# United States Patent

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[54] **HIGH-VOLTAGE OUTDOOR VACUUM SWITCH WITH CONDUCTIVE COATING SERVING AS ELECTROSTATIC SHIELD MEANS AND END CAP-MOUNTING MEANS**
**8 Claims, 1 Drawing Fig.**


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[51] **Int. Cl.** ..... **H01h 33/66,** H01h 17/42
[50] **Field of Search** ..... 200/144.2; 174/142, 140 C, 143, 73, 31, 50.61, 152.4


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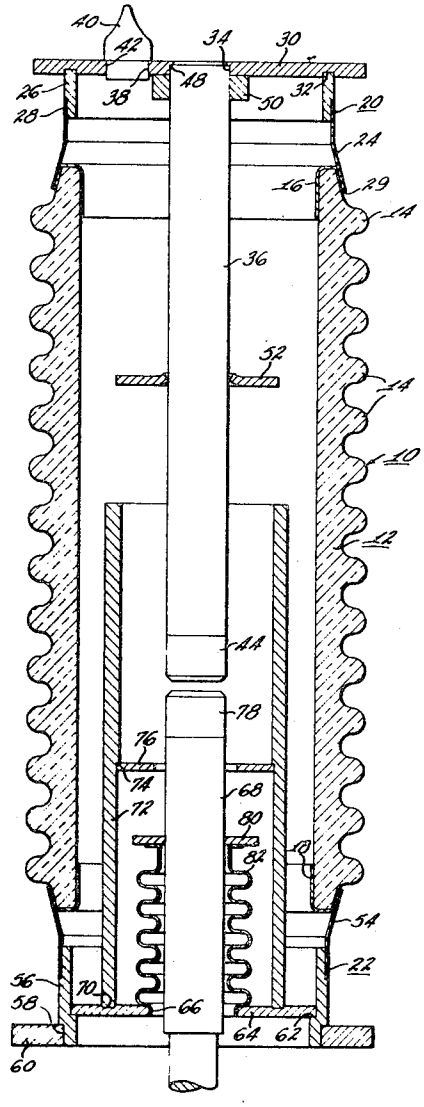
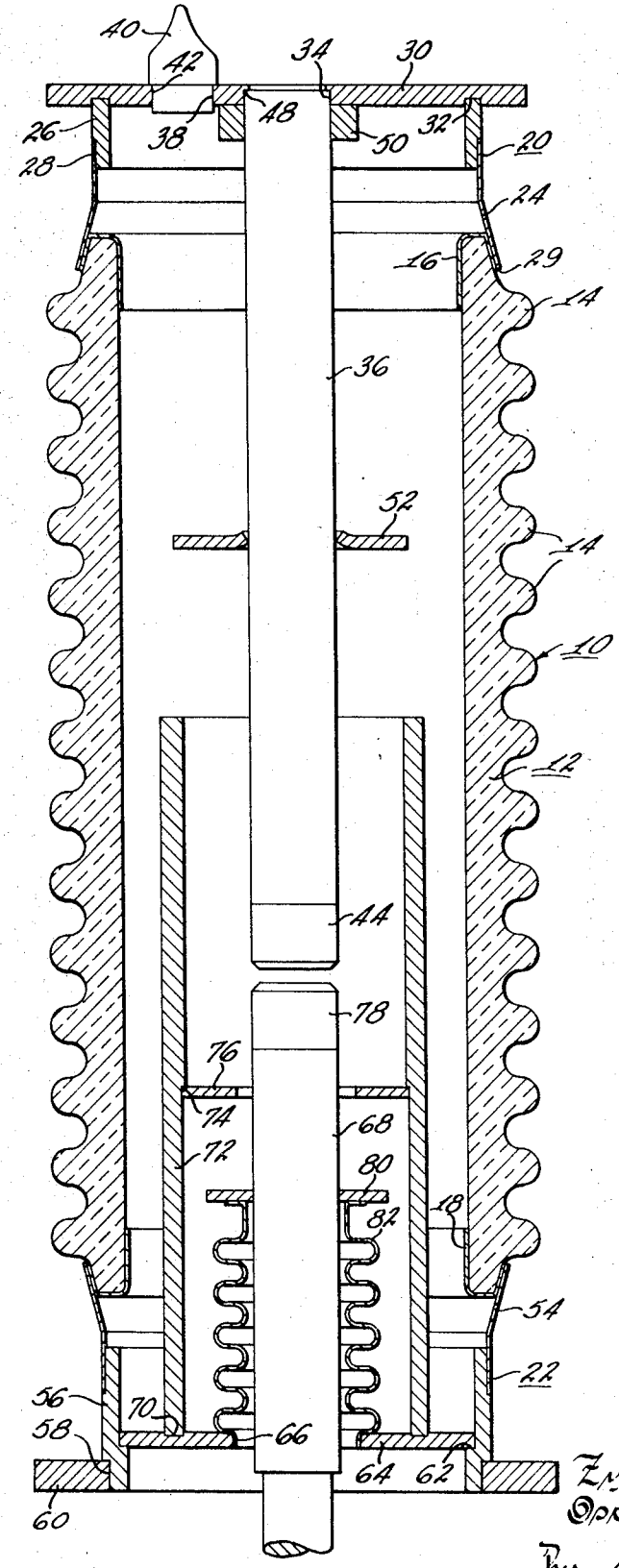
**ABSTRACT:** A high-voltage vacuum switch for outdoor use comprises a hollow cylindrical skirted ceramic envelope having electrically conductive coatings on the inner and outer surfaces at each end. End cap assemblies are provided at each end and each assembly comprises a ring of material thermally compatible with the envelope, which is brazed to a metal coating, fused to the ceramic and the other end of the ring welded to a collar forming part of an end cap assembly. In one end cap assembly, the collar is brazed or welded to a plate which is brazed to a stationary contact stud, having a disc-type arc shield attached thereon, which extends into the envelope. In the other end cap assembly, the collar is brazed or welded to a plate having a hole which accommodates a movable contact stud. A bellows is brazed or welded between the plate of the said end cap assembly and a washer attached to the movable contact stud. A cylindrical arc shield is brazed or welded to the plate and a disc-type arc shield is brazed or welded inside the cylindrical arc shield Both end cap assemblies are provided electrical and mechanical connection means.

