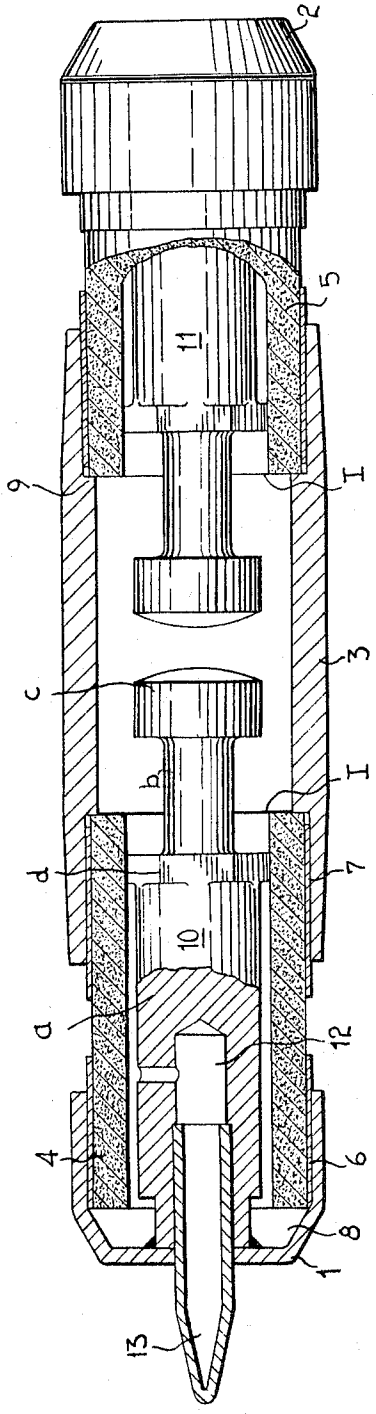
Nov. 29, 1966 R. D. JONES 3,289,027

GAS FILLED EXCESS VOLTAGE PROTECTOR HAVING ELECTRODES OF NON-UNIFORM DIAMETER

Filed Jan. 4, 1965



United States Patent Office 3,289,027
Patented Nov. 29, 1966

3,289,027

GAS FILLED EXCESS VOLTAGE PROTECTOR HAVING ELECTRODES OF NON-UNIFORM DIAMETER

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Filed Jan. 4, 1965, Ser. No. 423,219
Claims priority, application Great Britain, Jan. 7, 1964, 747/64
6 Claims. (Cl. 313—231)

A known form of gas-filled excess voltage protector which has proved very successful comprises two cup-shaped metal end caps spaced by respective insulating spacers of cylindrical form from an intermediate conductive sleeve. The insulating cylinders fit within and are hermetically sealed to the ends of the intermediate sleeve on the one hand and the end caps on the other hand, so that the end caps, cylindrical spacers and intermediate sleeve together form a sealed enclosure. The two end caps carry internal electrodes which extend towards each other through the spacers into the sleeve, in which they terminate with a protective gap between them. The sleeve constitutes a third electrode having a protective gap between it and each of the two other electrodes.

According to the present invention a protector of the above form is further improved in that, as regards each of the internal electrodes, a portion of its length which extends to a point short of the inner end of the electrode from a point within the cylindrical spacer through which it passes, has a cross-section smaller than that of the remainder of the electrode at its inner end and also sufficiently smaller than the internal diameter of the spacer to be radially spaced from the inner surface thereof.

A gas-filled excess voltage protector according to the invention is illustrated by way of example in the accompanying drawing showing the protector in partial cross-section.

Referring to the drawing the hermetically sealed gas-filled enclosure of the protector is formed by two cup-shaped metal end caps **1** and **2**, an intermediate metal sleeve **3** and two hollow ceramic spacing cylinders **4** and **5** preferably of 85% alumina ceramic. The cylinders **4** and **5** fit closely within the end caps **1** and **2** on the one hand and within the opposite ends of the sleeve **3** on the other hand, and metal-to-ceramic seals are formed between them, for example by brazing. To this end the outer surface of each of the ceramic cylinders **4** and **5** is metallised in two separate end bands **6** and **7** (care being taken to ensure that the metallising does not extend on to the end faces I of the cylinders) and annular seals are established between the interfitting parts by brazing between the facing metallic surfaces of the sleeve and the ceramic cylinders on the one hand and of the cylinders and end caps on the other hand.

To limit the extent of penetration of the cylinders into the end caps **1** and **2** and sleeve **3**, thereby to determine the spacing between the caps and the sleeve, the caps are chamfered as indicated at **8** and the sleeve is internally shouldered at **9**. Secured internally of the caps **1** and **2** in any convenient manner but preferably by welding, brazing or both are respective electrodes **10** and **11** extending towards each other through the cylinders **4** and **5**. The inner end faces of the electrodes are slightly rounded in order that the gap between them will be maintained should the axes of the electrodes not be in exact alignment; as an alternative to the illustrated form, these end faces may be defined by spherical end sections of the electrodes.

