May 26, 1953 H. H. FAHNOE ET AL 2,640,128

CIRCUIT INTERRUPTER

Filed May 2, 1952

Fig. 1.

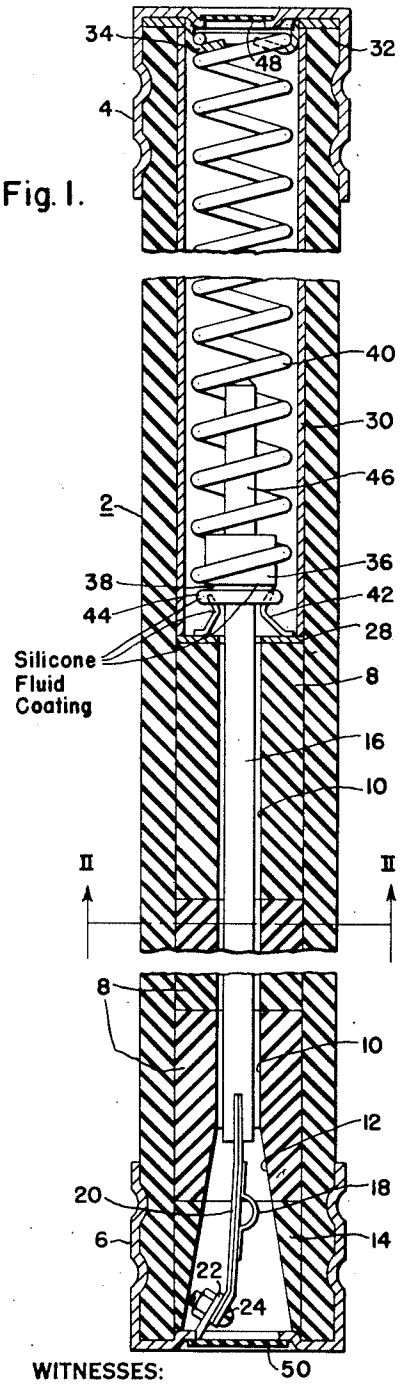
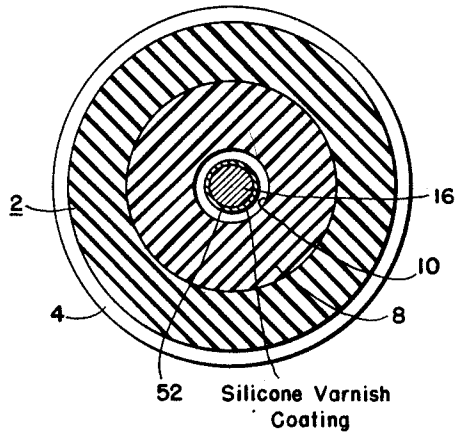


Fig. 2.



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Patented May 26, 1953

2,640,128

UNITED STATES PATENT OFFICE

2,640,128

CIRCUIT INTERRUPTER

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Application May 2, 1952, Serial No. 285,694

7 Claims. (Cl. 200—120)

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This invention relates to an improvement on high voltage circuit interrupters, particularly of the type described and claimed in the patent of H. L. Rawlins, et al., Serial No. 2,403,121, granted July 2, 1946.

Circuit interrupting devices of this type are subjected in service in power line circuits to voltages high enough to make corona a problem. Corona itself is not harmful, however, there are serious secondary effects which result from the production of powerful oxidizing agents in an intense electrical field. Ozone is produced, which accelerates oxidation of adjacent organic materials. Nitrogen oxide components, produced by the ionization of the air, combine with water to form acids that attack the internal metallic parts of the circuit interrupter unit.

Serious difficulties have been experienced by reason of the accumulation of incrustations of nitrous salts on the above-mentioned internal metallic parts, by reason of the reaction of the metal, generally copper, with the acids formed by the corona. These incrustations are deposited during the period of time when the device is carrying line current, that is, before it undertakes to perform its circuit interrupting action in response to an overcurrent in the line.

