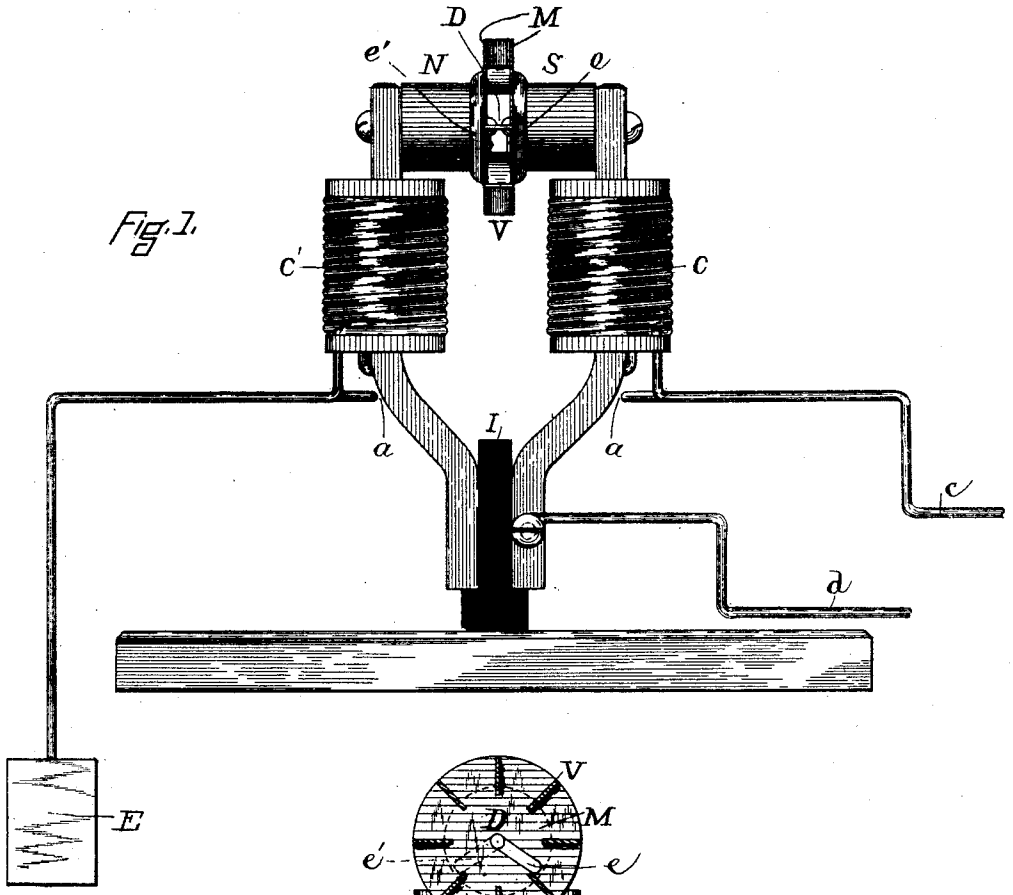
(No Model.) 2 Sheets—Sheet 1.

E. THOMSON.

LIGHTNING ARRESTER.

No. 470,721. Patented Mar. 15, 1892.

Fig. 1.



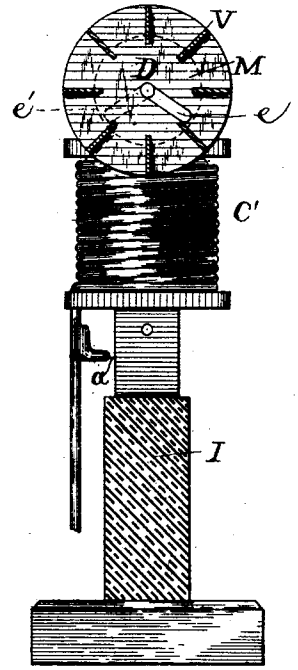


Fig. 2.

WITNESSES:

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Thos. F. Cafael

INVENTOR

Elihu Thomson

BY

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(No Model.) 2 Sheets—Sheet 2.

