April 14, 1936. F. M. CLARK 2,037,686

INSULATING AND DIELECTRIC COMPOSITIONS

Original Filed Feb. 10, 1933

Fig. 1.

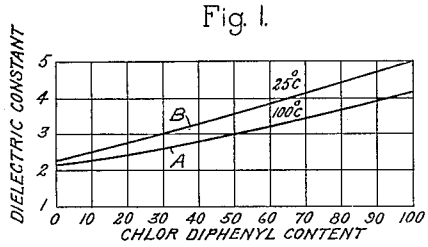


Fig. 2.

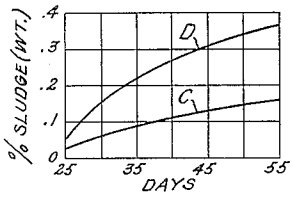


Fig. 4.

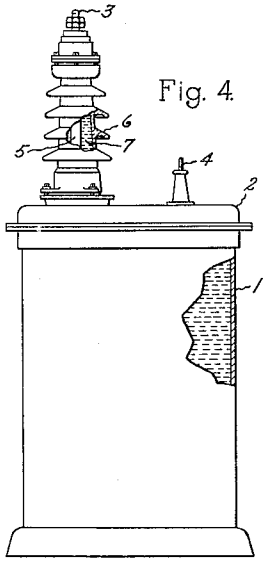


Fig. 5.

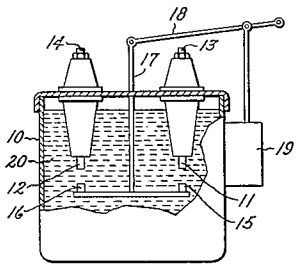
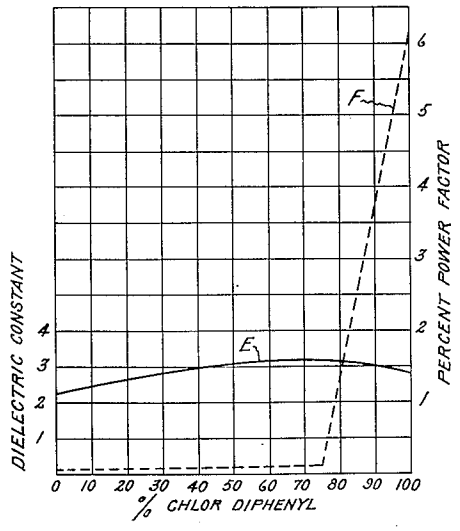


Fig. 3.



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2,037,686

INSULATING AND DIELECTRIC COMPOSITIONS

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Original application February 10, 1933, Serial No. 656,142. Divided and this application August 17, 1933, Serial No. 685,568

4 Claims. (Cl. 252—1)

The present application is a division of my prior application Serial No. 656,142, filed February 10, 1933, in which claims are made to a lubricant consisting of chlorinated polyphenyl and an oil which may be either vegetable or mineral oil.

The present invention comprises new liquid composition comprising either mineral or vegetable oil and a halogenated polyphenyl compound, and being particularly suitable for use in electric apparatus.

It has been found that when some compositions which are liquid at ordinary temperatures are caused to become solidified by exposure to very low temperatures, such as encountered in northern winter climates, the insulating property of the compositions becomes depreciated. This deleterious effect apparently is produced by shrinkage of the compositions when solidifying. For example, upon the solidification of ordinary mineral oil gas bubbles or cavities are formed in the mass which depreciate its dielectric properties. Material containing cavities when subjected to electric stresses is easily broken down electrically as the gases in the cavities become ionized. When liquid halogenated diphenyl, which also is employed for dielectric purposes, solidifies at low temperatures it pulls away from the sides of the container, the resulting cavities lowering its insulating value.

I have discovered that mixtures of mineral hydro-carbon oil and halogenated polyphenyl when solidified are homogenous, that is, are free from this disadvantage of cavity formation which is characteristic of these materials singly and that such mixtures possess other superior properties as hereinafter described. For example, these mixtures exhibit very much improved resistance to the formation of mineral oil sludge.

Fig. 1 of the accompanying drawing is a graph showing the dielectric constants at 25° and at 100° C. of various mixtures of heavy mineral oil and pentachlor diphenyl; Fig. 2 is a graph showing sludging characteristics of a 35% pentachlor diphenyl and 65% light mineral oil mixture in the presence of copper; Fig. 3 shows graphs of the dielectric constant and power factor of heptachlor diphenyl and mineral oil; Fig. 4 illustrates in elevation an electric transformer provided with a liquid insulated high tension bushing; and Fig. 5 shows a high voltage switch, the devices shown being forms of electric apparatus embodying my invention.