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# HIGH-VOLTAGE OUTDOOR VACUUM SWITCH WITH CONDUCTIVE COATING SERVING AS ELECTROSTATIC SHIELD MEANS AND END CAP-MOUNTING MEANS

## SUMMARY OF THE INVENTION

This invention relates to vacuum-type electrical devices, such as high-voltage vacuum interrupters, switches and circuit breakers, which are primarily adapted for outdoor use.

Present devices of the foregoing type are quite fragile and not suited for outdoor use unless physically protected by plastic, ceramic or insulated metal enclosures. Furthermore, present devices are so constructed that voltage gradients occur at the ends thereof to cause corona discharge unless special measures are taken. Also, fabrication techniques presently employed tend to preclude the use of standardized electrical terminations and mounting means for such devices. Finally, these same fabrication techniques and material selections dictate a device which has many components which are not easily standardized for rapid and simple assembly.

It is desirable, therefore, to provide improved vacuum-type electrical devices, such as vacuum interrupters and the like, which overcome the aforesaid drawbacks and have other advantages.

A vacuum-type electrical device in accordance with the present invention comprises a hollow tubular insulating envelope, exteriorly skirted to increase electrical creepage distance. The envelope ends are provided on their exterior and interior surfaces with electrostatic shield means which control voltage gradients and serve as a means whereby end cap assemblies can be vacuum sealed to the envelope. Each end cap assembly comprises an electrically conductive ring which is electrically and mechanically connected to the electrostatic shield means. Each ring has thermal expansion characteristics which are similar to those of the envelope. Each end cap assembly comprises a collar which is electrically and mechanically connected to its respective ring. Each end cap assembly further comprises an end plate which is electrically and mechanically connected to its respective collar and also affords mechanical support for one or more electrical components such as contact studs, bellows, and arc shields which are housed within the envelope. The various parts in the end cap assemblies and their associated components are so fabricated and machined so as to be interfitting, self-aligning and subject to a minimum number of brazing and/or welding steps.

It is an object of the present invention to provide improved vacuum-type electrical devices.

Another object is to provide improved vacuum-type electrical devices such as vacuum interrupters, switches and circuit breakers primarily for outdoor use.

Another object is to provide devices of the aforesaid character which are electrically reliable, physically rugged, usable outdoors without additional protective means or special adapters, and in which voltage gradients at the ends thereof are substantially eliminated thereby avoiding the need for corona shields or the need for excessive flashover distance between end rings by virtue of the resultant increased corona threshold voltages achieved.

Another object is to provide devices of the aforesaid character which employ improved and simplified manufacturing and assembly techniques and the latest technology.

Another object is to provide devices of the aforesaid character which have fewer parts, increased strength, are more easily standardized, and lend themselves to higher temperature bake-out and welding processes during manufacture to thereby enhance overall performance.

Other objects and advantages of the invention will hereinafter appear.

## DESCRIPTION OF THE DRAWINGS

The accompanying drawing illustrates a preferred embodiment of the invention, but it is to be understood that the embodiment illustrated is susceptible of modifications with respect to details thereof without departing from the scope of the appended claims.