E. THOMSON.

LIGHTNING ARRESTER.

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Fig. 3.

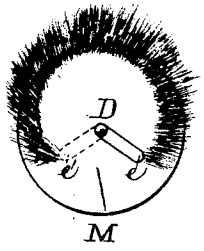

Fig. 5.

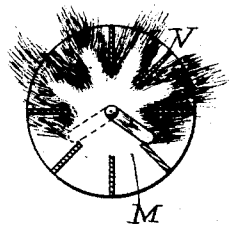

Fig. 4.

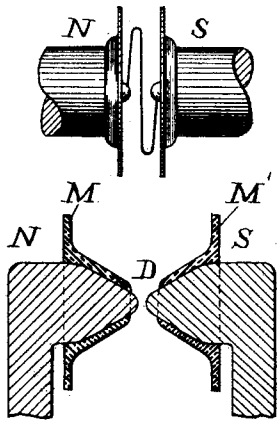

Fig. 6.

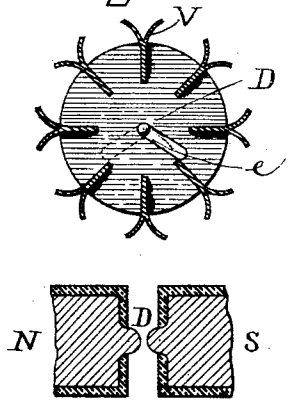

Fig. 8.

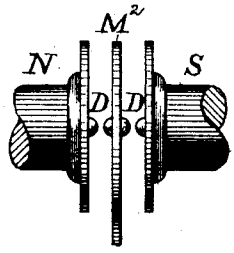

Fig. 7.

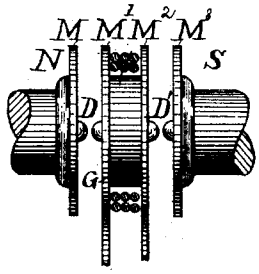

Fig. 9.

Fig. 10.

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UNITED STATES PATENT OFFICE.

ELIHU THOMSON, OF LYNN, MASSACHUSETTS, ASSIGNOR TO THE THOMSON-HOUSTON ELECTRIC COMPANY, OF CONNECTICUT.

LIGHTNING-ARRESTER.

SPECIFICATION forming part of Letters Patent No. 470,721, dated March 15, 1892.

Application filed December 26, 1889. Serial No. 335,063. (No model.)

To all whom it may concern:

Be it known that I, ELIHU THOMSON, a citizen of the United States, and a resident of Lynn, in the county of Essex and State of Massachusetts, have invented certain new and useful Improvements in Lightning-Arresters and Static-Discharge Protectors, of which the following is a specification.

My invention relates to electrical apparatus in which an electro-magnet is employed for disrupting or removing an electric arc formed between two points or electrodes included in an electric circuit; and it consists more particularly in the relative disposition or the arrangements of the electrodes and the arc-rupturing magnet or magnetic field.

My invention is applicable to lightning-arresters, static-discharge protectors, electric fuses, or any other electric apparatus wherein two conducting bodies or electrodes are liable to have an arc formed between them which it is desired to suppress or remove immediately.

I have in the present specification described my invention as carried out in connection with a lightning-arrester or static-discharge protector, the electrodes of which, being placed in close proximity, are liable to have an arc formed between them and maintained by the current of the dynamo-machine or other source of the circuit to which they are applied after the passage of a lightning or static discharge from one to the other of such electrodes. As before stated, however, my invention is applicable likewise to any other device wherein an electro or any other magnet is applied to disrupt or put out an electric arc between two electrodes.

The object of my present invention is to increase the power of disruption of the magnetic field and thereby to enable the apparatus to work more efficiently under conditions where a powerful arc would be apt to follow the lightning or static discharge or to ensue upon other changes in the conditions of the circuit or the apparatus—as, for instance, by the rupture of a fuse in a safety-fuse device—in which case an arc would follow and be maintained across the electrodes or conducting-blocks in which the ends of the fuse are held.