The following are examples of compositions employed in electrical apparatus in accordance with the present invention. Other halogenated polyphenyls may be employed as later explained.

Example 1

Mineral hydrocarbon oil may be mixed with a liquid halogenated diphenyl, such for example as pentachlor diphenyl. There may be employed a mineral oil having a viscosity at 37.8° C. of about 1200 to 1300 seconds Saybolt Universal (100 seconds at 98.9° C.), a specific gravity of .935 at 15.5° C. (referred to water at the same temperature) and a fire point of 274° C. To 50 to 70 parts by weight of this oil are added 50 to 30 parts by weight of pentachlor diphenyl. The latter has a viscosity of about 48 seconds Saybolt Universal at 98.9° C. and a specific gravity of 1.495 to 1.505 at 65° C. (referred to water at 15.5° C.). A mixture of 70 parts of the oil and 30 parts of the chlorinated diphenyl has a viscosity of 1700 seconds Saybolt Universal at 37.8° C. (80 seconds at 98.9° C.) and a specific gravity at 25° C. of 1.065 (referred to water as 1 at 15.5° C.). Its pour point (solidification temperature) is about minus 2° C. My invention is not limited to a dielectric made up of any particular proportion of ingredients. Equal parts of oil and halogenated diphenyl, or other polyphenyl may be employed.

As shown in Fig. 1 the dielectric constant of the mixture increases with increasing proportions of chlorinated diphenyl. Graph A shows the progressive rise of dielectric constant at 100° C. with increase of chlorinated diphenyl content from about 2.2 (dielectric constants of oil) to about 4.2 (dielectric constant of chlorinated diphenyl). Graph B shows that at 25° C. the rise of dielectric constant with increase of chlorinated diphenyl in the mixture occurs at a greater rate than at 100° C.

This mixture may be employed advantageously as a dielectric and insulating material in cables, high tension bushings and also as an impregnant for capacitors. It is superior to mineral oil having a higher dielectric constant, having a lower coefficient of expansion, and being substantially noninflammable.

Example 2

I may employ as one of the ingredients of a dielectric a medium mineral oil having the following characteristics: a viscosity of 102 seconds Saybolt at 37.8° C., a specific gravity of .907 (referred to water at 15.5° C.), a fire point of 176° C. and a pour point of minus 40° C. When a medium oil of this type is mixed with substantially equal proportions of heptachlor diphenyl an exceptionally good dielectric composition is obtained. The mixture has a dielectric constant which is greater than either of the ingredients alone while the power factor remains very low. For example, the dielectric constant of the oil at 25° C. and 1000 cycles is 2.2, the chlorinated diphenyl used is 2.8 while the mixture containing fifty per cent of the heptachlor diphenyl and fifty per cent mineral oil has a dielectric constant of 3.1 (see Fig. 3). The power factor of the mixture at 25° C. is .045% at 1000 cycles. The heptachlor diphenyl itself has a power factor of 6.5% at 25° C., 1000 cycles. The resistivity in ohms per centimeter cubed of the mixture at 25° C. and 500 volts D. C. is 26.8×10^{12}.

Example 3

Trichlor diphenyl may also be employed as one of the ingredients of a dielectric material. A mixture of 25% medium mineral oil and 75% trichlor diphenyl by weight which has a viscosity of 34 seconds Saybolt at 98.9° C., a specific gravity of 1.4 (referred to water at 15.5° C.) and a pour point of minus 16° C., will give a composition having a viscosity of 76.8 seconds Saybolt at 37.8° C. Such a liquid is non-inflammable. It is particularly adapted for use in transformers and switches where fire hazards are present.

The general use of different mineral hydrocarbon oils for cooling and insulating mediums in electrical apparatus has not been entirely satisfactory because of the inflammability of the oil.

With properly selected oils and chlorinated diphenyls a non-inflammable liquid can be obtained. In the blending process, the oils and chlorinated diphenyls are selected with particular reference to their volatility. The chlorinated diphenyl selected should have a volatility similar to the oil used, the non-inflammable vapors of the former blanketing the burning characteristics of the latter.

Another disadvantage accompanying the use of mineral oil in electrical devices is the formation of sludge, a semi-solid material, which prevents the circulation of the cooling medium in a transformer or other electrical device and hastens electrical breakdown. In order to decrease the sludge formation in mineral oils various chemical retarders have been added but while such mixtures are adapted for use in connection with certain electrical devices they will not in themselves produce non-inflammability of the oil mixture.

I have discovered that sludge formation in the presence of copper is substantially decreased in a noninflammable mixture comprising mineral oil and a halogenated polyphenyl compound. For example, as shown by the graph C of Fig. 2 a mixture of 35% pentachlor diphenyl and 65% mineral oil forms about 0.16% of sludge in 55 days at a temperature of 110° C. The same mineral oil unassociated with chlor diphenyl, graph D, forms about 0.38% of sludge. The total decrease in sludge formation, both being in the presence of copper, is nearly 70%.

