Jan. 9, 1968 A. J. POLITO 3,362,908

ELECTRICAL APPARATUS AND DIELECTRIC MATERIAL THEREFOR

Filed Jan. 13, 1965

Fig. 1.

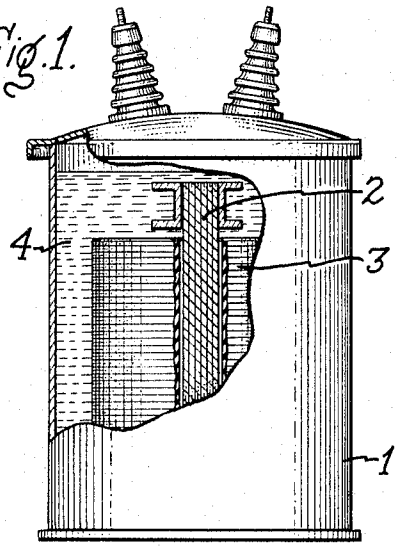
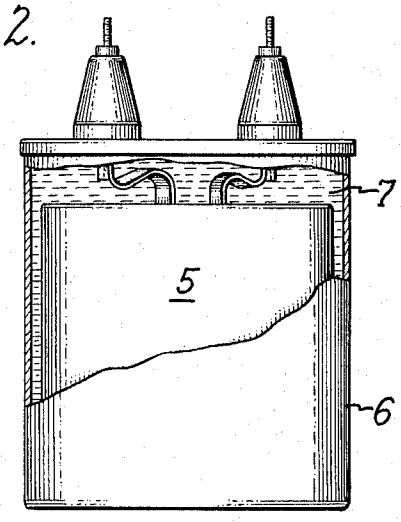


Fig. 2.



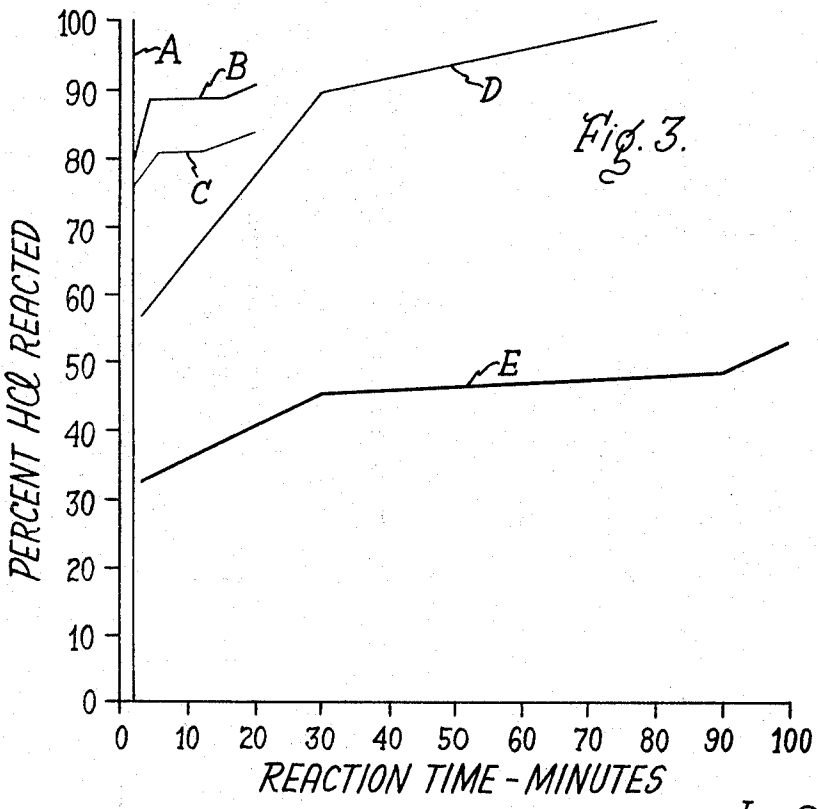


Fig. 3.

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ELECTRICAL APPARATUS AND DIELECTRIC MATERIAL THEREFOR

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3 Claims. (Cl. 252—65)

This application is a continuation-in-part of application Ser. No. 201,630 filed June 11, 1962 (now abandoned) and assigned to the same assignee as the present application.

The present invention relates to electrical apparatus and more particularly to an improved dielectric liquid for electrical apparatus.

