

[54] **LOW VOLTAGE SECONDARY
LIGHTNING ARRESTER SPARKGAP
ASSEMBLY**

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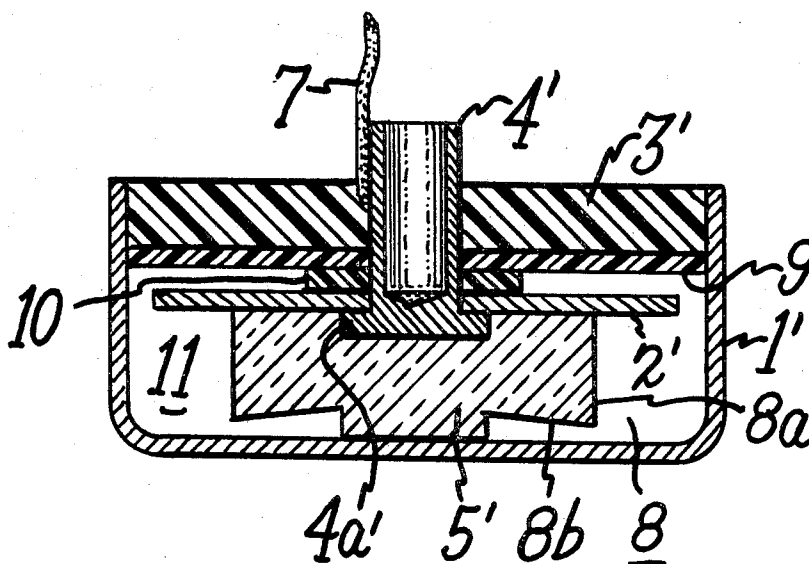
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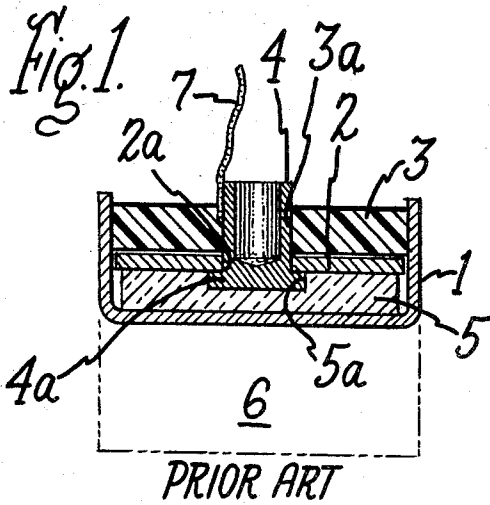
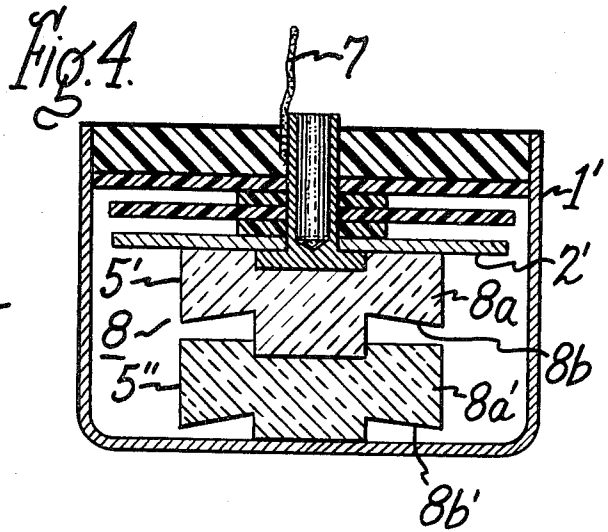
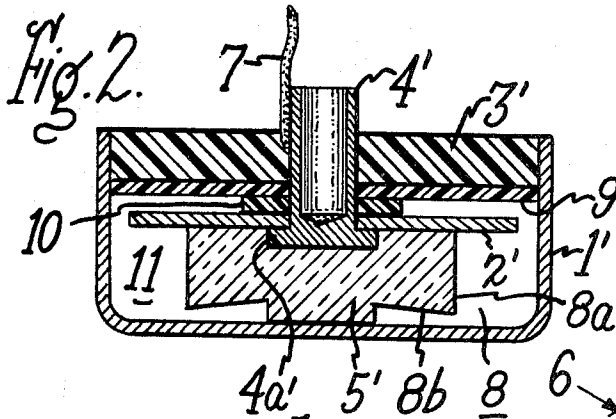
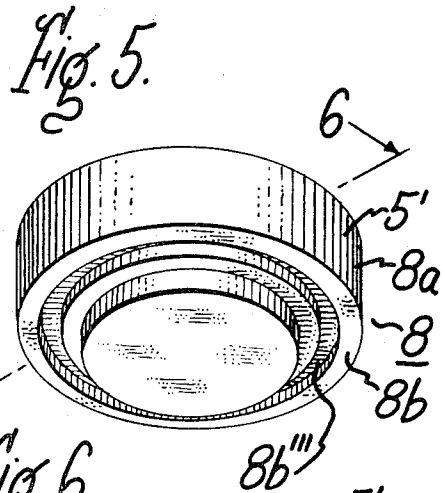
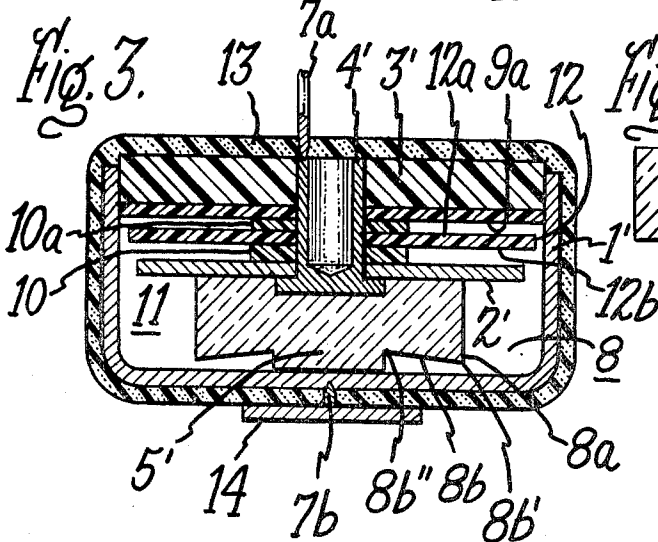
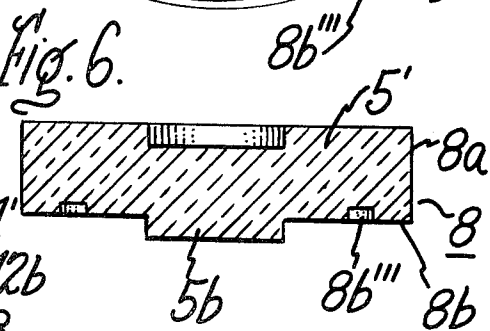
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[57] **ABSTRACT**

