Dec. 17, 1957 F. L. GELZHEISER 2,816,990

CIRCUIT BREAKER

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Fig. 1.

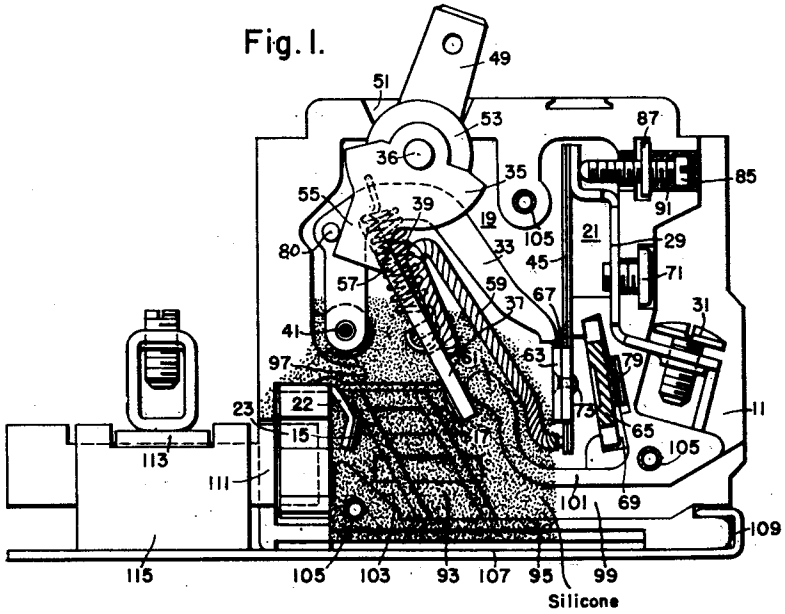


Fig. 2.

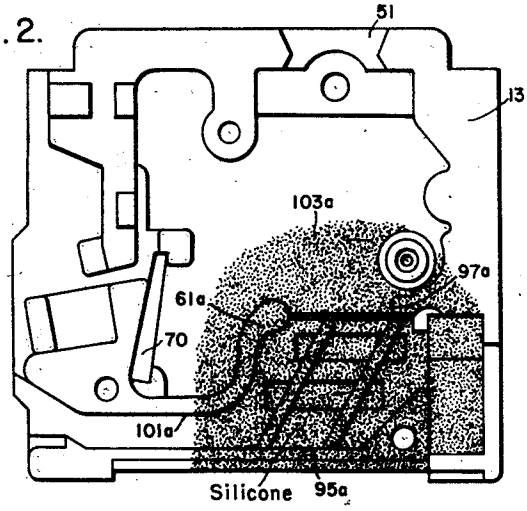


Fig. 3.

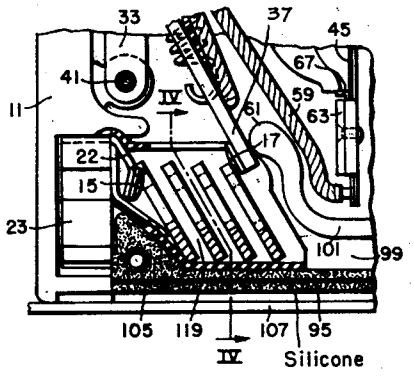
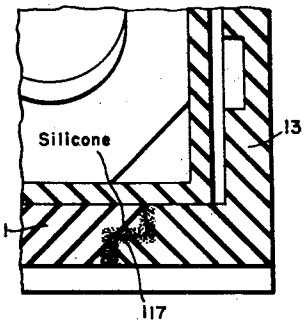


Fig. 4.



WITNESSES

Edwin E. Basden

Paul O. Harlen

INVENTOR

Francis L. Gelzheiser

BY

Ralph W. Swingle

ATTORNEY

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CIRCUIT BREAKER

Francis L. Gelzheiser, Beaver, Pa., assignor to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

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7 Claims. (Cl. 200—144)

This invention relates to circuit breakers, and, more particularly, to insulating housing members for enclosing and supporting circuit breaker mechanisms.

