United States Patent

[11] 3,612,795

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[54] SHIELDING ARRANGEMENTS FOR VACUUM-TYPE CIRCUIT INTERRUPTERS OF THE TWO-CONTACT TYPE

7 Claims, 11 Drawing Figs.

[52] U.S. Cl. ..... 200/144 B
[51] Int. Cl. H01h 33/66
[50] Field of Search ..... 200/144 B

[56] References Cited

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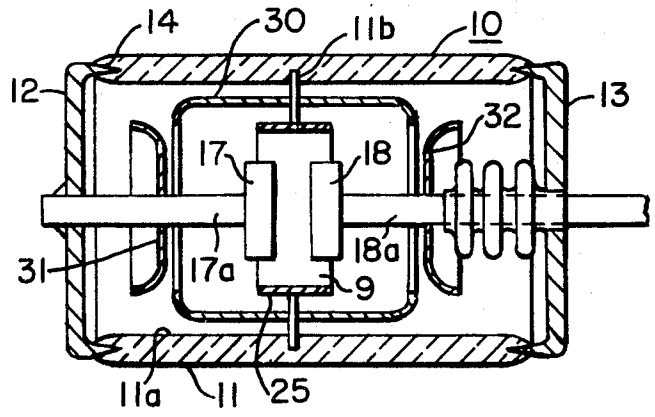
ABSTRACT: A vacuum-type circuit interrupter of the two-contact type is provided with a short shield for preventing the deposition of metallic vapor from the arcing region upon the inner surfaces of the outer insulating casing of the vacuum-type circuit interrupter. For certain applications, the shield is made of considerable thickness to enable it to withstand the heavy arcing, which may occur thereat. In addition, for other applications, the short shield may be formed of an electrode-type material so that arcing may occur without damage to the shield.



