Dec. 11, 1923. **1,477,306**

C. T. ALLCUTT

PROTECTIVE DEVICE

Filed Aug. 15, 1919

Fig. 1.

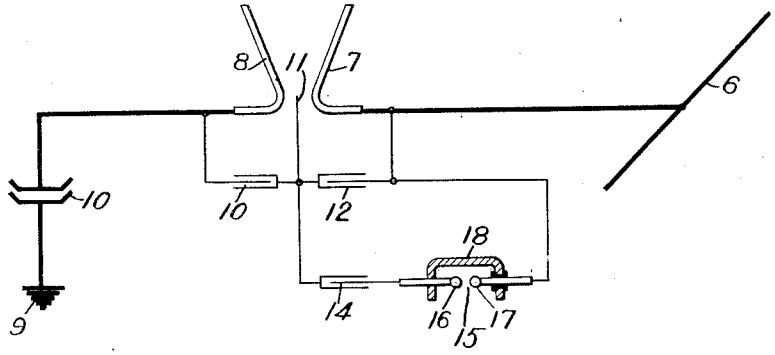


Fig 2.

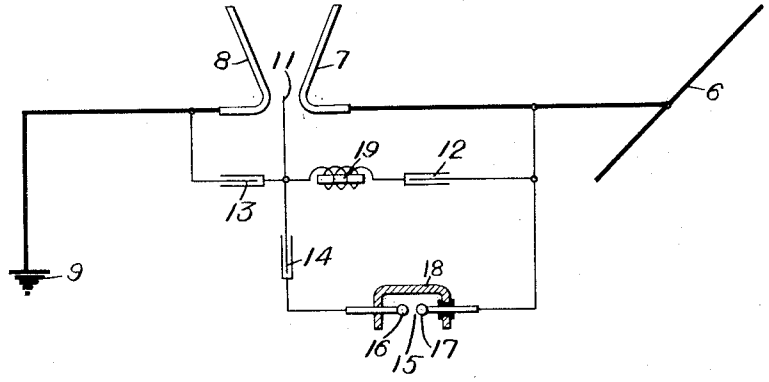


Fig. 3.

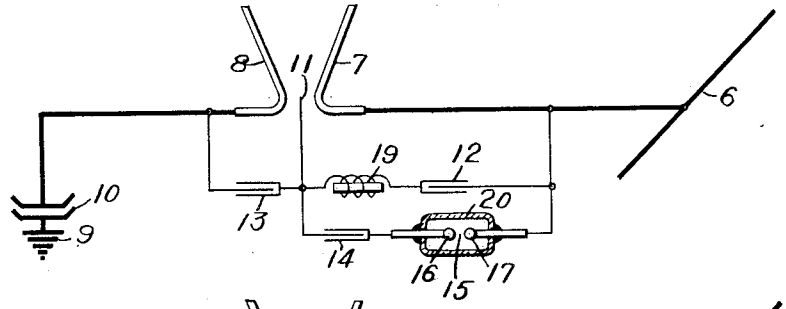
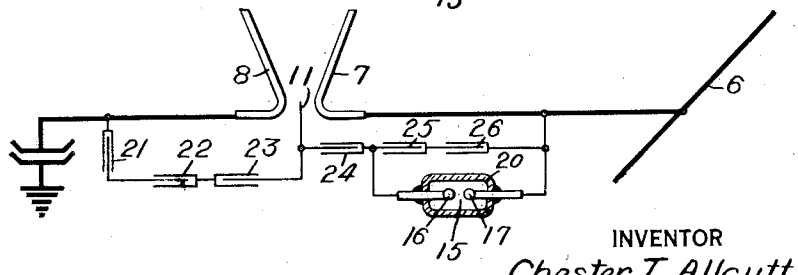


Fig. 4.



WITNESSES:

J. A. Helsel

F. A. Lind.

INVENTOR

Chester T. Allcutt.

BY

Wesley G. Carr

ATTORNEY

Patented Dec. 11, 1923. 1,477,306

UNITED STATES PATENT OFFICE.

CHESTER T. ALLCUTT, OF PITTSBURGH, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA.

PROTECTIVE DEVICE.

Application filed August 15, 1919. Serial No. 317,685.

To all whom it may concern:

Be it known that I, CHESTER T. ALLCUTT, a citizen of the United States, and a resident of Pittsburgh, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Protective Devices, of which the following is a specification.

