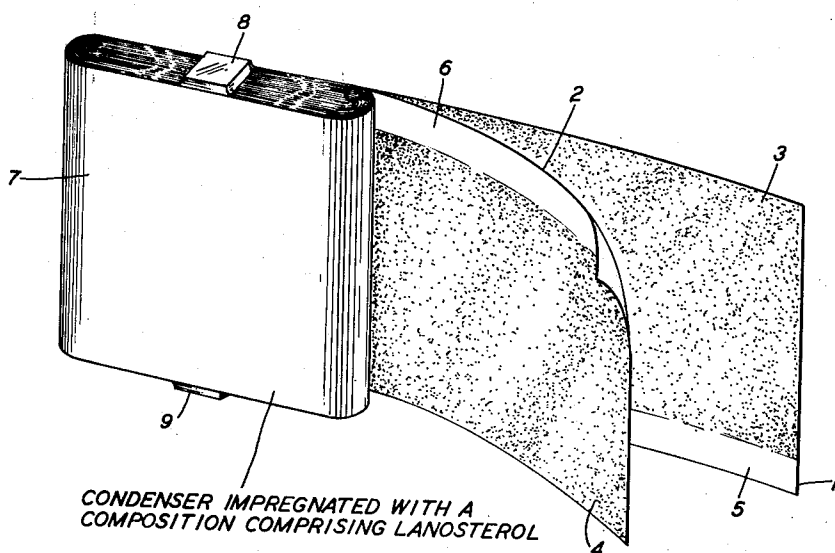


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COMPOSITION USEFUL THEREIN
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ELECTRICAL CONDENSER AND DIELECTRIC COMPOSITION USEFUL THEREIN

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This invention relates to electrical condensers, more particularly to electrical condensers having armatures spaced by a dielectric comprising a material of improved properties and it also relates to dielectric compositions capable of use in such condensers.

The most common form of electrical condenser consists of flexible metal armatures spaced by sheets of paper impregnated with liquid or waxy, solid dielectric materials which replace the air in the paper and between the paper and the armatures. In such condensers, the capacity for a given size can be increased, or the size of the condenser for a given capacity can be decreased, by the selection of an impregnant of increased dielectric constant. Increased capacity per unit size not only results in economy in the use of materials but is also of considerable importance in apparatus where size or weight must be kept at a minimum, as in mobile equipment or telephone exchanges.

Therefore, the art has been continually in search of impregnating materials of increased dielectric constant which will also possess the other requisite characteristics of a condenser impregnant, including chemical and physical stability, adequate resistivity, availability, economy and ease of impregnation. In addition, it is desirable for most applications that the impregnant be normally a waxy solid so as to eliminate the problem of ionic mobility and the problem of providing an impervious container which are encountered when a normally liquid impregnant is employed.

In the form of condenser which is made up of a pair of metal foils spaced by a plurality of paper sheets, the whole being rolled into a compact body, the most commonly used impregnants for yielding high capacity per unit size are the chlorinated aromatic hydrocarbons, particularly chlorinated naphthalene and chlorinated diphenyl. These impregnants are widely used because of their high dielectric constant despite the fact that condensers impregnated with these materials tend to have shorter lives than condensers impregnated with materials of lower dielectric constant, such as paraffin or mineral oil.

It has not been found feasible to use these chlorinated aromatic hydrocarbons as impregnants for metallized paper condensers. This type of condenser is formed of two sheets of paper each having a continuous thin metal film deposited on one surface. The two sheets are superimposed and wound into a compact mass, forming a condenser in which the two metal film electrodes are separated by a single sheet of paper. Short circuits between the two films, due to conductive particles in the paper, are eliminated by applying a

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potential across the two electrodes. The current flow through the conductive particles destroys the metal film in the vicinity of the conductive particle and interrupts the current path.

