

United States Patent

Yereance et al.

[15] 3,703,665

[45] Nov. 21, 1972

[54] **ELECTRIC OVERVOLTAGE
ARRESTERS WITH IMPROVED
ELECTRODE DESIGN**

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[22] Filed: **Oct. 8, 1970**

[21] Appl. No.: **79,341**

Related U.S. Application Data

[63] Continuation of Ser. No. 866,656, Oct. 15,
1969, abandoned.

[52] U.S. Cl.**317/61, 315/36, 313/217,**
337/28

[51] Int. Cl.**H02h 1/04**

[58] Field of Search ..**317/61; 313/217, 209, 23, 325,**
313/351, 357; 315/36; 337/28

[56]

References Cited

UNITED STATES PATENTS

1,657,452	1/1928	Atherton	313/325
1,133,671	3/1915	Sharples	317/61
2,749,467	6/1956	Rigden	313/217 X
3,328,623	6/1967	Hale	313/217
3,366,825	1/1968	Lafferty	313/217

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[57]

ABSTRACT

An electric overvoltage arrester having a housing, a pair of spaced carbon electrodes, an annular insulating spacer within the housing and an assembly carried by the housing to hold the electrodes and spacer within the housing is provided for use in protecting electrical transmission lines from in-line voltage surges. One of the electrodes is recessed within the annular insulating spacer to define a gap distance between the opposing faces of the electrodes and the second electrode has a plurality of grooves cut in its upper and lower surfaces to define a pattern of grooves and plateau areas.

13 Claims, 4 Drawing Figures

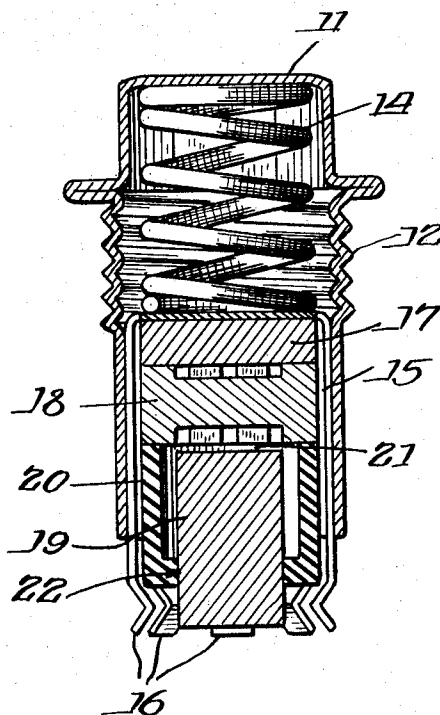


Fig. 1.

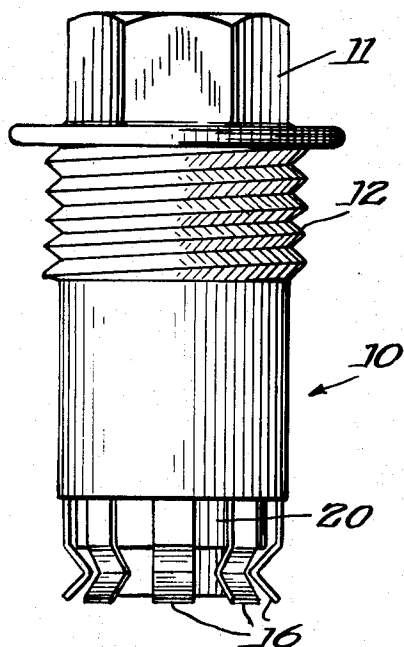


Fig. 2.

