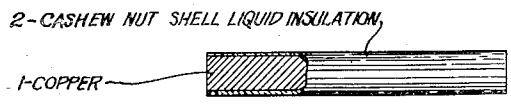
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INSULATED ELECTRICAL CONDUCTOR

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INSULATED ELECTRICAL CONDUCTOR

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1 Claim. (Cl. 173—264)

The present invention relates, generally, to insulated electrical conductors; and the invention relates more particularly to conductors having thereon electrical insulation made from cashew nut shell liquid.

The present invention is applicable to the making of insulated conductors of the enamelled wire type; the type in which the conductor has a coating of fibrous material thereon such as braided or wound cotton or silk, with a coating of varnish or lacquer-like material penetrating the fibrous covering and contacting with the conductor; and the type in which wound or taped coils of insulated conductors are impregnated with an insulating and protecting compound.

Other applications or modifications of the invention, and objects and advantages thereof, will be apparent from the following specifications and from the claim appended hereto.

In the drawing forming part of this application there is shown in side view, in part cut away, a section of copper conductor with an insulating covering thereon comprising cashew nut shell liquid material.

In this drawing a copper conductor 1 has over it an insulating layer 2 comprising cashew nut shell liquid or cashew nut shell liquid material which has been applied in the natural state or in an intermediate state of preparation and which has been set by the aid of the catalytic effect of the copper thereon, heat usually being used to further the speed of setting or of drying. The insulation can be of the wire enamel type, or of fabric such as a woven sleeve with impregnation of cashew nut shell liquid material which contacts with the copper of the conductor, or of extruded or molded plastic material.

I have discovered that dried varnish films, impregnations, and molded compositions made of cashew nut shell liquid have a higher dielectric value than do insulations made of linseed oil, China wood oil and other materials heretofore known. I have also discovered that films, impregnations, and molded compositions made with cashew nut shell liquid, as hereinafter described for example, are insoluble in petroleum spirits and oils, are impervious to water and moisture, and can be successively and repeatedly heated to temperatures as high as 500° F. and higher, and cooled without lowering their dielectric value.

One method of making an insulation film according to the present invention is as follows. A quantity of cashew nut shell liquid is brought up to about 600° F. and cooled to room temperature. As the temperature is lowering an equal volume of solvent vehicle such as gasoline or varnoline is added at about 300° F. At room temperature, there is added a 40% water solution of formaldehyde in amount about one to five per cent by volume of the amount of cashew nut shell liquid used. The mixture is then heated to about 235° F. to drive off the water and then cooled. This solution can be thinned with more solvent vehicle if desired. Electrical coils or fabrics, paper, and so on dipped in or coated with this solution and heated at about 285° F. for about one hour will dry to a firm film which has the advantageous properties above set forth.

An air drying varnish is made as follows. Heat one volume of commercial cashew nut shell liquid to about 450° F. and add 2.5% to 5% of manganese resinate which dissolves therein and permit to cool to about 300° F. and add an equal volume of varnoline or gasoline, then cool to about 140° F. and add a 40% water solution of formaldehyde, in volume about 10% to 20% of the cashew nut shell liquid used, raise the temperature to about 190° F., preferably under a reflux condenser, and hold for about one to two hours, then raise to about 235°–240° F. to drive off water and any excess formaldehyde. Add another volume of solvent and cool. Dippings and coatings made of this will dry in air at room temperature in about five to eight hours.

A method of making a molded composition having electric insulating qualities and mechanical strength is as follows. A quantity of cashew nut shell liquid is mixed with a water solution of formaldehyde, the latter being about ten to fifteen per cent by weight of the cashew nut shell liquid, and heated to about 235°–240° F. to drive off water. The material is then cooled and mixed with a filler of fibrous or comminuted material and as a lead oxide, white, yellow or red, lime, barytes, asbestos, wood pulp and so on, and pressed to form in a mold and cured in an oven at about 285° F. for from one to four hours, according to the size of the mass, the resulting product being a hard, solid body which has good electrical insulating qualities, water and moisture resistance, resistance to deterioration by heating or by changes in temperature, and insolubility in petroleum oils and spirits, alcohol and so on. This material can be used without the filler, between layers of canvas, for example, where it is compressed and heated to set it at about 285° F. for about five to sixteen hours, depending on the mass of the assembly. Driers can be used with this cashew nut shell liquid and formaldehyde preparation, such as manganese

resinate, copper oleate and the metal oxides above mentioned will serve as driers or accelerators to speed the setting. The manganese resinate when used can be about one-half to four percent or more of the cashew nut shell liquid used. These molded electrical insulations can be formed and set in place on or about an electrical conductor, also they can be placed on or about the conductor after being formed or set.

