Patented May 5, 1936 2,039,837

UNITED STATES PATENT OFFICE

2,039,837

INSULATING AND DIELECTRIC MATERIAL FOR ELECTRICAL APPARATUS

Anderson W. Ralston and Carl W. Christensen, Chicago, Ill., assignors to Armour and Company, Chicago, Ill., a corporation of Illinois

No Drawing. Application May 10, 1935, Serial No. 20,898

4 Claims. (Cl. 106—17)

This invention relates to insulating and dielectric materials for electric devices and it comprises electrical apparatus such as wires, cables, and condensers in which the insulating or dielectric material comprises a ketone having the general structural formula



in which R is a closed ring radical of the carbocyclic or heterocyclic series, and R' is an alkyl radical having at least eleven carbon atoms.

Many patents have been issued for the use of various materials as insulation for electric cables and for dielectric materials in electrical condensers. For example, mixtures of mineral oil and castor oil have been used. Paraffin wax is a common constituent of these mterials, and various organic halogenated compounds have been proposed. The requirements of this art are rather strict. It is of course necessary that the materials chosen have a high dielectric constant. There are many substances which answer this requirement but are unsatisfactory in other ways. Substances used must be strongly resistant to "break down". They must be resistant to chemical changes and should be unaffected by air or moisture. In many cases "break down" of insulation and dielectric can be attributed to decomposition of the material as the result of overheating. In other words, a suitable material must not only have a high dielectric constant, it must be extremely heat resistant, not affected by atmospheric conditions and not easily oxidized, and should have a low vapor pressure. If the vapor pressure be high, there is a marked tendency for the insulating material or dielectric to vaporize to some extent. This results in the formation of small quantities of gas and in turn leads to "break down".

It has hitherto been considered desirable that insulating materials and dielectrics be normally liquid on the theory that liquid dielectrics aid in the dissipation of heat. This however very largely depends upon the uses to which the dielectric is to be put. In the case of electric conduits and wires provided with insulating material, such as fibrous materials saturated with the insulator, it is best to use an insulating material which is normally solid but yet is not so brittle that it tends to fracture on mechanical handling. Most hydrocarbon waxes are satisfactory in this respect. Similar considerations apply in the case of condensers in which the dielectric material is paper or other fibrous sheet material impregnated with an insulating substance. For many other purposes it is desirable that the dielectric be of normally solid consistency but hitherto the art has not found substances which will wholly withstand "break down", atmospheric influences, highly oxidizing conditions, and the high temperatures commonly met with. A good insulating material should not only have a high dielectric constant but it should also be substantially inert chemically under all conditions of use.

We have now discovered a class of compounds which satisfy the requirements of this art. Our compounds can be generically described as ketones having the structural formula



wherein R is a closed ring radical of the carbocyclic or heterocyclic series and R' is an alkyl group having eleven or more carbon atoms. Most of these compounds are of wax-like consistency and paper, cotton threads, and the like can be readily saturated with them. Some of them are oily liquids. They are markedly resistant to atmospheric influences. Being ketones they have a very high heat resistance and are not broken down or decomposed at elevated temperatures. They all have low vapor pressures and thus do not tend to liberate gas under the normal heat development in electrical devices. They are unaffected by moisture and cannot generate chemicals, such as acids or water, which might harm condensers or electric conducting elements. Hence these compounds are substantially inert chemically under all conditions of use normally met with. In addition they have excellent dielectric properties. Whereas the average dielectric constant of mineral oil is 2, our compounds have a dielectric constant of 4 or higher. But perhaps the greatest advantage obtained in our invention is in the marked resistance of our materials to the various kinds of "break down" conditions found in electric devices provided with insulating or dielectric materials. It has been the object of our invention to find a class of substances which would show such resistance, and at the same time have physical properties similar to materials hitherto used. This means that we can use our materials in the present processes of insulating wire and forming condensers without extensive modification of such processes. While we are substituting one kind of material for another we are however obtaining greatly improved "life" in electrical conductors and condensers.

We shall now list many substances falling within the generic scope of our invention. These are:

Heptadecyl phenyl ketone	M. P. 59° C.
Heptadecyl p-tolyl ketone	M. P. 67° C.
Heptadecyl m-xylyl ketone	M. P. 39° C.
Heptadecyl p-xylyl ketone	M. P. 57° C.
Pentadecyl m-xylyl ketone	M. P. 37° C.
Pentadecyl p-tolyl ketone	M. P. 60° C.
p-Methoxyphenyl pentadecyl ketone	M. P. 70.5° C.

p-Ethoxyphenyl pentadecyl ketone ..... M. P. 69° C.
Phenyl undecyl ketone ..... M. P. 46° C.
p-Chlorphenyl undecyl ketone ..... M. P. 57° C.
p-Methoxyphenyl heptadecyl ketone ..... M. P. 76° C.
p-Methoxyphenyl undecyl ketone ..... M. P. 60° C.
p-Phenoxyphenyl heptadecyl ketone ..... M. P. 68° C.

p-Phenoxyphenyl tridecyl ketone ..... M. P. 53–54° C.
p-Phenoxyphenyl undecyl ketone ..... M. P. 45–46° C.
p-Nitro phenoxyphenyl heptadecyl ketone ..... M. P. 177–79° C.
p-Methyl phenoxyphenyl heptadecyl ketone ..... M. P. 77–78° C.
Alkyl phenones from lard fatty acids.

