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Hall

[11] **3,737,712**

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[54] **SPARKGAP ASSEMBLY HAVING A SEMI-CONDUCTIVE COATING ADJACENT THE ELECTRODES THEREOF**

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[51] **Int. Cl.**.....**H01j 7/44,** H02h 7/24

[58] **Field of Search**.....313/325, 311, 231, 313/DIG. 5; 315/35, 36

[56] **References Cited**

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[57] **ABSTRACT**

A surge voltage arrester sparkgap assembly having a plurality of horngap electrodes is provided with a coating of high resistance, electrically conductive material mounted adjacent the outermost ends of the electrodes. The coating of conductive material is effective to form high resistance electrical circuits between the respective ends of the electrodes and any electrically conductive metal particles that may be eroded from the electrodes and splattered onto the internal insulating surfaces of the sparkgap assembly. These high resistance electrically conductive circuits prevent the formation of a corona discharge between the electrodes and any such conductive particles.

6 Claims, 4 Drawing Figures

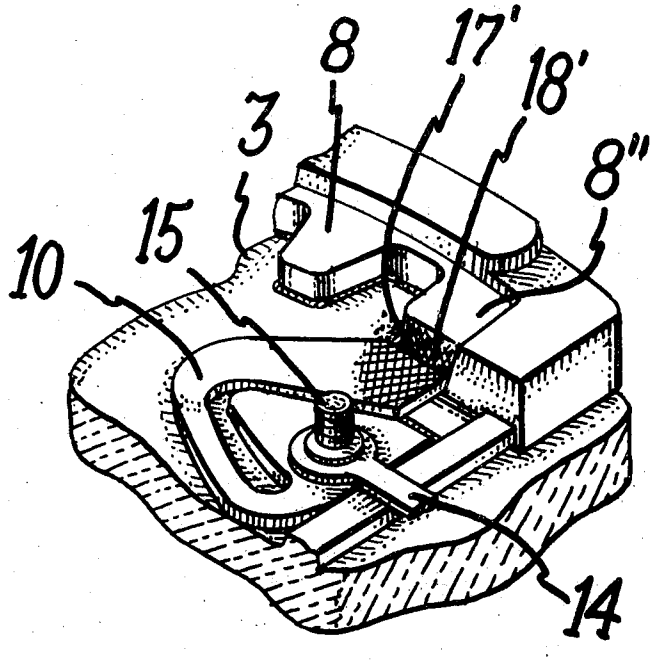


Fig. 1.

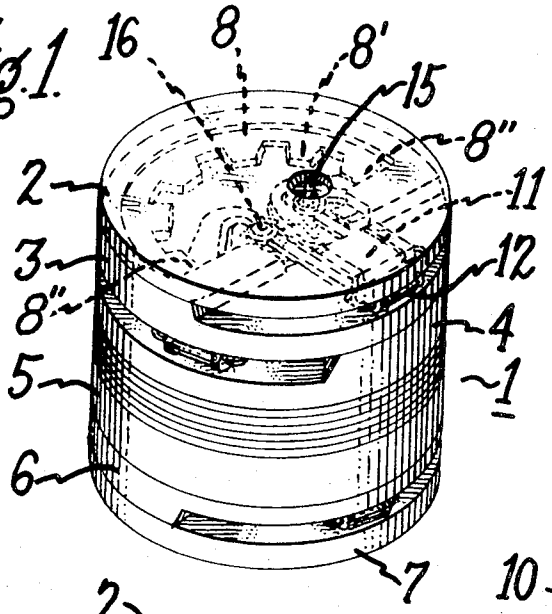


Fig. 4.

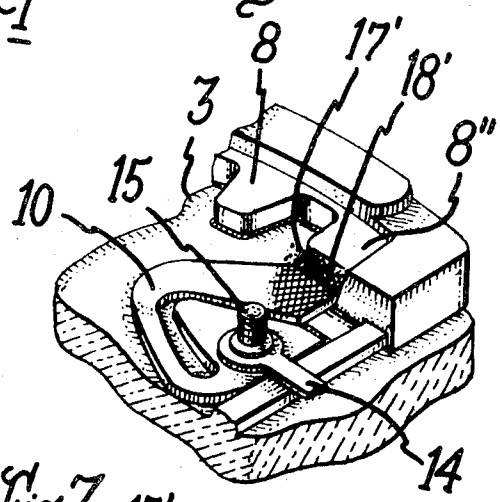


Fig. 2.

