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ELECTRICAL PROTECTIVE DEVICE

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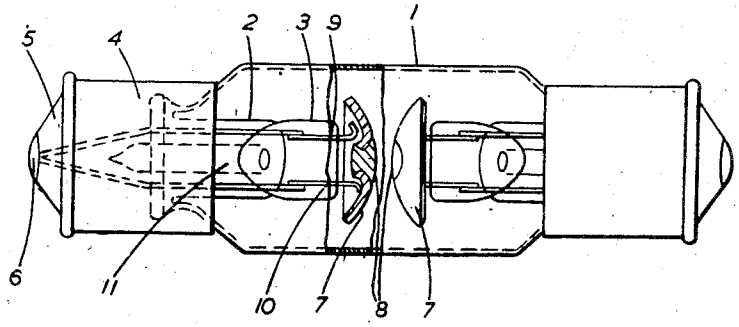

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ELECTRICAL PROTECTIVE DEVICE

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This invention relates to electrical protective devices and especially to devices comprising two electrodes spaced apart within an enclosing envelope having a filling of an inert gas and suitable for the protection of low tension electrical systems against lightning and other voltage disturbances in excess of the voltage normally obtaining.

It is an object of the present invention to provide such devices which are simple in construction and easy to manufacture and provide for a substantial reduction in the resistance of the discharge path once an arc discharge has been struck and yet without substantial deterioration of the electrodes so that many discharges can be catered for.

Well known discharge devices utilise electrodes of iron, steel or nickel of a convex shape so as to have a large cooling area in consequence of which, apart from the high melting points of the metals, no great volatilization of the electrode material takes place once the arc discharge starts.

Some volatilization is desirable from the point of view of reduction of the resistance of the arc discharge, but the amount should be controllable in some measure with a view to allowing of repeated use and a long life.

According to the present invention the electrodes are of iron, steel, nickel or nickel-steel, which allows of easy manufacture, having such a superficial area as to provide the desired extent of cooling, but a small part of each electrode is of a metal having certain characteristics. This metal should have melting point temperatures below that of the other metal of the electrode, but not too low. Alkali metals are not suitable as having melting and boiling point temperatures which are too low for our purpose. In general a melting point of not less than 400° C. and a boiling point between 1200° C. and 2000° C. at normal atmospheric pressure would be suitable for the purposes of the present invention. The particular metal selected is governed to a large extent by mechanical considerations and ready availability. Aluminium is eminently suitable and is the preferred material.

In order to render the device consistent in its characteristics independent of prevailing light conditions, at least the surfaces of the said small metal parts of the electrodes may be provided with a coating of a radio-active substance, such as uranium oxide, whereby the presence of ions in the inter-electrode space is always ensured.

A protective device incorporating the features of the present invention may be constructed as illustrated by way of example in the accompanying drawing and described in the following description. The illustration shows the device on an enlarged scale.

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The device illustrated comprises a tubular envelope 1 having sealed into each end a stem 2 which has a press at 3 sealing a pair of lead-in wires 9 and 10 carrying an electrode 7, 8. Each stem has passing through it and attached thereto and communicating with the interior of the envelope an exhaust tube 11 for evacuating the envelope and introducing thereinto an inert gas filling in known manner. The envelope has cemented onto each end a metal base 4 closed at its outer end by a conical portion 5 to which the lead-in wires are connected such as by soldering as indicated at 6.

The device may be fabricated by a technique similar to that employed in the manufacture of electric incandescent lamps.

The lead-in wires 9 and 10 on emerging, and at a short distance, from the press are bent in opposite directions away from each other, and these bent ends are curved to conform to the contour of the interior surface of a domed portion 7 of an electrode to which they are sweated, such as by welding.

The electrodes each consist of the aforementioned domed portion 7 of a metal having a high melting-point and therefore not easily volatilizable, such as iron, steel, or it may be nickel or nickel-steel although iron is preferred, having at its apex an aperture into which is riveted a stud 8 of a metal or it may be an alloy of metals. The studs are made from a metal or metals each having such characteristics that whilst having a comparatively high melting point it is capable of being melted by the heat of the arc discharge so that evaporation of the metal will take place under arc discharge conditions sufficient to establish a metal vapour arc. Such a metal will have a melting point lower than that of the metal of the dome. It is also essential for the construction of an electrode as described that the metal must be workable in the cold to enable it to be riveted into the dome. Aluminium and silver are both suitable, but we prefer aluminium owing to its cheapness, the ease of chemically cleaning its surface and working in the cold and other considerations. The dome portion 7 has a superficial area such that it will maintain the stud in its solid state except at the surface on which the discharge terminates.

The exterior surface of the electrode or it may be only the surface of the studs 8 is coated with

a thin layer of a radio-active substance such as uranium oxide.

The envelope prior to sealing is filled with an inert gas or mixture of gases such as neon, or a mixture of neon and argon at a predetermined pressure as hereafter referred to.

On the occurrence of an arc discharge between the electrodes, vaporisation at the surface of the metal of the studs almost instantaneously occurs and under heavy current conditions the discharge takes the form of a vapour arc characteristic of the metal and thus forms a low resistance path for the parasitic currents. The domed portions 7 by their mass assist in cooling the studs and maintain their temperatures, except at the surfaces from which vaporisation is required, below that of fusion.