My invention relates to discharge gaps as used, for example, in lightning arresters, and it has for its object to provide apparatus of the character designated that shall operate selectively in permitting current passage therethrough, preferably with a low impulse-ratio or, in other words, permitting the passage of high-frequency currents at equal or lower voltage than currents of normal frequency while also permitting the passage of currents of high voltage at any frequency.

Another object of my invention is to produce a structure of the character indicated that shall be substantially independent of atmospheric conditions.

In my copending application, Serial No, 216,088, relating to protective devices and assigned to the Westinghouse Electric & Manufacturing Company, I describe a selective discharge gap consisting of two spaced discharge members and an auxiliary electrode disposed therebetween and connected to the two discharge members through impedance members of dissimilar character, so that while the potential of the auxiliary electrode is maintained at substantially the potential of the immediately adjacent electrostatic fields at normal frequency, it is changed to a different potential at any other frequency on account of the dissimilar potential drops in the two impedance devices attendant upon the change in frequency.

It is now a known fact that the discharge potential of a spark gap varies with the atmospheric conditions, being considerably less when the electrodes of the gap are wet than when they are dry.

My present invention resides in the combination of an auxiliary spark gap with the previously described selective discharge device in such manner that the potential of the auxiliary electrode is raised to substantially that of one of the discharge members when the auxiliary gap breaks down. The auxiliary gap is provided with a protecting member so that the electrodes thereof and the space intermediate the electrodes will be protected from the changes in atmospheric conditions.

Recently, it has been recommended that sphere gaps, when used outdoors, be provided with a shield to prevent rain from falling upon the electrodes. However, rain is but one of several agencies which, at times, cause a deposit of moisture upon exposed surfaces. For example, when the temperature falls to such degree that the relative humidity of the air or of the gaseous medium in which the electrodes are immersed reaches 100%, the surfaces of the electrodes receive a precipitated layer of moisture, commonly known as dew, which reduces the breakdown voltage of the gap to a value substantially as low as that which exists when the gap is exposed to rain. By my present invention I may inclose the pilot gap, or the gap upon which the discharge of the entire combination depends, within a hermetically sealed container which is filled with a fluid, the moisture content of which is such that the relative humidity thereof can not reach 100% under any atmospheric conditions. By this feature of my invention, I avoid any possibility of moisture being deposited upon the electrodes.

In the accompanying drawings, Figs. 1 to 4 are diagrammatic views of my invention, of which Fig. 3 illustrates the preferred form.

Disturbances of abnormally high frequency are particularly destructive of electrical apparatus because of the fact that they produce very high electromotive forces between adjacent end turns of electric windings, caused by the choking effect thereof, and it is desirable to discharge such abnormal disturbances even before they have attained line voltage. Also, disturbances of normal frequency and abnormal potential are apt to occur on the line and are aqually dangerous to apparatus connected thereto. These two types of disturbances, or combinations thereof, constitute the chief sources of trouble in electrical apparatus connected to a distributing system. My present invention is adapted to eliminate both of these types of disturbances, irrespective of the atmospheric conditions.

Referring to the drawings for a more detailed understanding of my invention, I show, in Fig. 1, a line wire 6 connected to a

horn-type discharge member 7. A similar horn-type discharge member 8 is mounted in spaced relation thereto and is connected to ground at 9, either directly or through an electrolytic arrester 10, as desired. A small antenna 11 is mounted intermediate the horns 7 and 8 and is connected to the horns 7 and 8 through capacitative reactances 12 and 13, respectively. Also, a circuit embodying a capacitative reactance 14, connected in series relationship with a spark gap 15, is connected in parallel relationship with the condenser 12, and includes two electrodes 16 and 17 which are connected to the condenser 14 and the horn member 7, respectively. A shield 18 covers the electrodes 16 and 17 and the space therebetween to prevent rain from coming in contact with these members. The electrodes 16 and 17 are preferably spaced apart a distance equal to one-half the wet breakdown-voltage setting of the gap between the members 7 and 8. The condenser 14 is of considerably higher capacity than is either the condenser 12 or the condenser 13.