This burning out process which is incident to the manufacture of metallized paper condensers appears to generate decomposition products in the chlorinated impregnants which lead to high conductivity and short condenser life. It is therefore necessary, in condensers of this type, to use more stable impregnants of lower dielectric constant and, as a result, advantage cannot be taken of the increased capacity resulting from the use of the chlorinated impregnants.

The present invention resides in electric condensers in which lanosterol, alone or in mixture with other substances, is used as a dielectric material.

Lanosterol, which is a waxy solid substance, available in technical form as a product of wool fat, has been found to have a dielectric constant of about 7 to about 10 at 25° C., depending upon its purity, as compared to a dielectric constant of about 5 for chlorinated naphthalene and about 2.5 for mineral oils and waxes. Its dielectric constant can be increased substantially by mixture with other compatible dielectric materials. It is relatively stable and melts in the vicinity of 120° C. At about 140° C. its viscosity is reduced to a point at which it can be readily used for impregnating condensers. The melting point can be substantially reduced and the fluidity of the molten material can be substantially increased by the addition of other compatible dielectric materials.

By reason of its advantageous properties, lanosterol is well adapted to the impregnation of electrical condensers made up of electrodes spaced by a porous spacer such as paper. Foil type condensers of the present invention, impregnated with a lanosterol impregnant have been prepared with a capacity up to 30 per cent greater than that of identical condensers impregnated with chlorinated impregnants and with an average life, under accelerated life test, more than five times that obtainable with the chlorinated impregnants.

Lanosterol and lanosterol mixtures are sufficiently stable for use as impregnants for metallized paper condensers. Capacities up to 30 per cent greater than those of metallized paper condensers impregnated with the previously used hydrocarbon impregnants have been obtained with metallized paper condensers containing lanosterol impregnants in accordance with the present invention. The life of lanosterol impregnated metallized paper condensers is comparable

to that obtained with the hydrocarbon impregnants.

The accompanying drawing shows, by way of illustration of the invention, a perspective view of a metallized paper capacitor impregnated with a lanosterol composition.

The condenser shown in this drawing is made up of two sheets 1, 2 of paper, each having a vapor deposited coating 3, 4 of a suitable metal, such as zinc, on one of its faces. A margin 5, 6 extending the entire length of each of these sheets is left free from deposited metal. The two sheets are superimposed with their metallized sides each facing in the same direction and with their metal-free margins on opposite edges and are rolled longitudinally to form the rolled body 7. Contact terminals 8, 9 are formed on opposite edges of the rolled body by spraying on a small block of low melting metal, such as lead-tin solder, in contact with the respective edges so as to form an electrical connection with the edge of the metallizing coating of that sheet which does not have a metal-free margin at that edge. The entire condenser is impregnated with an impregnant containing lanosterol.

The technical grade of lanosterol consists essentially of lanosterol but may contain in addition a small percentage of material esterified with organic acids. The term lanosterol as used in this specification and in the appended claims is to be considered applicable to both pure lanosterol and the technical grade of lanosterol, both of which are effective condenser impregnants. The technical lanosterol may also contain suspended insoluble solid particles of foreign matter which contain some ionic material. This suspended solid matter should be removed, as by filtration of the lanosterol in the molten state or in solution in a volatile solvent, prior to the use of the lanosterol for impregnation. Further improvement in the technical material may be brought about by adding a finely divided adsorbent, such as fuller's earth, to the molten lanosterol prior to filtration, in order to achieve further removal of ionic material.

As indicated above, the dielectric constant can be increased by diluting the lanosterol with other compatible materials. The melting point and the viscosity of the melt can also be reduced in the same manner, particularly when a lower melting material of lower melt viscosity is added.