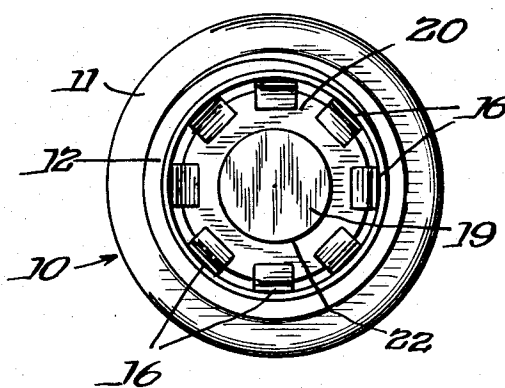


Fig. 3.

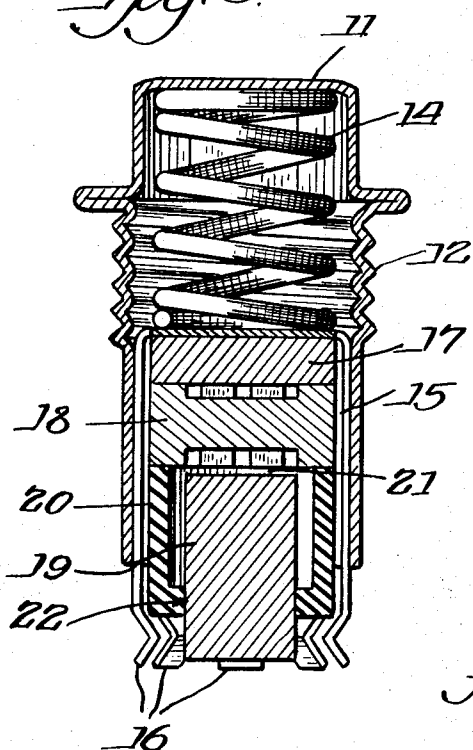
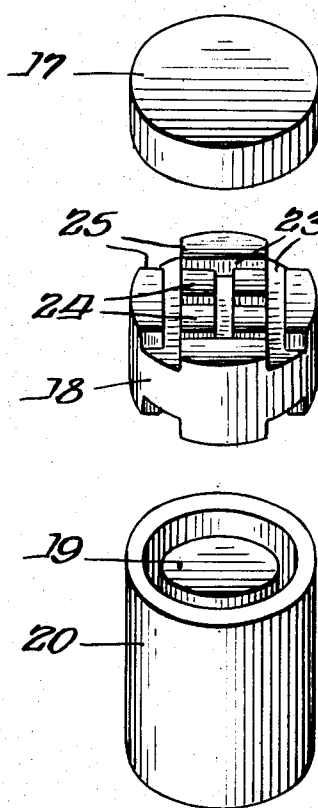


Fig. 4.



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ELECTRIC OVERVOLTAGE ARRESTERS WITH IMPROVED ELECTRODE DESIGN

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is related to an application for: METHOD FOR FUSING CARBON ELECTRODES AND INSULATING SPACERS USED IN ELECTRIC OVERVOLTAGE ARRESTERS. This application is a continuation of application Ser. No. 866,656, filed Oct. 15, 1969 and now abandoned.

BACKGROUND OF THE INVENTION

This invention relates to electric overvoltage arresters, often called electrical surge protectors or lightning arresters, which are used to protect telephone and other electrical transmission lines against the consequences of serious in-line voltage surges. More particularly, this invention concerns carbon electrode, spark gap type arresters that permit predetermined excess voltage surges to be discharged to ground.

Normally, such spark gap arresters have a valve characteristic that permits them to function both as non-conductors under normal voltage conditions and as conductors under high voltage conditions. Thus, when a high voltage surge, such as a lightning surge, is applied to a transmission line, the spark gap permits surge currents to flow to ground. After the surge has passed and normal line voltage is restored, however, the spark gap serves to insulate the line from ground to prevent leakage current through the arrester to ground.