Upon a disturbance of abnormal voltage being impressed upon the line 6, the condensers 12 and 13, being of substantially equal capacity, maintain the member 11 at a potential intermediate that of the horns 7 and 8 and at substantially the potential of the immediately adjacent electrostatic field: Since the condenser 14 has a relatively high capacitance, the electrode 16 is maintained at substantially the potential of the antenna 11, and the electrode 17, is maintained at the potential of the member 7 which is substantially one-half of the existing line potential that is impressed across the gap 15. When this potential reaches a slightly abnormal value, either due to a potential built up by a high frequency surge or by a high-potential disturbance being impressed on the line, the gap 15 will break down, charging the condenser 14. The condenser 14, being of greater capacity than the condenser 13 and being aided by the condenser 12, raises the potential of the antenna 11 to substantially that of the member 7, thus impressing the existing potential of the line member 6 upon the gap between the members 8 and 11. Since the gap 8—11 is set for slightly more than one-half of the normal line potential, this immediately causes a breakdown between the members 8 and 11 which, in turn, ionizes the surrounding medium and causes the discharge to pass directly from the member 7 to the member 8. It will be obvious that the spark gap 15 need be of but relatively small proportions on account of the fact that it, at no time, carries a power current, but merely serves to carry the charging current of the condenser 14.

In Fig. 2 I show a selective discharge gap embodying additional desirable features of my invention. In this embodiment of my invention, the antenna 11 is connected to the member 8 through a condenser 13 and to the member 7 through a condenser 14 and a spark gap 15, as described in connection with Fig. 1. However, an inductive reactor 19 is connected in series relationship with the condenser 12. In this embodiment of my invention, the condenser 13 and the inductance device 19, together with the condenser 12 to which it is connected, are of such values that the antenna 11 is maintained at a potential substantially midway between that of the discharge members 7 and 8, at normal frequency. A disturbance of normal frequency and abnormal potential upon the line 6 results either in a breakdown between the members 7 and 11 or in a breakdown of the gap 15 which charges the condenser 14 and changes the potential of the member 11, as described in connection with Fig. 1.

When the high-frequency disturbance is impressed upon the line 6, the voltage drop across the condensers 13 and 12 decreases, whereas that across the inductance device 19 increases, causing the potential of the antenna 11 to approach that of the discharge member 8. The voltage drop across the condenser 14 being negligible, in comparison with the drop across the gap 15, a potential greater than one-half the potential between the members 7 and 8 is impressed across the spark gap 15 which immediately breaks down, charges the condenser 14 and raises the potential of the antenna 11 to substantially that of the member 7, causing a discharge between the members 8 and 11 and inducing a discharge directly from the member 7 to the member 8, as described in connection with Fig. 1.

The structure shown in Fig. 3 is similar to that shown in Fig. 2 except that the electrodes 16 and 17 of the spark gap 15 are inclosed within a hermetically sealed container 20 which is filled with a fluid having such moisture content that it is impossible for any precipitation of moisture to be deposited, irrespective of the temperature of the ambient medium. As described in connection with Fig. 1, the hermetically sealed spark gap may be of relatively small dimensions, because the only current passing therethrough is a charging current for the condenser 14.

In Fig. 4 I show the antenna 11 connected to the discharge member 8 through three condensers 21, 22 and 23, and to the discharge member 7 through three condensers 24, 25 and 26, the aggregate capacity of these latter condensers, in series combination, being substantially equal to the aggregate capacity of the condensers 21, 22 and 23. The condensers 25 and 26 are connected in parallel relationship with an enclosed spark gap 15. An abnormal voltage surge will

cause a breakdown of the gap 15, raising the antenna 11 to substantially the potential of the member 7, since the capacity of the condenser 24 is considerably greater than that of the three condensers 24, 25 and 26 connected in series relationship, and inducing a discharge between the members 7 and 8, as previously described. It may, in some instances, be desirable to substitute other forms of impedance for the members 25 and 26, but, by connecting the gap 15 in parallel relationship therewith, the same desirable results may be effected.

From the foregoing description of my invention, it will be obvious to those skilled in the art that the breakdown of the gap 15 will be entirely independent of rain, atmospheric pressure or relative humidity of the air so that, under no conditions whatsoever, can a coating of moisture be deposited upon the electrodes thereof. Since the breakdown of the gap between the members 7 and 8 depends upon the breakdown of the gap 15, it will be obvious that the breakdown of the device as a whole will be substantially independent of atmospheric conditions.

While I have shown my invention in a plurality of forms, it will be obvious to those skilled in the art that it is not so limited but is susceptible of various minor changes and modifications without departing from the spirit thereof, and I desire, therefore, that only such limitations shall be placed thereupon as are imposed by the prior art or are specifically set forth in the appended claims.

