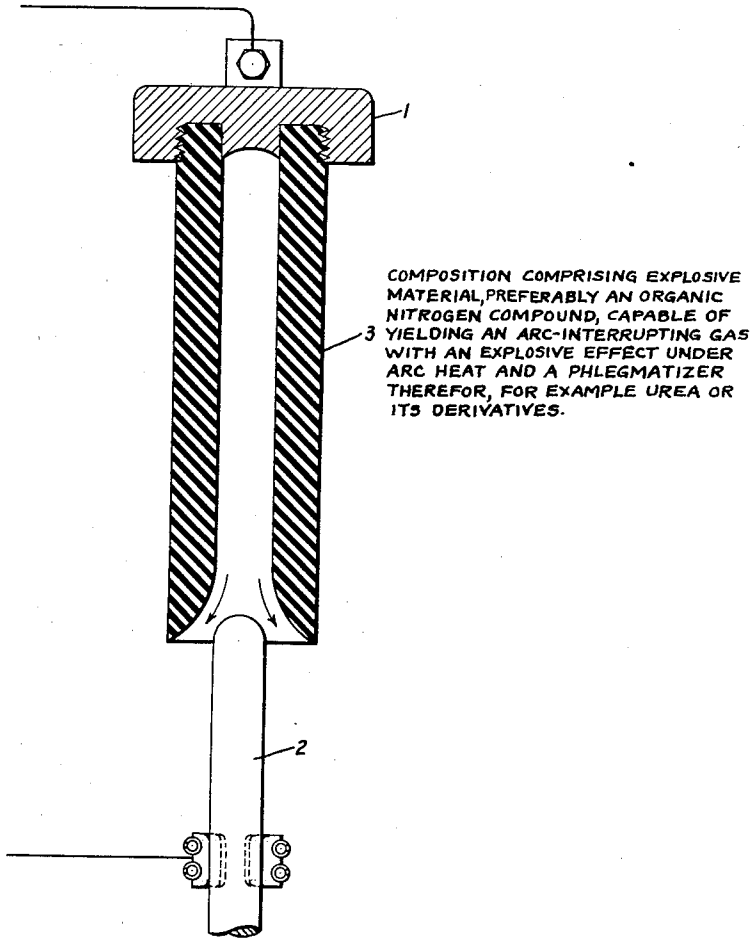
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ELECTRIC CIRCUIT INTERRUPTER

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ELECTRIC CIRCUIT INTERRUPTER

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This invention relates to electric circuit interrupters, and more particularly to circuit interrupters of the air-break expulsion type wherein a gas formed by decomposition of a material by the arc upon opening of the circuit is utilized to interrupt the arc.

In a well-known form of circuit interrupter of the aforesaid type, the arc is drawn in a confining insulating structure, such as a tube formed of material which under the influence of the arc emits gases or vapors tending to extinguish the arc. Inorganic materials such, for example, as boric acid, ammonium alum, etc., have been proposed as the gas-producing material. In these substances water is chemically combined so that, under the influence of the arc, vapors are released for the arc-extinguishing process. It has also been proposed to use aminoplasts (general term for synthetic resins from amido or amino compounds) in the construction of arc-confining structures. Aminoplasts contain nitrogen which is evolved under the arc heat and tends to extinguish the arc.

More recently, other gas-producing materials or compositions containing the same have come into prominence for making arc-insulating members. For example, in Burmeister U. S. Patent 2,089,050 is disclosed and claimed an arc-confining structure composed of oxalic acid; and in Burmeister U. S. Patent 2,089,051, mechanically strong organic material, for instance hard rubber, impregnated with an inorganic material which upon decomposition yields an arc-interrupting gas and, specifically, with ammonium carbonate or bicarbonate, calcium carbonate, etc. Reference is also made to the copending applications of Paul Nowak, Serial No. 200,798, filed April 7, 1938, of Hans Schuhmann, Serial No. 201,410, filed April 11, 1938, and of Vitaly Grosse, Serial No. 200,784, filed April 7, 1938, all of which applications are assigned to the same assignee as the present invention. In these co-pending applications other solutions to the same general problem of improving circuit interrupters of the air-break expulsion type are disclosed and claimed.

