Oct. 16, 1962 G. C. GAINER ETAL 3,059,081

SELF-GENERATED GAS BLAST CIRCUIT INTERRUPTER EMBODYING HIGH MOLECULAR WEIGHT POLYOXYMETHYLENES

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Fig. 1.

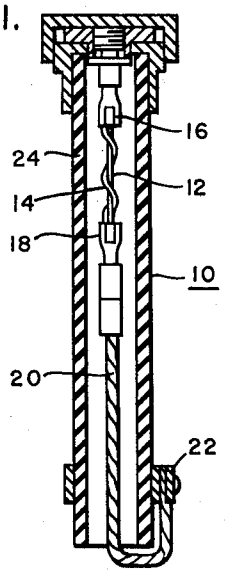


Fig. 2.

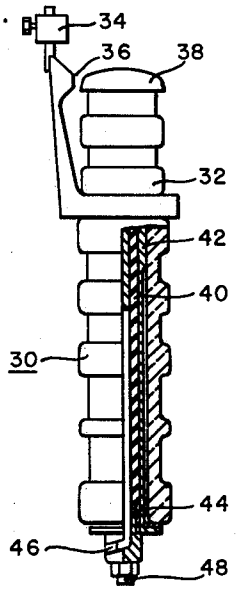


Fig. 3.