Alpha naphthyl heptadecyl ketone ..... M. P. 53–54° C.
Alpha napthyl pentadecyl ketone ..... M. P. 48° C.
Anthracyl heptadecyl ketone (mixtures)

Biphenyl heptadecyl ketone ..... M. P. 108–109° C.
Biphenyl tridecyl ketone ..... M. P. 102–103° C.
Biphenyl undecyl ketone ..... M. P. 97– 98° C.
p-Methyl biphenyl heptadecyl ketone ..... M. P. 105–106° C.
p-Chlorbiphenyl heptadecyl ketone ..... M. P. 96– 97° C.

Furyl heptadecyl ketone ..... M. P. 52.5–54° C.
Furyl undecyl ketone ..... B. P. 165–167° C./5 mm.
Methyl furyl heptadecyl ketone ..... M. P. 68–69° C.
Dibenzofuryl heptadecyl ketone ..... M. P. 83–84° C.
Dibenzofuryl undecyl ketone ..... M. P. 74–75° C.

Also ketones wherein the heterocyclic radical is derived from carbazol, thiophene and fluorene.

All of the above compounds are so-called "mixed ketones" in which one of the groups connected to carbonyl is either an aryl or a heterocyclic radical and the other group is an alkyl radical having at least eleven carbon atoms. Many of these compounds are new materials and we have separately described and claimed them in copending applications. They can be prepared in well known ways. Generally use is made of the "Friedel Crafts" synthesis. In this, the acid chloride of a higher fatty acid, for example stearyl chloride is reacted with benzene in the presence of aluminum chloride. This will give heptadecyl phenyl ketone. In a similar manner when we wish to make the tolyl compounds we can start with toluene instead of benzene, naphthalene when making the naphthyl compounds, and so on. In a similar way we make ketones containing any desired alkyl radicals by starting with the acid chloride of the corresponding fatty acid. Stearic acid for example is first converted to stearyl chloride in ways well known. Palmityl chloride yields pentadecyl ketones, and from a mixture of lard fatty acids (chiefly oleic acid) we can make corresponding alkyl phenones by converting the fatty acids to their corresponding acid chlorides and then reacting these substances with benzene in the presence of aluminum chloride.

We can of course use various mixtures of the ketones, for example equal parts of heptadecyl phenyl ketone and alpha naphthyl heptadecyl ketone. In the ordinary practice of our invention we find it best to use ketones of the benzene, naphthalene, or anthracene series since these are less expensive than ketones of the heterocyclic series but we have disclosed numerous ketones in both series to indicate the generic scope of our invention. We can, of course, combine our ketones with other dielectric materials such as paraffin wax and mineral oil.

As stated we use our insulating and dielectric materials in the usual ways. We can assemble condensers and then impregnate them with our materials while liquefied. That is to say we can melt our ketones and then immerse the condensers therein. Advantageously the condensers are vacuum treated and dried in accordance with well known practice before the impregnation. Similarly we can impregnate the cotton insulation on electrical conducting elements such as wires and the like with our materials. All of our ketones yield thin-flowing liquids having high penetrability when melted.

As stated, many of the ketones which we use are new materials. In our copending applications we have described and claimed them as such. In our copending application Serial Number 17,873, filed April 23, 1935, we have claimed the mixed phenoxy phenyl alkyl ketones, in our copending application Serial Number 17,874, filed April 23, 1935, we have claimed the mixed diphenyl alkyl ketones, in our copending application Serial Number 17,875, filed April 23, 1935, we have claimed the mixed furyl alkyl ketones, and in our application Serial Number 48,940, filed November 8, 1935 as a division of serial Number 17,875, we have claimed the benzofuryl alkyl ketones.

Having thus described our invention what we claim is:

1. An electric insulating material or dielectric for use in electrical devices including a ketone of the general formula



wherein R is a radical chosen from the group consisting of carbocyclic and heterocyclic radicals and R′ is an alkyl radical containing at least eleven carbon atoms.

2. An electric insulating material or dielectric for use in electrical devices including a ketone of the general formula

wherein R is an aryl radical and R′ is an alkyl radical containing at least eleven carbon atoms.

3. An electric insulating material or dielectric for use in electrical devices including a ketone of the general formula

wherein R is an aryl radical and R′ is heptadecyl.

4. An electric insulating material or dielectric for use in electrical devices including phenyl heptadecyl ketone.

ANDERSON W. RALSTON.
CARL W. CHRISTENSEN.