It is also known to provide switch chambers with explosive materials in cartridge form, or else as liquid or vapors, which are caused to explode and the explosion gases driven between the separating switch contacts. Switches so made, however, have not attained any practical importance, for one reason because the constant storage of large quantities of explosive or highly inflammable material in or adjacent the switch installation is dangerous. Further, numerous problems of design and construction are involved, as the comparatively great and shock-like explosive forces must be dependably controlled. This requires complicated mechanism, so that the charge of explosive gases which is released in the switch chamber will be adequate to extinguish the arc under a wide variety of service conditions.

Our invention will be set forth in the following description referring to the accompanying drawing, and the features of novelty which characterize our invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

The single figure of the drawing is an elevational view, partly in section, of an electric circuit breaker of the expulsion type to which the present invention is applicable.

It is known that various explosive materials disintegrate rapidly without forming any residue. In accordance with the present invention electric circuit interrupters having insulating structures disposed adjacent and in confining relation to an arc formed upon opening the circuit have walls formed of, or surfaced with compositions comprising a combination of explosive material and phlegmatizing material that slows up the decomposition of the explosive material. Examples of explosive materials suitable for the purpose are organic nitrogen compounds as, for instance, nitrocellulose (cellulose nitrate), nitrotoluene, and the like. The explosive materials may be contained in the walls in powdery, granular or fibrous form. The phlegmatizing materials preferably are compounds which decompose substantially completely into volatile components (gases and vapors) under the arc heat. Advantageously the phlegmatizers may be fusible compounds, such as urea or urea derivatives, which at the arc temperature form arc-extinguishing gases without depositing carbon. Ammonia substitution products as, for instance, hexamethylene tetramine may be used; also, aminoplasts such, for example, as urea- or thio-urea-formaldehyde condensation products. As phlegmatizing materials one may also use compounds which under the arc heat form carbon in a non-conductive modification. Examples of such compounds are acrylic acid derivatives, especially acrylonitrile and acrylic acid esters, for instance the methyl and ethyl esters of acrylic and meth-acrylic acid; also, vinyl compounds, especially vinyl ether; and aromatic amines such, for example, as aniline and diphenyl-amine. It is also possible to use organic salts with a low carbon

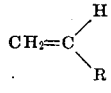
content, for example tetraethyl ammonium carbonate, $[N(C_2H_5)_4]_2CO_3$, or the carbonates of monomethylamine, or formates such, for instance, as ammonium formate. In the selection of the phlegmatizing materials, consideration of course must be given to the properties of the explosive material, so that the selected materials will be compatible with each other.

The explosive decomposition of the explosive materials contained in the walls of the insulating structure is restricted, through the addition of the phlegmatizing materials, to those points that are exposed directly to the influence of the arc. Therefore the desired decomposition of the layers of the chamber walls exposed to the arc heat does not continue through to the underlying layers. The phlegmatizing material also may serve as a binder for the explosive material.

In the accompanying drawing there is shown merely by way of example an electric circuit interrupter, more particularly a circuit breaker having means such as the stationary contact 1 and the movable rod contact 2, for opening the circuit so as to form an arc, and an insulating structure 3 forming an arc chamber for closely confining the arc between the contacts. The insulating structure 3 consists of a tubular member closed at the fixed contact end and open at the other end for receiving the rod contact. Upon opening of the circuit, separation of the contacts 1 and 2 causes formation of an arc which decomposes some of the material of the arc chamber walls 3. The gas so formed is under considerable pressure by reason of the comparatively close fit of the rod contact 2 and the tube 3, with the result that when the rod leaves the tube a blast of gas is released as indicated for interrupting the arc.

The following examples illustrate compositions of which the insulating structure 3 may be formed in accordance with the present invention:

A compound of the type



wherein R represents a condensed cyclic system with nitrogen united to the nucleus, and specifically fibrous vinyl carbazole, is ground without destroying its fibrous structure, with about 1 to 10 per cent by weight of a substance capable of emitting oxygen in the heat of the arc and about 10 to 30 per cent by weight of an organic compound containing nitrogen and capable of evolving arc-extinguishing gases with an explosive effect under the arc heat. An example of such an organic compound is cellulose nitrate having a low nitrogen content (about 10.5 to 11.5 per cent), which material also is known as pyroxylin. Examples of oxygen-emitting substances which are suitable for use are inorganic peroxides as, for instance, peroxides of barium, magnesium and the like. Sufficient aminoplast, such as urea-formaldehyde resin, is incorporated into the mass to form a composition adapted to be shaped, for example by molding, extrusion, and so on. The molding or extruding temperatures are kept as low as possible so as to prevent decomposition of the explosive material. The fibrous vinyl carbazole serves as a rigid carrier of the cellulose nitrate, the aminoplast acts as a binding agent, and the oxygen-emitting substance provides oxygen for oxidizing into carbon dioxide any carbon that may be formed during the gasifying process.