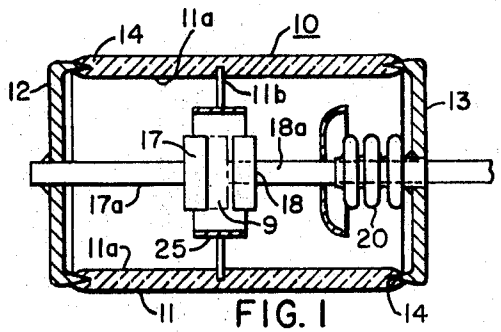


FIG. 1

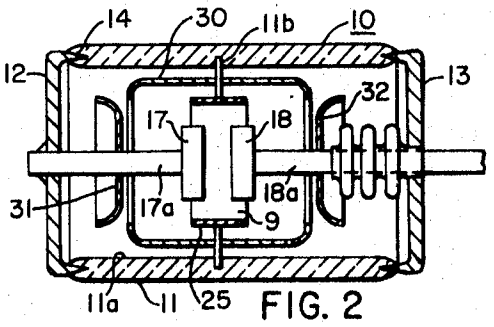


FIG. 2

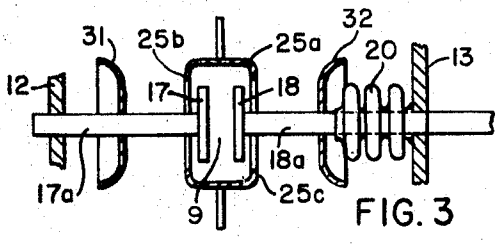


FIG. 3

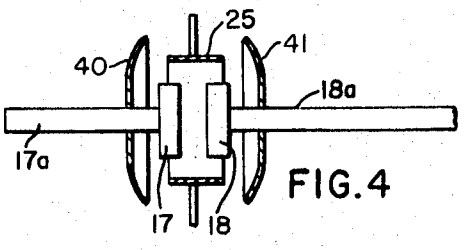


FIG. 4

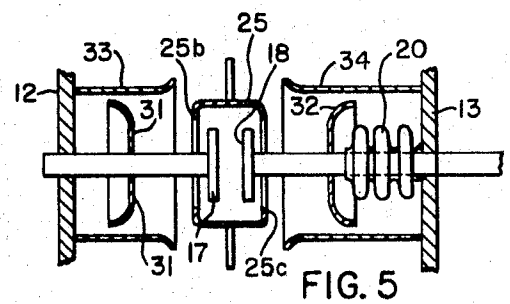


FIG. 5

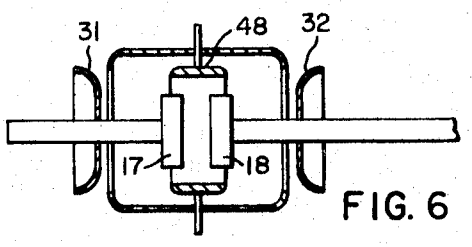


FIG. 6

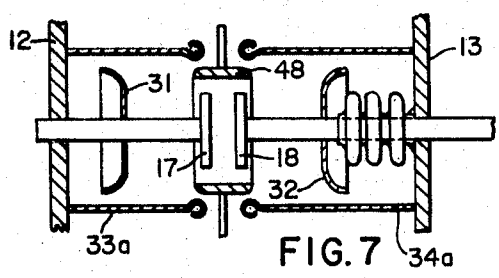


FIG. 7

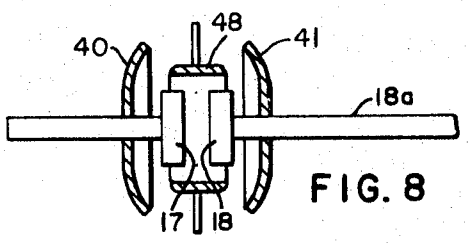


FIG. 8

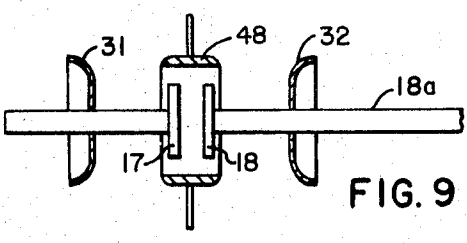


FIG. 9

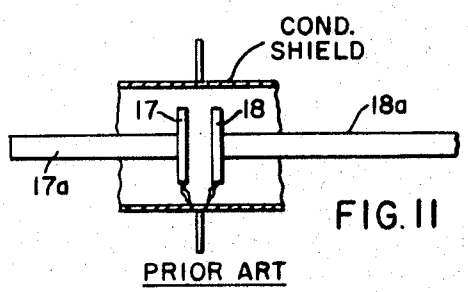


FIG. 11
PRIOR ART

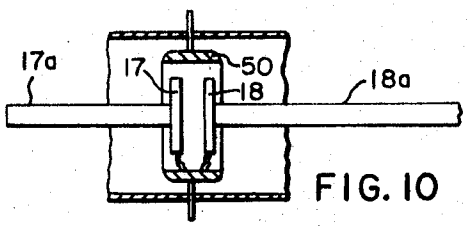


FIG. 10

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SHIELDING ARRANGEMENTS FOR VACUUM-TYPE CIRCUIT INTERRUPTERS OF THE TWO-CONTACT TYPE

BACKGROUND OF THE INVENTION

Most of the metallic vapor emanating from the electrode region in a vacuum interrupter deposits upon the vapor shield in a relatively narrow band extending not much beyond the open space between the electrodes. If, for instance, the electrode spacing is one-half inch, a shield length of 1½ inches, extending one-half inch on either side, would catch most of the vapor. Not only that, but any vapor particles striking a shield beyond that distance are not likely to be scattered into a space, where they could be detrimental to the interrupting capability of the circuit breaker. For example, the shield described in U.S. Pat. No. 3,048,681, issued Aug. 7, 1962 to George Polinko, Jr. is typical of such types of long metallic shields of the prior art. Another patent, which is typical, is Veras U.S. Pat. No. 3,048,682, issued Aug. 7, 1962.

SUMMARY OF THE INVENTION

In accordance with preferred embodiments of the present invention, it is proposed to provide a narrow special shield incorporated into the vacuum circuit-interrupter geometry of the two-contact type. This shield is to be made of well-outgassed metal and sufficiently thick so as to have maximum effectiveness in catching metallic vapor emitted from the electrode region. The material chosen should also be one for which the sticking probability is naturally good, that is, it welds easily with the electrode material.