In the drawing, the single FIGURE shows a side elevational cross-sectional view of a vacuum interrupter in accordance with the present invention.



## DESCRIPTION OF THE INVENTION

Referring to the drawing, the numeral 10 designates a vacuum-type electrical device such as a high-voltage vacuum interrupter or vacuum switch in accordance with the present invention and particularly well suited for outdoor use. Device 10 comprises a hollow cylindrical or tubular open ended envelope 12 which is made of nonporous insulating material which has great physical strength and is well adapted to have other material hermetically sealed thereto. In practice, envelope 12 is preferably made of high-density nonporous vacuum grade ceramic such as alumina either with enough silica therein for fusion to a metallic surface deposit or with silicon based adducts to the metallic deposit. Envelope 12 is preferably glazed on its exterior. Envelope 12 is provided on its exterior with a plurality of skirts, corrugations or sheds 14 which are of such number and dimension to provide a lengthwise creepage ratio of about 1.5 to 1 or greater.

Electrostatic shielding means 16 and 18 are provided at opposite ends of envelope 12 to reduce or eliminate voltage gradients which would otherwise occur and provide corona discharge in high-voltage outdoor use of device 10. Shielding means 16 and 18 are substantially identical in form and function and, therefore, only the former will be described in detail. Shielding means 16 comprise a continuous electrically conductive member which extends on the inside surface of envelope 12 as far in as the thickest portion of the first skirt 14 of the envelope, and to a position closer to the opposite electrode 78 than any external edge 29 of the end cap. The position of the internal edge of shielding means 16 causes a concentration of voltage gradients thereon. Voltage gradients so disposed in vacua will not cause corona because of the absence of any gaseous media necessary for this phenomenon. Shielding means 16 also cover the extreme end surface of envelope 12 and extend on the outside surface of the envelope as far as is practical to the base of the first skirt 14. Preferably, shielding means 16 takes the form of an electrically conductive coating which is applied by brush, spray or dip and firmly adheres to envelope 12. In practice, a coating comprising a molybdenum-manganese alloy fired at a temperature sufficient to cause fusion sintering thereof to the silica in envelope 12 and then provided with a nickel plate by electrolysis or chemical bath gives good results. If preferred, however, shielding means 16 could take the form of a solid metal member hermetically sealed to envelope 12 by suitable adhesive means. Shielding means 16 and 18, in addition to providing an electrical function, also serve as the means by which end cap assemblies 20 and 22, respectively, are hermetically sealed to envelope 12.

End cap assembly 20 comprises a ring 24 which adapts it to be hermetically sealed to shielding means 16. Ring 24 has substantially the same thermal coefficient or the same expansion characteristic as envelope 12 and is compatible with shielding means 16 so as to be weldable thereto in a vacuumtight connection. In practice, ring 24 is made of KOVAR metal alloy (iron-nickel-cobalt) or 52 nickel-balance iron or a similar alloy which has such thermal characteristics. In addition, ring 24 is cylindrical and is flared to a conic section to enhance its expandability and contractibility and area of adhesion. Ring 24 is brazed to coating 16 on the exterior of envelope 12 by a suitable brazing alloy or material such as gold (35 percent), copper (62 percent) and nickel (3 percent) heated to about 1,025° C. or above. The specified alloy is compatible with KOVAR metal and with the nickel plate of coating 16 to form a physically strong hermetic seal.

End cap assembly 20 further comprises a cylindrical collar 26, preferably made of stainless steel having a low-carbon content to inhibit carbide precipitation during welding which could cause premature failure of the vacuum environment in envelope 12. Collar 26 is provided with a shoulder 28 for automatically locating and spacing ring 24 and the ring is fusion welded to the collar.

End cap assembly 20 also comprises an end plate 30 having a circular groove 32 and a circular hole 34 for locating and spacing collar 26 and an electrical component such as a stationary contact stud 36, respectively, which is brazed thereto. Plate 30 serves as a means whereby electrical and mechanical connections are made to one end of device 10 and also as a support means for an electrical component within the device. Plate 30 is also provided with a hole 38 for accommodating a metallic vacuum pinch-off tube 40 which has a shoulder 42 to facilitate its accurate location during brazing or welding.

Contact stud 36 is a cylindrical member of high purity copper and is provided with a brazed on contact 44 made, for example, of tungsten, tungsten-copper or a copper alloy. Stud 36 is provided with a shoulder 48 for locating it during brazing. A supporting ring 50 is brazed or welded to stud 36 and plate 30 to afford additional mechanical support. A disc-type arc shield 52, preferably of high-purity copper, is brazed or welded to stud 36.