If it is desired to form the quenching tubes or filling pins by a winding operation, then the procedure may be as follows: Cellulose nitrate having a nitrogen content of approximately 8 per cent, and in continuous sheet or fabric form, is coated and impregnated with an aminoplast, and wound into tube shape. In order to increase the mechanical strength, the sheet or fabric of cellulose nitrate may be suitably combined with fibrous material. For example, cellulose fibers, especially those resulting from the well-known sulphite process, asbestos fibers and the like may be incorporated in the cellulose nitrate prior to sheeting it. Or, layers of hard fiber, paper, or wool or linen fabric may be alternated with layers of sheet cellulose nitrate in forming the tube.

Insulating structures produced by our invention have the advantage of a very quick and residue-free development of gas in the course of the arc interruption. At the same time the development of the extinguishing gas is dependent upon the strength and the duration of the arc, and adapts itself automatically to the value of the current that is to be interrupted. Special dosing devices are eliminated. Further, as in each case there is an explosive decomposition of only a small part of the explosive material contained in the walls of the insulating structure, due to the presence of an agent adapted to retard explosion of the explosive material, the structure is subjected to no shock-like stress and therefore need not have any unusual dimensions. The phlegmatizing material also eliminates danger of a violent explosion which might destroy the circuit-interrupting device.

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

1. An electric circuit interrupter comprising means for forming an arc, and an insulating structure disposed adjacent and in confining relation to said arc, the walls of said structure in proximity to said arc being surfaced with a composition comprising an organic nitrogen compound selected from the class consisting of cellulose nitrate and nitrotoluene, and a phlegmatizer therefor.

2. An electric circuit interrupter including an arc-confining structure, said structure being formed of a substance comprising an organic nitrogen compound selected from the class consisting of cellulose nitrate and nitrotoluene and a material adapted to retard the explosive decomposition of said compound.

3. An electric circuit interrupter comprising means for forming an arc, and an insulating tubular structure within which said arc is drawn, said tubular structure being in confining relation to said arc and having walls in proximity thereto formed of a composition comprising cellulose nitrate and a phlegmatizing material adapted to retard the explosive decomposition of cellulose nitrate in the heat of the arc.

4. An electric circuit interrupter comprising means for forming an arc, and an insulating structure disposed adjacent and in confining relation to said arc, said insulating structure comprising nitrotoluene and a phlegmatizing material capable of decomposing substantially completely into volatile components at the arc temperature and at such temperature being adapted to retard the explosive decomposition of the nitrotoluene.

5. An electric circuit interrupter including an arc-confining structure, said structure comprising cellulose nitrate and a phlegmatizing mate-

rial selected from the class consisting of urea and its derivatives.

6. An electric circuit interrupter comprising means for forming an arc, and an insulating structure disposed adjacent and in confining relation to said arc, said insulating structure being formed of a composition comprising fibrous vinyl carbazole, cellulose nitrate and a substance capable of emitting oxygen in the heat of the arc.

7. An electric circuit interrupter including a tubular arc-confining structure, said structure comprising sheet cellulose nitrate coated and impregnated with an aminoplast.

8. An electric circuit interrupter comprising means for forming an arc, and an insulating structure disposed adjacent and in confining relation to said arc, the walls of said structure in proximity to said arc being surfaced with a composition comprising an organic nitrogen compound selected from the class consisting of cellulose nitrate and nitrotoluene, a phlegmatizer that will retard the explosive decomposition of the said nitrogen compound under the heat of the arc, and a substance capable of emitting oxygen in the heat of the arc.

9. An electric circuit interrupter as in claim 1 wherein the phlegmatizer is an aminoplast.

10. An electric circuit interrupter as in claim 8 wherein the phlegmatizer is an aminoplast.

11. An electric circuit interrupter comprising means for forming an arc, and an insulating structure disposed adjacent and in confining relation to said arc, the walls of said structure in proximity to said arc being surfaced with a composition comprising a rigid material carrying an organic nitrogen compound selected from the class consisting of cellulose nitrate and nitrotoluene, and in addition thereto an aminoplast.

12. An electric circuit interrupter as in claim 11 wherein the rigid carrier material is fibrous vinyl carbazole and the organic nitrogen compound is cellulose nitrate.

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