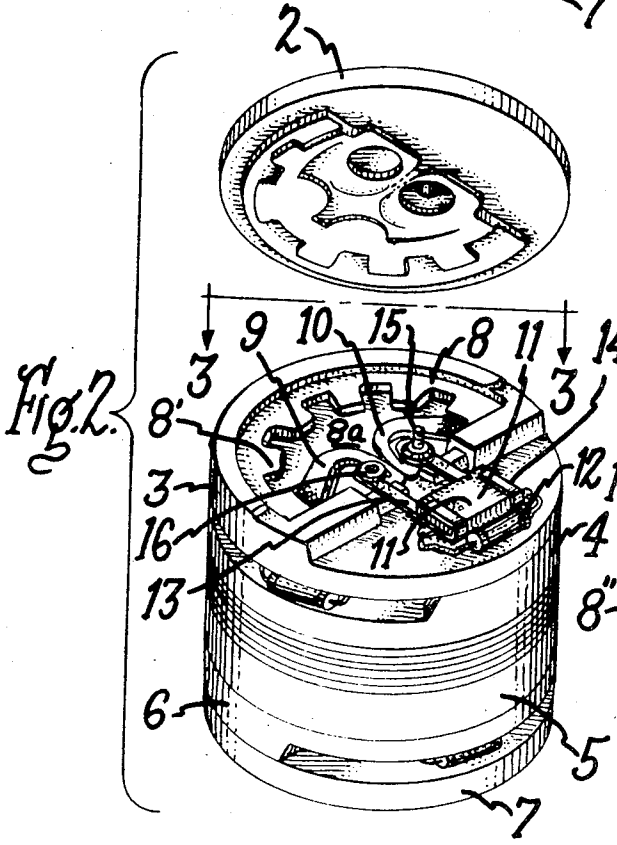
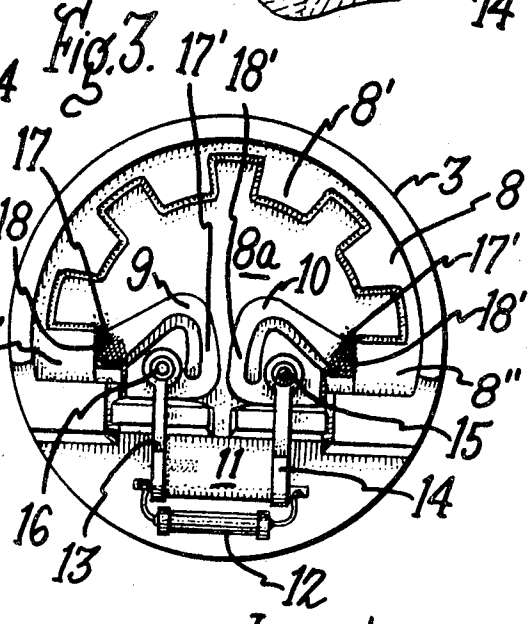


Fig. 3.



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SPARKGAP ASSEMBLY HAVING A SEMI-CONDUCTIVE COATING ADJACENT THE ELECTRODES THEREOF

BACKGROUND OF THE INVENTION

The present invention relates to a sparkgap assembly structure for lightning arresters or similar surge voltage arresters, and more particularly relates to such a surge voltage sparkgap assembly in which semi-conductive means are provided adjacent the sparkgap electrodes of the assembly to prevent the formation of corona-producing high voltage fields between the electrodes and metal particles eroded from them and splattered onto the insulating walls of the assembly.

