C. F. FRANK.

PROTECTIVE DEVICE.

APPLICATION FILED MAY 15, 1914.

1,159,205. Patented Nov. 2, 1915.

2 SHEETS—SHEET 1.

Fig. 1.

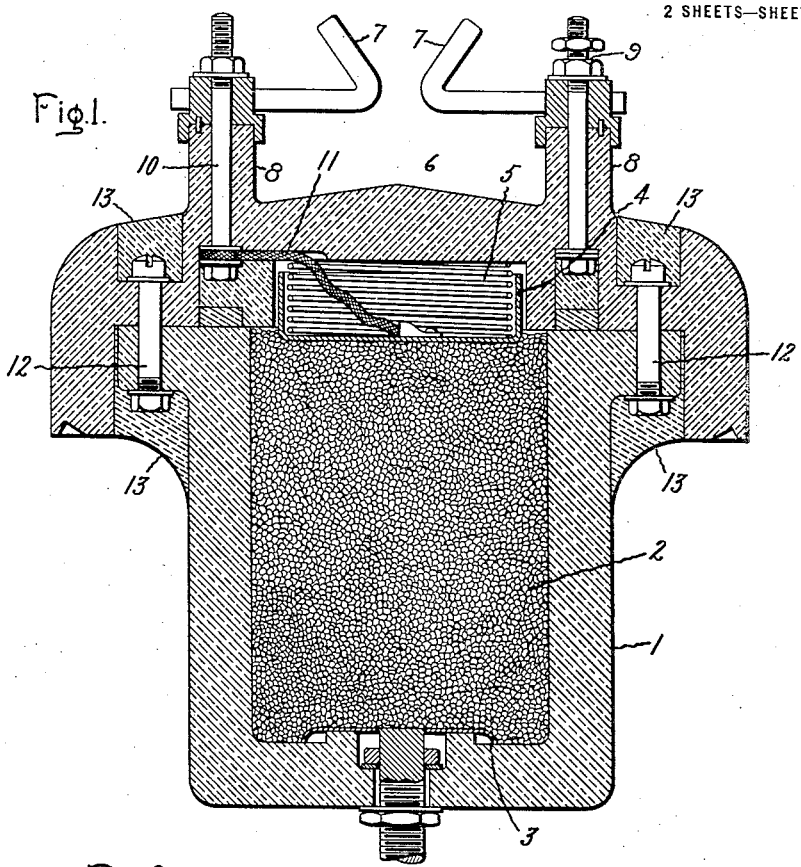
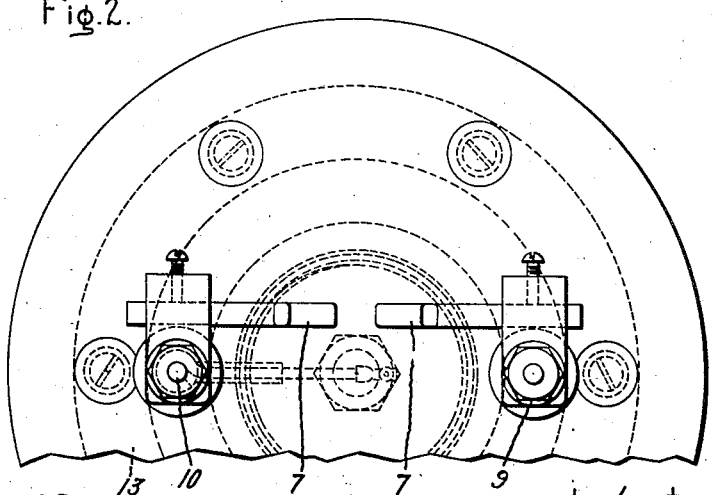


Fig. 2.



Witnesses:

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2 SHEETS—SHEET 2.

Fig. 3.

