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LIGHTNING ARRESTER

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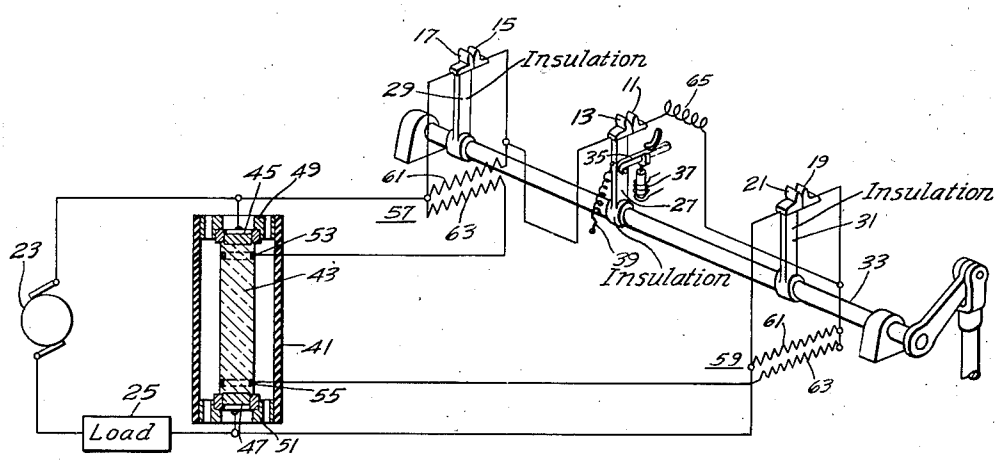

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LIGHTNING ARRESTER

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My invention relates to electric discharge apparatus and has particular relation to arc extinguishing devices.

In circuit breaker apparatus for interrupting substantial current the principal problem which arises involves the prompt extinguishing of the arc ignited between the contacts when the breaker is opened. In accordance with the teachings of the prior art of which I am aware, a chamber in which the arc may be extinguished is provided and the arc is either ignited in the chamber or transferred to it. Since the range of movement of the contacts of a circuit breaker is in general relatively limited, the expediency of striking the arc in the extinguishing chamber is only adopted where the conditions are such that they may be satisfied by a relatively small chamber. Where the arc is transferred to the extinguishing chamber, the transfer takes place in discrete stages through arc horns, or auxiliary contacts are opened in the chamber. The resultant structure is relatively complex.

It is accordingly an object of my invention to provide an arc extinguishing device of simple structure for a circuit breaker.

Another object of my invention is to provide a lightning arrester that shall respond to potentials of moderate magnitude and that shall function to efficiently interrupt the arc ignited.

A more general object of my invention is to provide an arc extinguishing arrangement of simple structure.

An ancillary object of my invention is to provide a contrivance for facilitating the ignition of an arc in a desired region.

More concisely stated, it is an object of my invention to provide an arrangement for localizing an arc in a region in which it may easily be extinguished or controlled.

My invention arises from the realization that a discharge may be initiated over the surface of a semi-conductor such as silicon carbide, boron carbide, and zirconium compounds of the type used in the art for the construction of resistance rods by the application of a relatively low potential. Thus I have found that a discharge may be produced over the surface of a rod of silicon carbide crystals, such as are sold under the trade name of Carborundum crystals, by the application of a potential gradient of approximately 800 volts per inch. In other cases where the crystals were of different dimensions I have found 10,000 volts to be required for a discharge. The magnitude of the potential which produces the discharge is dependent on the dimensions and structure of the surface. For example, a discharge may take place over the surface of a single large silicon carbide crystal or a bar formed of a number of crystals held together by a binder such as water glass or a ceramic glaze. This discharge takes the form of an arc when it is part of a circuit in which the power available is sufficiently large. In the claims I shall refer to a surface or a substance "of the silicon carbide type" meaning thereby any semi-conductor over the surface of which the discharge described above is produced. I am referring to silicon carbide advisedly because I have found it to be by far the most satisfactory substance for this purpose.

In accordance with one aspect of my invention, a circuit interrupting device is provided in which, on the opening of the contacts, a discharge is initiated over a silicon carbide surface disposed in an arc extinguishing chamber. A pair of fixed electrodes shunting the contacts is provided in the chamber and by reason of the ionization produced by the discharge over the silicon carbide surface, an arc is ignited between the electrodes. The arc between the contacts is, therefore, interrupted and when the current next passes through zero the arc in the chamber is extinguished.

In accordance with another aspect of my invention silicon carbide surfaces are provided along the surfaces of the slots of an insulator which forms a gas in the presence of an arc. The surfaces facilitate the ignition of an arc and, therefore, the arrangement responds to a substantially lower potential than a corresponding arrangement in which they are absent.

The novel features I consider characteristic of my invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and its method of operation together with additional objects and advantages thereof, will best be understood from the following description of a specific drawing in which the figure illustrated is a diagrammatic view showing the essential elements of a circuit breaker constructed in accordance with my invention.

The apparatus shown in the figure comprises a set of cooperative fixed and movable main contacts 11 and 13, respectively, and a plurality of sets of cooperative fixed and movable auxiliary contacts 15 and 17, and 19 and 21. The sets of contacts 11 to 21 are interposed in series between a source 23 of any general type and a load 25, the main contacts 11 and 13 being connected between the auxiliary contacts 15 to 21.