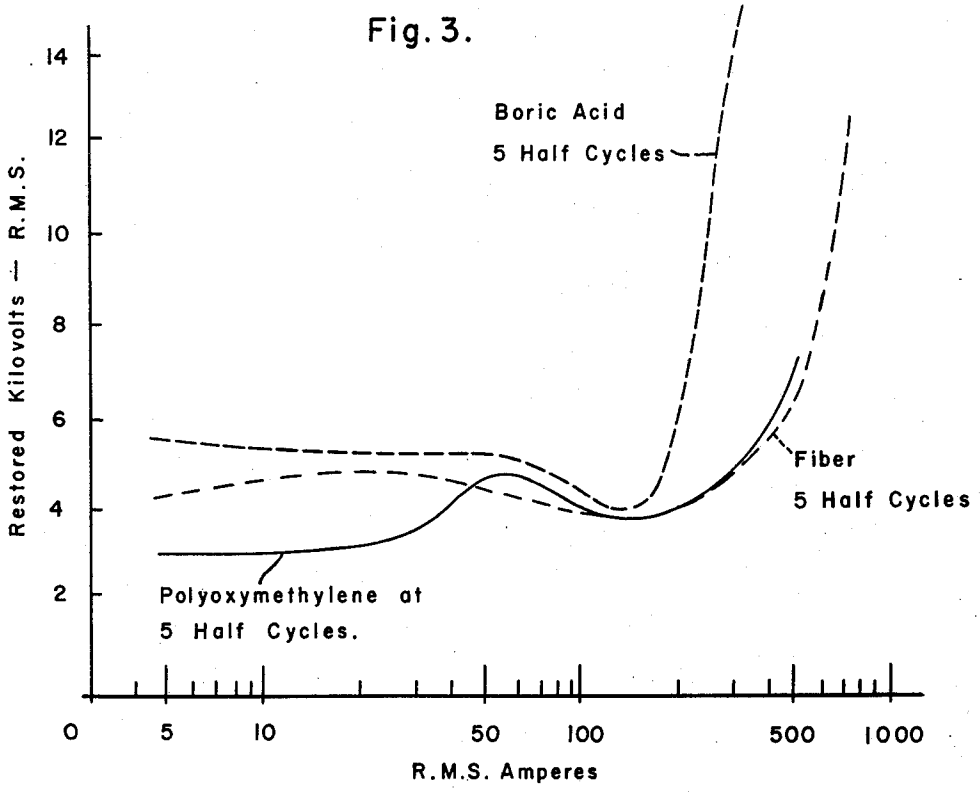

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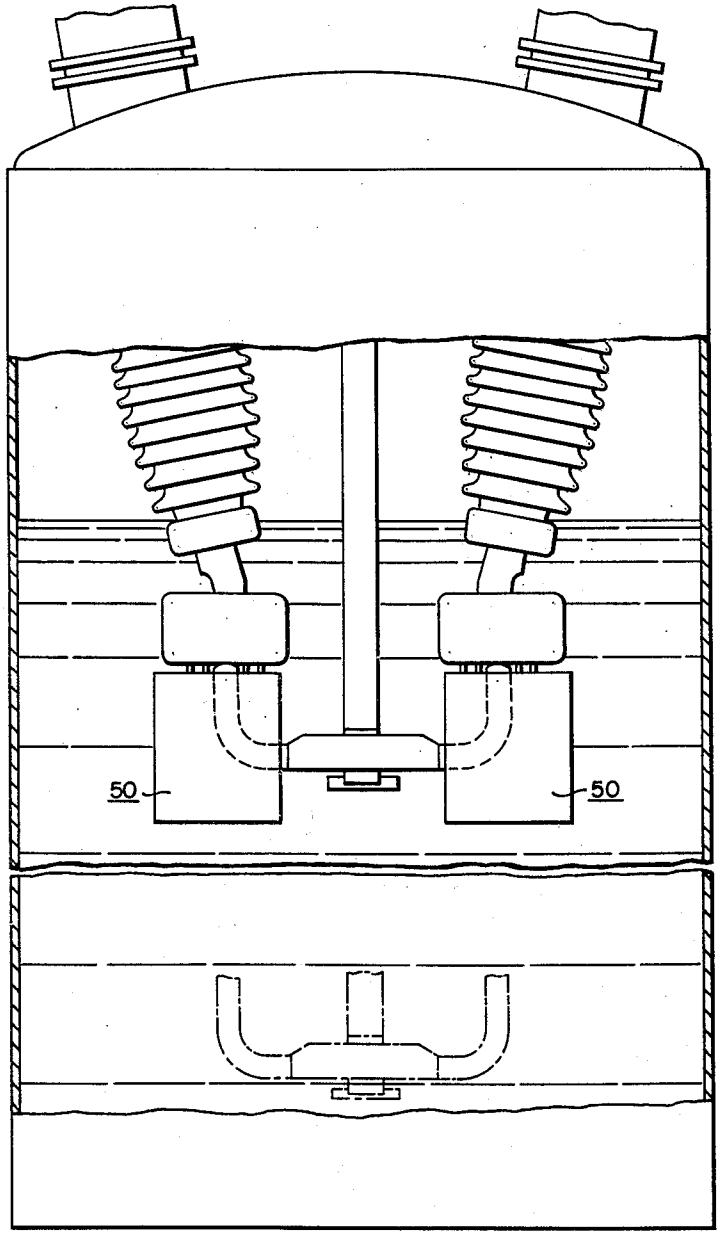
Fig.4.



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# SELF-GENERATED GAS BLAST CIRCUIT INTERRUPTER EMBODYING HIGH MOLECULAR WEIGHT POLYOXYMETHYLENES

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The present invention relates to circuit interrupters which generate arc-extinguishing and confining gases automatically upon the occurence of an arc, and has particular reference to electrical devices embodying high molecular weight polyoxymethylenes as an arc confining and extinguishing member.

Heretofore, a relatively large number of arc confining and extinguishing materials have been suggested for use in circuit interrupters. Certain prior art materials have proven to be so outstanding in this respect that they often are selected as a standard of comparison of materials. Specifically, horn or vulcanized fiber and compressed boric acid have been accepted as standards of comparison because each of these materials has exhibited generally desirable characteristics over a wide range of conditions of use.

The surprising discovery now has been made that high molecular weight polyoxymethylenes provide unusually good characteristics as gas generating materials when exposed to arcs. It has been found, over a wide range of current, that such polyoxymethylenes are in many cases superior in the restored voltage to horn fiber. For certain applications, polyoxymethylenes have given results such that it is possible to use these materials in applications where boric acid cannot be used. Consequently, high molecular weight polyoxymethylenes possess certain unexpectedly superior characteristics to the best materials, indeed the standard materials, available to the art at the present time for use as an arc-extinguishing medium.