A sparkgap assembly for a low voltage lightning arrester is formed by mounting a disc-shaped electrode in spaced-apart relation with a cup-shaped electrode with a block of insulating material between the two electrodes. The block of insulating material serves as a preionizer to ionize the sparkgap between the electrodes when a surge voltage is applied to the arrester. The block of material is also characterized by incorporating baffle means that operate to prevent arc-generated contaminants, such as particles of electrode metal, from being deposited on preselected, shielded portions of it. By thus maintaining portions of the resistance path disposed between the two electrodes free of electrically conducting contaminants, the sparkover level of the arrester is preserved during and after successive arc discharge operations and the noise generating capability of the assembly is reduced.

13 Claims, 6 Drawing Figures





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LOW VOLTAGE SECONDARY LIGHTNING ARRESTER SPARKGAP ASSEMBLY

It is well known in the lightning arrester field that arc discharge operations of an arrester cause arc-generated contaminants to be distributed in the arc-confining chambers of the arrester's sparkgap assemblies. Such contaminants generally include particles of metal that are eroded from the electrodes of the assembly by the high temperatures developed during an arc discharge operation. These particles range in size from invisible ionized particles to pieces of electrode metal the size of granules of sand. During an arc discharge operation, the larger electrode particles are splattered directly into contact with surfaces of an arcing chamber adjacent to the arc discharge path. The smaller, ionized particles may be carried throughout the arcing chamber by high pressure gases and strong electromagnetic forces present in the chamber during an arc discharge. Thus, such ionized particles may be condensed on surfaces of the arcing chamber that are not directly in line with the arc discharge path between the electrodes mounted in the chamber.