My invention consists, first, in the combination, with electrodes connected to an electric circuit supplied or connected with a source of electric energy sufficient to maintain an electric arc once formed across the space between said electrodes, of an arc-rupturing magnet or magnets having said electrodes disposed in a portion of the magnetic field or space containing lines of magnetism passing from one pole to another of the magnet in such manner that the line joining said electrodes shall be parallel to the lines of the magnetic field which operates to rupture the arc.

My invention consists, further, in giving such a polarity to said magnetic field that the tendency shall be to displace the arc in an upward direction. The effect of so disposing the electrodes is that any arc forming between them will be displaced in the magnetic field in a direction to elongate its path very greatly while still remaining in the field, thereby impelling the discharge or arc to take up a movement in the field, whereby it shall inclose such field in a widening arc or circle.

My invention consists, further, in the combination, with the arcing-electrodes and their disrupting-magnets, of one or more arc diverting or interrupting plates or vanes in the path of the widening arc, as will be hereinafter more fully described.

My invention consists, also, of other details of construction and disposition of parts to be hereinafter more particularly described, and then specified in the claims.

In the case of the application of my invention to a lightning-arrester the relative disposition of the electrodes and the arc-rupturing magnet may be described as one in which the electrodes are presented or directed toward one another, so that the lightning or static discharge will take place in the general direction of the lines of force of the arc-rupturing magnetic field or in a line coincident with or parallel to the line joining the poles of the magnet in case the action of both poles of the magnet is resorted to for the purpose of disrupting or putting out the arc.

In the accompanying drawings, which illustrate the application of my invention to a lightning-arrester, Figure 1 shows a side ele-

vation of an arrester embodying the elements of my invention. Fig. 2 shows an elevation, partly in section, through the device. Figs. 3, 4, and 5 are explanatory of the actions involved. Figs. 6, 7, and 8, as well as Figs. 9 and 10, show some of the minor modifications, which do not, essentially, depart from the principle involved.

In Fig. 1, N S are magnetic poles, which may have a magnetism engendered by any desired means, even by permanent magnets, but which are preferably energized by means of coils C C′, surrounding the bars of iron upon which the poles N S are mounted or of which they form extensions. The coils C C′ may be included in an electric circuit, in which current flows constantly or in which current is made to flow temporarily only when the occasion arises for disrupting the arc. The poles N S are made of opposite polarity by the manner of winding the coils or of causing the current to circulate through them. In the case of a lightning-arrester, where the coils C C′ are included in the path of the discharge, care must be taken to so wind or connect the coils to the circuit that the current circulating through such coils and across the discharge points or electrodes D, constituted between the poles, shall set up poles of opposite name at N S. The discharge-points D are mounted on the poles, as shown, and are preferably electrically connected to or carried by them, though this course is not essential to my invention, the prime object being to locate them within the field, and preferably in the middle thereof, in such manner that the points or discharge-surfaces shall be presented to one another on a line joining the magnet poles or parallel to the magnetic lines of force joining such poles. To attain the best construction and action the poles N S are separated by a small space, so that the electrodes D, existing as little buttons of metal, such as copper or other material secured to the poles N S, may come within a very short distance of each other.

In prior patented devices in which an arc-rupturing magnet is employed the arcing electrodes have been disposed in the arc-disrupting field in such way that the line joining the conducting-faces which are presented to one another, and from one to the other of which the electric circuit is normally formed, is a line transverse to the lines of magnetic force or to the line joining the poles of the arc-disrupting magnet. In my present invention, however, the line is one such that in the case of a lightning-arrester the discharge shall occur in the line of the magnetic field between which the discharge points or electrodes are placed, instead of transversely to such field, the effect being that the arc following a discharge will be contorted or twisted out of its straight path to a rotary path or position which will make it include the magnetic field or encircle the same. This distortion of the arc, to make it include a path of considerable length or extent, is facilitated by the addition of devices, which will be hereinafter described, but which are not essential to the operation of the invention.