Halogenated aromatic compounds, known as askarels in the industry, and specifically chlorinated diphenyl and related compounds, have been widely used in the past as dielectric media in electrical apparatus such as electrical transformers for cooling and insulating purposes, these compounds having the advantage over mineral oil dielectrics of being non-flammable. A difficulty which arises in the use of chlorinated aromatic compounds as dielectric media, however, is that electrical discharges in the apparatus may cause decomposition products of the chlorinated compound to form, particularly hydrogen chloride, which adversely affect the properties of the dielectric liquid and lead to corrosion of the metal parts of the electrical apparatus and to degradation of other insulating components therein. To overcome this problem, so-called scavenger or getter materials have been incorporated in the dielectric liquid for removing or neutralizing the effect of the hydrogen chloride and other halogen-containing decomposition products. However, the known scavenger materials heretofore employed for this purpose have had various drawbacks, such as reacting too slowly with the decomposition products, or involving excessive cost, or having other unsatisfactory characteristics.

It is an object of the invention to provide an improved dielectric liquid composition of halogen aromatic type for electrical apparatus having incorporated therein a novel scavenger material to protect the electrical apparatus from harmful effects of decomposition products of the dielectric liquid.

It is a particular object of the invention to provide a scavenger material for the above purposes which has superior speed of reaction with the harmful decomposition products, is compatible with commonly used dielectric liquids of the above type, is easily handled, and is relatively low in cost.

Other objects and advantages will become apparent from the following description and the appended claims.

With the above objects in view, the present invention relates to a dielectric liquid composition comprising a halogenated aromatic compound having dissolved therein a scavenger material comprising an epoxide compound characterized by epoxide groups attached to two cyclic groups, as more fully described hereinafter.

The invention will be better understood from the following description taken in conjunction with the accompanying drawing, in which:

FIGURE 1 is a view of an electrical transformer, partly broken away, in which the invention may be embodied;

FIGURE 2 is a similar view of an electrical capacitor in which the invention may be embodied; and

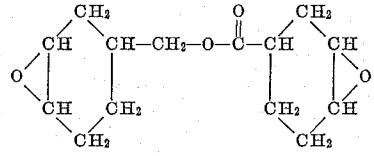
FIGURE 3 is a graphical showing of the characteristics of the scavenger material of the present invention as compared to known scavenger materials.

Referring now to the drawing, and particularly to FIGURE 1, there is shown a transformer comprising a hermetically sealed tank 1 enclosing a magnetic core 2 and coil 3 comprising high and low voltage windings and partially filled with a dielectric liquid 4 composed essentially of a halogenated aromatic compound, e.g., chlorinated diphenyl or other askarel type of dielectric liquid, such as chlorinated benzene, chlorinated alkyl benzene, or mixtures of such halogenated aromatic compounds. Dielectric liquid 4 is provided, as conventional in the art, for insulating purposes and to dissipate the heat generated by the apparatus. The coil windings are normally insulated by cellulosic material such as kraft paper, as well understood in the art.

Contained in the halogenated aromatic dielectric liquid 4 is an epoxide compound of the composition more fully described hereinafter which functions as a scavenger for any hydrogen chloride evolved from the dielectric liquid as a result, for example, of arcing conditions during the operation of the apparatus. Such hydrogen chloride, unless removed or neutralized, will attack the metal and insulation components employed in the transformer and lead to shortened life or reduced efficiency of the apparatus.

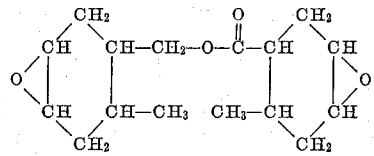
FIGURE 2 shows an electrical capacitor comprising a rolled capacitor section 5 assembled in conventional arrangement of wound alternating layers of metal foil electrodes and dielectric sheets such as kraft paper, the roll section 5 being enclosed in casing 6 containing dielectric liquid 7 having a composition in accordance with the present invention. While in capacitors arc formation is unlikely, decomposition of the aromatic dielectric liquid contained in the capacitor may even occur when such compound is subjected for long periods to voltage stress, especially at elevated temperatures.

In accordance with the invention, halogenated aromatic dielectric liquids 4 and 7 have incorporated therein an epoxide compound comprising a dicyclo diepoxy carboxylate, the preferred material being specifically 3,4-epoxy - cyclohexylmethyl - 3,4 - epoxy-cyclohexanecarboxylate. The structural formula for this compound is:



A commercially available epoxy compound of this composition is known as Unox Epoxide 221. This material is a liquid at ordinary temperature, has a molecular weight of 250 and a specific gravity of about 1.176.

Another dicyclo diepoxy carboxylate which may be used is 3,4 - epoxy-6-methylcyclohexylmethyl-3,4-epoxy-6-methyl-cyclohexanecarboxylate. The structural formula for this compound is:



An epoxide compound of this composition is known commerically as EP 201. This material is also a liquid at ordinary temperature, and has a molecular weight of 280 and a boiling point of 335° C. at 760 millimeters Hg pressure.