It has been found that the buildup of arc-generated contaminants within the arcing chambers of a lightning arrester sparkgap assembly can produce two undesirable effects. First, and most importantly, such particles may result in diminution of the electrical resistance between the electrodes of an arrester's sparkgap assemblies so that the sparkover rating of the arrester is undesirable lowered. In fact, a sufficiently heavy deposit of such particles may result in the sparkover level of the arrester being lowered to a point such that the electrodes would arc over under normal line voltage. Of course, such a condition would cause the arrester to fail and might result in the protected line being removed from service. A second major disadvantage caused by arc-generated electrode particles being deposited in an arrester's arcing chambers, is that such particles cause radio noise and television interference. This second disadvantage is particularly undesirable in low voltage arresters that are frequently used in areas that are in close proximity to radio receivers and television sets.

Although the foregoing disadvantages inherent in many conventional lightning arrester sparkgap assemblies have been identified for some time, prior to the present invention, it is not believed that a satisfactory lightning arrester has been designed to overcome these disadvantages. One prior art approach to these problems has been to make lightning arrester sparkgap assemblies having electrodes that are at least partially formed of metals that have higher-temperature fusion levels than copper or copper alloys, which are the metals most commonly used in manufacturing present day lightning arrester electrodes. While this approach is partially satisfactory in that it does result in a reduction of the number of particles of ionized or molten electrode metal that are thrown about the interior of a sparkgap arcing chamber during an arc interruption, it is a relatively expensive expedient to employ. Therefore, in low voltage lightning arresters, which must be relatively inexpensively manufactured in order to be competitive in the market place, such an expedient is frequently not feasible. Moreover, the use of metals other than copper or copper alloys to form arrester electrodes often results in poorer current carrying

characteristics during an arc discharge operation, therefore, the elimination of one disadvantage simply results in its being replaced by another disadvantage that may in many instances be less acceptable. In view of this present state of the art, it can be appreciated that a strong demand exists for a low voltage lightning arrester with means therein for reducing or eliminating radio noise and television interference, and with means for eliminating the sparkover level altering problem caused by the distribution of arc-generated metal particles throughout the arcing chambers of the arrester during an arc interrupting operation.

Accordingly, a primary object of my invention is to provide an improved lightning arrester sparkgap assembly that incorporates baffle means which are effective to improve the operating characteristics and noise or interference generating properties of the arrester.

Another advantage of the invention is to provide a low voltage lightning arrester having a sparkgap assembly, or assemblies, in which a preionizer is disposed between the primary electrodes of the arrester, and means are provided for shielding at least a portion of the surface of the preionizer so that the effective electrical resistance between the electrodes is not reduced as a result of arc-generated conductive metal particles being deposited on the preionizer.

Still another object of the invention is to provide a compactly constructed low voltage lightning arrester in which all of the electrical creep paths between the primary electrodes of the arrester contain insulating surface areas that are shielded from contamination by arc-generated particles, so that the sparkover level of the arrester is maintained at a substantially constant value following a number of arc-discharging operations.

Further objects and advantages of my invention will become apparent from the description of it that is given below, taken in connection with the accompanying drawings.

In one preferred form of the invention, a low voltage lightning arrester sparkgap assembly is formed by mounting a block of non-linear resistance valve material in series with a sparkgap assembly comprising a cup-shaped metal electrode that has a second electrode nested within its cup-shaped surface. A block of insulating material is mounted within the cup-shaped surface of the first electrode and serves to position the pair of electrodes in exact, spaced-apart relationship to form a primary sparkgap between them. Pursuant to my invention, a block of insulating preionizer material of novel configuration is mounted between the pair of electrodes and is formed to embody baffle means that operate to prevent arc-generated metallic particles from contaminating at least a predetermined portion thereof. The shielded portion of the insulating preionizer is sufficiently large in area to preserve the sparkover rating of the arrester after substantial electrode erosion, and attendant contamination of the arcing chamber, has taken place due to successive arc discharge operations through the arrester. In alternative embodiments of the invention, additional baffle means are provided adjacent the first baffle-type preionizer, as well as on the opposite side of the primary sparkgap to that on which the preionizer is mounted.