It is common practice in the lightning arrester field to manufacture arrester sparkgap assemblies of granular insulating materials that are molded into self-supporting stacked plates. Such sparkgap assemblies normally include a number of such plates stacked on one another and arranged to define arcing chambers between adjacent plates. Conventionally, a pair of sparkgap electrodes are mounted within each of these arcing chambers and electric circuit means are connected between the respective electrodes to form a discharge path through each of the sparkgaps from one end of the assembly to the other. Various granular insulating materials may be used to form such insulating plates of a lightning arrester sparkgap assembly. One common type of granular material suitable for this purpose is ALURITE which is the type of material described in the porous sparkgap assembly structure described in U.S. Pat. No. 3,259,780, that issued on July 5, 1966 and is assigned to the assignee of the present invention.

In the manufacture of lightning arresters having sparkgap assemblies formed of porous insulating plates, it has been recognized that metal particles may be eroded from the electrodes of the assembly and splattered on the internal surface of the arrester arcing chambers, when a surge voltage is discharged through the assembly. Moreover, it is recognized that the presence of such metal particles in the arcing chamber of a sparkgap assembly can result in the formation of "radio noise," or corona discharge, due to the establishment of high voltage electric fields between the particles and the assembly electrodes by the normal line voltages present on the arrester electrodes during usual operating conditions.

Although high voltage lightning arresters are usually provided with electrical shielding that tends to diminish the effect of such "radio noise" producing sources on communications equipment, such as radios which may be in operation near a lightning arrester installation, it is now recognized that the presence of a corona-producing source within a sealed lightning arrester can have undesirably deletrious effects on the operating life and performance characteristics of such arresters. It is believed that these undesirable effects are due primarily to the generation of ozone gas during the corona discharges. The presence of ozone within the hermetically sealed environment of a high voltage lightning arrester can cause the insulating properties of the arrester components to deteriorate much more rapidly than they would if not contaminated by ozone. Moreover, the sparkover voltage of arresters that have been exposed to minor amounts of ozone for extended periods of time can be appreciably lowered, so that the arrester

might either fail due to its inability to clear an overvoltage surge, or it might ground a transmission system to which it is connected at an undesirably low level of over-voltage.

One prior art solution to this problem of "radio noise" sources caused by the erosion and splattering of electrode metal on the walls of lightning arrester sparkgap assembly arcing chambers is to remove such particles. Of course, this expedient is only practical when the arrester is opened, or unsealed, for some other reason; or if the assemblies have been splattered by pre-assembly testing or other manufacturing operations. Another drawback encountered with such techniques is that the arcing chamber may be damaged when subjected to the abrasive treatment often required to remove molten particles that have been partially embedded in the porous surfaces of such assemblies. In any event, such prior art procedures are expensive and time-consuming to practice.

A primary object of the present invention is to provide a sparkgap assembly for a surge voltage arrester which will overcome the above-mentioned problems in prior art surge voltage arresters.

Another object of the invention is to provide a sparkgap assembly with electrically semi-conductive means adjacent its electrodes, thereby to afford a means for preventing the formation of corona discharges between the electrodes and metal particles eroded from them.

A further object of the invention is to provide a sparkgap assembly having a high electrical resistance coating mounted on the dielectric housing of an arcing chamber of the assembly at points adjacent the electrodes mounted therein, so that any capacitive charge on metal particles disposed within the chamber adjacent the electrodes is drained through the coating to the electrodes following the discontinuance or reduction of a voltage that initiated such a charge.

Additional objects and advantages of the invention will become apparent to those skilled in the art from the description of it that is given herein.

SUMMARY OF THE INVENTION

In one preferred embodiment of the invention, a sparkgap assembly for a surge voltage arrester is formed of a plurality of self-supporting insulating plates. The plates are formed to define a plurality of arcing chambers between adjacent plates when they are stacked in their assembled position. Each arcing chamber has a pair of sparkgap electrodes of the horn-gap type mounted therein and, pursuant to the present invention, a coating of high resistance, electrically conductive material is mounted on the insulating walls of the arcing chambers adjacent the outermost end of each of the electrodes. The coating of electrically conductive material is thus positioned to cover or contact those areas of the arcing chamber most likely to have metal particles deposited on them as a consequence of the erosion of the sparkgap electrodes when a high voltage arc is discharged through the assembly. Accordingly, such particles are effectively connected, electrically to the electrodes, by the coating, so that no corona discharges are allowed to form between the particles and the electrodes.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a sparkgap assembly for a surge voltage arrester embodying the invention,

showing a plurality of self-supporting insulating plates stacked upon each other to form a number of arcing chambers in each of which a pair of sparkgap electrodes is mounted.