A very suitable impregnating compound is obtained by adding castor oil to lanosterol. The mixing can be accomplished by melting the lanosterol and adding the castor oil, which is completely miscible therewith. The resulting homogeneous molten mixture may be used for condenser impregnation. A specimen of lanosterol having a dielectric constant of about 7 at 20° C., as measured in a fixed plate condenser, yielded the following values of dielectric constant at 20° C. and the following melting points when the following amounts of castor oil were added:

Added-Castor Oil (Percent by Weight)	Dielectric Constant at 20° C. and 1 kc.	Melting Point (° C.)
0.....	7.0	120
5.....	8.5	116.5
10.....	11.7	118
15.....	11.1	114
25.....	10.5	112
33 1/3.....	9.7	107
40.....	9.2	103
50.....	8.7	89

It can be seen that the addition of 10 per cent castor oil results in an increase in dielectric constant of almost 70 per cent and that, even when diluted with 50 per cent castor oil, the composition has a dielectric constant about 25 per cent higher than the lanosterol containing no castor oil. Castor oil itself has a dielectric constant of less than 5. These mixtures are all waxy solids at room temperature and are somewhat less brittle than lanosterol itself.

Improvement in the dielectric constant of the lanosterol is obtained by the addition of as little as 2 per cent or 3 per cent castor oil but it is ordinarily desirable that at least 5 per cent be present. From the standpoint of lowered melting point and increased melt fluidity, it is desirable that at least 10 per cent castor oil be present in the composition. A proportion of 15 per cent castor oil yields a composition which appears to be substantially the optimum from the standpoint of ease of impregnation as balanced against dielectric constant. Above about 25 per cent or 35 per cent castor oil, the decrease in dielectric constant renders the compositions less desirable than those of lower castor oil content, although these compositions are still excellent impregnating materials as indicated by the fact that with even a castor oil content of 50 per cent, the dielectric constant is higher than that of lanosterol alone.

Compositions containing castor oil and lanosterol enjoy the beneficial effects of the high dielectric constant of lanosterol even when small amounts of lanosterol are present. However, it is ordinarily desirable that at least 25 per cent lanosterol be present. At low lanosterol contents, the melting point of the mixtures will be lowered to room temperature or below. It is ordinarily desirable, but not essential, that the condenser impregnants have a melting point above their highest normal operating temperature, usually about 60° C. Compositions containing at least 25 per cent lanosterol will melt above 60° C.

The lanosterol may be diluted with other compatible, normally liquid, or fusible, normally solid, dielectric materials. The added materials should be ones which are miscible with lanosterol in the molten state to produce a homogeneous impregnating liquid. The added material should also be chemically stable and possess no detrimental electrical properties. Any common dielectric material miscible with lanosterol in the molten state may be used. Preferably, it should have a direct-current resistivity greater than 10⁷ ohm-centimeters and more preferably the resistivity of the added material should be greater than 10¹⁰ ohm-centimeters.

Hydrogenated castor oil, which is a waxy solid melting between about 75° C. and 85° C. and having a dielectric constant in the vicinity of 8 or somewhat higher, when added in an amount of 25 percent to lanosterol having a dielectric constant of 7 at 20° C., produced a mixture having a dielectric constant of 10.3 at 20° C. A similar mixture containing 50 per cent hydrogenated castor oil had a dielectric constant of 9.8 at 20° C.

A mixture of equal parts by weight of the same lanosterol and the organic oil sold commercially as HB40, which is a mixture of partially hydrogenated terphenyl isomers, was found to have a dielectric constant substantially the same as the lanosterol alone.

Various other hydrocarbon materials may be mixed with lanosterol to form desirable condenser impregnants. Thus, the paraffin oils and

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waxes may be added. The mineral wax known as "Superla" wax, which has a dielectric constant of about 2.5, when added to the lanosterol referred to above in the proportions of two parts of lanosterol by weight to one part of wax, yielded a mixture having a dielectric constant of 6.25 at 20° C. and having a high direct-current resistivity.

