **21** and a second portion **22***b* and **23***b* extending from each of the first portions **22***a* and **23***a*, respectively.

The first portion **22***a* of the second metallic strip **22** and the first portion **23***a* of the third metallic strip **23** extend with such an angle to the longitudinal direction of the first metallic strip **21** that one is directed at an acute angle and the other is directed at an obtuse angle, so that one of the side edges of each of the first portions **22***a* and **23***a* engages firmly with respective inclined surfaces of the trapezoidal projection when the second and third metallic strips are bent in the directions indicated by the arrows in FIG. **2**. Similarly, the second portion **22***b* of the second metallic strip **22** and the second portion **23***b* of the third metallic strip **23** are formed so that one of the side edges of each of the second portions **22***b* and **23***b* contact firmly the internal surface of the casing **11** and the other of the edges contacts the outer surface of the intermediate tubular shield **15**.

It is preferable that the first metallic strip be secured to the outer surface of the intermediate shield continuously along the whole circumferential outer surface of the tubular shield to make it easy to adjust the supporting member with respect to the trapezoidal projection **11***a* of the casing **11**. Metal fittings having one second and one third metallic strip each extending from the respective sides of a first metallic strip or having two second and two third metallic strips each extending from the respective sides of a first metallic strip, as shown in FIG. **2**, may be used as a unit of the supporting member.

FIG. **3** illustrates a plane view of a completed supporting member, the metal fittings being formed as shown in FIG. **2** in accordance with the above explanation. Both inclined surfaces of the trapezoidal projection **11***a* are held tightly between one of the side edges **22***c* and **23***c* of each first portion **22***a* and **23***a*, and the intermediate shield can be firmly supported by the trapezoidal projection **11***a* of the casing **11**.

The moment of inertia of each one of the side edges **22***c* and **23***c* of each first portion **22***a* and **23***a* which engage with the inclined surfaces of the trapezoid projection **11***a* of the casing is extremely large, accordingly the flexural rigidity of the supporting member is maintained at a high value, not withstanding the decrease in the tenacity of the supporting member and the increase of the brittleness of it after the heating up operation on the vacuum interrupter.

Each one of the side edges **22***d* and **23***d* of the second portion **22***b* and **23***b* contact the internal surface of the casing and each of the other side edges (not shown) of the second portion **22***b* and **23***b* contact the outer surface of the intermediate shield.

FIG. **4** shows a modification of the metal fitting shown in FIG. **2** in that it is provided with additional means for supporting the intermediate shield **15** more firmly by the casing **11**. Metal fitting **20** of FIG. **4** has abutting portions **24** extending from the one side of each of the first portions **22***a* and **23***a* and from the one side of each of the second portions **22***b* and **23***b* that engage with the inclined surfaces of trapezoidal projection **11***a* and the internal surface of the casing **11** when the second and third metallic strips **22** and **23** are bent in the directions indicated by the arrows in FIG. **4**.

The abutting portions **24** are intended to increase the contact surface with the inclined surface of trapezoidal projection **11***a* and the internal surface of the casing **11** and to prevent the circumferential displacement of the intermediate shield **15**. The abutting portions **24** are bent in such a manner that the planes of the abutting portion **24** become perpendicular to the plane of the second and third metallic strips **22** and **23**, respectively, during the above-explained bending operation of each of the second and third metallic strips **22** and **23**.

The fixing operation of the intermediate shield **15** to the casing **11** are as follows;

The first metallic strip **21** of the metal fitting **20** shown in FIG. **2** or FIG. **4** is secured along the circumferential outer surface of the intermediate shield **15** by means of spot welding, while adjusting the position of the first metallic strip **21** to fit to the trapezoidal projection **11***a*. Next, after bending each of the second metallic strips by using a proper tool in the direction indicated by the arrows in FIG. **2** or FIG. **4** to the extent that the angle formed between the first metallic strip and the second metallic strip equals a predetermined value, e.g., 45°, intermediate shield **15** is inserted into the casing **11** and the side planes **22***c* of each first portion **22***a* of the second metallic strips **22** engage with the upper inclined surface of the trapezoidal projection **11***a*. After that, bending each of the third metallic strips in the direction indicated by the arrows in FIG. **2** or FIG. **4** by using the tool which is inserted in the space between the casing **11** and the intermediate shield **15** from the bottom of the casing **11** so as to engage lightly with the lower inclined surface of the trapezoidal projection. And next, further bending each of the second metallic strips in the same direction indicated by the arrow using the tool which in turn is inserted from the top of the casing **11** so as to firmly engage with the upper inclined surface of the trapezoidal projection, and these operations are completed. Although it is preferable that the angle formed between the plane of the first metallic strip **21** and the second or the third metallic strip **22** or **23** is 90° after finishing the fixing operation so as to obtain the maximum moment of inertia of the supporting beams consistent with the second and the third metallic strips, it is not limited to that value. The adjustment of the angle is very useful to compensate for the production tolerance of the trapezoidal projection **11***a* and metal fittings **20**. In addition, it is not necessary that the plane of the second metallic strip and the plane of the third metallic strip be coextensive after finishing the fixing operation.