The object of this invention is to provide in a circuit interrupter an arc confining and interrupting structure comprising high molecular weight polyoxymethylenes.

Another object of the invention is to embody in a self-generated gas blast circuit interrupter an arc confining and interrupting structure comprising a body composed of at least 70% by weight of high molecular weight polyoxymethylenes.

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

For a more complete understanding of the present invention reference is made to the following description taken in conjunction with the accompanying drawing, in which:

FIGURE 1 is a vertical cross-section view through a fuse;

FIG. 2 is a view in elevation, partly in section, of a self-expulsion type of lightning arrester;

FIG. 3 is a graph plotting restored kilovolts against amperage for fibre and high molecular weight polyoxymethylenes and boric acid; and

FIG. 4 is a side elevational view, partially in section, of an oil-type circuit interrupter embodying molded grids in accordance with the invention.

In accordance with the present invention and in the attainment of the foregoing objects, arc-confining and arc-extinguishing gas generator portions of circuit interrupters are prepared from formaldehyde polymers, specifically, high molecular weight polyoxymethylenes. The formaldehyde polymers of this invention are obtained by continuously passing gaseous, substantially anhydrous, monomeric formaldehyde into a reaction zone containing a reaction medium which is inert to formaldehyde, under



the conditions of reaction, and permitting the formaldehyde to polymerize continuously as the monomer is introduced therein.

The high molecular weight polyoxymethylenes of this invention are disclosed fully in U.S. Patent No. 2,768,994. The disclosure contained in that patent is incorporated herein by reference. These polymers are defined as either having a minimum of toughness retention, defined as a "degree of toughness" of at least 1, or having a minimum thermal stability, defined as a reaction rate constant for thermal degradation at 222° C. of less than 1% by weight of the polymer per minute.

As disclosed in U.S. Patent No. 2,768,994, these polyoxymethylenes may be prepared in several ways. One satisfactory process for preparing the high molecular weight polyoxymethylenes consists of passing a continuous stream, consisting essentially of monomeric formaldehyde in a concentration of at least 99.5% formaldehyde, into contact with a two component polymerization reaction medium. Said medium consists of (1), a liquid hydrocarbon having from 3 to 10 carbon atoms per molecule. The hydrocarbon may be selected from the group consisting of aliphatic hydrocarbons, cycloaliphatic hydrocarbons, and aromatic hydrocarbons. The second ingredient of the polymerization reaction medium is (2) a catalytic amount of a compound selected from the group consisting of primary, secondary, and tertiary aliphatic amines; primary, secondary, and tertiary cycloaliphatic amines; and primary aromatic amines. The resultant mixture of formaldehyde and polymerization reaction medium is continuously agitated at a temperature within the range of from about −50° C. to about +70° C. at substantially atmospheric pressure. The polymeric particles formed comprise high molecular weight polyoxymethylene.

The high molecular weight polyoxymethylenes are thermoplastic in nature and, therefore, will melt when heated to substantially high temperatures. In cases where melting and softening is found to be undesirable, thermosetting resins may be incorporated with the high molecular polyoxymethylene in amounts up to about 30% by weight. Examples of suitable thermosetting resins which may be so incorporated include polyester resins, epoxy resins, silicone resins, and the like. The high molecular weight polyoxymethylene polymers, either alone or in combination with the thermosetting resins, may be molded conveniently or extruded in the form of tubes, bars, tapes, and the like. It is particularly convenient, for example, to extrude the polymer in the form of tubes of one-quarter to one-half inch internal diameter, such tubes then only need to be cut or sawed to length whereby they are ready for use in fuse manufacture. The finished molded polymer may be readily machined to any predetermined shape.