FIG. 2 is a partially exploded perspective view of the sparkgap assembly illustrated in FIG. 1, showing the interior of one of the arcing chambers, with a pair of horngap electrodes mounted therein and with the corona-preventing, high resistance electrical coating of the invention mounted on the walls of the arcing chamber adjacent the outer ends of the electrodes.

FIG. 3 is a top plan view of the sparkgap assembly shown in FIG. 2 taken along the plane 3—3 therein.

FIG. 4 is a fragmentary, perspective view, on an enlarged scale, of one of the electrodes and a portion of the arcing chamber of the sparkgap assembly shown in FIG. 3.

DESCRIPTION OF A PREFERRED EMBODIMENT

Referring now to FIG. 1 of the drawing there is shown a sparkgap assembly 1 for a surge voltage arrester. At the outset, it should be understood that the sparkgap assembly 1 may generally be of any conventional form. For example, one suitable form of such an assembly is described in detail in U.S. Pat. No. 3,259,780, which was mentioned above. Accordingly, except insofar as is deemed necessary or helpful to an understanding of the present invention, a detailed description will not be given herein of the various conventional components that may be found in such an assembly.

The sparkgap assembly 1 comprises an insulating housing that is formed of a plurality of molded insulating plates 2, 3, 4, 5, 6 and 7. As is well understood in the lightning arrester field, each of the insulating plates 2–7 is formed so that the plates define a plurality of arcing chambers, respectively between adjacent plates, when the plates are stacked in their self-supporting assembled position as shown in FIG. 1. Various configurations of wall means 8 may be used to define such arcing chambers 8*a* (see FIGS. 2 and 3) but in the preferred embodiment of the invention the wall means 8 include a plurality of arc-stretching teeth 8′ arranged around the periphery of the arcing chamber 8*a*. These teeth are shown between the plates 2 and 3, in phantom, in FIG. 1. It will be understood that similar wall means are used in each of the other arcing chambers located respectively between the remaining adjacent pairs of plates of the assembly 1.

By referring to FIG. 2 of the drawing, a clearer view of the wall means 8 and teeth 8′ can be seen. In addition, it will be observed that a pair of horngap electrodes 9 and 10 are mounted in spaced-apart relationship to define a sparkgap therebetween within the arcing chamber 8*a* defined by the wall means 8 and insulating plates 2 and 3. A capacitance type preionizer 11 and a grading resistor 12 are shunt connected by electrically conductive straps 13 and 14 to the electrodes 9 and 10, respectively. Again, it should be understood that similar preionizers and grading resistors will be shunted across the respective sparkgap electrodes positioned in the other arcing chambers of the assembly 1, in a manner well known in the art. Finally, electric circuit means are connected to each of the electrodes of the assembly 1 for transmitting an overvoltage surge to the electrodes during operation of the assembly. A portion of these circuit means are shown in FIG. 2 as a copper conductor 15 affixed to the electrode 10 and a second copper conductor 16 affixed to the electrode 9. Of course, similar copper conductors will be connected to the respective electrodes in the adjacent arcing chambers so that a discharge circuit is formed from the conductor 15 through the assembly 1 to a similar conductor (not shown) disposed in an aperture in the insulating plate 7.

The above-described structural features of the sparkgap assembly 1 are generally well known in the field of surge voltage arresters, and as pointed out at the outset of this description, various conventional components may be used to form these respective parts of the assembly 1. Now, the novel features of my invention will be described in detail with reference to FIG. 3 of the drawing. Since each of the arcing chambers of assembly 1 are substantially identical in configuration and function, only one of these arcing chambers is shown in FIG. 3, but it should be understood that the invention as described may be applied to each of the chambers of assembly 1.

