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CIRCUIT BREAKER CASING WITH COATED ARC EXTINGUISHING CHAMBER

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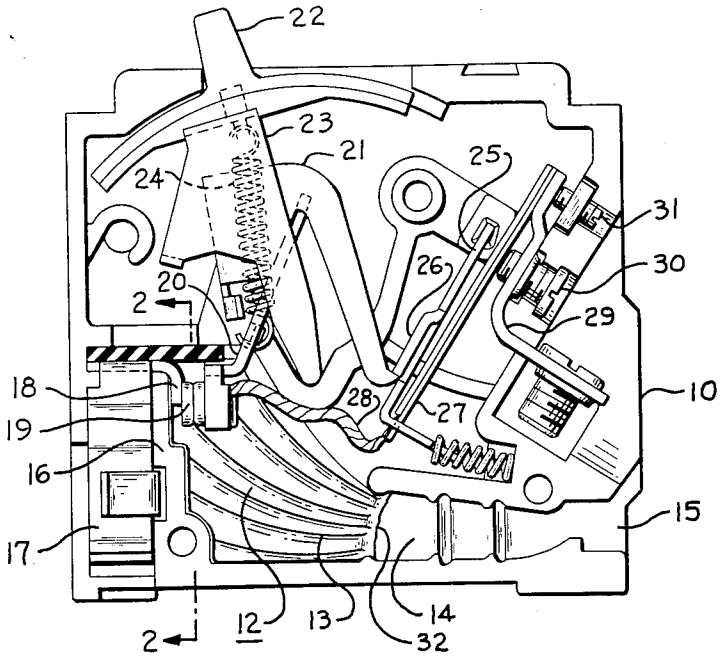


Fig. 1

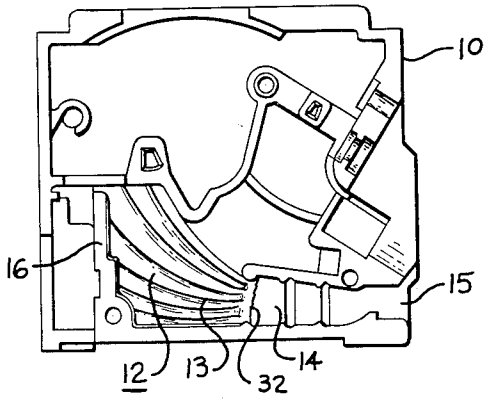


Fig. 3

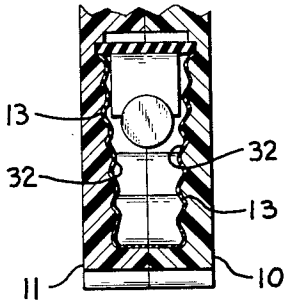


Fig. 2

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CIRCUIT BREAKER CASING WITH COATED ARC EXTINGUISHING CHAMBER

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14 Claims. (Cl. 200—149)

The present invention relates to electric circuit breakers and particularly to electric circuit breakers having a casing of molded insulating material provided with a specially adapted arc-extinguishing chamber for confining and extinguishing an electric arc.

It has been the practice in the past, in the manufacture of such molded-case circuit breakers, to provide arc extinguishing means therefor comprising an integral chamber molded in the casing and a separately fabricated or molded "arc chute" structure adapted to be mounted and retained within the chamber both to protect the chamber and to help extinguish the arc. Such structures, for instance, ordinarily comprise a molded ceramic body, vulcanized cellulosic fiber sheet material, spaced slotted metallic plates, or a combination thereof. Such separate arc chute structures are relatively expensive and involve difficulty in fabrication and assembly.

It is an object of my invention to provide an electric circuit breaker having an enclosing casing of molded insulating material including an integral arc confining and extinguishing chamber the surface of which is treated so as to obviate the necessity for use of a separately fabricated "arc chute," thereby greatly reducing the expense and difficulty of fabrication and assembly of such circuit breakers.

A further object of my invention is the provision of an electric circuit breaker having an enclosing casing of molded insulating material including an arc extinguishing and confining chamber coated with a relatively thin coating of plastic material, which material performs the necessary arc extinguishing and confining functions.

A further object of my invention is the provision of a coating material which can be easily applied to the inner surface of a molded insulating casing of an electric circuit breaker and which imparts thereto good arc extinguishing, confining and arc-resistant characteristics.

A further object of my invention is the provision of such a coating material which adheres well to the base insulating material.

A further object of my invention is the provision of such a coating material which does not erode rapidly under the influence of an arc.

A further object of my invention is the provision of such a coating material which does not form a carbonized path under the influence of an electric arc.