I claim as my invention:

1. In an electrical-discharge-gap device, the combination with two sets of spaced discharge members, of means whereby the breakdown between the discharge members of one of said sets is caused to depend on the other of said sets, and means whereby any moisture whatsoever is prevented from being deposited on the discharge members of said last-mentioned set.

2. In an electrical-discharge-gap device, the combination with two sets of spaced discharge members, of means whereby the breakdown between the discharge members of one of said sets is caused to depend on the other of said sets, and means whereby the relative humidity of the medium in which the discharge members of said last-mentioned set are immersed is prevented from reaching 100%.

3. In an electrical-discharge-gap device, the combination with two sets of spaced discharge members, of means whereby the breakdown between the discharge members of one of said sets is caused to depend on the breakdown between the discharge members of the other of said sets, the discharge members of said last-mentioned set being inclosed within a hermetically sealed vessel.

4. In an electrical-discharge-gap device, the combination with two sets of spaced discharge members, of means whereby the breakdown between the discharge members of one of said sets is caused to depend on the breakdown between the discharge members of the other of said sets, the discharge members of said last-mentioned set being inclosed within a hermetically sealed vessel containing a substantially dry fluid.

5. In an electrical-discharge-gap device, the combination with two spaced discharge members, of an auxiliary electrode mounted adjacent said discharge members, and means connecting said auxiliary electrode to one of said discharge members, said means comprising two spaced electrodes enclosed within a hermetically sealed container.

6. In an electrical-discharge-gap device, the combination with two spaced discharge members, of an auxiliary electrode mounted adjacent said discharge members, and means connecting said auxiliary electrode to one of said discharge members, said means comprising two spaced electrodes surrounded by an enclosed substantially dry medium.

7. In an electrical-discharge-gap device, the combination with two spaced discharge members, of an auxiliary electrode mounted adjacent said discharge members, and means connecting said auxiliary electrode to one of said discharge members, said means comprising two parallel circuits one of which comprises two totally enclosed members arranged to form a spark gap and the other of which comprises capacitative reactance.

8. In an electrical-discharge-gap device, the combination with a main gap consisting of two spaced discharge members and an antenna therebetween, of an auxiliary device provided with a totally enclosed spark gap connected in parallel relationship with a portion of said gap.

9. In an electrical-discharge-gap device, the combination with two spaced discharge members, of an auxiliary electrode mounted adjacent said discharge members, and means connecting said auxiliary electrode to one of said discharge members, said means being provided with a totally enclosed spark gap and an inductive reactance connected in parallel relationship.

10. In an electrical-discharge-gap device, the combination with two spaced discharge members, of an auxiliary electrode mounted adjacent said discharge members, and means connecting said auxiliary electrode to one of said discharge members, said means being provided with a spark gap and a capacitative reactor connected in series relationship, and means connecting said auxiliary electrode to the other of said discharge members comprising a capacitative reactor.

11. In an electrical-discharge-gap device, the combination with two spaced discharge

members, of an auxiliary electrode mounted adjacent said discharge members, and means connecting said auxiliary electrode to one of said discharge members, said means being provided with a totally enclosed spark gap, and a capacitative reactor connected in series relationship, and means connecting said auxiliary electrode to the other of said discharge members comprising a capacitative reactor.

12. In an electrical-discharge-gap device, the combination with two spaced discharge members, of an auxiliary electrode mounted adjacent said discharge members, and means connecting said auxiliary electrode to one of said discharge members, said means comprising a capacitative reactor, and means connecting said auxiliary electrode to the other of said discharge members comprising two parallel circuits one of which consists of a capacitative reactor and an inductive reactor connected in series relationship and the other of which consists of a capacitative reactor and a device provided with a spark gap.

13. In an electrical-discharge-gap device, the combination with two spaced discharge members, of an auxiliary electrode mounted adjacent said discharge members, and means connecting said auxiliary electrode to one of said discharge members, said means comprising a condenser of relatively low capacity, and means connecting said auxiliary electrode to the other of said discharge members comprising two circuits connected in parallel relationship, one of which comprises a condenser of relatively low capacity connected in series relationship with an inductive reactor and the other circuit of which is provided with a totally-enclosed spark gap connected in series relationship with a condenser of relatively great capacity.

In testimony whereof, I have hereunto subscribed my name this 1st day of August, 1919.

CHESTER T. ALLCUTT.