In the case of a lightning-arrester such as shown herein it is well to have one of the coils, as C, in a circuit or energized from the line, so as to keep up a certain magnetization between the poles N S. I have shown a coil C connected into a line passing between *c d*, the coil C having its inner terminal connected to the core or magnetic bar on which it is wound and which, therefore, is in connection with the right-hand discharge point or electrode at D. The line *c d* may be any lighting or power line or other electric line which it is desired to protect or a branch from the same. The faces of the poles N S presented under these circumstances will, when the coil C is traversed by current, be very strongly magnetized, and to enhance this the lower ends of the magnetized bars on which the polar extremities are supported are brought near together with an interposed insulation below, as at I, the arrangement shown being virtually a horseshoe-magnet whose bent portion is separated and insulated. The discharge point or electrode D at the left, Fig. 1, and carried by the pole N, is connected to earth at E through the coil C′ or to another point, as will be presently described, for carrying off the static discharge. The electrical connection may be formed by connecting one end of the coil C′ to the iron bar on which the pole N is mounted, while the other or outer end of such coil is connected to the earth-plate E.

It is advisable in some cases to have a small discharge-space, as at *a*, between the outer wire of the coil C′ and the core on which it is wound, though this is not necessary in all cases. This discharge-space simply allows a quick or static discharge to leave the discharge-point carried by N without going through the coil C′, which might oppose its passage. A similar arrangement might be provided for the coil C, it being a sort of disruptive shunt; but these form no features of my present invention.

While the devices as thus organized would be very effectual in disrupting or putting out any arc which might form across the electrodes of the lightning-arrester, I sometimes prefer to prevent the formation of a discharge-circuit or an arc at any other point, excepting at the electrodes D, by adding a facing of insulation to each of the poles N S, as indicated at M. This facing may be of mica or slate and sufficiently thin to allow the electrodes, between which the arc is liable to form, to project through. The facing or cover M should extend beyond the outer edge of the poles. In addition, I prefer in some cases to locate between the plates M one or more plates, wings, or vanes V, preferably of mica, which are shown more distinctly in Fig. 2 and which operate to divert or interrupt the arc, owing to the fact that they are arranged in lines

transverse to the line of the arc which will be formed when the electrodes are arranged as described. These vanes, plates, or arc-diverting barriers are shown more clearly in Fig. 2 as radiating outward from the center at which the electrodes D are located in the middle of the insulating facings or disks M, covering the poles. I also prefer to provide the electrodes D, though it is not essential to do so, each with a projection or extension *e* or *e'*, extending laterally from the electrode outward toward the edge or confines of the magnetic field formed between the poles. These extensions are made of metal, and when the winding of the coils C C' and the arrangement of magnetism of the poles is such as to force the arc upwardly are carried downwardly, as indicated in Figs. 2 to 6, inclusive. The faces of these extensions or projections lie a little back of the discharge surface or point of the electrodes D, so that the latter are nearer together than the extensions from them. The extensions *e e'* from the discharge-points do not project radially outward on coincident radial lines, but as shown in Fig. 2, while the extension *e* proceeds radially downward to the right. The projection *e'* proceeds in a divergent path, as shown by the dotted lines, or to the left. While, therefore, the discharge points or electrodes are directly opposite to one another, the projections or extensions therefrom are inclined away or project in divergent radial paths. The utility of this will be seen presently.

It should be understood that the plates or vanes V and extensions *e e'* are not essential features of my invention, though they are of value as adjuncts to it, the main principle being to cause the discharge to pass from one electrode to the other in the middle of the field or on a line, as before described, which shall be coincident with or parallel to that joining the polar faces of the arc-disrupting magnet, or, in other words, on a line substantially parallel to the magnetic axis of the arc-disrupting magnet, and thereby be acted on powerfully and take the course which will be described in case an arc forms.