Typically, the properties of effective carbon electrode, spark gap arresters include: high current-carrying capability, closely controlled firing or breakdown voltages, firing voltages independent of environmental conditions, such as temperature, humidity and altitude, fast firing times, and repeated surge capability or long life. Often, however, surface deficiencies resulting in the carbon electrode elements of spark gap type arresters after repeated firings make such arresters short-lived, e.g., an average of 30 to 40 firings before failure on arresters tested in accordance with R.E.A. standards, and thus, such arresters do not provide the high reliability needed in telephone protective service. Additionally, the mode of failure for many spark gap arresters is "non-safe" in the sense that the arresters fail in a permanently open-circuited manner in contrast with the preferred short circuiting failure between the arrester electrodes, which insures continued protection to the transmission line.

Although arrester failures can occur in a variety of ways, it has been found that two prime reasons for such failures are humidity effects on the carbon electrodes and actual physical breakdowns in the electrode surfaces which occur after repeated firings. The detrimental effect of humidity on the electrodes results when inadequate ventilation between the electrode surfaces causes water droplets to form on the electrodes during periods of changing atmospheric pressure and temperature. Furthermore, it has been observed that surface eruption and cratering in the carbon electrodes, which cause an upheaval and fissure of the electrode surfaces, frequently result from repeated firings over a long period of time.

SUMMARY OF THE INVENTION

According to this invention, a highly reliable, spark gap type electric overvoltage arrester capable of receiving repeated voltage surges over extended periods of time is provided for use in telephone line protective equipment. The general configuration of one form of the overvoltage arrester includes: a housing, a pair of spaced carbon electrodes, an annular insulating spacer within the housing, and an assembly carried by the housing to hold the electrodes and spacer within the housing.

A series of firing tests conducted on overvoltage arresters has shown that the problems of venting and electrode surface eruption and cratering can be obviated and that the life of such arresters can be markedly extended by placing a predetermined pattern of grooves on the surfaces of one or both of the spaced electrodes. The desired reduction in surface eruption and cratering has been observed to result only when a specific arrangement of grooves and plateau areas are used on the electrode surfaces.

More particularly, and in accordance with this invention, one of the electrodes is recessed within the annular insulating spacer to define a gap distance between the opposing faces of the electrodes and the second electrode has a plurality of grooves cut in its flat upper and lower surfaces. These grooves define a pattern of grooves and plateau areas; it has been found through extended significant that the ratio of each plateau area in the pattern to the combined groove area and plateau area is significant to obtaining repeated surge capability. Currently a ratio within the range of 0.35 to 0.65 is preferred.

In another embodiment of this invention, the surface of the carbon electrode recessed within the insulating spacer, and defining a gap space with the opposing face of the second electrode surface, also has a plurality of grooves in its surface. These grooves define a pattern of plateau areas and grooves in which the ratio of each plateau area in the pattern to the combined groove area and plateau area is likewise important to obtaining repeated surge capability. Typically, a ratio in the range of 0.55 to 0.70 is presently preferred.

The grooved surfaces on the second carbon electrode alone or on both the second carbon electrode and the electrode recessed within the insulating spacer vastly improve the repeated surge capability and useable life of arresters assembled from the electrodes, e.g., arrester life of 190 to 200 firings before failure as tested in accordance with R.E.A. standards. It is currently believed that one reason for the unusually high reliability and repeated surge capability of the overvoltage arresters of this invention is the additional ventilation which takes place between the opposing faces of the electrodes as a result of their grooved surfaces. This added venting allows expanded gases resulting from electrical discharge across the gap and disembody carbon particles from the electrode surfaces to be cleared away from the gap. Moreover, the use of particular groove depths in relation to the gap distance between the electrodes provides sufficient ventilation between the electrodes to inhibit the formation of moisture in the gap during periods of changing atmospheric pressure and temperature.

Finally, the grooved surfaces on the electrodes of this invention also provide a significant reduction in surface eruption and cratering on the electrodes after repeated firings. Thus, the use of particular grooved patterns on the electrodes serves both to increase the repeated surge capability, reliability and life of arrester units assembled from the electrodes and to make such arrester units particularly useful in telephone line protective equipment.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings illustrate several examples of the embodiments of this invention.

