Sept. 29, 1942. A. R. KEMP 2,296,854

DIELECTRIC MATERIAL

Filed June 18, 1937

FIG. 1

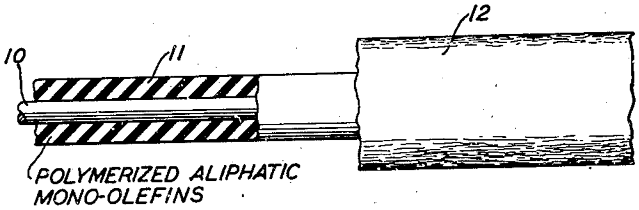
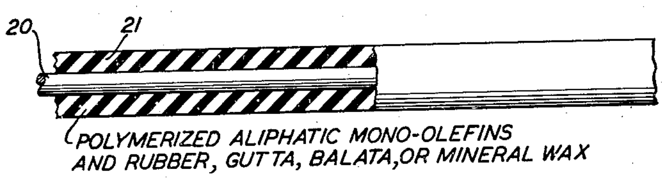


FIG. 2



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DIELECTRIC MATERIAL

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1 Claim. (Cl. 260—4)

This invention relates to electrical insulation and more particularly for dielectric materials employed for insulating electrical conductors.

An object of this invention is to insulate electrical apparatus effectively and efficiently.

A more particular object of this invention is an insulated electrical conductor, the insulation of which has excellent dielectric properties, is stable and is free from any corroding materials.

Insulation for electrical apparatus, and more particularly for drop wire, in addition to possessing desirable electrical characteristics, must withstand the various conditions to which the apparatus is subjected and not corrode the apparatus. For example, a temperature range between —40° F. to +140° F. prevails for drop wire employed extensively as a conductor in telephone communication systems and insulation for the drop wire must not flow or crack without healing in this temperature range. Then again, the insulation for submarine cables must not be brittle at temperatures which obtain at the ocean bottom, must not corrode the conductor and most important of all, must have low leakance and a low dielectric constant.

In accordance with this invention, electrical apparatus, and more particularly submarine cable, is insulated by a medium which is not brittle at low temperatures, which does not corrode the metallic parts to which it is applied and which possesses extremely desirable electrical properties. This medium comprises polymerized aliphatic mono-olefins varying in physical characteristics from viscous liquids to tough elastic solids similar to crepe rubber. The leakance and dielectric constants of these materials are particularly low and they may be obtained commercially substantially free from any deleterious substance which corrodes the conductor or other apparatus. Further, their physical characteristics are such that they are adaptable to use under a wide range of temperatures.

Chemically, the polymerized aliphatic olefins are among the most highly stable high polymeric organic materials known. They are pure hydrocarbons and free from any corroding or conducting substance. They have an extremely low water absorption which is almost negligible and they have an extreme resistance to oxidation and in this latter respect are superior to rubber, gutta percha or para gutta. This oxidation resistance is due primarily to the saturated nature of the polymerized aliphatic mono-olefin molecules.

The polymerized aliphatic mono-olefins may be employed alone or as an ingredient in mixtures with other materials such as high melting point waxes, rubber, gutta percha or balata. The particular type of polymerized aliphatic mono-olefins employed depends to a great extent upon the use to which the apparatus for which it serves as an insulating medium is subjected. When these substances are mixed with other materials to produce an insulation composition. the amount employed varies with the use of the composition. For example, the polymerized aliphatic mono-olefins may be employed as a compounding ingredient in rubber mixtures used for coating conductors. In some cases the paramount consideration is the utilization of the superior electrical characteristics of the polymerized aliphatic mono-olefins which comprise a relatively high percentage of the composition, whereas when the plasticizing efficiency of the polymerized aliphatic mono-olefins is required, a small proportion of them in relation to the other ingredients is added to the mixture.

These polymerized olefins are prepared by one of several methods well known in the art. A typical material is prepared by treating a particular aliphatic mono-olefin separately or in a mixture with another or several other aliphatic mono-olefins under pressure with an organic halide as a catalyst such an anhydrous aluminum chloride, stannic chloride, boron fluoride, titanium chloride, etc. For the polymerization the aliphatic mono-olefin or a mixture of aliphatic olefins is dissolved in butane. Subsequent to the polymerization reaction conducted for various periods of time at temperatures usually below —10° C., the catalyst is removed by filtration, washed and the butane distilled from the polymerization product. Preferably, the aliphatic mono-olefin contains from 4 to 10 carbon atoms and branch chain mono-olefins are likewise preferred over the straight chain variety since the former polymerize more quickly and are more readily obtainable commercially in large quantities than the latter. Examples of the preferred aliphatic mono-olefins from which the polymerized products of this invention are employed are the isomers of butylene, amylene, hexylene, heptylene, octylene, nonylene and decylene. Isobutylene due to its relative cheapness and its ease of polymerization is particularly well adapted for large scale production of polymerized products. In the polymerization of the mono-olefins, the mono-olefins intermolecularly react to link together with the elimination of most of the double bond and the resulting product is substantially saturated. By the proper selection of a particular aliphatic mono-olefin or a mixture of aliphatic mono-olefins and by the control of the condition of polymerization such as temperature, polymerized products are obtained which vary in physical characteristics from viscous liquid to solid elastic materials. Perhaps the best criterion for differentiating the polymerization products from each other and for serving as an index of the physical characteristic of the polymerization product in the molecular weight as determined by the Staudinger viscosity method. Polymerized aliphatic mono-olefins having a molecular weight of from 10,000 to 150,000 as determined by this method are preferred for electrical insulation.