The presence of radio-active material within the device ensures always the existence of an amount of ionisation of the inert gas filling and increases the concentration of ions in the interspace between the electrodes whereby reliable striking is always ensured at a predetermined voltage at which the device is designed to operate, independently of prevailing light conditions. It is probable that after several operations of the device the radio-active material will be sputtered from the surfaces of the studs and, mainly, deposited onto the envelope leaving the said surfaces clean, but this is immaterial as the surfaces of the domes if coated will retain the deposits, their temperature being maintained below that at which sputtering occurs, and in any case the sputtered material remains present in unaltered form in the envelope, and will be sufficient always to ensure a preliminary ionisation.

A suitable process for the manufacture and treatment of the electrodes and fabrication of the device is as follows:

A stud 8 is riveted into the dome 7 in any suitable manner, the exterior surface of the stud, however, being made as far as possible to conform with the contour of the dome. Short stout tails of the lead-in wires 9 and 10 are welded to the interior surface of the dome, these tails later being sweated to more flexible wires extending the connections through the press and stem to the base 4.

The electrode as thus assembled may be furnaced, and on cooling at least the surfaces of the studs 8 are coated with an aqueous solution of uranium nitrate, the coating being dried by a further furnacing in vacuum. The treatment is completed by a baking process in a reducing atmosphere of hydrogen or cracked ammonia at a temperature between 600° and 700° C. for 10 to 15 minutes which removes oxidised material from the electrode surfaces and decomposes the uranium nitrate to uranium oxide or other degradation product.

The device is fabricated in known manner, that is, the short stout tails before referred to, are sweated to the flexible portions of the lead-in wires, and these are sealed into the stems, the latter then being sealed into the ends of the envelope.

The device on being thus far assembled is exhausted of air, and it is preferred that during this exhausting process the envelope and electrodes are subjected to a baking treatment in vacuum at a temperature of about 400° C. for approximately 10 minutes. After this treatment and on cooling the envelope is filled with an inert gas or a mixture of gases, such as argon or neon or a mixture of these in such proportions and at such a pressure as to obtain a desired striking voltage. For example, in a device in which the electrodes are spaced at 2 millimetres apart, to obtain a striking voltage of 150 volts a mixture consisting of 99% neon and 1% argon at a pressure of 30 to 100 millimetres of mercury is suitable, and to obtain a striking voltage of 400 volts a suitable mixture is 80% neon and 20% argon at a similar pressure.

The envelope is sealed off and capped in known manner.

In its final form it is preferred to subject the device to a discharge process in which a current is passed through the device for a required period to clean up minute impurities in the gas and bombard the surfaces of the electrodes, the current density and period being regulated so as to ensure that the device will have a constancy of striking voltage.

It will be appreciated by those skilled in the art that the simple manner of construction and processing of the electrodes lends itself to the production in quantity of electrodes so like each other that devices incorporating them, and fabricated by methods following the technique employed in the manufacture of electric lamps, can be made without difficulty to have characteristics substantially identical with one another. For example, the domed portions 9 can be stamped and shaped identical with one another, and the rivets 8 shaped and riveted into the domes, so that negligible difference exists between them. The coating of the electrodes or preferably only the surfaces of the studs 8 with radioactive material consists merely in applying a coating of standard solution to the surfaces and drying off in a suitable atmosphere. The coating in any case will be very thin and any difference in thickness likely to occur will produce negligible if any modification of the expected performance of the device. Further as the striking voltage depends mainly upon the product of the pressure of the inert gas, and it may be the proportions of the different gases in a mixture, and the electrode spacing, devices having different breakdown voltages, but otherwise physically similar, can be obtained by varying the gas pressure or the proportions of gases in a mixture, or both.

The amount of metal of the stud that is evaporated is negligible even under heavy discharge conditions, and in consequence a device with electrodes constructed in accordance with the present invention will give repeated and consistent performance over a long period.

What we claim as new and desire to secure by Letters Patent is:

1. An electrical protective device comprising an envelope, a filling of inert gas therein, two spaced electrodes of iron of convex shape connected to terminals on opposite ends of the device and having the convex sides adjacent, and an aluminum insert in the face of each said electrode at their points of nearest approach.

2. An electrical protective device comprising a sealed envelope, a filling of inert gas therein, metal terminals on opposite ends of said envelope, two opposing spaced electrodes of iron of convex shape within said envelope and connected respectively to said terminals, an aluminum insert in the face of each electrode, and a coating of a radio-active material on the opposing convex faces of said electrodes.

3. An electrical protective device comprising an envelope, an inert gas filling therein, a pair of spaced dome-shaped electrodes within said envelope having the convex sides adjacent each

other and having the main portion thereof formed of a metal having a high melting point, an opening in the center of said main portion of said electrodes, and an aluminum insert riveted in place in said opening and formed to the same contour as the main portion of said electrodes.

4. An electrical protective device comprising a sealed glass container, an inert gas in said container, two separated convex shaped electrodes in said container having their convex sides facing each other and aligned center to center, an outer portion in each electrode formed of a metal having melting and boiling points of the order of those of iron and nickel, and an insert of solid metal having melting and boiling points of the order of those of aluminum and silver rigidly secured to the central portion of each electrode.

5. An electrical protective device comprising a sealed housing, an inert gas in said housing, two dome shaped electrodes mounted a short distance apart from each other in said housing with their romed sides in juxtaposition, an outer portion in said electrodes formed of a metal having a melting point between 1400 and 2000 degrees centigrade, a solid central portion in said electrodes comprising an insert of a different metal having good cold working properties and a melting point between 400 and 1000 degrees centigrade, and a coating of radio-active material covering both portions of each electrode.

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