This difficulty has been a problem, particularly in the type of high voltage power fuse of the Rawlins et al. patent referred to above, in which it is necessary for an arcing contact rod to be withdrawn longitudinally through the bore of a gas-evolving liner, such as boric acid, during the circuit interrupting operation of the fuse. The bore of this boric acid liner must be as small as practicable, in order that the arc which results from the current interruption will come into contact with the side walls of said bore, as the rod is being withdrawn out of the bore during the circuit interrupting operation. This contacting of the liner by the arc is necessary so that the surfaces of said bore will evolve arc-extinguishing gases. In order that the rod shall have sufficient mechanical strength and current carrying ability, the outer diameter of the rod is made as large as is permitted by the diameter of the bore of the boric acid liner, and with the minimum possible clearance, so that it does not take very much outer incrustation on the rod to prevent it from being withdrawn through the bore of the boric acid liner during the circuit interrupting operation.

In an attempt to solve this corrosion problem, the internal metallic parts of a fuse unit were plated with many metallic coatings, including

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silver, cadmium, zinc, gold, etc. These applied metallic coatings, however, were soon tarnished and corroded when subjected to corona conditions.

To the best of our knowledge, it has never, heretofore, been taught nor suggested how to successfully prevent the detrimental effects of corona in high voltage electrical fuses by providing a protective coating on the internal metallic parts.

An object of this invention is thus to provide protection for the internal metallic parts of a high voltage circuit interrupter unit from the formation of corrosion deposits and incrustations thereon caused by corona by applying a silicone coating to the parts affected.

Other objects of the invention will, in part, be obvious, and will, in part, appear hereinafter.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description and drawing, in which:

Figure 1 is a schematic vertical longitudinal sectional view showing an exemplary circuit interrupter assembly embodying our invention, and

Fig. 2 is a sectional view taken on the line II—II of Fig. 1.

We have discovered that the detrimental effects of corona on the internal metallic parts in a circuit interrupter unit are prevented by applying to the parts affected a silicone coating. The metallic parts affected are generally those having a relatively small cross-sectional area, particularly the arcing contact rod, fusible interrupter strips, and sliding contacts. Either of two types of silicone coatings are applied, the particular one selected depending upon the function of the metallic part to be coated. A coating of hardened silicone varnish is applied to the arcing contact rod and interrupter strips and a coating of silicone fluid is applied to the sliding contacts for reasons to be hereinafter described. All of the parts subject to corona, however, may be coated with silicone fluid, or if desired, a coating of silicone fluid, to act as a lubricant, may be applied over the silicone varnish coating.

In practicing our invention, we first silver plate all the metallic parts to be treated. The silver-plate is not essential, however, it provides a better silicone to metal bond. Other metal plating may be used, such as cadmium or zinc. Two coatings of silicone varnish are applied over the silver plate on the parts, such as the arcing rod, not subject to sliding contact. Each coating of the silicone varnish is baked after being applied. The baked silicone varnish forms a hard glazed

surface which is not affected by the heat generated inside the interrupter unit. This permits free withdrawal of the arcing rod when a circuit interruption occurs. The silicone fluid applied to the electrically conducting parts having sliding contact will remain in a fluid state after application in order that a metal to metal electrical contact is maintained during sliding movement of the contacts. The fluid surrounds the contact, flowing to cover any area exposed during movement, and thus in this manner the metal is always protected.

Silicone varnishes for use in the practice of this invention may comprise a silicone resin dissolved in a suitable solvent. The silicone resins are thermosettable polymers containing an R to Si ratio of from 1.1 to 2. The R represents monovalent organic groups and may comprise monovalent alkyl groups such as methyl, ethyl, and propyl, aryl groups such as phenyl, tolyl and xylyl, and alkaryl groups such as benzyl. The silicone resin may comprise a single type of R groups—for example a polymethylsiloxane having an R to Si ratio of 1.4—or different groups—for example a phenylmethyl polysiloxane having an R to Si ratio of 1.5 and a substantially equal number of phenyl to methyl radicals. Suitable solvents are toluene and xylene. The phenyl methylene siloxane above mentioned forms a suitable varnish when dissolved in 3 parts by weight of toluene for each part of resin.

