

E. E. F. CREIGHTON.
 PROTECTIVE DEVICE.
 APPLICATION FILED JAN. 5, 1914.

1,144,029.

Patented June 22, 1915.

Fig. 1.

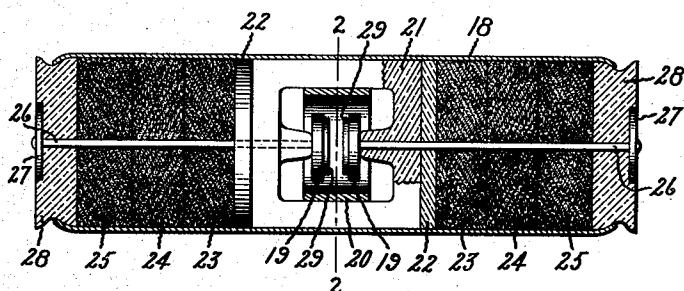


Fig. 2.

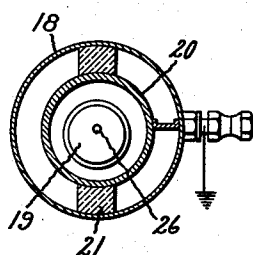
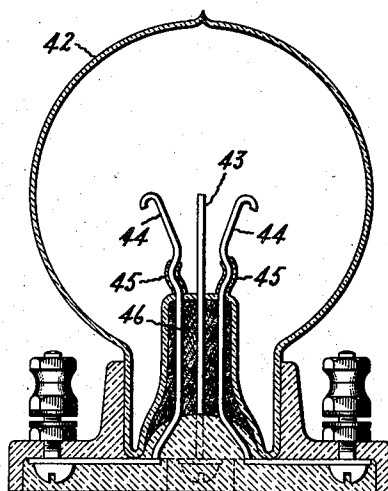


Fig. 3.



Witnesses:

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UNITED STATES PATENT OFFICE.

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

PROTECTIVE DEVICE.

1,144,029.

Specification of Letters Patent.

Patented June 22, 1915.

Original application filed March 19, 1913, Serial No. 755,529. Divided and this application filed January 5, 1914. Serial No. 810,275.

To all whom it may concern:

Be it known that I, ELMER E. F. CREIGHTON, 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.

This application is a division of my application filed March 19, 1913, Serial No. 755,529, and relates to devices for protecting circuits from abnormal voltages, lightning and similar disturbances, and more especially to protective devices for circuits of low normal operating voltage.

The protective device most commonly used for telephone circuits, signal circuits and similar systems of low normal operating voltage, is a form of spark gap lightning arrester comprising essentially two electrodes separated by a very short air gap. The air gap has an appreciable time lag, as it will not break down the very instant an excess voltage appears, and is furthermore liable to be bridged by dust, dirt and by the metal carried from the electrodes by a heavy discharge.

The object of my invention is to provide a protective device which does not have the defects of the usual spark gap lightning arrester and which will remove abnormal voltages and transient disturbances without dangerous delay and before the abnormal voltage rises to dangerous value.

My invention comprises certain novel features set forth more particularly in the appended claims, but the invention itself will be better understood in connection with the accompanying drawings, which, merely for purposes of illustration, show some of the various forms in which my invention may be embodied, and in which—

Figure 1 is a longitudinal section of one form of a lightning arrester embodying my invention in which a desirable form of seal is shown and the electrodes are so arranged that the arcing takes place in a sort of circular horn gap, the electrodes also having fusible disks on them; Fig. 2 shows a transverse section of the form of arrester shown in Fig. 1 on the line 2—2; and Fig. 3 is a longitudinal section of a form of arrester in which the discharge takes place in a horn gap mounted in the vacuum chamber.

