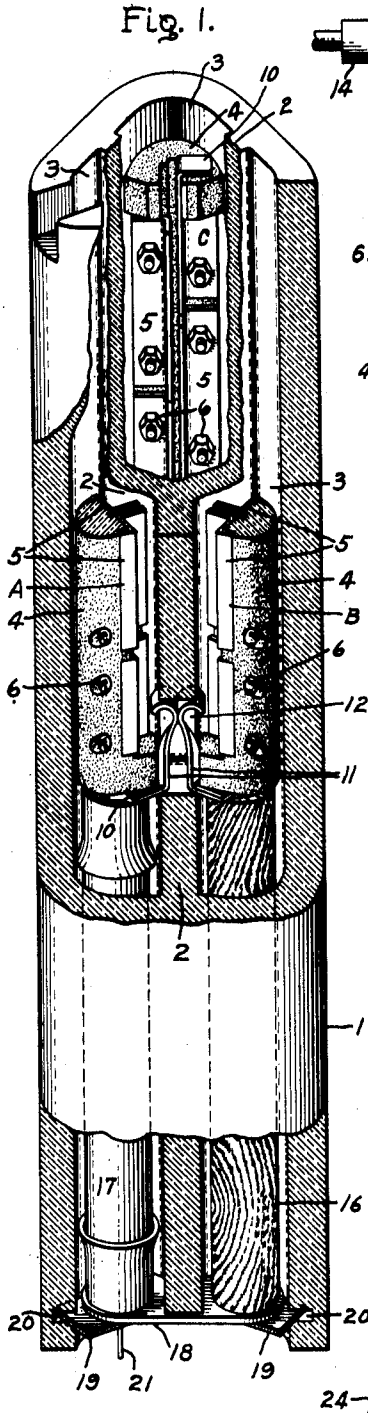
March 27, 1928. 1,664,194

E. E. F. CREIGHTON

PROTECTIVE DEVICE

Filed Sept. 5, 1924

Fig. 1.



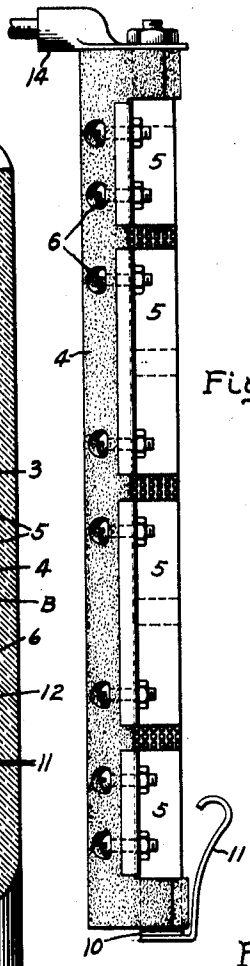


Fig. 3.

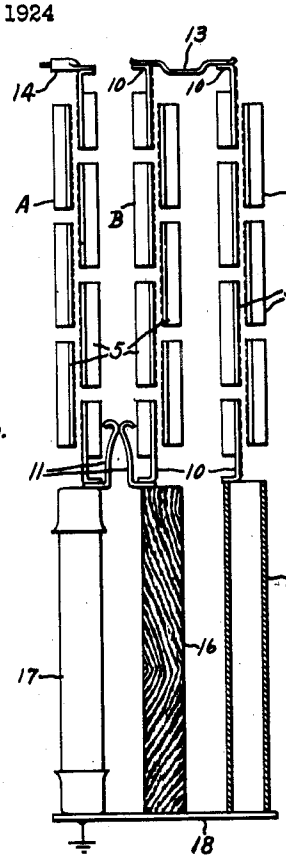


Fig. 4.

Fig. 6.

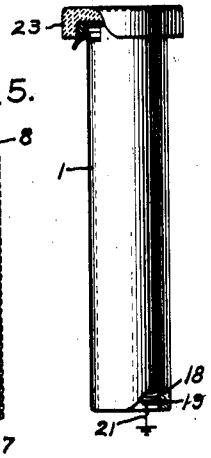


Fig. 5.

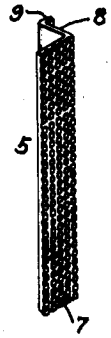
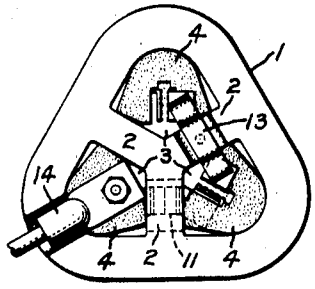


Fig. 2.



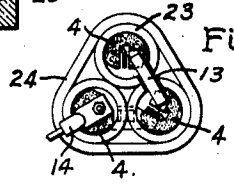


Fig. 7.