Another object of my invention is the provision of such a coating material which generates a predetermined or controlled amount of arc-cooling and arc-extinguishing gas under the influence of an electric arc.

Another object of my invention is the provision of such a coating material which is not damaged or deformed by relatively high temperatures such as, for instance, 125 degrees centigrade.

Another object of my invention is the provision of such a coating material which can be easily applied to such casings and which requires no special treatment or processing thereafter.

A specific object of my invention is the provision of

such a coating material suitable for use with molded insulating casings which are made of a material comprising a wood-flour filled phenolic aldehyde condensate product such as "Bakelite."

In general, in accord with my invention, I have discovered that certain aromatic hydroxy compounds, especially when combined with selected organic strengthening agents and applied in hot molten form are remarkably effective as materials for coating the arc chamber of phenolic molded circuit breaker casings and accomplishing the objects set forth above as well as others which will hereafter appear, while avoiding the many drawbacks and disadvantages inherent in the use of other materials for this purpose.

It will be appreciated that such a coating material is required to meet a number of electrical requirements as determined by the rating and capacity of the electric circuit breaker. In addition, the material must meet a number of equally rigid mechanical or physical requirements peculiar to such an application, and not required of material used as fillers in fuses, etc.

My invention will be more readily understood from the following description taken in conjunction with the accompanying drawings and its scope will be pointed out in the appended claims.

In the drawings:

Figure 1 is a side elevation view of a circuit breaker incorporating my invention the one side of the enclosing casing being removed.

Figure 2 is a section view of the arcing chamber of the enclosing of the circuit breaker of Figure 1 taken on the line 2—2 of Figure 1.

Figure 3 is a side elevation view of the half of the circuit breaker casing shown in Figure 1, the parts being removed.

While any suitable circuit breaker mechanism may be utilized, I have shown my invention as incorporated in a circuit breaker having an operating mechanism of the type shown in Patent 2,700,086, issued January 18, 1955, to W. A. Thomas, and assigned to the same assignee as the present invention.

Referring to the drawing, there is shown an electric circuit breaker comprising an insulating casing made up of two halves 10 and 11, each generally rectangular in outline and having suitably shaped recesses and bosses formed therein for supporting the mechanical parts, whereby the insulating casing serves as a frame for the mechanical parts, and also having an arc chute or chamber 12 therein. The arcing chamber 12 preferably has its sides 13 provided with undulations or ribs and grooves for substantially increasing their surface area. Arc venting means is also preferably provided comprising irregularly-shaped passage 14 terminating at the exterior of the casing at 15. A barrier 16 preferably separates the arcing chamber 12 from the line contact jaws 17. This barrier may be a separate piece set in between the sides 10 and 11, but is preferably formed by two similar abutting barriers made integral with the casing halves 10 and 11. The contact-supporting lug 18 extends over the end of barrier 16 so that the barrier is between the stationary contact 19 and the line contact jaws 17.

The operating mechanism is as set forth in the above-mentioned patent and includes a movable contact member 20 pivotally supported on a releasable trip member 21 and adapted to be moved between open- and closed-circuit positions by means of handle 22 carried on handle support 23 and connected to the contact member 20 by an over-center tension spring 24. The releasable trip member 21 is releasably held by a latch 26 adapted to be moved to releasing position by a current-responsive bimetallic strip 27. The bimetallic strip is connected electrically in series with the contact member 20 by a

flexible braid 28 and is mounted on the inner end of load terminal 29 which is anchored to the casing by screw 30. Calibrating means is provided by screw 31.

The enclosing casing comprising halves 10 and 11 is preferably made of a suitable molding compound such as a phenolic condensate material. Such phenolic condensate products are made in varying compounds utilizing different materials which are adapted to act as body or "filler" material, the most common of these being finely-divided particles of wood, known as "wood flour." Such "wood flour-filled" phenolic condensate material is highly suitable for electrical purposes in general, and is especially desirable for use in circuit breaker enclosing casings, having been so used for many years. Various expedients have been found necessary, however, to protect such material from the effects of an electric arc impinging directly upon it. When unprotected, such material forms a carbon path which quickly causes electric breakdown between conductive parts of the breaker. It is also subject to burning and deterioration by the arc.

For the purpose of protecting the base material of the casing and also for the purpose of affirmatively inhibiting and extinguishing the electrical arc in a manner to be more specifically described, the chamber 12 is preferably formed so that its sides are spaced relatively close to the path of the moving contact 20 and is coated with a closely adherent coating of plastic material 32.

The coating 32 preferably comprises an aromatic hydroxy compound such, for instance, as orthodihydroxy benzene (also known as "pyro-catechol"), metadihydroxy benzene (also known as "resorcinol"), and paradihydroxy benzene (also known as "hydroquinone"). Such material may be utilized alone if desired, being applied in a hot melted condition and allowed to harden.