The other end cap assembly 22 comprises a ring 54 and a collar 56 similar to ring 24 and collar 26, hereinbefore described. However, collar 56 is further provided with an exterior shoulder 58 for locating a mounting ring 60, preferably made of stainless steel, which is welded thereto. Mounting ring 60 adapts device 10 for physical mounting in a suitable environment. Collar 56 is also provided with an interior shoulder 62 for locating a disc 64, preferably of copper, which is brazed or welded thereto. Disc 64 is provided with a central opening 66 for accommodating a movable contact stud 68 and with a concentric groove 70 for locating a cylindrical arc shield 72.

Arc shield 72 is a hollow cylindrical member or component made, for example, of nickel, molybdenum or monel metal and is provided with an interior shoulder 74 for locating a disc type arc shield 76 of the same material.

Movable contact stud 68 is a component similar to stud 36 hereinbefore described and has a contact 78 thereon. Stud 68 is provided with an abutment or washer 80, preferably of monel metal, to which one end of a cylindrical bellows 82, also of monel metal, is welded. The other end of bellows 82 is brazed or welded to disc 64 at opening 66. Stud 68 is adapted for connection to an electrical conductor (not shown) and to means (not shown) which effect its axial movement to open and closed position.

As is apparent from the foregoing description, device 10 is fabricated of physically rugged, weather resistant materials which are capable of superior electrical performance in outdoor use. From an electrical standpoint, device 10 has a high creepage to flashover length ratio to prevent external flashover and the high-vacuum interior also prevents flashover therein. Furthermore, the electrostatic shields 16 and 18 provide a unipotential interior to exterior seal area which minimizes undesirable corona effects and also provides a rugged hermetic seal for end cap assembly attachment. The parts of which device 10 are made are standardized geometric shapes which are readily fabricated from stock materials with simple machining operations. Furthermore, the parts are premachined to interfit and permit automatic centering, distancing and alignment prior to brazing and/or welding. Materials are selected from the standpoint of corrosion resistance and compatibility to welding to adjacent components which may, of necessity, be of special materials. The total design and arrangement of all parts is such as to permit jigging and welding together of parts with a minimum number of brazing or welding operations.

The embodiments of the invention in which an exclusive property or privilege we claim are defined as follows:



1. In a vacuum-type electrical device constructed to reduce voltage gradients therein and simplify manufacture,
a cylindrical envelope of ceramic insulating material having a cavity wherein a vacuum is maintained and arcing occurs,
said cavity having at least one opening communicating therewith which is defined by a portion of said envelope which has an inside surface, an end surface, and a conical exterior surface,
electrostatic shielding means comprising a metallic coating fused to said ceramic envelope on said conical exterior surface, on said end surface and on a limited portion of said inside surface,
an end cap assembly for said opening, said end cap assembly comprising an annular metal ring having a portion with a conical shape by which its inside surface mates with and is brazed directly to said conical exterior surface on said envelope, said ring having thermal expansion characteristics similar to those of said envelope,
and at least one electrically conductive contact stud connected to said end cap assembly and extending into said cavity.

2. An electrical device according to claim 1 wherein said cavity has a second opening communicating therewith defined in the same manner as said one opening, having second electrostatic shielding means similar to said electrostatic shielding means for said one opening, and having a second end cap assembly which comprises a second annular metal ring similar to the aforesaid annular metal ring for said one end cap assembly,
said second end cap assembly comprising a second collar sealed to said second annular ring,
said second collar having an exterior and an interior shoulder,
a second mounting plate which is sealed against said exterior shoulder of said second collar,
a supporting disc which is sealed against said interior shoulder of said second collar,
said supporting disc which is sealed against said interior shoulder of said second collar,
said supporting disc having a central opening,
an electrically conductive second stud which extends through said central opening in said disc,
an abutment disposed on said second stud,
and a cylindrical bellows sealed to said supporting disc and to said abutment.

3. An electrical device according to claim 2 wherein said supporting disc has a groove concentric with the central opening therein,
a hollow tubular arc shield which is aligned in said groove and sealed thereto,
said cylindrical arc shield having a shoulder on the interior thereof,
and a disc-type arc shield sealed against said shoulder of said tubular arc shield.

4. An electrical device according to claim 1 wherein said coating comprises a molybdenum-manganese alloy which is nickel plated and wherein said ring is an iron-nickel-cobalt alloy.

5. An electrical device according to claim 1 wherein said end cap assembly further comprises a collar sealed to said ring and a plate having an alignment groove in which said collar is sealed.

6. An electrical device according to claim 5 wherein said collar has a shoulder against which said ring fits and is sealed.

7. An electrical device according to claim 5 wherein said plate has a central opening for accommodating and aligning said electrically conductive stud which is sealed to said plate.

8. An electrical device according to claim 7 wherein said plate has an opening therein in which a pinch-off tube is sealed and wherein said stud is provided with a disc-type arc shield.