In the drawings:

FIG. 1 is a side elevation view, in cross section, of a low voltage lightning arrester sparkgap assembly constructed pursuant to a known prior art teaching.

FIG. 2 is a side elevation view, in cross section, of a sparkgap assembly for a lightning arrester, which may be used in an application similar to that in which the assembly of FIG. 1 might be used, but which is characterized by embodying a preionizer-baffle arrangement that is constructed pursuant to the teachings of the present invention.

FIG. 3 is a side elevation view, in cross section, of a second embodiment of my invention, showing a lightning arrester sparkgap assembly in which baffle means are mounted on both sides of a primary sparkgap in the assembly to afford the objectives of the invention noted above.

FIG. 4 is a side elevation view, in cross section, of still another embodiment of my invention, showing an extension of the principles of the embodiment of the invention depicted in FIG. 3.

FIG. 5 is a perspective view of the bottom side of a block of preionizer insulating material that is corrugated pursuant to the teaching of my invention to afford a baffle means that may be used in lieu of, or to supplement, the baffle means shown in FIG. 3, thus it constitutes yet another embodiment of my invention.

FIG. 6 is a side elevation view, in cross section, taken along the plane 6—6 of FIG. 5 showing the corrugations in the block of insulating material illustrated in FIG. 5.

Before describing the sparkgap assembly of my invention, reference will first be made to FIG. 1 of the drawing which illustrates a prior art form of sparkgap assembly for a secondary lightning arrester of the type in which the novel features of my invention may find most advantageous utilization. The sparkgap assembly shown in FIG. 1 comprises a cup-shaped electrode 1 that may be formed of brass or any other suitable electrically conductive material that may be machined or punched and pressed into dimensions that can be held to reasonably close tolerances. Nested within the cup-shaped electrode 1 is a second electrode 2 that has a generally disc-shaped central portion with a plurality of radially extending spikes extending outward therefrom to form the electrode 2 into a generally star-shaped configuration. The electrode 2 is held in fixed position with respect to a block of insulating material 3 that is designed to fit snugly against the inner surfaces of the cup-shaped electrode 2. In order to afford this holding function, and to provide a means for introducing electric voltage to the electrode 2, a rigid, hollow metallic pin 4 having a flange or head portion 4a thereon, is inserted through preformed apertures 2a and 3a respectively in electrode 2 and insulating block 3 so that when the pin 4 is press fitted into the aperture 3a it operates to hold the electrode 2 snugly in position against the lower surface of insulating block 3. Finally, a second block of insulating material 5 is positioned on the bottom of cup-shaped electrode 1 and centered with respect to the electrode 2 by positioning flange 4a in a recess 5a formed in the center of block 5. Conventionally, the insulating block 5 may be formed of ceramic, mica or other suitable material that will serve to preionize the sparkgap defined between the concentrically positioned electrodes 1 and 2. The block of in-

ulating material 3 may be formed of an epoxy resin, or any other suitable, relatively rigid, insulating material.

Normally, to complete such an arrester circuit, the cup-shaped electrode 1 is mounted so that the bottom portion of its outer surface rests on a block of nonlinear resistance valve material 6 which, in turn, may be connected in any conventional manner to one terminal of an arrester (not shown) that includes a housing for the sparkgap assembly and series connected nonlinear resistance valve 6. The other terminal of such an arrester is electrically connected by a suitable conductor, such as wire 7 that is soldered or otherwise fastened to the pin 4, so that when a surge voltage is applied across the terminals of the arrester a discharge circuit is formed through the electrodes 1 and 2, across the sparkgap defined between them, and through the series connected nonlinear valve 6 to the ground potential terminal of the arrester.

If additional information is desired, a more detailed description of the structure and normal mode of operation of such a low voltage, preionized lightning arrester sparkgap assembly is set forth in U.S. Pat. No. 3,524,107-Reitz, which issued on Aug. 11, 1970 and is assigned to the assignee of the present invention.