FIG. 1 is an end elevational view of one form of the electric overvoltage arrester of this invention;

FIG. 2 is a bottom plan view of the electric overvoltage arrester;

FIG. 3 is a longitudinal sectional view through the overvoltage arrester showing the pair of carbon electrodes and insulating spacer with a spring and basket assembly holding the electrodes and spacer within the outer housing;

FIG. 4 is an exploded perspective view of the overvoltage arrester showing the grooved surface patterns for one of the electrodes and showing the second electrode recessed within an annular insulating spacer.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings, the overvoltage arrester of this invention comprises an outer housing 10 shown in FIGS. 1 and 3 which is used as a body member to carry the other elements of the arrester assembly. Housing 10 is composed of a metallic, cylindrical-shaped body and is closed at one end by means of a cap 11. The opposite end of the cylindrical housing is open so as to receive the working components of the arrester. In addition, the capped end of housing 10 is provided with threaded portion 12 to allow the arrester to be adapted for use in larger electric overvoltage protective units.

The electrode and spacer components of the arrester are held within housing 10 by means of spring 14 which applies a slight bias to brass basket 15 when it is placed within the housing. Basket 15 is adapted to receive metallic disc 17, electrodes 18 and 19, and insulating spacer 20 within the plurality of tongues 16 which surround the bottom portion of the basket. When the basket is inserted within housing 10, the plurality of tongues 16 are slightly compressed so that the electrodes, metallic disc and insulating spacer are firmly held within the housing. Similarly, when it is desired to remove basket 15 from the housing, the tongues 16 are depressed and the basket is pulled from the housing. Consequently, the arrester components can be quickly assembled or replaced by merely removing basket 15 from the housing.

The pair of electrodes used in the arrester is preferably a carbon disc-shaped electrode 18 and a cylindrical, rod-shaped carbon electrode 19 recessed within annular insulating spacer 20 to define a gap distance 21 between the electrodes. Metallic disc 17 merely serves as an electrical connecting means between disc electrode 18 and basket 15. Since metallic disc 17 bears against one surface of disc electrode

18 and annular insulating spacer 20 bears against the opposite face of the disc electrode, it can be seen that the gap distance 21 between the electrodes is determined by the distance that cylindrical electrode 19 is recessed within insulating spacer 20. The position of the cylindrical electrode in the insulating spacer is established during manufacture and is fixed by means of a bonding composition which secures the electrode to the spacer 22. One end of cylindrical electrode 19 extends beyond the lower edge of insulating spacer 20 and is conveniently arranged for electrical connection to the line or ground.

Attention is directed to the plurality of grooves 23 cut in the flat upper and lower surfaces of disc-shaped electrode 18 which define a pattern of grooves 23 and plateau areas 24. The purpose of the grooves is to provide a space for ventilation between the disc electrode 18 and rod electrode 19, to reduce the degree of electrode surface eruption, i.e., the upheaval and fissure of the disc-shaped electrode surface, and to increase the repeated surge capability and life of the assembled arrester. As shown in FIG. 4, a rectangular pattern of plateau areas 24 and grooves 23 is normally used in disc-shaped electrode 18. However, it is understood that other arrangements of grooves and plateau areas would also be suitable for use in the electrodes of this invention. The four smaller plateau areas 24, as contrasted with larger plateau areas 25, are typically arranged to coincide with the corresponding surface area of cylindrical electrode 19 which forms the spark gap with disc electrode 18.

Repeated performance tests have shown that the use of particular groove patterns on the disc-shaped electrode reduce the rate at which surface eruptions, and consequently, arrester failures occur after repeated firings of the electrodes. One explanation for this improved repeated surge capability of the overvoltage arresters of this invention is that the pattern of grooves and plateau areas in the disc-shaped electrode reduce surface eruptions which appear as a result of high sub-surface pressures caused by local heat build up in the region of the discharge arc between the electrodes. In addition, the pattern of grooves provides an area to dissipate the expanding gases resulting from electrical discharge across the gap and provides recesses for any disturbed or disembody carbon particles created by the discharge. Thus, the grooves also allow venting or movement of discharge debris during operation of the arrester.