In accordance with particular embodiments of the invention, the short shield may be backed up by other shields, either metallic, or nonmetallic, of arbitrary thickness, whose only function is to shield the insulator against residual metallic vapor from the arc. Such shields could be mounted on the insulators, on the end plates, or on the electrode stems.

In accordance with another embodiment of the present invention, the auxiliary shield is of such thickness that it constitutes an auxiliary electrode, to which arcing may occur, and thus constitute a circuit interrupter which establishes two arcs in series.

Still further embodiments of the present invention involve a shielding arrangement in which the shield material is formed of an electrode-type material, so that erosion thereat may be maintained at a minimum.

Accordingly, it is a general object of the present invention to provide an improved vacuum-type circuit interrupter of the two-contact type having an improved shielding arrangement.

Another object of the present invention is the provision of an improved vacuum-type circuit interrupter in which the shield is of minimum axial length.

Another object of the present invention is the provision of an improved shielding arrangement for a vacuum-type circuit interrupter in which the shield may constitute an auxiliary electrode in which two arcs are drawn thereat during a normal operation of the interrupter.

Still a further object of the present invention is the provision of an improved vacuum-type circuit interrupter in which the short shield is formed of a suitable electrode material to prevent arc erosion, and to constitute auxiliary electrode means.

Further objects and advantages will readily become apparent upon reading the following specification, taken in conjunction with the drawing.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross-sectional view of a vacuum-type circuit interrupter of the two-contact type embodying the invention in one form;

FIGS. 2–5 illustrate modifications of the short vapor shield of the present invention;

FIGS. 6–9 illustrate variants of the shield construction of FIGS. 1–5 except that the short vapor shield is of sufficient thickness so as to be capable of withstanding arcing;

FIG. 10 illustrates a modification of the invention in which the short shield is made of an electrode material; and,

FIG. 11 illustrates a phenomenon which has been observed to occur during circuit interruption in prior art structures.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the interrupter of FIG. 1, there is shown a highly evacuated envelope 10 comprising a tubular casing 11 of insulating material, such as a suitable glass, and a pair of metallic end caps 12 and 13 closing off the ends of the casing. Suitable seals 14 are provided between the end caps and the casing to render the envelope 10 vacuumtight.

Located within the envelope is a pair of separable electrodes, or rod contacts 17 and 18, shown by solid lines in the open-circuit position. The electrode 17 is a stationary electrode suitably united to the end cap 12, whereas the electrode 18 is a movable electrode suitably mounted for reciprocal movement, and projecting through an opening in the end cap 13. A flexible metallic bellows 20, interposed between the end cap 13 and the movable electrode 18, provides a seal about the removable electrode, and allows for reciprocal movement thereof without impairing the vacuum inside the interrupter. As shown on the drawing, the bellows 20 is sealingly secured at its respective opposite ends to the electrode 18 and to the end cap 13.

Coupled to the end of the movable electrode 18, I provide suitable actuating means (not shown), which is capable of driving the electrode rapidly inwardly from its solid-line position of FIG. 1 to its dotted-line position to close the interrupter, and which is also capable of returning the electrode to the solid-line position to open the interrupter.

When the electrode is driven outwardly to open the interrupter, a circuit-interrupting, or arcing gap is established between the adjacent ends of the electrodes, and the resulting are, though quickly extinguished, vaporizes some of the metal constituting the electrodes.

In order to prevent this metallic vapor from condensing on the internal insulating surfaces 11*a* of the casing 11, there is provided a short metallic shield 25. This short metallic shield 25 is of a generally tubular configuration, and extends along the length of the casing 11 for only a short distance. The shield 25 is electrically isolated from both of the electrodes 17 and 18 and, preferably, is also isolated from ground; or in other words, the shield is at a floating potential relative to the two electrodes 17, 18.