It has been found in accordance with the invention that the dicyclo diepoxy carboxylates provide marked improvement in protecting electrical apparatus from the effects of decomposition products of the halogenated aryl compound used in the dielectric liquid. In particular, the dicyclo diepoxy carboxylates exhibit greatly increased

speed of reaction with such decomposition products, notably hydrogen chloride, as compared to known scavenger compounds including epoxides such as phenoxypropylene oxide alone or even in combination with an accelerating catalyst such as an amine, and are superior in this respect to tin tetraphenyl, a metallo organic compound extensively used for such scavenging purposes.

FIGURE 3 is a graph showing the relative reaction rates with hydrogen chloride of a number of scavenger materials including the dicyclo diepoxy carboxylates of the invention. In the graph, the percent hydrogen chloride reacted is plotted against reaction time in minutes. The curves shown represent the different scavenger materials as follows, the scavengers being used in stoichiometric equivalent quantities:

Curve:

A——Dicyclo diepoxy carboxylate.
B——Phenoxypropylene oxide plus .02% tribenzylamine.
C——Dipentene dioxide (EP269).
D——Tin tetraphenyl.
E——Phenoxypropylene oxide.

Curve A represents both the dicyclo diepoxy carboxylates described above since they exhibited substantially identical reaction rates.

As is evident from the graph, the dicyclo diepoxy carboxylate scavengers are considerably better than all the other scavengers in their speed of reaction with hydrogen chloride. Whereas it required at least 20 minutes for the next best scavenger (phenoxypropylene oxide plus tribenzylamine) to react with 90% of the hydrogen chloride, the dicyclo diepoxy carboxylates had reacted with 100% of the hydrogen chloride within two minutes.

The following examples are illustrative of dielectric liquid compositions containing the dicyclo diepoxy carboxylate scavenger which may be suitably used in electrical apparatus:

Example I

	Parts by weight
Hexachlordiphenyl	45
Trichlorbenzene	40
Tetrachlorbenzene	15
Dicyclo diepoxy carboxylate	0.125

Example II

Trichlordiphenyl	100
Dicyclo diepoxy carboxylate	0.3

Example III

Pentachlordiphenyl	100
Dicyclo diepoxy carboxylate	0.3

The dicyclo diepoxy carboxylates are readily soluble in halogenated aromatic liquids, such as those mentioned above. The relative amount of scavenger compound present in compositions embodying this invention depends upon the nature of the electrical apparatus and the amount of electrical stress or arcing to which the composition may be exposed in the ordinary use of the apparatus. Thus, the proportion of the scavenger compound in the dielectric liquid may vary widely from trace amounts up to any desired proportion. As a practical matter, a range of scavenger content of .001% to about 10% by weight of the dielectric liquid would cover a wide variety of operating conditions, with a narrow range of the order of .05% to .25% being generally preferred for typical applications.

The accelerated removal of the decomposition products thus provided by the invention results not only in materially reduced corrosion of metal parts of the apparatus, but also in an advantageous reduction in the harmful chemical effects of dissolved hydrogen chloride on paper or other cellulosic material present therein.

In addition to such important advantages, further benefits are obtained due to the substantially lower cost of the dicyclo diepoxy carboxylates as compared to other scavenger materials heretofore used such as the phenoxypropylene oxide and tin tetraphenyl mentioned above, and the generally reduced amount of scavenger material which can be employed to obtain equivalent neutralization effects as compared to the known scavenger compounds.

While the present invention has been described with reference to particular embodiments thereof, it will be understood that numerous modifications may be made by those skilled in the art without actually departing from the scope of the invention. Therefore, the appended claims are intended to cover all such equivalents as come within the true spirit and scope of the invention.

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

1. A dielectric composition consisting essentially of a chlorinated aromatic dielectric liquid containing dissolved therein an epoxide compound selected from the group consisting of 3,4 - epoxy-cyclohexylmethyl-3,4-epoxy-cyclohexanecarboxylate and 3,4-epoxy - 6 - methylcyclohexylmethyl-3,4-epoxy-6-methylcyclohexanecarboxylate.

2. A dielectric composition consisting essentially of a chlorinated aromatic dielectric liquid containing dissolved therein an epoxide compound comprising 3,4-epoxy-cyclohexylmethyl-3,4-epoxy-cyclohexanecarboxylate.

3. Electrical apparatus comprising, in combination, a container, an electrical device in said container, a dielectric liquid in said container consisting essentially of a halogenated aromatic compound, said dielectric liquid being subject to decomposition forming halogen-containing products, and an epoxide scavenger compound in said dielectric liquid for neutralizing said halogen-containing products, said epoxide scavenger compound being selected from the group consisting of 3,4-epoxycyclohexylmethyl-3,4-epoxy-cyclohexanecarboxylate and 3,4 - epoxy - 6-methylcyclohexylmethyl - 3,4 - epoxy - 6 - methyl-cyclohexanecarboxylate.

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