The size and spacing of grooves 23 and plateau areas 24 are determined by the evaluation of test results for arrester firing performance and by the structural limitations of the disc-shaped electrode. A suitable parameter used in defining the size and depth of grooves 23 and the size of plateau areas 24 is the ratio of each individual plateau area (A_m) in the pattern to the combined groove area (A_g) and plateau area (A_m) where groove area is defined as the area from the center line of each groove adjacent to the plateau area to the edge of each plateau area. Thus, for example, if the width of grooves 23 shown in FIG. 4 is 30 mils and the dimensions of each square plateau area 24 is 50 mils $\times$ 50 mils, then each plateau area is 0.0025 inch² and the combined groove area and plateau area is 0.0064 inch². Consequently, the ratio of each individual plateau area

to the combined groove area and plateau area ($A_m/A_m + A_g$) is 0.0025 over 0.0064, or approximately 0.39. The desired ratio of plateau area to combined groove area and plateau area is in the range of about 0.35 to 0.65. It has been found, for example, that nearly a five-fold increase in arrester life can be accomplished by using a patterned disc-shaped electrode, having a plateau area to combined groove area and plateau area ratio of about 0.35 to 0.65, and a flat smooth surfaced cylindrical electrode.

While the desired ratio of each individual plateau area to the combined groove area and plateau area ($A_m/A_m + A_g$) permits a determination of the relative size and spacing of grooves 23 and plateau areas 24 in disc-shaped electrode 18, it does not allow one to determine the exact size and number of individual plateau areas desired on the electrode surface. This latter determination can be made from an empirical analysis of firing tests carried out on the arresters. It has been observed, for example, that craters are formed on the cylindrical, rod-shaped electrode after repeated firings. Since this cratering effect appears to be a consequence of electrode polarity, crater formation inevitably occurs on the more positive electrode, which in this instance is rod-shaped electrode 19. Moreover, it is observed that crater diameter for any environment can be expressed as a function of the magnitude of the discharge current, electrode gap distance and electrode composition.

Firing tests carried out on arresters having non-patterned disc-shaped electrode and rod-shaped electrode surfaces showed a recurring formation of craters having diameters of 40 mils. Subsequent tests using disc-shaped electrodes having patterned surfaces showed that arrester life could be vastly improved when the size of plateau areas 24 on the disc-shaped electrode approximate the diameter of the craters formed on the rod-shaped electrode. More specifically and as a result of the firing tests, it is presently preferred that the plateau size be set so as to define ratios of plateau width to crater diameter ranging from about 0.50 to 1.50. Thus, for example, the plateau width for the disc-shaped electrode used in the present invention is preferably about 20 to 60 mils, e.g., corresponding to plateau width to crater diameter ratio of about 0.50 to 1.50 (20/40 to 60/40), since the observed crater diameter is 40 mils. It should be understood, however, that the width of plateau area 24 also defines its length, since the plateau area is square shaped.

With these factors in mind, therefore, one can first determine the crater sizes which recur on the rod-shaped electrode surface and then define the range of plateau widths based on the preferred plateau width to crater diameter ratio of 0.50 to 1.50. Finally, the spacing of grooves and plateau areas can be determined by the preferred range of 0.35 to 0.65 for the ratio of each individual plateau area to combined groove area and plateau area. Thus, empirical test firing results for any arrester can be used to define the pattern of grooves and plateau areas on the disc-shaped electrode.