The silicone fluids are liquid organo-silicon oxide polymers either linear or cyclic in molecular structure and often comprise both linear and cyclic polymeric units. The silicon atoms of the organo-silicon oxide polymers are joined to other silicon atoms through an oxygen linkage, namely Si—O—Si, and all valences of the silicon atoms not taken up by such oxygen linkages are satisfied by monovalent organic radicals attached to the silicon atoms through a carbon to silicon bond (except for possibly a few residual OH or other groups attached to silicon). The organic radicals are saturated alkyl radicals such as methyl, ethyl, propyl, isopropyl, butyl, aryl, hexyl and higher. Saturated alicyclic radicals such as cyclohexyl and methyl cyclohexyl; aryl and saturated alkaryl radicals such as phenyl, benzyl, tolyl, naphthyl xylyl and mesityl may be attached to a small proportion of the silicon atoms. The preferred fluids are dimethyl silicones.

Illustrated in Fig. 1 of the drawing is an exemplary form of circuit interrupter embodying the invention. The circuit interrupter unit is constructed of a fuse tube of insulating material, such as fiber, synthetic resin or the like, and opposite ends of the fuse tube are closed by end terminal caps **4**, **6** respectively, fastened thereto by cooperating indentations. Within the lower portion of fuse tube **2**, as viewed in Fig. 1, are a plurality of blocks **8**, of an insulating material which is capable of evolving an arc extinguishing gas when in proximity to an electric arc. The insulating material **8** is preferably boric acid, but any other insulating material having the property set forth above may be employed, such, for example, as horn fiber or a synthetic resin as urea-aldehyde polymer. The insulating blocks **8** are each provided with a central bore **10**, so that the bores, when the blocks are mounted in the tube **2**, form an elongated arc passage of restricted cross-section. The lower end of the arc passage formed by bores **10** is outwardly flared portion **12**. Disposed on end cap **6** is a lower block **14** which supports the blocks **8** in position.

The block **14** is preferably of the fiber or a synthetic resin which has a greater mechanical strength than boric acid.

An arcing contact rod **16** is adapted to be normally positioned within the arc passage formed by bores **10**. The lower end of rod **16** is electrically connected to the terminal cap **6** by a fusible strip **18**, paralleled by a strain member **20**, secured in any desired manner to the rod **16** and terminal cap **6**. As shown, fusible strip **18** and strain member **20** have one end inserted in a slot in the lower end of arcing contact rod **16** to be secured therein, as by soldering or riveting, and the other end of the fuse strip and strain means is bolted or otherwise secured as by the screw **24** to an inwardly bent tongue **22** formed integral with end terminal cap **6**. Fusible strip **18** may be of any desired fusible material, such, for example, as silver, zinc, tin, or alloys thereof. The strain member **20** paralleling the fusible strip is preferably of a higher resistance material which has a greater tensile strength than the material comprising fusible strip **18**.

A conducting washer **28** is mounted within fuse tube **2** immediately above insulating blocks **8**. Abutting on washer **28** is a tube **30** of good electrical conducting material, the latter being clamped between end terminal cap **4** and the upper end of fuse tube **2**. As shown in Fig. 1, an end washer **32** is provided with a central aperture and with integral inwardly extending supporting and locking tongues **34**, for a purpose to be hereinafter referred to. Just above the conducting washer **28**, arcing contact rod **16** is provided with an enlarged portion **36** having a tapered lower surface **38**, on which is seated an end coil **44** of a coiled tension spring **40**. The opposite end coil of spring **40** is supported by tongues **34**. The rod **16** is biased upwardly towards end terminal cap **4** by spring **40** and strain member **20** is normally maintained under tension thereby.