To show the operation of the device, Fig. 3 exemplifies the position taken by an arc immediately after a discharge has occured between the points D upon the poles. The dischage does not remain for an instant at the center point, but separates at once radially outward in all directions and runs down the discharge points or extensions *e e'*, which, diverging relatively, lead the heated gas at each side to a distance of separation, while the arc or discharge plays outwardly in the space between the poles or between the insulated faces M, surrounding or facing these poles. The radial wings or vanes between the insulating-faces, when they exist, as in Fig. 5, act as arc interrupting or diverting plates or barriers to cut up or further elongate the arc-discharge, which is being driven outward in the way just described, causing it to take a star form if it has not already been disrupted by the vigorous action of the magnetic field upon it.

In constructing the apparatus care should be taken to wind or apply the coils C C' so that the direction of current in them will be such as to produce a field which will cause the discharge or arc to be driven upward or into the position or form shown in Figs. 3 and 5, so as to be interrupted or broken up by the rings or vanes. If the discharge were driven downward instead of upward, the space traversed by the arc between the ends of the extensions of the electrodes obviously would not be so long and the action would be less efficient.

Fig. 4 shows a lateral view of the course which would be taken by the arc in Fig. 3, leaving one discharge-point to go to the other. It is turned about in the course there indicated, and if the extensions *e e'* are properly located will not continue discharging from the discharge-points at all, but will follow down the extensions to their extremities.

Modifications in the shape of the parts, not departing from the essential features of the invention, may be made. Thus in adding the vanes or radial projections V between the faces M they may be made to still further separate the heated gases while being driven outward by giving them the form shown at V in Fig. 6, where they are shown enlarged or thickened at their outer ends, so as to contract the openings or increase the distance between the same outside the wings or vanes. The construction thus produced, it will be seen, affords virtually a ring or envelope of insulating material having a number of discharge-openings almost of the character of jets around the central discharge points or electrodes D, so that the heated gases being driven outward are expelled in separate streams and cannot reunite to continue the arc-discharge.

Fig. 7 shows the discharge-points at D, made in one piece with the poles N S and such poles covered all over with a coating of insulating material, which, however, is not herein claimed.

Fig. 8 shows the presentation of the poles N S as blunted cones, their extremities making the discharge-points or being capped with copper buttons for the same purpose, while over each pole is fitted a flanged cap or hollow conical shell with flanges M M', which enable the discharge to play out from between the poles into the free air beyond without reaching or settling down upon the magnet-poles themselves.

Fig. 9 shows the separation of the discharge-points into two sets D D' in series, with an intermediate insulating-plate M^2 interposed between the two sets of discharge-spaces. In this case two arcs are formed and two spaces for disruption are provided in the same field.

This is particularly adaptable to the case of very intense discharges and arcs sustained by considerable electro-motive force. Of course three or more discharge-spaces might be adopted and their distance apart might be made correspondingly small, with the effect of having a number of disruptive points in series. When a number of discharge-spaces in series are thus provided, the effects are intensified to a great degree, owing to the fact that any static disruptive discharge will leap a number of separate spaces of a given width arranged in series more readily than it will pass over a single space whose width is the sum of the small spaces.

Fig. 10 shows the interposition between the two sets of discharge-points of a mass of iron G, intended merely to act as a conveyer of the magnetic force. This figure illustrates how it would be possible to put a number of discharge-points in series, since the magnetic bar or portion G might even be wound with energizing-coils, which would increase the magnetization, though generally it would be magnetized from the poles N S to a sufficient extent. In this case the insulating disks or washers face the polar portions and are indicated by the letters M M′ M^2 M^3.

Modifications in the forms and disposition of the discharge-points themselves in relation to each other, not departing from the essence of my invention, may be made.

The action of the extensions *e e′*, in connection with the interrupting-plates, will be clearly understood from Figs. 3 and 5. The extensions act to cause the arc to be first formed at points somewhat below the level of the electrodes D, where they are nearest together; but owing to the action of the magnetic field the arc following is instantly thrown upward, and thus caused to traverse a long space, in which are interposed the vanes or wings V. Being thus prolonged or extended, it may be broken with comparative ease.