Inventor:
Elmer E. F. Creighton,
by Alexander S. Lunt
His Attorney.

Patented Mar. 27, 1928. 1,664,194

UNITED STATES PATENT OFFICE.

ELMER E. F. CREIGHTON, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

PROTECTIVE DEVICE.

Application filed September 5, 1924. Serial No. 736,136.

My invention relates to protective devices for electrical apparatus including line conductors whereby abnormal potential charges, such as atmospheric disturbances, static accumulations, resonance of frequencies, switching surges, etc., may be carried off without injury to the apparatus.

The object of my invention is to provide an improved protective device or arrester which is simple and inexpensive to construct and has improved operating characteristics.

The improved arrester hereinafter disclosed and involving my invention is of the so-called multigap type and is well adapted for use in the electrical systems operating at potentials of a few thousand volts.

The multigap arrester is well-known in the art. In its most common form is comprises a plurality of conducting members usually in the form of brass cylinders with a small air space of insulation between adjacent cylinders, to form a series of short air gaps. The aggregate length of these air gaps for any given potential is considerably greater than could be employed if a single gap were used. In the multigap arrester, the electrostatic capacity of the cylinders or other conductors is relied on, in a measure, to assist in starting a spark across the gaps and thereby initiate a flow of lightning current when an abnormal potential arises on the line. When this ionization occurs there seems to be a progressive spark beginning on the line side of the series of gaps and traveling along the successive gaps to the other terminal. The time interval of this progression of the discharge is, of course, extremely small, estimated in billionths of a second from cylinder to cylinder, but the total time interval of the arrester is, nevertheless, appreciable in considering the protection of insulation. For practical purposes, as distinguished from purely scientific investigations, it is not customary to express the time of establishment of sparks across the circuit of a lightning arrester but an easier and simpler expression is used. In other words, the quickness of discharge is measured in the laboratory by the length of an equivalent sphere gap in parallel with the arrester or insulation upon which an abnormally high voltage is impressed. The gap or circuit which first begins to discharge relieves the other parallel circuit of high voltage. Consequently, the fastest gap is the only one that visibly sparks. With this method available for measuring the equivalent sphere gap, it is possible for any one familiar with this art to determine whether one lightning arrester discharges more quickly and better than another.

In my Patent No. 1,071,710, September 2 1913, I have used auxiliary electrodes, which I called antennæ, to cause the circuit of a multigap arrester to be established more quickly than could be done without the use of antennæ.

My present invention is somewhat along the same lines but is simpler in that no auxiliary electrodes are used, and is much cheaper to apply to a multigap lightning arrester. As a matter of fact, there are no auxiliary parts used to act inductively on the multigap.

My invention will be better understood from the following description taken in connection with the accompanying drawing, and its scope will be pointed out in the appended claims.

In the drawing, Fig. 1 is an elevation of an arrester constructed according to my invention with the cover removed and with parts of the enclosing tube broken away to more clearly show the construction; Fig. 2 is a top view of the same with the cover removed; Fig. 3 is an elevation on a larger scale of one of the three insulating strips carrying the electrodes; Fig. 4 is a development of the current carrying members showing the circuit arrangement; Fig. 5 is a detail of one of the plates or electrodes; Fig. 6 is an elevation on a smaller scale of the complete arrester with parts broken away to more clearly show the construction; and Fig. 7 is a top view of a modified form.

In my present invention I divide the total length of circuit comprised of the multigaps into several parts, three in the illustration, and place these three parts side by side in an insulating tube such as porcelain, glass or quartz. In Figs. 1 and 2 such a tube is shown at 1, having the general form of an equilateral triangle with longitudinal partitions 2 connecting the sides and forming three longitudinal chambers 3. Within each chamber is a supporting block or strip 4 which may be of porcelain or other suitable material to which thin discharge plates 5 are secured, as for example, by bolts 6. For convenience in the description the strips