In order to provide a good electrical connection from arcing contact rod **16** to terminal cap **4**, flexible strips **42** of a conducting material such as copper, are preferably secured to conducting washer **28** at the lower end of conducting tube **30**, and the free ends of the strips are inserted between the tapering contact surface **38** on the arcing contact rod and the lower coil **44** of spring **40**. Thus, spring **40** also acts to maintain contact strips **42** in engagement with the tapered surface **38** on the contact rod under pressure.

The contact strips **42** and end coil **44** are in sliding contact with the tapered surface **38** of the enlarged portion **36** in order to allow for expansion and contraction resulting from changing temperatures incurred during operation of the device. Also, the enlarged portion **36** must be freely disengageable from the contact fingers **42**, in response to fusion of fusible strip **18** and strain member **20** upon the occurrence of an overload of current through the circuit.

It will be noted that arcing contact rod **16** is provided with an integral extension **46** above enlarged portion **36**, and that the end terminal caps **4** and **6** are each provided with a central aperture normally closed by displaceable closure disks **48** and **50**, respectively, which may be releasably maintained in position, such, for example, as by cementing or the like.

The electric circuit through the fuse described above extends from one end terminal cap **4** through conducting washer **32**, conducting tube **30**, contact strips **42**, contact arcing rod **16**, fusible

strip 18 to the other end terminal cap 6. When an overload occurs on the circuit in which the fuse is connected, fusible strip 18 will melt and strain member 20 will be vaporized shortly thereafter, to thereby release arcing contact rod 16 and permit spring 40 to move it upwardly towards terminal cap 4. As soon as fusible strip 18 and strain member 20 are melted, the pressure created in the flared passage 12, augmented by gas evolved from the material of bores 10, as arcing rod 16 moves upwardly, will be sufficient to displace closure disk 50 to thereby permit the gases to be expelled to the atmosphere. Spring 40 will be effective to move contact arcing rod 16 upwardly and extension 46 of the rod will engage closure disk 48 and displace the disk so that the extension will be projected from terminal cap 4 an amount limited only by engagement of enlarged portion 36 of the rod with tongues 34 on washer 32. It will be noted that the space between tongues 34 is slightly less than the diameter of rod extension 46, so that in passing upwardly between the tongues the extension will bend them upwardly, and the tongues will therefore lock extension 46 in its projecting position and prevent any subsequent tendency of the rod or extension 46 to move into the fuse tube. During interruption, when an arc is drawn between the lower end of arcing contact rod 16 and arcing tongue 22 on end cap 6, contact strips 42 will move out from between the lower turn of spring 40 and the tapered surface 38 on the contact rod, so that as the rod moves upwardly, the current will be carried by spring 40. Inasmuch as the arcing time is very short, it has been found that the spring will be undamaged by the passage of current therethrough for such short periods of time. Coil spring 40 also performs the function of moving contact rod 16 an amount sufficient to project extension 46 thereof out through the aperture in terminal cap 4 where it is locked against movement by locking tongues 34.

As shown in Fig. 2 of the drawing, baked coatings of silicone varnish 52 are applied to the arcing contact rod 16, fusible strip 18, and strain member 30 in the manner described at the beginning of the specification. The baked silicone varnish assures the free withdrawal of arcing rod 16 through bore 10 which is of greatest importance in the satisfactory operation of the circuit interrupter unit.

It is also desirable to coat all other of the internal metallic parts of the unit affected, including the enlarged portion 36 and contact fingers 42 in order that there be no corrosion of these parts. The enlarged portion 36 and the contact fingers 42, to be hereinafter referred to as sliding contact means, are painted with a coating of a silicone fluid, silicone varnish not being suitable as hereinbefore described.