The insulating housing and support members for enclosing and supporting circuit breaker structures are usually made from a general purpose phenolic molding compound and are subjected to the heat of the arc drawn upon separation of the circuit breaker contacts. This is particularly true when the circuit breaker is not equipped with an arc extinguishing structure. It is well known that when repeatedly subjected to arcs, such insulating members become carbonized and their insulating properties are destroyed or greatly reduced. The carbon formed on the surfaces of the insulating parts thus provides a path along which the arc may track across the surface of the insulation from line to load. This further decreases and may destroy the insulating property of the insulating housing parts.

The insulating housing parts of circuit breakers have heretofore been coated with various preparations for the purpose of protecting them from the heat of the arc, but the coating materials previously used for this purpose themselves become carbonized when repeatedly subjected to arcs and dielectric breakdown results.

Small circuit breaker structures are usually enclosed in two-part insulating housings formed from a general purpose phenolic molding compound and are sometimes mounted on metal panels or plates in panelboards and load centers. The two-part housing members sometimes form imperfect or loose seams or joints which provide creepage or flashover paths from the live parts within the circuit breaker housing to the grounded metal mounting plate.

I have discovered that the tracking of the arc along the surfaces of the insulating parts of a circuit breaker is prevented by applying a selected silicone coating to the affected area of the housing parts. The silicone coating is capable of withstanding temperatures in the neighborhood of 600° F. and when subjected to higher temperatures the silicone decomposes into silicon dioxide which has high insulating properties.

By applying a selected silicone coating to the interior of the insulating housing parts, specifically in the areas affected by the arc, the insulating properties of the parts are increased to the extent that the arc extinguishing structure usually provided in conventional circuit breakers can be omitted, thus effecting a considerable reduction in the cost of the circuit breaker.

It has been further discovered that a silicone coating applied to the joints and overlapping portions of the circuit breaker housing members seals the cracks or joints and prevents creepage or flashover therethrough to ground.

An object of the invention is to prevent tracking of the arc across the inner surfaces of insulating housing members of a circuit breaker by applying certain silicone coatings to the affected areas.

Another object of the invention is to prevent creepage from the live parts of a circuit breaker to ground through

the seams of abutting insulating housing members by applying a silicone coating to the adjoining or overlapping portions of the members before they are assembled.

The invention both as to structure and operation, together with additional objects and advantages thereof, will be best understood from the following detailed description thereof when read in conjunction with the accompanying drawing.

In said drawing:

Figure 1 is a side elevational view with the cover removed of a circuit breaker embodying the principles of the invention;

Fig. 2 is an elevational view showing the inside of the cover with the silicone coating applied;

Fig. 3 is an elevational view of a part of the circuit breaker shown in Fig. 1 but provided with an arc extinguisher structure; and

Fig. 4 is an enlarged fragmentary sectional view taken substantially on line IV—IV of Fig. 3.

Several silicone compositions may be used to coat the housing parts, such for instance, as silicone gels, silicone emulsions, silicone varnish and silicone greases. For the purpose of this invention silicones having methyl and ethyl substituents on silicon are suitable. Silicones are often designated as siloxanes or organopolysiloxanes.

Silicones suitable for providing coatings having non-tracking properties are methyl silicones and ethyl silicones having an average of from 1.1 to 1.9 of the methyl or ethyl groups, or combinations of both, per silicon atom. These silicones are resinous or of gel-like characteristics. They may be dissolved or emulsified in a volatile liquid solvent or carrier to produce liquid compositions and when such compositions are sprayed, brushed or otherwise applied, the solvent or liquid carrier evaporates leaving an adherent coating on the surface to which it is applied.

A suitable silicone grease or gel comprising a fluid dimethyl silicone combined with a substantial proportion of a finely divided filler may be used. One such silicone gel consists of 88% by weight of a dimethyl silicone oil combined with an inert, refractory, nonconducting filler such as 12% silica aerogel.

An emulsion consisting of 25% methyl or ethyl silicone gel or resin suspended in water may also be used to coat the housing parts.

Silicone varnishes for use in coating the housing parts may comprise a methyl or ethyl silicone resin dissolved in a suitable solvent. The silicone resins are thermosettable polymers containing an R to Si ratio of 1.1 to 1.9. Where R represents methyl and ethyl groups, a suitable silicone resin may have an R to Si ratio of 1.5. Suitable solvents are toluene and xylene. Butyl titanate may be present to enable hardening of the applied resin at room temperatures. The methyl silicone resin above mentioned forms a suitable varnish when dissolved in 3 parts by weight of toluene for each part of resin.