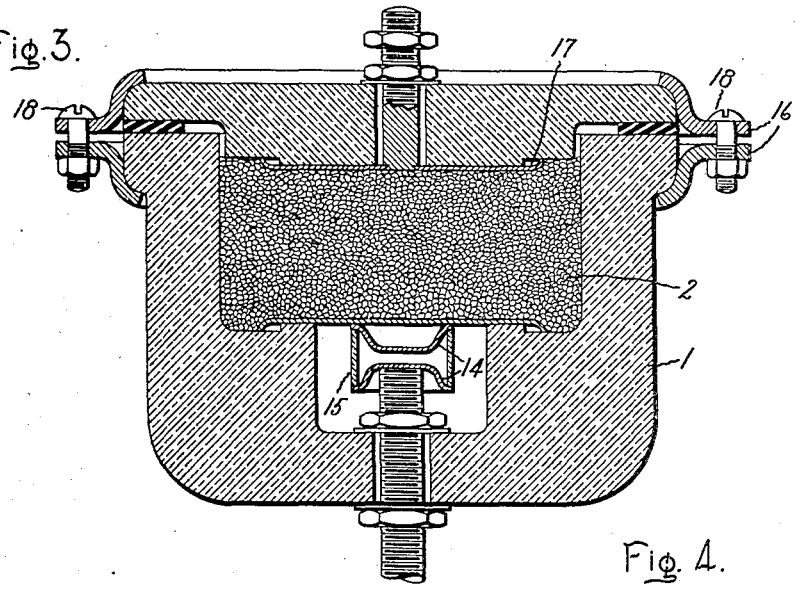
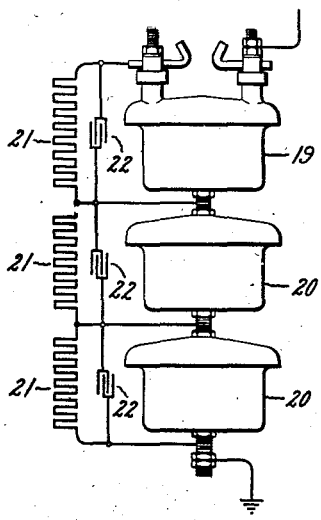
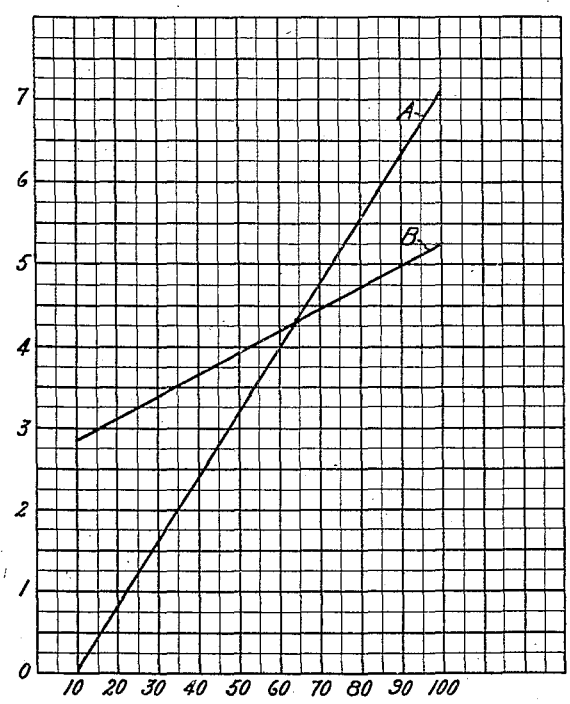


Fig. 4.

Fig. 5.





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Inventor:
Crosby F. Frank,
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His Attorney.

UNITED STATES PATENT OFFICE.

CROSBY FIELD FRANK, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

PROTECTIVE DEVICE.

1,159,205. Specification of Letters Patent. Patented Nov. 2, 1915.

Application filed May 15, 1914. Serial No. 838,675.

To all whom it may concern:

Be it known that I, CROSBY FIELD FRANK, a citizen of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Protective Devices, of which the following is a specification.

The present invention relates to the protection of electrical distribution systems and conductors from the abnormal conditions due to lightning, static disturbances, resonance, switching, etc.

The object of my invention is to provide apparatus which will relieve the line of these abnormal conditions, particularly abnormally high potentials, by providing a path to earth of comparatively low resistance and which will at the same time prevent any heavy flow of the dynamic current from the line over the same path.