Turning now to FIG. 2 of the drawing, the novel features of one embodiment of the sparkgap assembly of my invention will be described with reference to the illustration of this embodiment depicted therein. It should be understood that such a sparkgap assembly will normally be used in a low voltage lightning arrester, such as the one described above with reference to FIG. 1, in lieu of the particular sparkgap assembly structure shown in FIG. 1. Accordingly, in describing the pertinent features of my invention, it is not deemed to be necessary to further orient the sparkgap assembly with relation to associated lightning arrester terminals, valve resistors and insulating hardware. Moreover, in order to facilitate an appreciation of the relationship of my invention to prior art apparatus, such as the sparkgap assembly described in FIG. 1, like reference numerals will be used to designate functionally similar component parts, with the numerals used in FIG. 2 being distinguished by a "prime, (')" symbol. Thus, a first electrically conductive electrode 2' having a generally disc-shaped central portion is shown nested within a second electrically conductive electrode 1' that is generally cup-shaped in configuration. Mounting means are provided for mounting these electrodes in fixed predetermined positions with respect to a block of insulating material 3', in the manner described above with reference to FIG. 1, so that a sparkgap is formed between the electrodes 1' and 2'. These mounting means generally comprise a rigid, electrically conductive pin member 4' having a flattened head or flange portion 4a' thereon. Also, a second block of insulating material 5' that serves as a preionizer for the sparkgap defined by electrodes 1' and 2' is nested within the cup-shaped surface of electrode 1' on the bottom surface thereof.

In this embodiment of the invention, the baffle means 8 comprises the vertical outer cylindrical surface 8a of the generally disc-shaped second block of insulating material 5'. This surface 8a is terminated a predetermined distance above the bottom surface of cup-shaped electrode 1', as shown in FIG. 2, so that a

given portion of the surface area of insulating block 5' that is mounted between primary electrodes 1' and 2' is shielded from metallic particles that otherwise might be splattered or condensed thereon. This unique arrangement of the baffle means 8 preserves the electrical resistance of the shielded portion, which generally comprises surface 8b of the outer surface of insulating block 5', so that its electrical resistance is maintained at a substantially constant value during and after successive arc discharge operations of the sparkgap assembly.

It will be noted that the sparkgap assembly configuration shown in FIG. 2 of the drawing also comprises an insulating plate member 9 and an insulating washer 10 both of which may be formed of mica or other suitable insulating material. Plate member 9 and washer 10 are mounted concentrically around the pin 4' so that the first electrode 2' is spaced a predetermined distance away from the block of insulating material 3', which seals the arcing chamber 11 of the sparkgap assembly. As noted above, the block of material 3' may be made of a moldable plastic resin. These additional insulating discs 9 and 10 need only be utilized with this embodiment of the invention when the electrical insulating properties of the material used to form insulating block 3' are not deemed to be fully adequate for a given application.

Reference will now be made to FIG. 3 of the drawing to describe a second embodiment of the invention. Again, the same reference numerals used with regard to the embodiment of the invention shown in FIG. 2 are used to identify identical parts. Accordingly, no further description of these parts will again be stated. It will be noted that in this embodiment of the invention the baffle means 8 also comprises a (second) block of insulating material 5' which has a first surface 8a and a second surface 8b. The first surface 8a of the second block of insulating material 5' comprises a shield on which at least some of the arc-generated particles thrown from electrodes 1' and 2' during an arc discharge operation will be deposited. The second surface 8b in this embodiment of the invention is generally frusto-conical and has its large diameter end 8b' adjacent the peripheral surface 8a of the generally disc-shaped block of material 5', and this large diameter end of the surface 8b is spaced closer to the bottom of the cup-shaped electrode 1' than is its smaller diameter end 8b''. I have found that such a frusto-conical surface 8b is superior to the generally flat surface (8b) depicted in the embodiment of the invention shown in FIG. 2, because there is less tendency for ionized metallic vapor to be deposited on it following an arc discharge operation in the sparkgap assembly.