The polymerized mono-olefins may be employed alone as insulation or as a compounding ingredient in rubber, gutta percha, balata or high melting point wax composition. The polymerized reaction product is applied over an electrical conductor, for example, by extrusion or other well-known method. As a sealing compound for condensers and loading coils the polymerized reaction product may be mixed with rosin or rosin oil or employed alone.

To illustrate the use of the polymerized mono-olefins for insulation, reference is made to the accompanying drawing in which:

Fig. 1 illustrates a submarine cable insulated with polymerized aliphatic mono-olefins; and

Fig. 2 shows an insulated conductor in which a rubber mixture comprising polymerized aliphatic mono-olefins is employed for the insulating material.

In Fig. 1, a copper conductor **10** is insulated by polymerized aliphatic mono-olefins **11** having a molecular weight of 50,000 to 150,000 as determined by the Staudinger method. A coating **12** of jute is placed over the insulation **11**. In Fig. 2 a copper electric conductor **20** is covered with an insulation **21** comprising polymerized aliphatic mono-olefins and rubber, balata, gutta percha, high melting point hydrocarbon wax or other materials. The insulation **21** may be vulcanized by the continuous vulcanization process or the older pan method.

The insulation **11** of the submarine cable shown in Fig. 1 or the insulation **21** of the insulated wire illustrated in Fig. 2 may comprise the polymerized aliphatic mono-olefins alone or as an ingredient in mixtures with other insulating materials. Several examples are hereinafter described in which the polymerized aliphatic mono-olefins are employed in compositions for insulating conductors and other electrical apparatus.

EXAMPLES OF COMPOSITIONS COMPRISING GUTTA AND POLYMERIZED ALIPHATIC MONO-OLEFINS

The following compositions comprising the reaction product resulting from the polymerization of aliphatic mono-olefins and gutta have been found satisfactory for electrical purposes:

	Composition A	Composition B
	Parts by weight	*Parts by weight*
White leaf gutta	60	50
Polymerized aliphatic mono-olefin (molecular weight 100,000)	35	40
Amorphous high melting point mineral wax (M. P. 160° F.)	5	10

Sheets approximately 0.050 inch in thickness of the gutta composition A and gutta composition B were compared in electrical characteristics with leaf gutta obtained from Dutch plantations. The sheets were measured at 2 kilocycles at 22° C. before and after soaking in water for two weeks at room temperature. The insulation resistance was measured at 400 volts. Tinfoil electrodes were used. The sheets were weighed and the thickness measured before and after soaking. The data are tabulated below:

Compound	Thickness (cm.)	Percent increase in weight	G/C	Loss factor $G/\omega C$	Dielectric constant ϵ	Spec. cond. (mho. cm.$^{-1}$)	Spec. res. (ohm.cm.)
TREATMENT BEFORE SOA KING							
White leaf gutta	0.1485	0.00	5.4	0.00043	2.53	1.2×10^{-12}	$>9.3\times10^{15}$
White leaf gutta	0.1505	0.00	6.3	0.00050	2.47	1.4×10^{-12}	$>9.2\times10^{15}$
Composition A	0.1512	0.00	2.7	0.00022	2.40	0.58×10^{-12}	$>9.2\times10^{15}$
Composition B	0.1543	0.00	2.1	0.00017	2.39	0.45×10^{-12}	$>9.0\times10^{15}$
TREATMENT AFTER SOAKINO TWO WEEKS							
White leaf gutta	0.1476	0.05	9.7	0.00077	2.54	2.2×10^{-12}	$>9.6\times10^{15}$
White leaf gutta	0.1512	0.13	6.5	0.00052	2.52	1.5×10^{-12}	$>9.3\times10^{15}$
Composition A	0.1522	0.12	5.7	0.00045	2.45	1.2×10^{-12}	$>9.3\times10^{15}$
Composition B	0.1548	0.07	5.2	0.00041	2.40	1.1×10^{-12}	$>9.1\times10^{15}$

It is observed in the comparison between the leaf gutta from Dutch plantations and compositions A and B containing polymerized aliphatic mono-olefins that the compositions A and B possess better water absorption characteristics, have lower dielectric constants, and have better insulating properties than the leaf gutta percha hydrocarbon alone. Polymerized aliphatic mono-olefins may be employed to replace some or substantially all of the rubber employed in paragutta compositions, i. e., mixtures of gutta and rubber, for submarine cable insulation.