I prefer to use a silicone liquid consisting of a silicone dissolved in a volatile liquid solvent which is readily sprayed on the housing parts. Spraying the parts with such a liquid silicone is quickly done and saves considerable time compared to brushing or otherwise applying the coating. Another advantage of spraying the silicone coating is that the volatile solvent quickly dries at room temperature, hence, no special drying apparatus is required. When the solvent dries it leaves a hardened, adherent coating, whereas the silicone gels and greases remain greasy or tacky and are thus less desirable, though usable.

Figure 1 of the drawing illustrates a conventional circuit breaker which comprises generally an open-sided housing member 11 for receiving and supporting the several parts of the breaker structure, a cover or cooperating housing section 13 both made of molded insulating material, a

stationary contact **15**, a movable contact **17**, an operating mechanism **19** and a trip device **21**.

The stationary contact **15** is rigidly secured to the inner end of a conducting member **22** integral with a plug-in connector member **23** supported in the housing **11** and in the cover **13**. At the opposite end of the housing **11** is disposed a conducting strip **29** which at its inner end is connected to the trip device **21**, and is provided with a terminal connecting means, such as a screw **31**, at its outer end for connecting the circuit breaker in an electric circuit.

The movable contact **17** is rigidly secured on the free end of a U-shaped switch member **37** having its legs **57** supported in recesses in the legs **55** of a U-shaped operating lever **35** of molded insulating material. The operating lever **35** is pivotally supported by trunnions **36** molded integral therewith and mounted in suitable companion openings in the housing member **11** and in the cover **13**. An overcenter operating spring **39** is connected under tension between the bight of the switch member **37** and a releasable carrier **33** pivoted on a pin **41** supported in the housing **11** and in the cover **13**.

The operating lever **35** is provided with a handle **49** molded integral therewith and extending outwardly through an opening **51** in the housing **11**. The operating lever **35** is also provided with an arcuate portion **53** which cooperates with the housing **11** and the cover **13** to substantially close the opening **51** in all positions of the handle. The switch member **37** is conductively connected by a flexible conductor **59** to one end of a bimetal element **45** forming a part of the trip device **21** which is suitably secured to and supported by the inner end of the conductor strip **29**.

The switch arm **37** is operated to manually open and close the contacts by operation of the lever **35** which is effected by manipulation of the handle **49**. Movement of the handle **49** in a clockwise direction forms the position shown in Fig. 1, carries the pivoted ends of the legs **57** of the switch member **37** across to the left of the line of action of the operating spring **39** which then biases the switch member **37** to the open position and causes movement of the switch member to the open position with a snap action.

The contacts are manually closed by reverse movement of the operating lever **35**. Counterclockwise movement of the lever **35** from the open position to the closed position moves the upper pivoted ends of the legs **57** of the switch member **37** across to the right of the line of action of the spring **39** which then acts to close the contacts with a snap action.

The circuit breaker is tripped open after a time delay in response to overload currents below a predetermined value, and instantaneously in response to overload currents above the predetermined value, or in response to short circuit currents, by means of the trip device **21**. Operation of the trip device **21** causes release of the carrier **33** whereupon the operating spring **39** moves the carrier **33** clockwise about its pivot **41** until it is arrested by a projection **61** molded integral with the housing part **11** and a matching projection **61***a* (Fig. 2) on the cover **13**. The clockwise movement of the carrier **33** moves the line of action of the spring **39** across to the right of the center line of the switch arm **37** and the spring **39** then acts to move the switch member to the open position with a snap action.

The trip device **21** comprises the bimetal element **45** connected to the movable switch member by the flexible conductor **59** and electromagnetic means including a magnetic member or armature **63** rigidly mounted on the bimetal element **45** and a magnet yoke **65** movably supported in a recess **69** (Fig. 1) in the housing **11** and a companion recess **70** (Fig. 2) in the cover **13**. The conducting strip **29** extends along an end wall of the housing **11** and is rigidly secured thereto by a screw **71**, the bimetal element at one end being rigidly secured by suitable means, such as welding, to the upper inner end of the conductor strip **29**.