In carrying my invention into effect I make use, as a part of the path to earth, of a body of finely divided granular material possessing certain predetermined electrical characteristics. Carborundum is especially suitable for this purpose though other materials such as boron or its compounds, ilmenite, etc., having the desired characteristics may be employed.

The most marked characteristics of the material used is its rapid decrease in resistance when subjected to voltages above a certain critical value. If the potential across a mass of loose carborundum granules be increased gradually, at a certain point the current will suddenly begin to increase very rapidly, in this respect much resembling the volt ampere curve of an aluminum cell. As soon as the voltage decreases to its normal value the resistance increases rapidly to its initial value.

My invention will be best understood by reference to the accompanying drawings forming a part of this specification and in which:

Figure 1 shows a cross-section of one form of my apparatus; Fig. 2 is a partial plan view thereof; Fig. 3 shows a modification; Fig. 4 is a diagrammatic representation of the relation between the size of the granules employed and the equivalent needle gap of the arrester under static conditions and corresponding to dynamic breakdown; Fig. 5 illustrates diagrammatically a system for connecting the arrester to the line which may be desirable in some cases, especially when used on a high voltage system.

In the particular form of my invention shown in Fig. 1, a container 1 of porcelain or other suitable insulating material holds a mass 2 of granules of carborundum or other suitable material. At the bottom of this mass I provide an electrode 3 having a rounded edge and having a smaller area than the cross-sectional area of the container. At the top of the mass is placed a second electrode 4 which is also smaller than the cross-sectional area of the container. A coiled spring 5 between the cover 6 and the electrode insures a uniform contact pressure between the electrode and the mass of granules. In order to prevent leakage of current through the arrester under normal operating conditions it will usually be found desirable to provide a spark gap in series with the arrester. This gap should be of such dimensions that the complete arrester will withstand the normal voltage of the line but will break down under any appreciable increase in the potential applied to it. In this case I have shown a gap of the horn type, the horns 7, 7 being suitably mounted on projections 8, 8 on the cover of the arrester. A terminal 9 is provided for connecting the line wire to one of the horns and the other horn is connected by means of the bolt 10 and the flexible connector 11 to the electrode 4. The cover may be held in place by bolts 12 which may be concealed by suitable water-proofing compound 13 to render the arrester thoroughly waterproof and suitable for outdoor use.

In the form of my device shown in Fig. 3, a spark gap is provided of the compression chamber type. This comprises electrodes 14 made of thin sheets or disks of metal suitably dished or concaved as shown. These electrodes are spaced, so as to have a gap between them, by a ring 15 of insulating material which engages them near their edges so as to form a substantially closed chamber containing the gap. When a discharge occurs from one electrode to the other through the spark gap the air in the gap is heated and its pressure increased. This in-

creases its tendency to extinguish the arc which forms. The cover in this case is shown as held in place by clamping rings 16 and the pressure of the upper electrode 17 upon the mass of granules may be adjusted to a certain extent by means of the clamping bolts 18.

In determining the characteristics of the material to be used, I have discovered that with pure carborundum granules the breakdown voltage of a mass of the granules of a given length is directly dependent upon the size of the granules used. This variation in the breakdown voltage with the size of granules is illustrated in Fig. 4 in which the ordinates represent the value of the equivalent needle gap and the abscissæ represent the size of the granules used as determined by passing them through a series of screens having from 10 to 100 meshes per inch. Curve A represents the measure of the ability of the mass to resist dynamic breakdown and curve B represents the measure of its ability to discharge high potential static charges. It will be noted that the smaller sizes of granules are apparently much better in their protective value for carrying away static as compared with their dynamic breakdown but I have discovered that if the granules are too small difficulty is experienced due to rapid heating and a tendency of the granules to weld together. The larger granules have greater heat absorbing qualities and will withstand much heavier discharges for a longer period without welding together. On this account I have found it best in practice to adopt a compromise between the two qualities and use only granules which will pass through the 40 mesh screen and will not pass through the 80 mesh. By using granules which come between these limits I secure a breakdown effect approximately the same as that of the 60 mesh granules and it will be noted that with granules of that size the breakdown voltage is practically the same for dynamic as for static. Inasmuch as the voltage of the disturbances which it is desired to remove from the line are always appreciably higher than the line voltage, this size of granules will be entirely suitable, whereas if larger granules were used the static breakdown voltage would be much greater than the dynamic and the arrester would fail in some cases to afford the desired relief to the line.