This electrical isolation between the shield 25 and the electrodes 17 and 18 is achieved by mounting the shield 25 on the insulating casing 11 adjacent the central region of the shield, as at 11*b*, and by spacing the short shield 25 radially inwardly from the tubular insulating casing 11 at all points on opposite sides of the centrally disposed mounting region.

I have discovered that the metallic vapor emanating from the electrode region 9 is a vacuum-type circuit interrupter deposits on the vapor shield in a relatively narrow band extending not much beyond the open space between the electrodes. If, for instance, the electrode spacing 9 is one-half inch, a shield length of 1 ½inches, extending one-half inch on either side, would catch most of the emitted metallic vapor. Not only that, but any vapor particles striking a shield beyond that distance are not likely to be scattered into a space, where they could be detrimental to the interrupting capability of the circuit breaker.

It is, therefore, an objective of the present invention to provide a special narrow shield 25 incorporated into the geometry of the vacuum-type circuit interrupter. This shield 25 is preferably made from well-outgassed metal, and sufficiently thick so as to have maximum effectiveness in catching metallic vapor emitted from the electrode region 9. The material chosen should also be one for which the sticking probability is naturally good, that is, it welds easily with the electrode material 17, 18. Such preferable materials are metals and alloys having a vapor pressure lower than magnesium but are not as refractory as tungsten. Nickel, copper, silver and stain-

less steel are examples of suitable materials which may be used.

The short shield **25** may be backed up by other shields, either metallic or nonmetallic of arbitrary thickness, whose only function is to shield the insulator **11** against residual metallic vapors from the arc. Such shields may be mounted on the insulator **11**, on the end plates **12, 13**, or on the electrode stems **17***a*, **18***a*, as shown in FIGS. **2–5** of the drawings.

With reference to FIG. **2**, it will be observed that an outer backup shield **30** is provided together with end metallic shields **31, 32** connected, respectively, to the electrode stems **17***a*, **18***a*.

FIG. **3** illustrates a modified construction in which the relatively short central shield **25***a* has inwardly extending end portions **25***b*, **25***c* to assist in confining the metallic vapor emitted from the arcing region **9**. As in the construction of FIG. **2**, end metallic shields **31, 32** are provided fixedly attached to the electrode stems **17***a*, **18***a*.

FIG. **4** illustrates a construction in which the relatively short central vapor shield **25** has cooperating therewith end metallic shields **40, 41**, which are attached, respectively, to the electrode stems **17***a*, **18***a* and curve inwardly.

FIG. **5** shows a modified arrangement in which the short shield **25***a* has inwardly extending end portions **25***b*, **25***c*, and the end shields **33, 34** project inwardly from the end plates **12, 13** of the interrupter.

It has been found that during very high-current arcing, breakdown may occur to the shield entailing currents of sufficient magnitude to melt holes in the shield according to prior arrangements, as shown in FIG. **11**. If the short shield **25** is manufactured of sufficient thickness to not only withstand the normal vapor deposition, but also able to withstand arcing, then such failures cannot occur. In fact, arcing to the short shield **25** can be tolerated in the normal operation of the interrupter, and the short shield is, in fact, an auxiliary short shield electrode.

FIGS. **6–10** illustrate modifications of FIGS. **1–5** with the exception that the short shields **25** are of considerable thickness, as is evident from an inspection of the figures. Thus the short shields can tolerate the heavy-current arcing, which, in fact, may exist.

It will be noted that in the construction set forth in FIG. **7** of the drawings, the end metallic shields **33***a*, **34***a* are again fixedly attached to the end metallic plates **12, 13**. However, the inner adjacent ends of the end shields have an enlarged peripheral portion, such as provided by a spinning operation, for example, to enlarge the radius of curvature to thereby reduce the electrical field gradient. Again the end shields **31, 32** may be additionally used, as shown.

Many experiments emphasize the destructive arcing that can occur between electrodes by way of the central shield of a vacuum interrupter, even though the spacing is such that arcing is not expected. It is believed that this arcing can take place because of two simultaneous phenomena. One is the preferential motion of the arc toward the shield by magnetic fields set up from the current flowing in the electrodes and external circuitry. The other reason is that when the interrupter is in the high-current mode of arcing, voltage spikes of sufficient height are observed to tolerate the existence of a double-gap arc.