The desired depth of grooves 23 in disc-shaped electrode 18 is determined by striking a balance between the minimum depth necessary to assure adequate venting between opposing electrode surfaces and the maximum allowable depth required to insure the structural

integrity of the disc-shaped electrode. Consequently, it is presently preferred that the desired groove depth be at least three times greater than gap distance 21 between the opposing faces of the electrodes to assure adequate venting and not greater than the width of the grooves for structural reasons. Thus, if the groove width is 30 mils, or 0.03 inch, and the gap distance between the electrodes 6.6 mils, or 0.0066 inch, then the groove depth is at least 20 mils but not more than 30 mils.

The significance of the use of a specific pattern of grooves and plateau areas on the flat surfaces of the disc-shaped electrode is illustrated by arrester firing tests comparing the effects of grooved versus non-grooved disc-shaped electrodes on arrester life and performance. A disc-shaped electrode having a ($A_m/A_m + A_g$) ratio of 1.0, i.e., no grooves, is used for comparative purposes. A patterned disc-shaped electrode having a ($A_m/A_m + A_g$) ratio of 0.8 offers a moderate improvement over arresters using a non-grooved electrode because narrow grooves do not permit adequate ventilation between the electrode surfaces. In addition, such patterned electrodes are difficult to fabricate. A patterned disc-shaped electrode having a ($A_m/A_m + A_g$) ratio of 0.65 shows some improvement over non-grooved electrodes but is likewise difficult to fabricate. However, a patterned disc-shaped electrode having a ($A_m/A_m + A_g$) ratio of 0.39 offers substantial improvements in arrester life as compared to non-grooved electrodes, and is both readily fabricated and structurally sound. When a patterned electrode having a ($A_m/A_m + A_g$) ratio of 0.01 is used in an arrester, however, arrester life is reduced by comparison to non-grooved electrodes. Moreover, a patterned electrode with a ($A_m/A_m + A_g$) ratio of 0.1 is extremely fragile and impractical to fabricate.

It can be seen therefore, that the relative size and width of the grooves and plateau areas used on the surface of disc-shaped electrode 18 significantly effect the repeated surge capability of overvoltage arresters. In addition, the use of specific groove patterns reduces both the amount of surface eruption and damage in the disc-shaped electrode and the probability of current leakage from line to ground through the arrester.

Although it is not necessary to score the recessed surface of cylindrical, rod-shaped electrode 19, it is sometimes desirable to use a pattern of grooves and plateau areas on the rod-shaped electrode as well as the disc-shaped electrode to further improve the repeated surge capability of the arresters. However, in some instances, the use of a patterned surface on the cylindrical electrode increases the number of arrester failures by open-circuit which, of course, is undesirable. When the surface of cylindrical electrode 19 is grooved to define a pattern of grooves and plateau areas, it is desired that the ratio of each plateau area to the combined groove area and plateau area is about 0.55 to 0.70. For structural and fabrication reasons, the depth of grooves used in the surface of the cylindrical electrode should not exceed 1.5 times the groove width. Thus, for example, an electrode having a groove width of 6 mils should not have grooves which exceed a depth of 9 mils. The use of grooved surfaces on the cylindrical electrode tends to reduce the instances of crater formation on the electrode surface. In determining the size

and spacing of the grooves on the electrode surface, it is desirable that the size of the plateau areas approximate the size of the craters formed on the electrode surface. Since the results of firing tests on specific arresters showing a recurring crater size, 40 mils in diameter, appearing on the cylindrical electrode surface, it is desirable that the plateau width on the electrode surface be about 20 to 60 mils (e.g., plateau width to crater diameter ratio of about 0.50 to 1.50).

When a non-patterned, smooth surfaced cylindrical, rod-shaped electrode is used in the overvoltage arrester of this invention in combination with a pattern disc-shaped electrode, it is noticed that a slight groove pattern corresponding to the pattern on the disc-shaped electrode will begin to appear on the cylindrical electrode after repeated firings across the spark gap. The advantages of a pre-patterned cylindrical electrode are minimized, therefore, because a patterned effect tends to naturally arise after repeated arrester firings.