It is desirable in most cases that a dielectric material should have a high dielectric constant and a low power factor, the latter being a measure of energy loss in the dielectric. Fig. 3 shows the relation of these two characteristics in a mixture of mineral oil and heptachlor diphenyl. Measurements were made at 25° C., 1000 cycles. The abscissa represents progressive percentages from 0 to 100 of chlor diphenyl in the mixture. The lefthand ordinates, graph E, correspond to dielectric constant values and the right hand ordinates, graph F, correspond to power factor values. As shown by graph E, the dielectric constant rises as the chlor diphenyl content increases to a maximum value at approximately 70% chlor diphenyl content. The power factor, graph F, on the other hand, rises very little with increasing amounts of chlor diphenyl up to about 75% when a sharp rise takes place. For percentages of chlor diphenyl below 75% there is a fortuitous combination of high dielectric constant and low power factor.

The transformer shown in Fig. 4 of the drawing is of the usual construction in which primary and secondary windings (not shown) are contained in a metal tank 1, having a cover 2 on which are mounted low tension and high tension terminals, only two of which are shown for the sake of simplicity at 3 and 4 respectively. The high tension terminal, or bushing, 3 comprises a conductor 5 which is surrounded by a casing 6 having external petticoats. Between the conductor 5 and the casing 6 is a liquid composition 7 of the type herein described, preferably a composition such as described as Example 1.

The fact that a composition such as above described has a specific gravity greater than water renders it particularly advantageous for use in electrical devices. When such devices are not tightly sealed, air which contains moisture may penetrate into the casing. This would be facilitated by changes in temperature which cause a "breathing" action. The condensation of this moisture in the presence of a liquid which is lighter than water is apt to cause electrical failures due to the fact that the condensed water will sink in such a liquid and collect in the bottom of the casing. In the case of an electrical device containing a liquid which is heavier than water the condensed moisture will stay at the top where it will be evaporated before sufficient amounts can collect to cause damage.

The switch shown in Fig. 5 of the drawing is of the conventional form comprising a casing 10 containing fixed terminals 11, 12, carried by sealed-in insulated conductors 13, 14 and movable terminals 15, 16 carried by a T-shaped support 17. The support 17 in turn is linked to an operating lever 18 and actuating mechanism 19 which is well known and hence will not be described. The casing 10 contains a fluid mixture 20 embodying my invention.

The use of this composition is not limited, however, to the particular devices here illustrated. It may be used advantageously as a dielectric in other forms of electric apparatus and as regulators, cables, capacitors, junction boxes, and cable joints.

While my invention has been described with particular reference to mixtures comprising mineral hydrocarbon oil, I may also employ to advantage mixtures comprising a vegetable oil, such as castor oil and a chlorinated diphenyl either with or without mineral oil. I intend by the appended claims to cover mixtures containing in

combination with chlorinated polyphenyl either or both a suitable mineral or vegetable oil.

Instead of the diphenyl halogen compounds herein described other halogenated polyphenyls may be employed. For example, triphenyl when chlorinated yields viscous liquids or else compounds having a flow point above room temperature and hence being resin-like at room temperature. Other halogens may be used in place of chlorine such as iodine, bromine or fluorine. Other halogenated polyphenyls may be employed in accordance with my invention. For example, halogenated diphenyl ketone, halogenated diphenyl methane, halogenated diphenyl oxide, halogenated triphenyl methane and halogenated dibenzyl may be suitably admixed with mineral oil, vegetable oil or both, the mixtures being employed for dielectric purposes.

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

1. Electric insulating and dielectric compositions consisting essentially of about 25 to 75 parts by weight of mineral oil and 75 to 25 parts by weight of chlorinated polyphenyl.

2. Electric insulating and dielectric compositions which are liquid at ordinary temperatures and consisting essentially of about 25 to 75 parts by weight of oil selected from the group consisting of mineral oil and castor oil and 75 to 25 parts by weight of chlorinated polyphenyl, said composition when solidified at low temperatures forming a homogenous, cavity-free, solid mass, having a dielectric constant which is higher than the dielectric constant of either ingredient, a power factor less than one per cent and a specific gravity greater than unity.

3. An electric insulating and dielectric composition consisting essentially by weight of about 30 parts of mineral oil and about 70 parts of chlorinated polyphenyl.

4. An electric insulating composition consisting essentially by weight of about 30 parts of a mineral oil having a viscosity at 37.8° C. of about 1200 to 1300 seconds Saybolt Universal and about 70 parts of pentachlor diphenyl.

FRANK M. CLARK.