The movable contacts 13, 17 and 21 are mounted on insulating levers 27, 29 and 31, respectively, which are in turn secured to a pivotally supported pin 33. When the circuit interrupter is closed, the supporting shaft is latched so that the contacts 11, 15 and 19 and 13, 17 and 21, respectively, are in engagement. To open the interrupter the latch 35 is released by a solenoid 37 in the usual well known manner and the pin 33 carries the movable contacts 13, 17 and 21 to the open position under the action of a suit-

able spring 39. The arc ignited between the contacts when they are opened is interrupted within a hollow cylinder 41 of a material which forms a gas in the presence of an arc. In the preferred practice of my invention a cylinder of fibrous material is used. Of course, the cylindrical form of the arc interrupting chamber is not essential to the practice of my invention.

Within the cylinder 41 there is a bar 43 of porcelain or other suitable material to the surface of which a layer of silicon carbide crystals rigidly adhere. The silicon carbide layer may be formed on the rod by first depositing a silicon carbide paste on its surface and then firing the rod. The surface may also be formed by embedding the silicon carbide near the outer region of the ceramic material when the rod is molded.

At the ends of the rod 43, ring-shaped electrodes 45 and 47 of a suitable conducting material are disposed. The electrodes are interposed between the source 23 and the load 25 in parallel with the contacts 11 to 21. The rod 43 is held in the insulating cylinder 41 by a pair of rings 49 and 51 which are pressed into the cylinder and engage the electrodes 45 and 47 at their ends. The supporting rings 49 and 51 are perforated so that gas may flow through the cylinder 41 with facility. The rod 43 is also provided with a pair of conducting terminals 53 and 55 which are disposed adjacent to the electrodes 45 and 47, respectively, and are rigidly secured to the rod. In the preferred practice of my invention, the terminals should be mounted approximately ⅛'' from the corresponding electrodes.

To produce the preliminary discharge over the silicon carbide surface, step-up transformers 57 and 59 are provided. The primaries 61 of the transformers are connected across the auxiliary contacts 15 and 17 and 19 and 21. The electrode 45 and the associated terminal 53 are connected across the secondary 63 of one transformer 57 and the other electrode 47 and its associated terminal 55 are connected across the other secondary.

When the breaker is opened, the potential drop across the auxiliary contacts 15 and 17 and 19 and 21 results in the impressing of a potential across the silicon carbide surface between the terminals 53 and 55 and the electrodes 45 and 47, respectively. The potential is sufficient to produce a discharge over the adjacent surfaces. When the contacts 11 to 21 are disengaged, the total potential across the contacts is also impressed between the electrodes 45 and 47. By reason of the ionization produced by the discharge, the arc between the contacts 11 to 21 is transformed into an arc between the electrodes 45 and 47. To facilitate the transformation, a low resistance coil 65 is provided adjacent the main contacts 11 and 13. The coil is connected in series with the contacts 11 to 21 and carries the main arc current. By reason of its magnetic field, the arc at the main contacts 11 and 13 is blown out and its transfer to the extinction chamber is facilitated. In the extinction chamber the heat of the arc causes the fiber cylinder 41 to emit a deionizing gas and the arc is extinguished when the current passes through zero at the end of the half-period following the transfer.

In the modification shown in the figure, an insulator 43 surfaced with silicon carbide is used. This structure may of course be modified without departing from the scope of my invention. For example, the silicon carbide surface need not extend throughout the whole length of the insulator 43. It may be restricted to the ends. In a structure which may be used with advantage in the practice of my invention, an insulating tube is provided with silicon carbide ends. The composite tube may be constructed by securing small cylindrical blocks of silicon carbide to the ends of a porcelain cylinder and fastening the terminals 53 and 55 and the electrodes 45 and 47 to the silicon carbide.

Although I have shown and described certain specific embodiments of my invention, I am fully aware that many modifications thereof are possible. My invention, therefore, is not to be restricted except insofar as is necessitated by the prior art and by the spirit of the appended claims.

I claim as my invention:

1. In combination means for establishing an arc, an arc-extinguishing chamber one wall of which comprises a surface of the silicon carbide type, said means being outside said chamber, means for impressing a potential sufficient to produce a discharge over said surface, said means including means for connecting said arc in multiple with said surface.

2. In combination an arc-extinguishing chamber having walls which emit a gaseous substance when heated, means for establishing an arc outside said chamber, one wall of said chamber comprising a surface of the silicon carbide type in said chamber, means for producing a discharge over said silicon carbide surface, said means including means for connecting said arc in multiple with said surface.

3. In combination a circuit interrupter having contact means, an arc-extinguishing chamber, a surface of the silicon carbide type disposed in said chamber, means for connecting said contact means across said surface and means responsive to the opening of said contact means to produce a discharge over said surface.

4. In combination a circuit interrupter having a plurality of pairs of contacts, an arc-extinguishing chamber, a crystalline surface of the silicon carbide type disposed in said chamber, means for connecting said contacts across said surface and means responsive to the opening of one of said pairs of contacts for producing a discharge over said surface.

5. For use in the protection of a system including a load and a source for supplying said load, the combination comprising a plurality of pairs of contacts interposed in series between said load and said source, an arc-extinguishing chamber, a crystalline surface of the silicon carbide type disposed in said chamber, means for connecting said surface in parallel with said pairs of contacts and means responsive to the opening of one of said pairs of contacts to produce a discharge over said surface.

6. Circuit interrupting apparatus comprising contact means for interrupting a circuit which forms an arc when operating, an arc-extinguishing chamber, electrodes disposed in said chamber, means for connecting said electrodes in shunt with said contact means and means for igniting an arc between said electrodes on the operation of said contact means and igniting means including surfaces of silicon carbide within said chamber and means for producing a discharge over said surface.

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