Thus the beneficial effect of the high dielectric constant of the lanosterol is obtained even where the lanosterol is diluted with large amounts of other liquid or solid dielectric materials. In most cases the addition of limited amounts of other materials raises the dielectric constant, presumably either by increasing the molecular spacing of the lanosterol and thus facilitating the molecular or intramolecular movement or polarization of the lanosterol which may be responsible for its high dielectric constant, or by reducing the size of the interdispersed diverse solid phases in the lanosterol which may alternatively be responsible for its high dielectric constant. As the amount of added material is increased, the effect of this material in increasing the dielectric constant of the lanosterol decreases and is ultimately more than offset by the presence of the increasing amount of the diluent so that the dielectric constant of the mixture tends to approach that of the diluent. Even small proportions of lanosterol such as 5 per cent or 10 per cent, in such mixtures will contribute toward raising their dielectric constants but, in order to achieve a substantial effect, it is ordinarily desirable that at least 25 percent and preferably at least 50 per cent lanosterol be present.

The dielectric constant of lanosterol and its compositions, and therefore the capacity of condensers containing them, are dependent to some extent on the rate at which the material solidifies from a liquid to a solid state. The values of dielectric constant referred to above were obtained by allowing the materials to cool at an ordinary rate by heat radiation, namely at a rate of heat extraction such that the temperature drop just above the point at which solidification begins is of the order of 100° C. to 150° C. or more per hour.

If the rate of heat extraction during solidification is reduced to an extremely low value, for instance such as would produce a temperature drop of the order of 15° C. per hour just before solidification begins, the dielectric constant of the lanosterol or its compounds drops to a low value. Lanosterol cooled at this rate may have a dielectric constant of the order of 3. As the rate of heat extraction is increased, the dielectric constant increases until it reaches its normal value of about 7 to 10. Annealing of condensers impregnated with lanosterol should therefore be avoided in the vicinity of the melting point of the impregnant. It is desirable that the heat extraction during solidification be sufficient to produce a temperature drop, just before solidification begins, of at least 50° C. to 60° C. per hour and preferably at least 75° C. per hour.

The invention has been described in terms of its specific embodiments and, since certain modi-

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fications and equivalents may be apparent to those skilled in the art, this description is intended to be illustrative of, but not necessarily to constitute a limitation upon the scope of the invention.

What is claimed is:

1. An electric condenser comprising a pair of spaced electrodes having a dielectric comprising a normally solid fusible material therebetween, said fusible material containing at least 25 per cent lanosterol by weight.

2. An electric condenser comprising a pair of electrodes separated by a dielectric spacer, the condenser being impregnated with a dielectric material comprising at least 25 per cent by weight of lanosterol.

3. An electric condenser comprising a pair of conductive electrodes separated by a paper spacer impregnated with a normally solid dielectric impregnating material comprising at least 25 per cent by weight of lanosterol.

4. A condenser as described in claim 2 wherein the dielectric impregnating material consists of a mixture of lanosterol with at least one organic dielectric material, miscible therewith in the molten state, the lanosterol being present in an amount of at least 50 per cent by weight.

5. A condenser as described in claim 2 wherein the dielectric impregnating material consists of lanosterol and castor oil, the lanosterol being present in an amount of at least 50 per cent by weight.

6. A condenser as described in claim 2 wherein the dielectric impregnating material consists of lanosterol containing between 5 per cent and 25 per cent castor oil by weight.

7. A condenser as described in claim 2 wherein the dielectric impregnating material consists of lanosterol containing about 15 per cent by weight of castor oil.

8. A condenser as described in claim 2 wherein the dielectric impregnating material consists of lanosterol.

9. A condenser as described in claim 2 wherein the dielectric impregnating material consists of lanosterol and hydrogenated castor oil.

10. A dielectric composition consisting of lanosterol and castor oil, the lanosterol being present in an amount of at least 50 per cent by weight, the castor oil being present in an amount of at least 5 per cent by weight.

11. A dielectric composition consisting of lanosterol containing between 5 per cent and 25 per cent castor oil.

12. A dielectric composition consisting of lanosterol containing about 15 per cent castor oil.

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