are designated A, B, and C. The plates 5, as illustrated on a larger scale in Fig. 5, are angular in form and each has a face 7 formed with a series of small projections and other faces 8 and 9 engaging the strip 4. The plates are arranged in staggered relation as shown by Figs. 1 and 4 with the faces bearing the projections facing each other. Each of the extreme end plates of each strip 4 has an extension 10 which projects through a slot in the end of the strip 4 for the purpose of making electrical connection therewith. A spring connector 11 is secured to the extensions 10 at the lower ends of each of strips A and B and the upper ends of these connectors engage each other through a suitable opening 12 formed in the intervening partition 2 of tube 1. The extensions at the upper ends of strips B and C are connected together by a connector 13 attached to the tube 1. To the upper extension 10 of strip A is attached a terminal connector 14 which projects through a suitable opening in the tube 1, and the lower extension 10 of strip C is shown connected to a metal tube 15 which is adapted to connect that extension with earth and which also supports strip C in the tube. Strip B is supported on an insulating rod 16 which may be of wood, and strip A is supported by a resistance rod 17 whose upper end is in electrical connection with the lower extension 10 of strip A and whose lower end is in contact with the metal plate 18. The plate 18 has three tongues 19 which are adapted to slip into grooves 20 formed in the walls of the tube 1. A ground connection is made to the bottom plate 18 by attaching the ground wire 21 thereto. In making this ground connection, I prefer to attach the ground wire to the plate 18 by solder having a relatively low melting point and at a point opposite the resistance rod 17 for, by this arrangement, I obtain the advantage that should the arrester become short-circuited as a result of a direct stroke or other abnormal condition of discharge, the heating of the resistance rod by the power current will melt the solder and allow the ground wire to drop. A visual indication of the particular arrester at fault is thus given to an observer on the ground. Power transmission may be at once resumed by simply closing the circuit breaker after such a fault has occurred. The arrester may be restored to normal operating condition at any convenient time. A cap 23 covers the top of the arrester tube 1.

By the above described construction it will be seen that the total length of the normal discharge circuit is divided into several columns, three in particular form illustrated, the three columns being arranged parallel to each other and occupying separate chambers in the insulating tube 1. Current entering by the terminal 14 follows down the first column A, jumps the gaps between the plates 5 in a zigzag manner where it meets the resistance rod 17. From there it follows up column B and down column C in the same manner, finally escaping to ground through the pipe 15, plate 18 and ground lead 21. When a lightning or other abnormal discharge comes in at the top of column A, it must start sparks across the gaps of this column and some of the charge may pass through the resistance 17 to ground. The abnormal voltage of this first column of electrodes induces simultaneously a charge on both of the other two columns of electrodes, starting sparks across their gaps. Thus the complete circuit from the upper electrode 14, column A, to the lower electrode of column C through the three columns, requires very little more voltage than is necessary to spark over the first column.

I am aware that resistances have been used before to shunt part of the gaps of an arrester between the line and ground and that arresters have been constructed having multigaps in a more or less open zigzag form, but as far as I am aware a multigap arrester having a zigzag relation between the parts has never before been constructed where the parts are in such close proximity as to give valuable reductions in the equivalent sphere gap or, in common parlance, rapid discharge. The effect is obtained by using comparatively thin walls between the columns A, B, and C, as shown for example by Figs. 1 and 2 composed of insulating material such as porcelain, glass, fused quartz or other equivalent material. The use of fused quartz has the additional advantage of permitting the ultra-violet light from its sparks in one column to play upon the gaps of the other columns. Ultra-violet light, as is well known, ionizes a gap and permits a lower voltage to start a spark than would be necessary without the ultra-violet light. When fused quartz is used to enclose the columns of electrodes and space them from each other, it may be found more expedient to enclose each column in a separate quartz tube 23 as shown in Fig. 7 and enclose the three tubes in a round or a triangular case 24 which may be of insulating material such as porcelain, for example, or may even be metallic.

Rapid discharge of the arrester due to the electrostatic effect of the columns of electrodes upon each other is increased by reason of the relatively large electrostatic capacity between the columns. This results particularly from those portions 8 and 9 of the plates 5, Fig. 5, which are secured against the strip 4 and by which capacitance is added between columns without adding capacitance between the knurled faces of adjacent electrodes. The tendency to spark is

greater as the relative capacitance between facing electrodes is lessened. In addition thereto, rapidity of discharge is further increased with the arrangement of electrodes as disclosed herein by reason of the electromagnetic induction from the first column to the other two columns. It will be noted by reference to Fig. 4 that a circuit is complete from the line terminal 14 through the gaps of the first column and resistance 17, which may be made comparatively low, to ground. The suddenness of the establishment of current is very great—in mathematical language

$$L\frac{di}{dt}$$

is great. In consequence of these conditions and factors a considerable electromagnetic induction between columns is obtainable.

I have used for illustration but three columns for this arrester, but it is evident that as many as five, seven, nine, etc. may be used according to convenience and total voltage of the circuit for which its arrester is designed.

One of the difficulties met in the use of multigap arresters is the tendency of the discharge to melt down more metal in the crater of the arcs than is needed to supply the conducting metallic vapor. This molten metal has a tendency to globulate and in so doing close the gap with molten metal. A metallic connection across the gaps destroys any possibility of the current being interrupted by the extinguishment of the arc in the gap and the reestablishment of the air insulation through the series of gaps after the abnormal discharge has taken place. The heavy currents are derived not only from the abnormal charges on the line, but also from the regularly generated power.