Circuit interrupters of the type shown, with a silicone coating applied to the internal metallic parts in accordance with our invention, have undergone tests at voltages in excess of 69 kv. Examination of the interrupters after a considerable period of time showed that they had remained free of corrosion deposits. A circuit interrupter of the same construction, but without the benefit of the protective coatings of silicone as taught by our invention, and operating under the same conditions developed corrosion deposits after several hours service.

The application of silicone varnish and silicone fluid to the internal metallic parts of the interrupter unit affected by corona does not in any way affect the operating characteristics of the unit. A continuous protective coating is provided for all metal parts adversely affected by corona. Hence, the arcing contact rod 16 does not build up in any area to such an oversized diameter that it cannot slide freely through the bore 10 of the gas evolving member 8. It is necessary for only a relatively small clearance to be provided between the arcing rod 16 and the bore 10, because at least a portion of this bore has to be as small as possible, in order to best perform its gas evolving function when played upon by an electric arc.

While our invention is primarily designed and adapted for a circuit interrupter of the type described, it will be understood that our invention is not altogether limited to this particular type of circuit interrupter, as our invention may be applied to fuses of different construction. Accordingly, it is intended that all material contained in the above description or taken in connection with the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

We claim as our invention:

1. In a circuit interrupter adapted for service in a circuit at a voltage high enough to form corona, in combination, a tubular enclosure of insulating material having terminals adjacent opposite ends thereof, said terminals being electrically connected by conducting means disposed within said enclosure, said conducting means including fusible interrupting means capable of automatically interrupting the circuit in response to predetermined electrical conditions, a filler within the tube comprising a solid insulating material which is capable of evolving an arc-extinguishing gas when in proximity with an electric arc, a restricted bore through said filler, a movable arcing contact rod in said bore normally held against movement by said interrupting means, biasing means for moving the arcing contact through the bore in response to operation of the interrupting means, and a coating of silicone varnish applied to at least the arcing contact rod, and interrupting means to prevent formation thereon of detrimental corrosion deposits caused by corona.

2. In a circuit interrupter adapted for service in a circuit at a voltage high enough to form corona, in combination, a tubular enclosure of insulating material having terminals adjacent opposite ends thereof, said terminals being electrically connected by conducting means, disposed within said enclosure, said conducting means including sliding contact means and fusible interrupting means capable of automatically interrupting the circuit in response to predetermined electrical conditions, a filler within the tube comprising a solid insulating material which is capable of evolving an arc-extinguishing gas when in proximity with an electric arc, a restricted bore through said filler, a movable arcing contact rod in said bore normally held against movement by said interrupting means, biasing means for moving the arcing contact through the bore in response to operation of the interrupting means, a coating of a silicone fluid applied to the sliding contact means, and a coating of silicone varnish applied to the interrupting means and arcing contact rod, thereby preventing the detrimental effect of corona thereon.

3. The combination of claim 2 in which the coating of silicone fluid and silicone varnish is applied over a silver plate.

4. The combination of claim 2 in which the coating of silicone fluid and silicone varnish is applied over a cadmium plate.

5. The combination of claim 2 in which the coating of a silicone fluid and silicone varnish is applied over a zinc plate.

6. The combination of claim 2 in which a coating of silicone fluid is applied over the coating of silicone varnish.

7. In a circuit interrupter adapted for service in a circuit at a voltage high enough to form corona, in combination, a tubular enclosure of insulating material having terminals adjacent opposite ends thereof, said terminals being electrically connected by conducting means, disposed within said enclosure, said conducting means including sliding contact means and fusible interrupting means capable of automatically interrupting the circuit in response to predetermined electrical conditions, a filler within the tube comprising a solid insulating material which is capable of evolving an arc-extinguishing gas when in proximity with an electric arc, a restricted bore through said filler, a movable arcing contact rod in said bore normally held against movement by said interrupting means, biasing means for moving the arcing contact through the bore in response to operation of the interrupting means, a coating of a silicone fluid applied to the sliding contact means, interrupting means and arcing contact rod, thereby preventing the detrimental effect of corona thereon.

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No references cited.