What I claim as my invention is—

1. The combination, with an arc-rupturing magnet, of the arcing electrodes connected to a circuit supplied from a source of energy sufficient to maintain a continued arc once formed from one to the other and presented to one another on a line parallel to the lines of magnetism or line joining the poles of said magnet.

2. The combination, with the arc-rupturing magnet and the arc electrodes presented to one another on a line joining the magnet-poles, of one or more arc-diverting plates or vanes arranged in the arc of a circle around said electrodes and in planes substantially parallel to the line joining said electrodes.

3. The combination, with the arcing electrodes or abutments, of an arc-disrupting magnet tending to give the arc a rotary or twisted path transverse to the lines of magnetic force and surrounding them, and one or more barriers or plates disposed in a manner to oppose the free movement of such rotary arc and cause it to be interrupted or to assume a more lengthened path, substantially as and for the purpose described.

4. The combination, with the arc-rupturing magnet having poles brought into close proximity and adapted to produce an arc-rupturing magnetic field in which the lines of force may pass directly or without diversion from one pole to the other, of arcing electrodes located at or near the center of the magnetic space between the poles of the magnet and presented or directed toward one another on a line joining said poles and substantially parallel to the axis of the magnetic field or lines of force flowing between the poles, as and for the purpose described.

5. The combination, with the arcing electrodes and arc-rupturing magnet, of a surrounding cage or barrier arranged around the electrodes and provided with a number of discharge-openings.

6. The combination, with the arc-rupturing magnet and two or more sets of arcing electrodes arranged in series between the magnet-poles, of an intermediate conveyer of magnetism, as and for the purpose described.

7. The combination, with the opposed magnetic poles, of the discharge points or electrodes located between the same and provided with extensions for leading the discharge outward in different directions toward the confines of the magnetic field.

8. The combination, with the magnetic poles and the discharge points or electrodes located between the same, of disks or plates of insulating material over the pole-faces and connecting vanes or wings of mica between such plates.

9. In a lightning-arrester, two or more sets of discharge points or electrodes arranged in series within an arc-rupturing magnetic field and in line with one another substantially parallel to the lines of magnetic force or the magnetic axis of such field.

10. The combination, in a lightning-arrester, of two or more sets of electrodes arranged in series, means for diverting or forcing the arc laterally outward, and arc diverting or interrupting plates contiguous to the spaces between the several sets of electrodes and placed in the path of the arc following any discharge.

11. The combination, in a lightning-arrester, of two or more sets of discharge points or electrodes placed in series, in combination with an arc-rupturing magnet, between whose poles the said two or more sets are arranged in a line parallel with the line joining said poles.

12. The combination, with an arc-rupturing magnet, of electrodes placed within the magnetic field and having extensions projecting laterally outward toward the confines of the field.

13. The combination, with arcing electrodes

placed in an arc-rupturing field, of extensions projecting toward the confines of the field, but on divergent lines.

14. The combination, in a lightning-arrester, of arc-rupturing magnet or magnets having their poles brought close together, and discharge-electrodes electrically connected to the poles and directed toward one another in the magnetic field or space in which the lines of magnetic force pass from one pole to the other, as described, and so that the discharge from one to the other will take place in a line coincident with or parallel to the line joining the pole-faces.

15. The combination, substantially as described, of discharge points or electrodes D, connected to an electric circuit supplied with energy from a source of sufficient power to maintain an arc across the space between said electrodes, and an electro-magnet from opposite poles of which said electrodes project toward one another, said magnet being charged, as described, with a polarity such that its field will cause the discharge or arc between the electrodes to be driven upward, as and for the purpose described.

Signed at Lynn, in the county of Essex and State of Massachusetts, this 23d day of December, A. D. 1889.

ELIHU THOMSON.

Witnesses:
JOHN W. GIBBONEY,
ALBERT L. ROHRER.