Examples of Composition Comprising Rubber and Polymerized Aliphatic Mono-Olefins

The following rubber compositions suitable for the insulation 11 or 21 have been found satisfactory:

	Composition C	Composition D	Composition E	Composition F
	Parts by weight	*Parts by weight*	*Parts by weight*	*Parts by weight*
Pale crepe rubber	30.00	30.00	30.00	44.75
Mineral rubber	12.00	12.00	----------	15.00
Zinc oxide	32.75	3.00	3.00	31.00
Lithopone	----------	29.75	40.00	----------
Whiting	20.00	20.00	----------	----------
Polymerized aliphatic mono-olefins (molecular weight 15,000)	2.00	2.00	3.00	6.00
Retarder (salicylic acid)	0.50	0.50	0.50	----------
Sulphur	1.00	1.00	1.25	1.00
Accelerator (tetramethylthiuram-monosulphide)	0.25	0.25	0.25	0.50
Stearic acid	0.25	0.25	0.25	0.25
Ceresin wax	0.25	0.25	0.25	----------
Anti-oxidant (phenylalphanaphthylamine)	0.50	0.50	0.50	1.00
Carbon black	0.50	0.50	1.00	----------
Reclaimed rubber	----------	----------	20.00	----------
Accelerator (diphenylguanidine)	----------	----------	----------	0.25
Lead oleate	----------	----------	----------	0.25
	100.00	100.00	100.00	100.00

The ingredients of the compositions C, D, E or F are compounded together, vulcanized and applied to the conductors by any of the methods well known in the art. Other fillers, retarders, accelerators, and anti-oxidants may be employed instead of those used in the compositions C, D, E and F.

The relative amount of polymerized aliphatic mono-olefins in the compositions C, D, E and F varies from two to six per cent. These compositions illustrate the utilization of the plasticizing properties of the polymerized aliphatic olefins in rubber compounds. The resulting rubber insulation has superior dielectric properties for insulating conductors and possesses the necessary physical properties required of such conductors in the field.

As an example of a rubber composition which has a low leakance and low dielectric constant and in which the polymerized aliphatic mono-olefins comprise the major portion, the following compound has been found satisfactory for insulating electric conductors:

Composition G

	Parts by weight
Polymerized aliphatic mono-olefins (Molecular weight 100,000)	66.00
Crepe rubber	34.00
Zinc oxide	4.00
Stearic acid	2.00
Anti-oxidant (phenylalphanaphthylamine)	1.50
Accelerator (tetramethylthiuramdisulphide)	0.20
Sulphur	2.00

Other anti-oxidants and accelerators may be employed instead of those specified in the above formula. The ingredients are mixed, vulcanized and applied to the conductor in the usual way.

A hard rubber composition having extremely desirable electrical and physical characteristics may also be prepared from these polymerized aliphatic mono-olefins. For example, hard rubber compositions containing the following constituents may be mixed together and vulcanized for ten hours at approximately 150° C.:

	Composition H	Composition I
	Parts by weight	Parts by weight
Crepe rubber	70.00	70.00
Sulphur	30.00	30.00
Polymerized aliphatic mono-olefins (molecular weight 60,000)	10.00	20.00

Rubber compositions containing a considerable proportion of polymerized aliphatic mono-olefins are extremely resistant to the action of sulphuric and nitric acids, being most resistant when the polymerized aliphatic mono-olefins are used largely in place of the rubber. The dielectric constants and dielectric losses of rubber compositions containing polymerized aliphatic mono-olefins are lower than rubber alone.

Example of Composition Comprising Wax and Polymerized Aliphatic Mono-Olefins

The polymerized aliphatic mono-olefins may also be employed with hydrocarbon waxes, such as ceresin wax. For example, 50 parts of the polymerized aliphatic mono-olefins having a molecular weight of 100,000 may be mixed with 50 parts of ceresin wax. Other waxes such as amorphous mineral waxes may likewise be compounded with the polymerized aliphatic mono-olefins and the resulting compositions utilized for electrical insulation.

The molecular weight of the polymerized aliphatic mono-olefins specified in the compositions in all of the examples are the values obtained by the well-known Staudinger viscosity method.

While preferred embodiments of the invention have been illustrated and described, various modifications may be made therein without departing from the scope of the appended claim.

What is claimed is:

An insulation for submarine cable comprising 66 parts by weight of polymerized aliphatic mono-olefins having a molecular weight above 50,000, 34 parts by weight of crepe rubber and 2 parts by weight of sulphur.

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