The high molecular weight polyoxymethylene polymers of this invention are unique in that they contain no carbon-carbon bonds. Nearly all other known organic polymers contain at least one or more carbon-carbon bonds in a portion of the recurring structural unit. Compounds which contain a carbon-carbon linkage generally carbonize and result in tracking. Since carbon-carbon linkage is absent from the polymers of this invention they do not carbonize or track and are particularly well suited for use as arc- and track-resistant resinous materials.

Under the influence of an electric arc, formaldehyde present in the polymer decomposes to form carbon monoxide gas and hydrogen gas. Evolution of hydrogen gas during arcing is particularly desirable since hydrogen assists materially in quenching and extinguishing the electric arc due to its high diffusivity and consequent rapid deionization as the alternating current approaches zero value. Thus the arc space rapidly loses its conductivity and the arc is extinguished at the following current zero.

Because of the above properties and characteristics, high molecular polyoxymethylene compounds are particularly suitable for use in arc- and track-resistant molding compounds as well as various rubber compounds. The polymers are particularly suitable for use in forming the insert and tube in expulsion type lighting arresters wherein not only arc-expulsion and quenching is necessary but also where arc-resistance is required.

High molecular weight polyoxymethylene polymers also are particularly suitable for use in forming arc-resistant and arc-expulsion apparatus because, unlike hard vulcanized fiber, the polymers can readily be molded by conventional injection molding procedures into intricate and complex shapes. On the other hand, hard vulcanized fiber must be machined and otherwise mechanically fabricated into its desired shape. Unlike hard vulcanized fiber, the high molecular weight polymers of the present invention exhibit excellent dimensional stability as a function of humidity. Thus, the polymers absorb very little moisture.

Referring to FIG. 1 of the drawings, there is illustrated one application of a high molecular weight polyoxymethylene to a self-generating gas blast circuit interrupter. Specifically, there is illustrated a fuse **10** comprising a strain wire **12** and fusible wire **14**, both being connected to an upper terminal **16** which may be connected to one portion of a circuit passing through the fuse and a lower terminal **18** connected by a flexible conductor **20** to a second terminal **22** which is connectible to the complete circuit. A tube **24** surrounding the strain and fuse wires **12** and **14**, respectively, is prepared from a high molecular weight polyoxymethylene. If desired, only the inner portion of the tube **24** need be composed of high molecular weight polyoxymethylene, and the outer portion may be composed of fiber, paper, or other suitable material. When a sufficiently high current passes through the wires **12** and **14**, they will fuse and thereby create an arc. The lower terminal **18** will drop, either because of the gas-pressure developed by the heat of the arc alone, or, in some cases, by a spring (not shown) operating thereon to draw the arc out further. The heat of the arc will cause the high molecular weight polyoxymethylene in the tube **24** to evolve gases which will cause extinction of the arc. It is believed that the gases produced by the action of the arc on the polyoxymethylene are carbon monoxide and hydrogen. The turbulent flow of these gases through the core of the arc rapidly cools and deionizes the arc whereby when the current reaches zero at the end of a half cycle the arc will be extinguished without reforming.

Referring to FIG. 3 of the drawing, there are plotted curves of restored kilovolts against amperes, showing the interrupting ability of high molecular weight polyoxymethylene in a one-fourth inch by four-inch bore fuse. For comparative purposes, curves for fiber and boric acid derived from similar fuses are shown in the graph. The curves show interruption in five half cycles or less for each of the materials. It will be noted that for from 45 amperes to approximately 500 amperes, high molecular weight polyoxymethylene was equal to or superior in its ability to interrupt a higher voltage than fiber.

High molecular weight polyoxymethylenes may be used in many applications where boric acid is not suitable. Specifically, since the polyoxymethylenes have superior mechanical and chemical properties, moldability and ease of manufacture they are more suitable and indeed are preferable for use instead of boric acid.