In fact, the observed cratering or erosion effect on the rod-shaped electrode corresponding to the pattern on the disc-shaped electrode makes the flat-surfaced, non-patterned, rod-shaped electrode in combination with the patterned disc-shaped electrode the preferred arrester assembly of this invention. The formation of craters on the rod-shaped electrode corresponding to plateau areas 24 on the disc-shaped electrode is understandable, of course, when it is realized that discharge will occur only on those areas of the rod-shaped electrodes which correspond to the plateau areas in the disc-shaped electrode. Therefore, extended arrester life can be accomplished by using a patterned disc-shaped electrode and a non-patterned rod-shaped electrode.

In a suitable embodiment of this invention, a pair of spaced electrodes are used in which the disc-shaped electrode has a diameter of 0.315 inch and the cylindrical electrode has a diameter of 0.173 inch. In addition, the disc-shaped electrode has a rectangular pattern of grooves and plateau areas on its flat upper and lower surfaces as shown in FIG. 4, while the surfaces of the cylindrical electrode are non-patterned. A groove width of 0.03 inch and groove depth of 0.02 inch are used in the rectangular pattern. In addition, the dimensions of the four square plateau areas are 0.05×0.05 inch.

Firing tests conducted on arresters assembled from such electrodes showed that the average life of the arresters was on the order of 190 to 200 strikes or more as compared to about 30 strikes for arresters using non-patterned disc-shaped electrodes. Firing tests carried out on similar arresters showed that a desirable range for the groove widths used in the disc-shaped electrode are about 10 to 30 mils and that a desirable groove depth, measured by the sum of the groove depths on both surfaces of the electrode, should not exceed 30 percent of the total electrode thickness. Likewise, it was observed during firing tests carried out on arresters using patterned surfaces on both the disc-shaped and cylindrical electrodes, that the cylindrical electrode groove depths in excess of 10 mils resulted in a high percentage of open-circuit failures while groove depths between 6 to 9 mils resulted in improved repeated surge capability with reduced failures by open circuit.

We claim:

1. An electric overvoltage arrester for protecting telephone and the like equipment from voltage surges transmitted by lines associated with such equipment, comprising a housing, a pair of spaced electrodes, an insulating spacer separating said pair of electrodes, said housing including means for maintaining said pair of electrodes and said insulating spacer in assembled relationship, said insulating spacer being disposed relative to said pair of electrodes to orient opposing faces of said pair of electrodes in predetermined spaced relation to define an air gap between said opposing faces of said pair of electrodes, at least one of said electrodes having a plurality of grooves in at least one of said opposing faces to define a pattern of grooves and plateau areas, the ratio of each plateau area in said pattern to the combined groove area and plateau area being 0.35 to 0.65.

2. An electric overvoltage arrester as defined in claim 1, wherein the grooves in said one electrode have a depth of at least three times said gap distance between opposing faces of said electrodes.

3. An electric overvoltage arrester as defined in claim 2, wherein the size of said plateau areas is defined by the diameter of craters formed in the surface of the other of said pair of electrodes and wherein the width of said plateau area to said crater diameter is 0.50 to 1.50.

4. An electric overvoltage arrester as defined in claim 1, wherein the surface of the other of said pair of electrodes has a plurality of grooves defining a pattern of grooves and plateau areas, wherein the ratio of each plateau area in said pattern to the combined groove area and plateau area is 0.55 to 0.70.

5. An electric overvoltage arrester as defined in claim 4 wherein said grooves in the surface of said other electrode have a depth not in excess of 1.5 times the width of said grooves.

6. An electric overvoltage arrester as defined in claim 5, wherein said means comprises a basket having a plurality of projecting tongues to surround and hold said electrodes and said spacer within said housing.