In the particular form of arrester shown in Fig. 1, the tube 18 contains electrodes 19 mounted eccentrically to a ground ring 20 which, as best shown in Fig. 1, is electrically connected between the electrodes to ground. In this form of arrester the tendency to extinguish the arc between the electrodes and the tube may be increased by positioning the electrodes eccentrically with relation to the tube so that the arc occurs in a sort of circular horn gap formed by the co-operating surfaces of the electrodes, in which gap it is automatically lengthened and ultimately extinguished. The electrodes 19 and the ground ring 20 are carried in a yoke 21 made of porcelain or other suitable insulating material and fitting the tube 18 so as to hold the parts in proper relation. Stoppers 22 are mounted adjacent the yoke 21 and are made of some suitable porcelain like material which can be baked in the tube and which will not give off gases when heated. The stoppers 22 are backed up by layers 23, 24 and 25 of different kinds of waxes which form air-tight joints with the tube 18 and also with the leading-in wires 26, which are connected at their inner ends to the electrodes 19 and at their outer ends to connection plates 27 embedded in the porcelain end blocks 28.

The protective device constructed as above described is exhausted to produce in the metal tube a partial vacuum of such a value that lightning and similar abnormal disturbances are removed from the line with minimum delay and resistance. The desired vacuum may easily be obtained by pumps, such as are commonly used in the art, and after the tube is exhausted it may be hermetically sealed in any suitable way. In many cases I prefer to first fill the tube with some suitable gas and then exhaust it to the required vacuum, so as to leave in the tube a residual atmosphere of that gas. I prefer to use as a residual gas some of the monatomic gases, such as argon, neon, helium, or hydrogen, especially the inert atmospheric gases, such as argon or neon, although a residual atmosphere of air or nitrogen will give satisfactory results. The proper pressure of the residual gas depends upon the nature of the gas in the tube and upon the size of the gap. I prefer to use a pressure such that the equivalent needle gap is a

minimum at transient voltages of high superspark potential, that is, a potential greatly above the break down potential of the arrester. A disruptive spark discharge furnishes a favorable path for discharges to ground and is the kind of a discharge most suitable for relieving a system of lightning, high frequency oscillations and similar abnormal potentials and frequencies. A brush discharge carries but little current and does not relieve the line of very much energy. By heating up the electrodes the brush discharge may actually hinder the formation of the spark discharge and the relief of the system, especially where the arrester is used on comparatively low voltage direct current systems. I so space the electrodes that at the preferred pressure, the spark discharge occurs almost simultaneously with the appearance of a brush discharge and at a voltage somewhat above the normal voltage of the system to be protected. This preferred pressure is above the critical pressure at which the spark potential is a minimum.

A lightning arrester should permit the passage of transient over-voltage and very high frequency oscillations with a minimum time lag. By high frequency, I mean oscillations and oscillatory discharges of the frequency of lightning or of the spark discharge of condenser, probably from one-half million to several million cycles per second. The time lag must be so small that the transient over-voltage will not have time to puncture the insulation. The spark discharge should occur without appreciable time lag in response to the application of a transient high voltage of minimum amount over the normal potential of the system. I reduce the time lag to an unobjectionable amount by adjusting the gas pressure and the spark gap without seriously affecting the minimum equivalent needle gap. I have found that at pressures above 10 mm. of mercury, the time lag is not enough to be objectionable, but that it is serious at lower pressures, increasing very rapidly as the pressure decreases. I, therefore, make the pressure such and so space the electrodes that the time lag is unobjectionable, the equivalent needle gap is at or near the minimum, and spark potential is reasonably low.

Under some conditions I accentuate the arc extinguishing feature of the circular horn gap formed between the eccentrically disposed electrodes 19 and the ground ring 20 by so proportioning the space around the electrodes that upon a severe and long continued discharge the residual gases in the arrester expand to such an extent that their pressure is very greatly increased and their arc extinguishing effect is correspondingly increased. The arc extinguishing effect of the arresters shown in the other figures of

the drawing may be increased in the same way if considered advisable, although I prefer to so proportion the arrester that the pressure of the residual gases is increased but slightly during the usual discharge.

Discharges through the protective device may be very severe and long continued, if the telephone or signal circuit is crossed with a lighting or power circuit having a potential considerably higher than the potential at which the protective device discharges.