As a further modification of the invention, and to take advantage of such a situation, such as the foregoing, there is provided an auxiliary central cylindrical electrode **50** for the specific purpose of handline this type of a discharge. FIG. **10** illustrates an electrode geometry capable of supporting a double-gap arc without damage. This structure is similar to that previously described, but the essential difference is that in FIG. **10**, the central auxiliary electrode **50** is made of an electrode-type material, so that arcing may occur without damage to the shield. In other words, the central auxiliary electrode **50** is made of the same type of contact material, and capable of withstanding erosion, as the separable main contacts **17, 18** of the circuit-interrupting device. As examples of suitable electrode materials which may be used, a copper-silver alloy may be employed, or the electrode material set forth in U.S. Pat. application filed May 29, 1967, Ser. No. 641,881 now abandoned by Alfred Alexander Robinson may be used. This is a material comprising a matrix of chromium, cobalt, nickel or iron infiltrated with a second metal, such as copper, copper alloy, silver or a silver alloy, or an alloy of copper and zirconium, tantalum or titanium, as set forth in the aforesaid application, Ser. No. 641,881.

From the foregoing description of the invention it will be apparent that there have been provided short novel shielding arrangements for preventing the deposition of metallic vapor on the inner walls **11***a* of the outer insulating casing **11**, and additionally, providing a double-break type of circuit interrupter (FIG. **10**). By the provision of the relatively short central shield **48** of adequate thickness to serve as an auxiliary electrode, or by even fabricating the relatively short shield of electrode material **50** (FIG. **10**) to withstand erosion, a highly efficient and simplified type of vacuum circuit interrupter is provided having considerable voltage-interrupting power.

Although there have been illustrated and described specific structures, it is to be clearly understood that the same were merely for the purpose of illustration, and that changes and modifications may be readily made therein by those skilled in the art, without departing from the spirit and scope of the invention.

I claim:

1. A vacuum-type circuit interrupter of the two-contact type comprising, in combination:

a. an outer evacuated tubular casing of insulating material;

b. a pair of contacts disposed within said evacuated casing and separable to establish an arc;

c. said contacts when in the fully open-circuit position defining a gap separation distance of "*s*";

d. a generally tubular short vapor-condensing metallic shield surrounding the arcing region and of a relatively short axial length of approximately "3*s*";

e. the vapor-condensing shield being spaced radially inwardly of the inner wall of the outer tubular casing and close to the separate contacts;

f. the vapor-condensing shield being at a floating electrical potential and not electrically connected to either of the separable contacts; and,

g. said short shield having its ends curved inwardly toward the contacts to confine the metallic vapor emitted from the arcing region.

2. The combination of claim **1**, wherein the shield is of heavy sheet material.

3. The combination of claim **1**, wherein the shield is fabricated of electrode material.

4. The combination of claim **1**, wherein a pair of tubular end shield extend axially inwardly from the metallic end plates of the evacuated envelope and are supported thereby.

5. The combination of claim **4**, wherein the confronting facing inner ends of the end shields are rolled to form a large radius of curvature there at to thereby reduce the electrical field strength.

6. The combination of claim **1**, wherein a pair of end shields are secured to the contact rods.

7. A vacuum-type circuit interrupter comprising, in combination:

a. an outer evacuated tubular casing of insulating material;

b. a pair of contacts disposed within said evacuated casing and separable to establish an arc;

c. said contacts when in the fully open-circuit position defining a gap separation distance of "*s*";

d. a generally tubular short vapor-condensing metallic shield surrounding the arcing region and of a relatively short axial length of approximately "3*s*;

e. the vapor-condensing shield being spaced radially inwardly of the inner wall of the outer tubular casing;

f. the vapor-condensing shield being at a floating electrical potential and not electrically connected to either of the separable contacts;

g. said short shield having its ends curved inwardly toward the contacts to confine the metallic vapor emitted from the arcing region;

h. a backup shield disposed outwardly of said first-mentioned shield; and,

j. said backup shield being of greater axial length than the inner short shield.