In addition to the baffling effect of the uniquely shaped second block of insulating material 5', at least one plate member 12 is mounted within the cup-shaped surface of electrode 1' between the first electrode 2' and the first block of insulating material 3'. The plate member 12 is spaced away from both the first electrode 2' and the block of insulating material 3' by mica washers 10 and 10a. It will be appreciated that a plurality of additional plate members, such as the plate member 9, may be mounted in spaced-apart relationship between the plate member 12 and the block of insulating material 3' to afford a plurality of insulating

surfaces that are shielded from contamination by arc-generated particles in the manner that the surfaces 12a and 9a are shielded by the surface 12b of plate member 12. With an embodiment of my invention such as that shown in FIG. 3, the electrical resistance existing along the creep paths between electrodes 1' and 2' of the sparkgap assembly is maintained substantially constant during and following successive arc discharging operations of the assembly.

A further feature of the sparkgap assembly shown in FIG. 3 is that it is hermetically sealed by being completely encapsulated in a coating 13 of thermal setting plastic resin. The coating 13 is formed around the sparkgap assembly in any conventional molding process. Then, in order to electrically connect the sparkgap in a discharge circuit in the manner described above with reference to FIG. 1, a pair of rigid pointed electrical conductors 7a and 7b are forced through the coating 13 into current conducting contact with pin 4' and electrode 1', respectively. A flat, electrically conductive metal plate 14 is welded to the outer end of pointed conductor 7b to afford a good contact surface with a block of non-linear resistance valve material, such as the block 6, shown in FIG. 1. I have found that in practicing my invention to form the type of embodiment shown in FIG. 3, sometimes openings are formed around the pointed conductors 7a and 7b, through which moisture might seep into the sparkgap assembly. Accordingly, I provide means for sealing such openings around these conductors, 7a and 7b. In one form, this sealing means is a self-curing epoxy resin that is forced into any openings around rigid conductors 7a and 7b after they are mounted in operating position.

Still another embodiment of the invention is shown in FIG. 4 of the drawing where, again, like reference numerals are used to describe parts identical to those shown in FIGS. 2 and 3 of the drawing. Moreover, such identical parts will not be again described in detail, nor is it deemed necessary to reiterate their function. Thus, it can be seen that in FIG. 4 the primary difference in construction between this embodiment of the invention and that shown in FIG. 3 of the drawing is the provision of a plurality of blocks of insulating material 5' and 5'' which are mounted adjacent one another in the manner shown. Each of these blocks of insulating material 5'-5'' have first and second surfaces 8a-8b and 8a'-8b' respectively that afford the same functions as the first and second surfaces 8a and 8b of the block of insulating material 5' illustrated in the embodiment of the invention shown in FIG. 3. It should be apparent that with this plural-block baffle arrangement a number of shielded, conical surfaces 8b and 8b' are provided along the creep path between the first electrode 2' and the second electrode 1', thereby to improve the ability of the baffling feature of my invention to assure maintenance of a constant resistance characteristic for the sparkgap assembly, so that it maintains a constant sparkover rating following successive arc discharge operations. Of course, such a plural-block baffle arrangement would normally only be utilized on relatively high voltage applications where a substantial number of arc-generated metallic particles are thrown around the interior of the arcing chamber of the sparkgap assembly by discharge operations thereof.

Finally, another embodiment of the baffle means of my invention is shown in FIGS. 5 and 6 of the drawing. In this embodiment of the invention, a block of resistance material that is adapted to be used in lieu of the form of insulating blocks 5' shown in embodiments of the invention illustrated in FIGS. 3 and 4 is provided with a first peripheral surface 8a that serves as a shield in the manner described above with reference to the configuration shown in FIGS. 3 and 4, and a second, shielded surface 8b that is corrugated and lies in a plane that is generally perpendicular to the axis of the disc-shaped block 5' of insulating material. With this corrugated configuration of the baffle means 8 at least portions of the second surface 8b are always spaced a substantial distance away from the bottom of the cup-shaped electrode 1' (shown in FIGS. 2-4) when the block of insulating material 5' is nested therein. In fact, in the particular form shown, due to the reduced diameter cylindrical portion 5b of disc-shaped insulating block 5' the entire surface 8b is spaced away from the bottom of cup-shaped electrode 1'. As can best be seen in the cross-section view shown in FIG. 6, the annular indentation or corrugation 8b''' is shielded by two right angle turns from a line-of-sight view of the sparkgap that would be defined between a pair of electrodes, such as the electrodes 1', 2' shown in FIGS. 2-4 of the drawing; therefore, with this corrugated configuration of the invention at least this limited portion of the electrical creep path between the two electrodes is virtually assured of remaining free of arc-generated particles thrown from the sparkgap.