Under these conditions the system should be grounded to protect the apparatus connected to it. In addition the continuous and heavy discharges heat the electrodes and the adjacent portions of the arrester so hot that sufficient gases are evolved to lower the vacuum, and in general the arrester is deteriorated to such an extent that it should be removed and replaced by a new one. In order to automatically ground the system when crossed with a higher potential system, and to facilitate detection and removal of the arresters which have been injured, I provide means whereby the electrodes are automatically bridged and short circuited and are also connected to ground when the electrodes are heated to a certain extent. The preferred means for securing this result, as applied to the particular form of arrester shown in Fig. 1, comprises fusible metal films 29 secured to the faces of the electrodes 19 and made in the form of disks of less diameter than the electrodes. The arc or discharge from the edge of the electrode 19 does not touch the fusible disk, which is heated only by conduction of heat from the electrode. As the disks 29 are in intimate contact with the electrodes 19 a rise in temperature of the electrodes will cause the disks 29 to melt and the molten metal will run down and form a conducting bridge between both electrodes and the ground electrode, which in this case is the ground ring 20. When this has occurred, the short circuited arrester may easily be detected by suitable tests and then replaced.

In some forms of arresters designed to withstand severe and continued discharges, it is desirable to protect as far as possible the waxes and other material of the seal from undue heating by the action of the arc between the electrodes. I attain this result by placing the electrodes at a considerable distance from the seal and connecting them to the leading-in wires through metallic connections, so proportioned as to have a very great radiating surface by which heat transmitted from the hot electrode will be radiated to the tube and the surrounding atmosphere, instead of being transmitted directly to the leading-in wire and thence to the seal. If desired, the radiation of heat may be increased by immersing the tube in a liquid or similar cooling medium.

A modification in which the extinguishing action of the horn gaps is secured, is shown in Fig. 3. An evacuated glass bulb 42 contains a ground electrode 43 which coöperates with two line electrodes 44 so positioned with relation to the ground electrode 43 as to form therewith horn gaps in which the arc may rise vertically and be extinguished. To prevent the possibility of arcs following the electrodes 44 down to the seal and thereby injuring the seal, I coat both of the electrodes near the seal with a protective coating 45 of refractory insulating material so that the arc cannot reach the electrodes at points close enough to the seal to injure it. In this form of arrester the electrodes are sealed into the glass stem of the vessel 42, but the seal between the electrodes and the stem is not relied upon to hold the vacuum. The seal is made tight by filling the stem with suitable wax 46.

My invention may be embodied in many other ways than those described and I, therefore, do not limit my invention to the precise arrangements disclosed except in so far as it is limited by the scope of the appended claims.

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

1. A protective device comprising an evacuated vessel containing parallel disk electrodes having a common axis, and a grounded ring surrounding said electrodes and spaced away from the edges thereof, the axis of said ring being eccentric to the axis of said electrode.

2. A protective device comprising an evacuated vessel and electrodes in said vessel spaced away from one another to form a spark gap which increases in width in the direction of movement of the arc in said gap whereby the arc is lengthened and broken.

3. A protective device comprising an evacuated vessel, electrodes in said vessel

having curved coöperating surfaces spaced apart to form a spark gap, the corresponding portions of said coöperating surfaces having different radii and centers of curvature, said curved surface of one electrode being adjacent the concave side of the coöperating surface of the other electrode.

4. A protective device comprising an evacuated vessel, electrodes in said vessel having edges similarly curved about a common axis, and a grounded electrode curved about an axis eccentric to the axis of the other electrodes and spaced away from the edges of said other electrodes to form spark gaps to ground.

5. A protective device comprising disk electrodes mounted face to face, each of said electrodes having on its face a disk of fusible metal smaller than said electrode, and a grounded electrode spaced away from the lower edges of said other electrodes to form spark gaps which are bridged by the melting of said fusible metal.

6. A protective device comprising two electrodes mounted in thermal relation to a body of fusible metal, and a third electrode mounted beneath the other electrodes and spaced away from them to form spark gaps which are bridged by said fusible metal when it is melted by a rise in temperature of said electrodes.

7. A protective device comprising an evacuated vessel, a disk electrode in said vessel, a coöperating annular electrode mounted eccentric to said disk electrode and separated therefrom to form a spark gap between the edge of said disk and said annular electrode.

In witness whereof, I have hereunto set my hand this 3rd day of January, 1914.

ELMER E. F. CREIGHTON.

Witnesses:

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HELEN ORFORD.