I have discovered, however, that the physical characteristics such as strength, resistance to cracking, crazing, etc., can be further enhanced by the addition of organic strengthening agents such as (1) dibasic acids, including adipic acid, maleic acid, succinic acid, phthallic anhydride, sebacic acid, etc., and (2) resinous additives, including benzene derivatives such as polyurethane, polyester resins, polystyrene and polvinyl alcohol.

A preferred formulation utilizing a dibasic acid strengthening agent for instance is as follows:

	Percent
Hydroquinone	50
Adipic acid	50

A preferred formulation utilizing a resinous strengthening agent for instance is as follows:

	Percent
Hydroquinone	80
Polyurethane	20

If desired, I may modify the above formulations by the addition of not more than 5% citric acid, to improve the handling characteristics (spreadability, etc.) of the mixture during the application process.

The ingredients are preferably mixed while in a hot melted condition and the mixture applied while molten to the arc chamber walls of the circuit breaker casing and allowed to cool and harden. The temperature of the hydroquinone compounds during application for instance may be about 175° C. The casing to which the material is applied may be at room temperature. The coating material sets or hardens, at least enough to permit handling, almost at once, or within one minute of application. The method, therefore, is well suited to assembly-line techniques.

Circuit breakers having molded phenolic insulating casings coated in accordance with my invention have been found to equal and, in many cases, excel, the performance of circuit breakers incorporating the conventional fabricated type of arc chute assembly comprising refractory or ceramic materials, fiber, and spaced metallic plates. Thus, circuit breakers of the type illustrated but incorporating ceramic refractory molded arc chutes as set forth in the above Thomas patent are capable of interrupting only about 70–80 amperes direct current at 125 volts. With arc chutes prepared and coated with a formulation consisting of 50% hydroquinone, 48% adipic acid, and 2% citric acid in accordance wtih my invention, however, such circuit breakers, identical in every other respect, have successfully interrupted 350 amperes direct current at 125 volts 50 times in succession with no deleterious effects.

On alternating current interruption, circuit breakers including arc chutes coated in accordance with my invention demonstrated interrupting ability equal to that of either ceramic or metallic-plate arc chutes, both in normal current and short-circuit current ranges, and in addition are far less expensive.

Extensive testing of circuit breakers utilizing this material has indicated that the material can withstand a great number of arc interruptions without eroding so as to expose the base material of the casing, even though a relatively thin coating, of about 40 mils, is utilized. The material has also proved to be non-tracking under the influence of an electric arc. Thus, although a small amount of the surface layer of the material may actually be burned by the influence of an electric arc, no carbonaceous residue is left which might establish a low resistance path between conductive parts of the circuit breaker in the open-circuit position.

The material has also been demonstrated to have excellent physical characteristics as witnessed by the fact that after 100 hours at 120 degrees centigrade the material was still in good condition and did not display any cracking, crazing, brittleness or pulling away from the phenolic base material.

The material has also demonstrated exceptional performance on interruption of direct current, and in this respect has exceeded the performance of the so-called spaced metallic-plate type of arc chute.

The performance of this improved arc-interrupting chamber for molded circuit breaker casings indicates that the material, in addition to merely protecting the base material from the adverse effects of an electric arc, has an effect upon the arc-interrupting process itself so as to inhibit and more rapidly extinguish the arc. This arc extinguishing action or ability is to be differentiated from so-called "arc resistance." The term "arc resistance" is ordinarily taken to mean the ability of a material to maintain a substantially non-conductive surface when exposed to the effect of an electric arc, and is ordinarily measured by the length of time (e. g., in seconds) which an electric arc can be maintained adjacent the surface without causing substantial loss of the non-conductive property. The term "arc extinguishing" on the other hand, is not necessarily related to the surface properties of a material, but rather to its ability to aid and to accelerate the extinguishing of an electric arc by various mechanisms.

It is believed in the present case that the three aromatic hydroxy compounds indicated actively aid in the extinction and inhibition of the electric arc by the release of ionized particles and/or radicals which are free to combine with available oxygen to form water. These materials also have the property of subliming or passing directly from solid into gaseous form. This property is believed to result in spontaneous emission of particles of the solid material from the surface of the coating when exposed to an arc, which particles are projected into the active arcing area and are there transformed into the gaseous state with the accompanying formation of water and pressure as indicated above.