The armature **63** is rigidly secured to the bimetal element **45** by a rivet **73** which also rigidly fastens a latch member **67** to bimetal element **45**. The latch member **67** normally engages and releasably restrains the carrier **33** in operative position.

The recesses **69** and **70** (Figs. 1 and 2) in which the magnet yoke **65** is disposed, are wider at the bottom than they are at the top to permit pivotal movement of the magnet yoke in the direction of thermal bending of the bimetal element **45**, the magnet yoke **65** being biased by a light compression spring **79** to the position shown to provide a normal air gap between the magnet yoke **65** and the armature **63**. This arrangement permits maximum deflection of the bimetal element when it is hot and prevents it from taking a permanent set as it would if its deflection were opposed by any substantial force such as engaging a fixed magnet yoke.

Means is provided for calibrating the trip device. The calibrating means comprises a screw **85** threaded through a fixed nut **87** disposed in a recess **89** in the adjacent end wall of the housing **11**. The inner end of the screw **85** engages the upper end of the conductor strip **29** on which the bimetal element **45** is mounted and applies a pressure thereto. An access opening **91** is provided in the end wall through which the screw **85** may be rotated to vary the pressure on the conducting strip after which the opening **91** may be sealed to prevent tampering. Turning the screw **85** varies the pressure on the conductor **29** and causes movement of the upper end of the conductor according to the direction in which the screw is rotated. This varies the position of the bimetal element **45** and consequently varies the thermal tripping point of the breaker.

Upon the occurrence of a low persistent overload current below a predetermined value of, for example, ten times normal rated current, the bimetal element **45** becomes heated, and when heated a predetermined amount bends toward the right causing the latch **67** to release the carrier **33** which effects opening movement of the switch member **37** in the manner previously described.

When an overload current above ten times normal rated current or a short circuit current occurs, the electromagnetic trip means is energized and the armature **63** is attracted toward the magnet yoke **65** bending the bimetal element **45** and causing the latch member **67** to instantaneously release the carrier **33** and open the contacts.

The releasable carrier **33** is reset and relatched and the contacts closed following an automatic opening operation by first moving the handle **49** clockwise to the "off" position and then counterclockwise to the "on" position. Movement of the handle to the "off" position causes the legs **55** of the operating lever to engage a pin **80** in the carrier **33** and move the carrier counterclockwise about its pivot **41**. Near the end of this movement, the free or latching end of the carrier **33** wipes by the latch **67**, slightly bending the bimetal element which then resumes its normal latching position.

An arc chamber **93** is formed by the projection **61**, the bottom wall **95** of the housing **11** and a projection **97** on the housing **11** and by cooperating projections **61***a*, **97***a* and a bottom wall **95***a* (Fig. 2) on the cover **13**. The arc gases are vented through a passage **99** formed by the bottom wall **95** (Fig. 1) of the housing **11** and the matching bottom wall **95***a* (Fig. 2) of the cover **13**, and by matching ribs **101** and **101***a* formed respectively on the base **11** and the cover **13**.

As shown in Figs. 1 and 2 the silicone coating is applied to the base **11** and to the cover **13** in the area within the arc chamber **93** and the area immediately surrounding the arc chamber substantially as indicated respectively at **103** and **103***a* (Figs. 1 and 2). The silicone coating prevents the formation of carbon on the housing parts **11** and **13** and thus prevents tracking of the arc drawn between the breaker contacts. The silicone coating when

subjected to the heat of the arc decomposes into silicon dioxide which is itself an insulator and does not cause dielectric break down or electrical creepage. By use of the silicone coatings of this invention, general purpose molding materials of the phenolic or other inexpensive types may be used, and thus save the expense of using molding materials with better dielectric and arc-resisting properties. Also, the cost of providing a special arc chute or arc extinguishing structure may be saved.