Although the present invention has been described with reference to but a single embodiment, it is to be understood that the scope of the invention is not limited to the specific details thereof, but is susceptible of numerous changes and modifications as would be apparent to one with normal skill in the pertinent technology.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. a vacuum interrupter comprising:

a. a highly evacuated envelope formed by a dielectric cylindrical casing and a pair of metallic end caps closing off the ends of said casing,

b. at least a pair of separable electrodes disposed within said envelope,

c. a tubular metallic shield disposed between said casing and said electrodes encircling said electrodes,

d. a trapezoidal projection formed along the circumference of the internal surface of said casing substantially at its center portion,

e. a supporting member secured to the outer surface of said tubular metallic shield and engaging with said trapezoidal projection for supporting said tubular metallic shield, said supporting member having at least tow first metallic strips secured to the outer surface of said tubular metallic shield, at least one second metallic strip formed integrally with each of said first metallic strips and extending from one side of said first metallic strip and at least one third metallic strip formed integrally with each of said first metallic strips and extending from the other side of said first metallic strip, each of said second and third metallic strips consisting of first portion extending immediately from said first metallic strip and a second portion extending from said first portion, each of said second and third metallic strips being bent so that the folding lines between the main plane of said second and third metallic strips and the main plane of said first metallic strip are generally parallel to the axis of said tubular metallic shield, the direction of the bending of said second and third metallic strips being opposed to each other, one side plane of each of said first portions engaging with the respective inclined surface of said trapezoidal projection, one side edge of each of said second portions contacting the internal surface of said casing and the other side edge of each of said second portions contacting the outer surface of said tubular metallic shield.

2. The vacuum interrupter of claim **1**, in which each of said first and second portions have an abutting portion extending from one side of each of said first and second portions, each of said abutting portions being bent so that each plane of said abutting portion becomes generally perpendicular to the plane of said first and second portions, and each of said abutting portions engages with either the inclined plane of said trapezoidal projection or the internal surface of said casing.

3. The vacuum interrupter of claim **1**, in which the first portion of each of said second and third strips is disposed at an angle to said first strip and said second portion of each of said second and third strips is disposed along a line substantially transverse to said first strip.

4. The vacuum interrupter of claim **3**, in which the first portion of said second strip extending in an opposite direction from said first strip compared to the first portion of said third strip.

5. The vacuum interrupter of claim **4**, in which said supporting member includes a pair of second metallic strips extending from one side of said first strip and a pair of third metallic strips extending from the other side of said first metallic strips, the first portions of each of said second strips being directed toward each other and the first portions of each of said third strips being directed away from each other.

6. A vacuum interrupter comprising:

a. a highly evacuated envelope formed by a dielectric cylindrical casing and a pair of metallic end caps closing off the ends of said casing,

b. at least a pair of separable electrodes disposed within said envelope,

c. a tubular metallic shield disposed between said casing and said electrodes and encircling said electrodes,

d. a trapezoidal projection formed along the circumference of the internal surface of said casing substantially at its center portion,

e. a supporting member secured to the outer surface of said tubular metallic shield and engaging with said trapezoidal projection for supporting said tubular metallic shield, said supporting member having a first metallic strip secured to the outer surface of said tubular metallic shield, at least two second metallic strips formed integrally with said first metallic strip and extending from one side of said first metallic strip and at least tow third metallic strips formed integrally with said first metallic strip and extending from the other side of said first metallic strip, each of said second and third metallic strips consisting of a first portion extending immediately from said first metallic strip and a second portion extending from said first portion, each of said second and third metallic strips being bent so that the folding lines between the main plane of said second and third metallic strips and the main plane of said first metallic strip are generally parallel to the axis of said tubular metallic shield, the directions of the bending of said second and third metallic strips being opposed to each other, one side edge of each of said first portions engaging with the respective inclined surface of said trapezoidal projection, the one side edge of each of said second portions contacting the internal surface of said casing and the other side edge of each of said second portions contacting the outer surface of said tubular metallic shield.

7. The vacuum interrupter of claim **6**, in which each of said first and second portions have an abutting portion extending from one side of each of said first and second portions, each of said abutting portions being bent so that the plane of each of said abutting portions becomes generally perpendicular to the plane of said first and second portions, and each of said abutting portions engages with either the inclined surfaces of said trapezoidal projection or the internal surface of said casing.

8. The vacuum interrupter of claim **6**, in which the first portion of each of said second and third strips is disposed at an angle to said first strip and said second portion of each of said second and third strips is disposed along a line substantially transverse to said first strip.

9. The vacuum interrupter of claim **8**, in which the first portion of said second strip extending in an opposite direction from said first strip compared to the first portion of said third strip.

10. The vacuum interrupter of claim **9**, in which said supporting member includes a pair of second metallic strips extending from one side of said first strip and a pair of third metallic strips extending from the other side of said first metallic strip, the first portions of each of said second strips being directed toward each other and the first portions of each of said