In some cases especially when high voltage lines are to be protected it will be desirable to employ several units in series rather than to use a single unit with a long column of granular material. An arrangement of this kind is illustrated in Fig. 5. The top unit 19 which is connected to the line in this case may be of the form shown in Figs. 1 or 3 while in the other units 20 the spark gap will preferably be omitted. In order to secure a uniform distribution of potential over the different units they may be shunted by high resistances 21 as indicated. It may also be desirable to place condensers 22 in shunt with each unit.

I am aware that lightning arresters have previously been constructed in which the breakdown characteristic of carborundum at a critical voltage has been employed. As usually constructed, however, the carborundum granules have been mixed with a binder and molded into blocks. With this form of arrester it has been found difficult in the process of manufacture to accurately predetermine the equivalent spark gaps of the discharge blocks as well as the opposition offered by them to the passage of dynamic current after discharges. The heat dissipating properties of this form of arrester have also been so poor that they have soon failed when subjected to a continued discharge. With an arrester constructed according to my method, however, the equivalent spark gap is known to depend directly upon the distance between the electrodes and the size of the granules used and hence may be accurately predetermined. An arrester of this nature also has much better heat dissipating qualities than one constructed with molded carborundum blocks.

In constructing my arrester I have found that if the electrodes are made of the same size as the cross-sectional area of the container, there is a tendency for the discharge to follow paths along the wall of the container and that for some reason the granules weld together along these paths and the resistance of the arrester is greatly decreased. To overcome this difficulty, I have made the electrodes of less area than the interior of the container so that the discharge must pass through a larger number of granules in order to find a path along the wall. By this construction the discharge is uniformly distributed throughout the entire mass of granules. I have also found that carborundum granules as obtained commercially are not suitable for my purpose probably because of the presence of impurities such as graphite or metallic particles. Apparently these impurities cause the granules to weld together more easily. By taking the carborundum mass as it comes from the furnace, crushing it dry and carefully sifting it however, I secure material which seems to be entirely free from impurities. This is apparently due to the fact that the impurities are softer than the carborundum and hence are ground much finer and also that inasmuch as no water is used in the process the impurities do not stick to the carborundum granules. Microscopic examination shows that granules prepared according to my invention are clear and bright and have sharp edges while those prepared

by the ordinary commercial methods have a dull appearance and the edges are not as sharp.

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

1. In a protective device in combination a container, electrodes at opposite ends thereof and a mass of granules of carborundum between said electrodes, said granules being of such a size that they will pass through a screen having forty meshes to the inch but will not pass through a screen having eighty meshes to the inch.

2. In a protective device in combination a container, electrodes of less area than the container at opposite ends thereof and a mass of granular material having a critical breakdown voltage between said electrodes, the granules of said mass being of such a size that they will pass through a screen having forty meshes to the inch but will not pass through a screen having eighty meshes to the inch.

3. In a protective device in combination a container, electrodes of less area than the container at opposite ends thereof, a mass of granular material having a critical breakdown voltage between said electrodes, the granules of said mass being of such a size that they will pass through a screen having forty meshes to the inch but will not pass through a screen having eighty meshes to the inch, and a spring for holding said electrodes firmly in contact with said mass of granular material.

4. In a protective device in combination a container, electrodes of less area than the container at opposite ends thereof, a mass of granules of carborundum between said electrodes, said granules being free from impurities and of such a size that they will pass through a screen having forty meshes to an inch but will not pass through a screen having eighty meshes to an inch.

In witness whereof, I have hereunto set my hand this 13th day of May, 1914.

CROSBY FIELD FRANK.

Witnesses:

BENJAMIN B. HULL,

MARGARET E. WOOLLEY.