Each of the electrodes **10** and **11** has three integral

sections *a*, *b*, *c*, of different diameters. These will be considered in respect of electrode **10**. Section *a* of this electrode occupies the greater part of the interior of the spacing cylinder **4** but has a diameter somewhat smaller than the internal diameter of the cylinder. At a position within the cylinder a shoulder *d* of hexagonal or other polygonal cross-section locates the electrode **10** centrally within the ceramic cylinder **4** while leaving between the flats of the polygon and the inner surface of the cylinder segmentally shaped spaces permitting evacuation and subsequent gas filling of the protector through one end. For this latter purpose the electrode **10** is formed with a passageway **12** into which is fitted through the end cap **1** an exhaust tube **13** which is closed in a hermetically sealed manner after evacuation and gas filling. From the position of the hexagonal shoulder *d* within the ceramic cylinder **4** to a position short of the inner end of the electrode **10** the self-supported section *b* of this electrode is of reduced diameter compared with the remaining section *c* of the electrode at its inner end and also as compared with the inner diameter of the spacing cylinder **4**. The electrode **11** is similar except that it has no exhaust tube. The inner ends of the electrodes and the inside surface of the sleeve **3** may carry thermionic activating material which preferably is initially applied only to the opposing faces of the electrodes **10** and **11** but becomes distributed also over the inner surface of the sleeve **3** either as a result of heat applied during the process of sealing the various parts together or as a result of an ageing discharge to which the electrodes are subjected prior to being put into service.

If the electrodes **10** and **11** had been of uniform cross-section (diameter) over the sections *b* and *c* the protective gap between each of them and the sleeve **3** would likewise be of uniform width. Consequently, at the interface between the ends I of the insulating cylinders and the gas filling, there would have been an abrupt change (giving a concentration of electric stress) in the electric field pattern established by a potential difference applied between the electrodes **10** and **11** or between them and the sleeve **3** which constitutes a third (earth) electrode. This abrupt change results from the differing permitivity values of the ceramic and the gas, and under such conditions a discharge could occur preferentially at this interface, with the possibility that a resultant heavy current arc could occur close to the ceramic, leading to condensation of metal vapour on its surface and to reduced life of the protector. However, by forming the section *b* of each electrode of reduced cross-section in the manner shown, namely so that the sleeve-electrode gap over section *b* is significantly wider than that over section *c* and so that section *b* extends from a position within the cylinder **4**, the electric field pattern is so modified that discharge between the electrodes **10** and **11** and the sleeve **3** will tend to occur preferentially near the inner ends of the electrodes so that it is relatively remote from the end faces of the insulating cylinders and also from the positions of the metal-to-ceramic seals.

The presence of the reduced section *b* also promotes a fali safe feature whereby on excessive current loading of the protector when suitably mounted, preferably horizontally, the reduced section will more readily soften as a result of the generated heat and will allow the ends of the electrodes to sag and come into contact with the sleeve **3**. The fail safe operation resulting from sagging of the electrodes into contact with the sleeve **3** is due to the short-circuiting of the gap which then occurs. In the absence of such short-circuiting action under excessive load conditions the heat generated by the arc could burn a hole in the sleeve **3** allowing gas leakage to occur and causing the protector to lose its desired striking voltage

characteristics, while at the same time not giving warning to the user that the protector is faulty.

The internal electrodes may be tubular instead of the solid form shown in the drawing.

What I claim is:

1. A gas-filled excess voltage protector comprising a conductive sleeve, two cup-shaped metal end caps, two cylindrical insulating spacers fitting within and hermetically sealed to respective ends of the sleeve on the one hand and the respective end caps on the other hand, whereby said spacers cooperate with the sleeve and end caps in forming a sealed enclosure, and two internal electrodes carried by the respective end caps and extending towards each other through the spacers into the sleeve in which they terminate with protective gaps between these electrodes themselves, and between each of them and the sleeve which constitutes a third electrode, characterised in that, as regards each of the internal electrodes, a self-supported portion of its length which extends to a point short of the inner end of the electrode from a point within the cylindrical spacer through which it passes, has a cross-section smaller than that of the remainder of the electrode at its inner end and also sufficiently smaller than the internal diameter of the spacer to be radially spaced from the inner surface thereof.

2. A protector as claimed in claim 1, wherein the inner end faces of the internal electrodes are rounded.

3. A protector as claimed in claim 2, wherein the internal electrodes have spherical end portions.

4. A protector as claimed in claim 1, wherein each internal electrode has a polygonal shoulder portion, locating the electrode centrally within the cylindrical spacer through which it passes and defining between its flats and the internal surface of the spacer spaces which constitute passageways for the abstraction of air.

5. A protector as claimed in claim 1, wherein at least the inner ends of the internal electrodes carry thermionic activating material.

6. A protector as claimed in claim 1, wherein the spacers are of ceramic material and the outer surface of each is metallised adjacent its opposite ends in two separate end bands to which the sleeve and relevant end cap are respectively sealed by brazing.

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