There is shown in FIG. 3 a top view of the insulating plate 3 with the horngap electrodes 9 and 10 mounted thereon and electrically shunted by preionizer 11 and grading resistor 12. Also clearly visible in FIG. 3 are two patches of an electrically conductive coating 17 and 17′ mounted on the end teeth 8″ of wall means 8 defining the periphery of the arcing chamber 8*a*, and also disposed adjacent the outer portion of the arc-running surfaces of each of the electrodes 9 and 10. In the preferred embodiment of the invention depicted in FIG. 3, the patches of coating 17 and 17′ are positioned extending only over the outermost ends of the electrodes 9 and 10, but it will be understood that in other embodiments of the invention the coating may be extended along other areas of the wall means 8 defining the arcing chamber 8*a*, which are susceptible to being splattered with electrically conductive metal particles. Also, in the preferred embodiment of the invention, the patches of coating 17 and 17′ are in electrical contact, respectively, with the electrodes 9 and 10 by being painted directly on these electrodes, so that the coating is operable to form an electrical circuit between the arc-running surfaces of these electrodes and any electrically conductive particle that is in contact with the coating. For illustrative purposes, a number of metal particles 18 and 18′ are shown, respectively, positioned on the patches of coating 17 and 17′. As noted above, the metal particles 18 and 18′ may be deposited on the wall means 8 of the arcing chamber of plate 3 during the normal operation of the sparkgap assembly 1, when a high current arc is discharged through the assembly and, pursuant to the normal operation of the horngap electrodes, is moved outward along the arc-running surfaces of these electrodes so that the arc is forced into contact with the castellated teeth 8′ and 8″ or wall means 8 of the arcing chamber, where it is extinguished. (A clearer position of a common location of splattered particles 18′, with relation to the end of electrode 10 is depicted in FIG. 4 of the drawing.) In this extended position of the arc with its outward movement arrested by the wall means 8, the "feet" of the arc on the arc-running surfaces of electrodes 9 and 10 frequently generate sufficient heat to melt the ends of the electrodes, and the electromagnetic forces present in the arcing chamber tend to splatter the resultant

molten particles, such as particles **18** and **18'**, on the insulating surface of the arcing chamber **8***a*.

As just described, in the preferred embodiment of the invention, the high resistant electrical coating (**17** and **17'**) comprises two disconnected patches of coating **17** and **17'**, that are mounted respectively adjacent the outermost ends of each of the electrodes **9** and **10.** It has been found that the electrical resistance of each of these patches of coating should be at least 5,000 ohms per square unit thereof so that the magnitude of current caused to flow from isolated particles such as the particles **18** and **18'**, to the adjacent electrodes, is limited as a direct function of the resistance of the coating. A major advantage of a coating having such a resistance level resides in the fact that it is possible to position the patches of coating **17** and **17'** adjacent the respective electrodes **9** and **10,** without requiring that direct electrical contact be made between the coating patches and the electrodes. Due to the relatively low resistance of the coating, any tendency to develop a high voltage field on the particles **18** or **18'** is dissipated by current flow through the low resistance coating **17** or **17'**.

It has also been discovered that the electrical resistance of the patches of coating **17** and **17'** should be no greater than 100,000 ohms per square unit. If the electrical resistance of the coating is allowed to exceed this value, there is a risk of corona being developed between isolated particles that are relatively widely spaced from either of the electrodes **9** and **10.** In the preferred form of the invention, the electrical resistance of the patches of coating **17** and **17'** is maintained in the range of 15,000 to 30,000 ohms per square unit, because this resistance range affords an optimum damping action, as described above, while at the same time providing a sufficiently high resistance to prevent an arc that is created by the discharge of a surge voltage through the assembly **1** from forcing substantial arc current to flow directly through the coatings **17** and **17'**, rather than being confined to the electrodes **9** and **10.** This latter feature is particularly important when such an arc is moved to the outermost ends of the electrodes **9** and **10,** where there is some risk that the presence of the patches of coating **17** and **17'** might effectively prevent the movement of the arc further outward toward the extreme outer ends of the electrodes, if the electrical resistance of the coatings painted on the end teeth **8''** of wall means **8** was sufficiently low.