It will be appreciated that while there are a host of chemical materials which have desirable effects in connection with arc interruption, the limitations imposed by the requirements, and especially the physical requirements, of the subject use as a coating for a molded insu-

lating casing, automatically render most of such materials virtually useless. These requirements, which my coating compounds have been found to satisfy, include the following: It can be applied in liquid form and will "set" or harden without extended baking or other special treatment; it adheres well to molded phenolic material; it maintains its form without cracking, peeling, chipping, crazing, melting or otherwise deteriorating even when subjected to prolonged periods of high temperature; it does not crack or flake off under impact such as encountered in normal handling and shipping of circuit breakers; it does not erode too rapidly under an electric arc; it is not subject to surface carbonization under the influence of an arc.

Since many modifications may be made in the above formulations and the percentages of the various ingredients without departing from the scope thereof, I intend to cover all such modifications and changes as fall within the scope of the appended claims.

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

1. An electric circuit breaker comprising a casing of insulating material, conductor means within said casing adapted to form an arc in a predetermined arcing area within said casing, a protective coating on said insulated casing adjacent said arcing area comprising an aromatic hydroxy compound selected from the group consisting of pyro-catechol, resorcinol, and hydroquinone.

2. An electric circuit breaker comprising a casing of insulating material, at least two separable contacts within said casing adapted to draw an arc therebetween in a predetermined arcing area within said casing, a protective coating on said insulating casing adjacent said arcing area comprising an aromatic hydroxy compound selected from the group consisting of pyro-catechol, resorcinol, and hydroquinone.

3. An electric circuit breaker comprising a casing of insulating material, at least two separable contacts within said casing adapted to draw an arc therebetween in a predetermined arcing area within said casing, a protective coating on said insulating casing adjacent said arcing area comprising an aromatic hydroxy compound selected from the group consisting of pyro-catechol, resorcinol, and hydroquinone, and an organic strengthening agent selected from the group consisting of dibasic acids and organic resins.

4. An electric circuit breaker comprising a casing of insulating material, at least two separable contacts within said casing adapted to draw an arc therebetween in a predetermined arcing area within said casing, a protective coating on said insulating casing adjacent said arcing area comprising an aromatic hydroxy compound selected from the group consisting of pyro-catechol, resorcinol, and hydroquinone and a dibasic acid.

5. An electric circuit breaker comprising a casing of insulating material, at least two separable contacts within said casing adapted to draw an arc therebetween in a predetermined arcing area within said casing, a protective coating on said insulating casing adjacent said arcing area comprising an aromatic hydroxy compound selected from the group consisting of pyro-catechol, resorcinol, and hydroquinone and an organic resin.

6. An electric circuit breaker comprising a casing of insulating material, at least two separable contacts within said casing adapted to draw an arc therebetween in a predetermined arcing area within said casing, a protective coating on said insulating casing adjacent said arcing area comprising hydroquinone.

7. An electric circuit breaker comprising a casing of molded insulating material, at least two separable contacts within said casing adapted to draw an arc in a predetermined arcing area within said casing, a protective coating on said insulated casing adjacent said arcing area comprising hydroquinone and resinous additive, said hydroquinone constituting at least 60% by weight of said coating.

8. An electric circuit breaker comprising a casing of molded insulating material, at least two separable contacts within said casing adapted to draw an arc within said casing in a predetermined arcing area, a protective coating within said insulating casing adjacent said arcing area comprising hydroquinone and a dibasic acid additive, the hydroquinone comprising at least 40% by weight of said coating.

9. An electric circuit breaker comprising a casing of molded insulating material, at least two separable contacts within said casing adapted to draw an arc within said casing in a predetermined arcing area, a protective coating on said insulating casing adjacent said arcing area comprising eight parts by weight of hydroquinone and two parts by weight of polyurethane.

10. An electric circuit breaker as set forth in claim 9, in which the protective coating also comprises not more than 5% citric acid.

11. An electric circuit breaker comprising a casing of molded insulating material, at least two separable contacts within said casing adapted to draw an arc within said casing in a predetermined arcing area, a protective coating on said insulating casing adjacent said arcing area comprising equal parts by weight of hydroquinone and adipic acid.

12. The electric circuit breaker as set forth in claim 11, in which the protective coating also comprises not more than 5% citric acid.

13. An electric circuit breaker comprising a casing of insulating material, at least two separable contacts within said casing adapted to draw an arc therebetween in a predetermined arcing area within said casing, a protective coating on said insulating casing adjacent said arcing area comprising an aromatic hydroxy compound selected from the group consisting of pyro-catechol, resorcinol, and hydroquinone, said molded insulating casing comprising a phenolic condensate material.

14. An electric circuit breaker comprising a casing of insulating material, at least two separable contacts within said casing adapted to draw an arc therebetween in a predetermined arcing area within said casing, a protective coating on said insulating casing adjacent said arcing area comprising hydroquinone, said insulating casing comprising a phenolic condensate material.

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