In order to overcome this tendency of electrodes to short circuit by an over-supply of molten metal, I use metal so thin that heavy discharges will push the molten metal through the plate away from the gap. Plates too thin will be affected by the many usual discharges that take place, and partially damage it. Plates too thick will not be melted all the way through by the dangerous unusual discharges and will be ineffective. The thickness of plate which is most advantageous will, therefore depend upon the particular service for which the arrester is adapted.

Inasmuch as the cost of installing an arrester of the type disclosed herein may be as much as several times the cost of the arrester itself, there is a distinct advantage to be gained from the point of view of the user if, in the event that the arrester becomes disabled, the affected parts can be readily replaced without disturbing the mounting of the arrester. Such a renewal is possible with the arrester herein described for should the groups of electrodes become worn in the course of time by lightning discharges therethrough, it is a very simple matter to remove the holders 4 from the bottom of the tube 1 by removing the plate 18 or the cap 23 and substitute others, thus "reloading" the arrester without in any way affecting the mounting.

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

1. A multigap arrester comprising a plurality of adjacent columns of electrodes spaced to form spark gaps between the electrodes, said arrester comprising an enclosed compartment for each column, said compartments comprising walls transparent to ultra violet rays whereby the gaps in one of said columns may be ionized when a discharge takes place along another one of said columns.

2. A multigap arrester comprising a plurality of columns of spaced electrodes and means connecting said columns in series, said columns being arranged in parallel relation and adjacent each other whereby the electromagnetic induction from a discharge in one column causes ionization in another column.

3. A multigap arrester having electrodes spaced to form gaps between each other, the gaps and the electrodes being arranged in serial order, one section of the series of electrodes overlapping another section of the same series, the overlapping arrangement being such that comparatively distant gaps of the series are located nearer each other than intervening gaps in the series whereby sparking in one section between the electrodes causes sparking to be started across gaps in the overlapping section.

4. A multigap arrester having electrodes spaced to form gaps between each other, the gaps and the electrodes being arranged in serial order one section of the series of electrodes overlapping another section of the same series, the overlapping arrangement being such that comparatively distant gaps of the series are located nearer each other than intervening gaps in the series, said electrodes being each provided with extended metallic portions remote from the sparking faces of the electrodes, the said extended portions of one section of the series being in inductive relation with respect to the extended portions of the other section of the series.

5. A multigap arrester having electrodes spaced to form gaps between each other, the gaps and the electrodes being arranged in serial order, one section of the series of electrodes overlapping another section of the same series, the overlapping arrangement being such that comparatively distant gaps of the series are located nearer each other than intervening gaps in the series whereby sparking in one section between the elec-

trodes causes sparking to be started across gaps in the overlapping section, each section being enclosed in a transparent quartz tube.

6. A multigap arrester having electrodes spaced to form gaps between each other, the gaps and the electrodes being arranged in serial order, one section of the series of electrodes overlapping another section of the same series, the overlapping arrangement being such that comparatively distant gaps of the series are located nearer each other than intervening gaps in the series whereby sparking in one section between the electrodes causes sparking to be started across gaps in the overlapping section, and a supporting tubular member for said electrodes having partitions therein forming chambers, one of said sections being located in each of said chambers.

7. A multigap arrester having electrodes spaced to form gaps between each other, the the gaps and the electrodes being arranged in serial order, one section of the series of electrodes overlapping another section of the same series, the overlapping arrangement being such that comparatively distant gaps of the series are located nearer each other than intervening gaps in the series whereby sparking in one section between the electrodes causes sparking to be started across gaps in the overlapping section, each section being enclosed in a transparent quartz tube, one of said sections being shunted by an impedance element.

In witness whereof, I have hereunto set my hand this 4th day of September, 1924.

ELMER E. F. CREIGHTON.

CERTIFICATE OF CORRECTION.

Patent No. 1,664,194. **Granted March 27, 1928, to**

ELMER E. F. CREIGHTON.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 1, line 18, for the word "is" read "it", and line 74, for the word "gap" read "gaps"; page 4, line 21, claim 7, strike out the article "the"; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 1st day of May, A. D. 1928.

M. J. Moore,
Acting Commissioner of Patents.

(Seal)

CERTIFICATE OF CORRECTION.

Patent No. 1,664,194. Granted March 27, 1928, to

ELMER E. F. CREIGHTON.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 1, line 18, for the word "is" read "it", and line 74, for the word "gap" read "gaps"; page 4, line 21, claim 7, strike out the article "the"; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 1st day of May, A. D. 1928.

M. J. Moore,
Acting Commissioner of Patents.

(Seal)