It will be appreciated that various different types of high resistance electrical semi-conducting material may be used to form the patches of coating **17** and **17'**. But, it should be understood from the foregoing that by "high" electrical resistance, as the term is used herein to described the invention, an electrical resistance in the range of 5,000 to 100,000 ohms per square unit of the coatings **17** and **17'** is meant. In order to provide a coating material that may be easily applied to the wall means **8** of a granular, or porous, insulating plate, such as plate **3** in the preferred embodiment of the invention, the high electrical resistance coating material used in this form of the invention comprises the following composition:

300 grams bentonite clay
85 grams carbon
1,200 milliliters alkophos C
1,500 milliliters water

In this composition the bentonite clay is used to provide a desirable degree of viscosity or "body" for the mixture. Those familiar with the properties of such compositions will realize that the amount of carbon and the type of carbon used will greatly affect the electrical properties of the coating, however, the relatively wide ranges of electrical resistance established above make it apparent that many types of carbon are suitable for practicing the invention. Alkophos C is an inorganic adhesive material. Of course, other adhesive materials may be used in practicing the invention, so long as those adhesives provide sufficient bonding strength to adhere the carbon to the insulating walls of wall means **8.**

In practicing the invention it has been found that the patches of coating **17** and **17'** should be at least 2 mils thick throughout a major portion of its surface area in order to assure a continuous electrical conductance between isolated particles such as particles **18** and **18'** and electrodes **9** and **10**; thereby to shunt the air gaps between these particles and the electrodes with a current-limiting, high resistance circuit. In order to easily provide a coating of this minimum thickness the foregoing preferred composition for the coating material is ideal, because it results in a sufficient viscosity to allow one painted-on, or sprayed-on, coating to equal or exceed the desired 2 mil thickness. A further important advantage of this preferred composition of the coating material is that the resultant coating material is easily handled and applied in the conventional type of manufacturing processes used to make voltage arrester sparkgap assemblies. At the same time, the composition, in its liquid or uncured state, possesses sufficient viscosity to prevent it from penetrating more than 100 mils through the interstices of the granules forming teeth **8''** of wall means **8.** Thus, the application of the patches of coating **17** and **17'** do not create a risk of flashover between the adjacent arcing chambers of sparkgap assembly **1,** when the electrodes of the assembly are energized with a given line voltage.

From the foregoing description of the invention, it will be apparent that various modifications and alternative embodiments of it may be developed without departing from its true scope. Accordingly, it is my intention to encompass within the following appended claims all such obvious embodiments of my invention.

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

1. A sparkgap assembly for an over voltage surge arrester comprising an insulating housing, wall means arranged to define an arcing chamber within said housing, a pair of electrodes mounted in spaced-apart relationship to define a sparkgap therebetween within said arcing chamber, electric circuit means connected to said electrodes for transmitting an over voltage surge to the electrodes, said electrodes being formed to have arc-running surfaces along which arcs are movable away from said sparkgap, and a coating of high resistance electrically conductive material mounted on said wall means adjacent to and extending beyond the sides of a portion of the arc running surfaces of each of said electrodes, said coating being operable to form an electrical circuit between the arc-running surfaces of said electrodes and any electrically conductive particle lodged on said wall means in contact with the coating thereby to prevent the formation of a high voltage electrical field between the electrode and said particle.

2. An invention as defined in claim 1 wherein said electrodes comprise horngap electrodes, and wherein said coating comprises two disconnected coating patches that are mounted respectively adjacent the outermost ends of each of said electrodes.

3. An invention as defined in claim 2 wherein said coating has an electrical resistance of at least 5,000 ohms per square unit thereof, whereby the magnitude of current caused to flow from said particle to the electrode adjacent it is limited as a direct function of the resistance of the coating.

4. An invention as defined in claim 3 wherein said coating has an electrical resistance no greater than 100,000 ohms per square unit thereof, thereby to afford a current conducting path that effectively shunts the air gap between said particle and the electrode adjacent to it and thereby prevents a corona discharge across said air gap.

5. An invention as defined in claim 4 wherein said coating is at least 2 mils thick throughout a major portion of its surface area.

6. An invention as defined in claim 4 wherein said wall means comprise a pair of juxtaposed insulating plates formed of granular insulating material having air vent passageways through the interstices of its granules, said coating being formed of an air curable material that is liquid in its uncured state and possesses sufficient viscosity to prevent it from penetrating more than 100 mils through the interstices of said wall means.

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