While specific embodiments of my invention have been illustrated and described for the purpose of teaching the invention, it will be apparent that various modifications and other embodiments are possible, and the invention is not restricted to the particular arrangement shown herein but rather includes all equivalent embodiments and modifications which come within the true scope and spirit of the appended claims.

Accordingly, what I claim as new and desire to secure by Letters Patent of the United States is:

1. A surge voltage arrester sparkgap assembly comprising a first electrically conductive electrode having a generally disc-shaped central portion, a second electrically conductive electrode, a first block of insulating material, mounting means for mounting said first and second electrodes in fixed predetermined positions with respect to said block of insulating material thereby to form a sparkgap between said electrodes, baffle means mounted between the disc-shaped central portion of the first electrode and the second electrode, said baffle means being effective when in operating position between the first and second electrodes to intercept arc-generated particles thrown from said electrodes during a discharge operation thereof, thereby to shield portions of the area between said electrodes and prevent such particles from being deposited thereon, whereby the electrical resistance of said portions of the area between said electrodes is maintained at a substantially constant value during and after successive arc discharge operations of the sparkgap assembly.

2. An invention as defined in claim 1 wherein said baffle means comprises a second block of insulating material that is adapted to ionize the sparkgap between said electrodes when a predetermined voltage exists

across the electrodes, said second block of insulating material having first and second surfaces, the first surface of said second block comprising a shield on which at least some of said arc-generated particles are deposited, said second surface of said second block of insulating material comprising at least one of said portions of the area between said electrodes the electrical resistance of which is maintained at a substantially constant value.

3. An invention as defined in claim 2 wherein said baffle means comprises a plurality of blocks of insulating material mounted adjacent one another, each of said blocks of insulating material having first and second surfaces that afford the same functions respectively as the first and second surfaces of said second block of insulating material.

4. An invention as defined in claim 3 wherein each block of said plurality of blocks is substantially identical in configuration to said second block of insulating material.

5. An invention as defined in claim 2 wherein said second electrode has a generally cup-shaped surface, said second block of insulating material being adapted to nest within the space defined by said cup-shaped surface, said first surface of the second block of insulating material being disposed generally parallel to the walls of said cup-shaped surface, and said second surface of the second block of insulating material being disposed generally parallel to the bottom of said cup-shaped surface.

6. An invention as defined in claim 5 wherein said second block of insulating material is generally disc-shaped, said first surface thereof comprising the peripheral surface of said disc shape, said second surface being generally frusto-conical with its large diameter end adjacent said peripheral surface and spaced closer to the bottom of said cup-shaped second electrode than is its small diameter end.

7. An invention as defined in claim 5 wherein said baffle means also comprises at least one plate member mounted within said cup-shaped surface between the first electrode and the first block of insulating material, said plate member being spaced away from both said first electrode and said first block of insulating material.

8. An invention as defined in claim 7 including a plurality of additional plate members mounted in spaced-apart relationship between said at least one plate member and said first block of insulating material, at least some of said plate members being formed of insulating material, thereby to afford a plurality of insulating surfaces that are shielded from contamination by arc-generated particles.

9. An invention as defined in claim 5 wherein said second block of insulating material is generally disc-shaped, said first surface thereof comprising the peripheral surface of said disc shape, said second surface being corrugated and lying in a plane generally perpendicular to the axis of said disc-shaped second block of insulating material, whereby at least portions of said second surface are spaced away from the bottom of said cup-shaped second electrode and are shielded from arc-generated particles.

10. An invention as defined in claim 9 including means for spacing all of said second surface away from said second electrode.

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11. An invention as defined in claim 2 wherein said sparkgap assembly is encapsulated in an epoxy resin housing, and including a pair of rigid pointed electrical connectors that are driven through the housing into electrical contact respectively with said first and second electrodes.

12. An invention as defined in claim 11 including

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means for sealing the openings around said pointed electrical connectors, thereby to make said sparkgap assembly essentially water-tight.

13. An invention as defined in claim 4 wherein at least two of the blocks in said plurality of blocks differ from one another in configuration.

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