High molecular weight polyoxymethylene polymers are particularly suitable materials for circuit interrupters because they are nonhygroscopic and do not warp. Also, they possess extremely good electrical insulating properties and are insoluble in water. The polymers possess outstanding mechanical properties and therefore will withstand the pressures developed by the generated gas on exposure to arcs, particularly in confined chambers.



One particularly desirable use for high molecular weight polyoxymethylene is in self-expulsion type lightning arresters, one form of which is shown in FIG. 2 of the drawing. The lightning arrester **30** comprises an exterior casing **32** preferably of porcelain to which is affixed an external contact member **34** which is connected to a power line or the like to be protected against lightning. An external gap is arranged between an arcing tip **36** and a cap **38** affixed to one end of the casing **32**. The cap **38** extends inside of the casing **32**, and terminates in an arcing contact **40** disposed inside of a sleeve **42** composed of high molecular weight polyoxymethylene. At the lower end of the sleeve **42**, there is located, in threaded engagement therewith, a hollow contact **44** forming an internal gap with respect to the arcing contact **40** between which an arc is adapted to be drawn upon a lightning surge passing to the arrester **30**. The hollow contact **44** is adapted to be grounded through the terminal **48**. A slot **46** through the contact permits the expulsion of gases through the hollow contact **44** from the interior of the sleeve **42**. The distance and arrangement of the external gap **36—38** in series with the gap between contacts **40** and **44** is predetermined and requires a surge of a given value to be present at **34** before the lightning arrester will operate. When a lightning surge of this given value or greater is imposed on the contact **34**, an arc will pass through the gap **36—38** and internally between contacts **40** and **44**. The internal arc will cause the high molecular weight polyoxymethylene sleeve **42** to produce a volume of gas and the deionizing effect of the gas, in conjunction with the gas-blast effect, will tend to blow the arc out and thereafter restore the electrical resistance of the lightning arrester proper. The gases produced during the arc interrupting operation will be expelled through the slot **46** to the exterior of the arrester.

High molecular weight polyoxymethylenes also may be used in place of fibre in oil circuit breakers as illustrated in FIG. 4. The grids **50** in such circuit breakers can be molded as a single piece from the polyoxymethylenes instead of assembling a plurality of stampings by bolting or the like.

While the present invention has been described with respect to what is at present, considered to be preferred embodiments thereof, it will be understood, of course, that certain substitutions, modifications, changes, and the like may be made therein without departing from its true scope.

We claim as our invention:

1. An electric circuit interrupter comprising, in combination, conductor means between which an arc is formed, and arc-confining and extinguishing means disposed along the path of the arc from which an arc-extinguishing gas can be evolved by the heat of the arc, the arc-confining and extinguishing means comprising a body composed essentially of a high molecular weight polyoxymethylene.

2. An electric circuit interrupter comprising, in combination, a pair of contact members disposed to produce an arc to interrupt a circuit established between them, a chamber within which the contact members are arranged, and arc-confining and extinguishing means disposed along the path of the arc from which an arc-extinguishing gas can be evolved by the heat of an arc, the arc-confining and extinguishing means comprising a body composed essentially of a high molecular weight polyoxymethylene.

3. In a fuse device, in combination, means adapted to fuse and form an arc on the occurrence of an overload in an electrical circuit embodying the fuse device, and an arc-confining and extinguishing means disposed along the path of the arc from which an arc-extinguishing gas can be evolved by the heat of an arc, the arc confining and extinguishing means comprising a body composed essentially of a high molecular weight polyoxymethylene.

4. In a lightning arrester, in combination, means

adapted to form an arc when an electrical circuit embodying the arrester is struck by lightning, and an arc-confining and extinguishing means disposed along the path of the arc from which an arc-extinguishing gas can be evolved by the heat of an arc, the arc-confining and extinguishing means comprising a body composed essentially of a high molecular weight polyoxymethylene.

5. An oil-type circuit interrupter including contact means for establishing an arc, a grid molded of a body composed essentially of a high molecular weight polyoxymethylene, and the arc being extinguished within said grid by evolution of gas.



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