As shown in Fig. 1 the breaker parts are assembled in the open sided base **11** after which the cover **13** is rigidly secured in place preferably by means of rivets **105** in a well known manner. A plurality of circuit breakers are usually mounted in a load center or panelboard on a grounded metal plate **107** by means of a hook or clip **109** formed on one end of the plate and engaging a recess at the end of the breaker housing. The plug-in connector **23** at the other end of the breaker is forced into engagement with a stab connector **111** integral with a conductor **113** which is mounted on an insulating member **115** supported on the plate **107**.

As shown in Fig. 4, when the base **11** and cover **13** are fitted together, a portion of the bottom wall **95***a* of the cover overlaps a portion of the bottom wall **95** of the base **11** as indicated at **117** (Fig. 4). Since the seam or joint formed thereby is not sealed it has been found that, even with an arc extinguisher **119** as shown in Fig. 3, creepage may occur therethrough from the live parts within the breaker housing to the grounded plate **107**. By coating the edges of the bottom wall **95** of the base **11** and the bottom wall **95***a* of the cover with a silicone coating before the parts of the housing are assembled, the seam is completely sealed upon assembling the parts of the housing thereby preventing dielectric breakdown to ground through the seam.

Tests have been made on circuit breakers of the type illustrated both with and without the silicone coating. The tests consisted of applying voltages to the terminal of the breakers following the interruption of a short circuit. The results of the tests show that in the case of the circuit breakers without the silicone coating dielectric breakdown occurred with an applied voltage as low as 120 volts, whereas with the silicone coating applied in accordance with the invention, between 2600 volts and 3000 volts were applied before dielectric failure occurred.

I claim as my invention:

1. In a circuit breaker comprising a housing of molded insulating material, terminals at opposite ends of said housing, operating means disposed in said housing comprising separable contacts for drawing an arc, and a coating of a non-tracking silicone of a consistency ranging from a fluid to a gel applied to the insulating material of said housing after said housing is molded at least in the area where the arc is drawn.

2. In a circuit breaker comprising a housing of molded insulating material, terminals supported by said housing, operating means disposed in said housing comprising separable contacts for drawing an arc, and a coating of a non-tracking hydrocarbon silicone having as hydrocarbon substituents on the silicon atom thereof, groups selected from at least one of the class consisting of methyl and ethyl radicals, said coating being applied to said housing of insulating material after said housing is molded and improving the insulating properties thereof.

3. In a circuit breaker comprising a housing of molded insulating material, terminals supported by said housing, operating means disposed in said housing comprising separable contacts for drawing an arc, and a coating of dimethyl silicone fluid combined with a substantial proportion of a finely divided filler applied to said housing at least in the area where the arc is drawn after said housing is molded.

4. In a circuit breaker comprising a housing of molded insulating material, terminals at opposite ends of said housing, operating means disposed in said housing comprising separable contacts for drawing an arc, and a coating of a hydrocarbon silicone having an average of from 1.1 to 1.9 hydrocarbon groups per silicon atom, the hydrocarbon groups being selected from the group consisting of methyl and ethyl radicals, the silicone being gel-like or resinous in consistency when applied, said coating being applied to said housing at least in the area where the arc is drawn after said housing is molded and then drying at room temperatures to form a hardened coating.

5. In a circuit breaker comprising a housing of insulating material, terminals supported by said housing, operating means disposed in said housing comprising separable contacts for drawing an arc, and a coating of a non-tracking silicone fluid having a volatile liquid solvent, said fluid drying at room temperatures and being in the form of a hardened coating on a portion of said housing.

6. In a circuit breaker comprising a housing having two parts of molded insulating material, said two parts being secured together, terminals supported by said housing, operating means disposed in said housing comprising separable contacts for drawing an arc, and a hydrocarbon silicone having as hydrocarbon substituents on the silicon atom thereof, groups selected from at least one of the class consisting of methyl and ethyl radicals, said silicone being applied to the joint between the two parts of the housing after said housing parts are molded.

7. In a circuit breaker comprising a housing of insulating material, terminals supported by said housing, operating means disposed in said housing comprising separable contacts for drawing an arc, and a hydrocarbon silicone having as hydrocarbon substituents on the silicon atom thereof, groups selected from at least one of the class consisting of methyl and ethyl radicals, said silicone being a liquid solution in a volatile solvent spray coated and air hardened on said housing of insulating material.

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