7. An electric overvoltage arrester as defined in claim 5, wherein said other electrode is a cylindrical carbon electrode, recessed within said insulating spacer, and said one electrode is a disc-shaped electrode, the grooves in said disc-shaped electrode having a depth of 10 to 30 mils and the grooves in said cylindrical electrode having a depth of 6 to 10 mils.

8. In an electric overvoltage arrester having a housing, a pair of spaced carbon electrodes having a gap space between them, an insulating sleeve disposing said electrodes in spaced apart relationship to define an air gap, and said housing including means for holding said electrodes and said sleeve in assembled relationship, the improvement comprising one of said electrodes being a generally disc-shaped electrode and the other being a generally cylindrical electrode spaced from said disc-shaped electrode, said disc-shaped electrode having substantially flat upper and lower surfaces, the lower surface of which faces said cylindrical electrode and contains a plurality of grooves which define a pattern of grooves and plateau areas, the ratio of each plateau area in said pattern to the combined groove area and plateau area being 0.35 to 0.65, and said grooves in said disc-shaped electrode having a depth of 10 to 30 mils.

9. An electric overvoltage arrester as defined in claim 8, wherein said cylindrical electrode has a surface which forms the gap with the lower surface of said disc-shaped electrode and which has a plurality of grooves defining a pattern of grooves and plateau areas, the ratio of each plateau area in said pattern to the combined groove area and mesa area being 0.55 to 0.70 and the depth of said grooves being 6 to 10 mils.

10. An electric overvoltage arrester comprising a housing, a pair of spaced carbon electrodes, an insulating spacer separating said electrodes, and means carried by said housing for holding said electrodes and said insulating spacer within said housing, said insulating spacer being disposed relative to said pair of electrodes to orient opposing faces of said pair of electrodes in predetermined spaced relation to define an air gap between said opposing faces of said pair of electrodes, at least one of said electrodes having a plurality of grooves in at least one of said opposing faces to define a pattern of grooves and plateau areas, the ratio of each plateau area in said pattern to the combined groove area and plateau area being 0.35 to 0.65.

11. In an electric overvoltage arrester of the type including a housing in the interior of which are disposed a hollow insulating spacer, a first carbon electrode disposed within the spacer, and a second carbon electrode disposed adjacent one end of the spacer with the first and second electrodes having opposed surfaces spaced from each other to define an air gap disposed within a closed chamber defined by the spacer and first and second electrodes, the opposed surface on the second electrode being disposed adjacent the said one end of the spacer, the improvement comprising a plurality of grooves in the opposed surface of the second electrode forming a pattern of individual planar plateau areas separated from each other by the grooves, and cooperating structures on the spacer and the second electrode defining passage means placing the chamber

containing the air gap in communication with the interior of the housing, said cooperating structures including at least two spaced ones of said grooves adjacent opposite edges of the second electrode forming spaced projections resting on the end of the spacer and larger than the plateaus, portions of said spaced grooves extending across the end of the spacer to define the passage means and placing the chamber containing the air gap in communication with the interior of the housing at points spaced around the air gap.

12. An electric overvoltage arrester comprising a housing having an open end, a hollow insulating spacer having first and second ends and disposed within the housing with the first end adjacent the open end of the housing, a first carbon electrode disposed within the spacer with one end of the first electrode sealed in the first end of the spacer and with the other end of the first electrode spaced below the second end of the spacer, a second carbon electrode disposed adjacent and closing the second end of the hollow spacer so that the hollow spacer and the first and second electrodes define a closed chamber, said other end of the first electrode and the area of the second electrode adjacent the spacer having opposed surfaces spaced from each other to define an air gap within the closed chamber, and a plurality of grooves in the opposed surface of the second electrode forming a pattern of individual planar plateau areas separated from each other by the grooves, at least one of the grooves having a portion extending transversely across a part of the second end of the spacer to form passage means placing the closed chamber containing the air gap in communication with the housing.

13. The arrester set forth in claim 12 in which pairs of transversely extending grooves intersect at a point above said second end of the spacer to form the passage means.

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