As an example of steps in obtaining a liquid for dipping or coating the following is given. A quantity of the cashew nut shell liquid of commerce is brought up to a temperature of 600° F. and then permitted to cool. A mixture of one hundred parts by weight of this heat-treated cashew nut shell liquid and three parts of hexamine are raised to a temperature of about 265° F. and then allowed to cool. This latter temperature is suitable for small batches, for larger batches lower temperatures would need to be used depending on the rate of cooling after the heating. The reaction product is a liquid at normal temperatures. Dippings and coatings made of this liquid product when set at a temperature of 285° F. give a film which is water and moisture proof, is resistant to petroleum solvents, to acids and alkalies, and has a comparatively high dielectric value. This material, before setting, can be taken up and applied with a solvent such as gasoline, varnoline, benzol. The drying or setting time, when a solvent is used, is longer than when none is used.

An example of a method for making and applying an impregnating compound for electric coils is now given. Commercial cashew nut shell liquid is brought up to a temperature of about 600° F. and then permitted to cool, and as it cools, about one per cent of manganese resinate is added at 450° F. When the liquid reaches room temperature about three per cent of hexamine is added and the mixture is heated to 195° F. to dissolve the hexamine. Coils to be impregnated are heated for about two hours at about 225° F. and then placed in an autoclave and the air withdrawn therefrom, the suction being held for about one-half hour after maximum vacuum is obtained. The above prepared impregnating liquid is then charged into the autoclave without breaking the vacuum and the vacuum held for another half hour after charging with the impregnating liquid. From the time the liquid is charged into the autoclave the temperature therein is raised above room temperature to make the impregnating liquid thin but is kept below 160° F. so that said liquid does not set prematurely. The temperature used on a coil with paper between layers was kept around 125° F. At the end of the second half-hour period, that is one-half hour after the impregnating liquid is charged into the autoclave, the vacuum is released and pressure is applied of about 60 to 80 pounds for about one-half hour, to drive the liquid into the coils, the temperature being unchanged. At the end of this period the coils are removed from the autoclave, drained, and are baked in an oven at about 225° F. for about twelve hours to set the impregnating liquid. At the exposed surfaces the said liquid has a comparatively hard, smooth film, and inside the surface the impregnating liquid has set into a firm, binding mass. No solvent or vehicle was used for this impregnation, but when desired as in cases for dipping cloth or paper, for example, a vehicle can be used, petroleum spirits such as gasoline, varnoline and so on being suitable.

Another example for making coating, dipping, or impregnating material is now given. Two parts of commercial cashew nut shell liquid and one part of stearine pitch are mixed and heated together to about 600° F. and allowed to cool and as it cools hexamine, about two per cent of the whole, is added at 265° F., care being taken to cool the mass at a rate sufficient to retard setting reaction. With different size batches, the hexamine is added at different temperature to suit the rate at which the mass can be cooled. A vehicle, varnoline, is added at about 140° F.

Coatings of this material on paper and cloth dry to a smooth, flexible, and strong film in twenty minutes at about 265° F. For some purposes, such as for impregnations, the vehicle is omitted; and the hexamine is not added until the cashew nut shell liquid stearine pitch mixture has reached a lower temperature than that given above, for example, at 195° F., this for the purpose of slowing down or delaying the setting of the material and keeping it at an optimum state of fluidity until it has been forced into the material and structure to be impregnated.

Electrical insulation is made also by heating the cashew nut shell liquid to change it from its natural non-drying to the drying state, and it is used with or without driers or accelerators. This change from the non-drying to the drying state by heating is described in my applications Serial No. 37,865, filed June 17, 1925; patented August 27, 1929, No. 1,725,791; and Serial No. 234,027, filed November 17, 1927, patented August 27, 1929, No. 1,725,794, to which reference is hereby made, and the range of heating temperatures goes from about 200° F. upward through 600° F. to 700° F. and above. The driers or accelerators suitable are any one or any number of those hereinbefore and hereinafter mentioned and they can be added to the cashew nut shell liquid before, during or after the heating process. Among the driers mentioned herein are manganese resinate, copper oleate, and the several lead compounds, white, yellow, and red lead.

A particular example of the making of electrical insulation of the present invention is as follows: a quantity of the cashew nut shell liquid is heated to about 600° F. and then allowed to cool, and drier is added consisting of litharge and manganese resinate, each in amount about 1% of the weight of the cashew nut shell liquid used. The drier can be added at any time, 450° F. being found to be practical for handling the materials. The prepared composition can be applied as it is, either at room temperature or at higher temperature, and it can be applied with a suitable solvent vehicle such as varnoline or gasoline; and the composition, however applied, is suitable for use for electrical insulation in many ways such as a coating or varnish; as an impregnation; for making molded compositions, either by itself without fillers or with fillers, such for example, as those hereinbefore named; as an insulating binder or cement; and in other ways. The composition above described can be set or dried in a film on paper or cambric at about 285° F. in about one-half hour, and in impregnations and molded compositions in about one-half hour to one hour at the above given temperature.

Also, insulation can be made on copper conductors by dipping the latter in either raw or heat treated cashew nut shell liquid, or otherwise obtaining a coating of said liquid on the copper, and heating to set the liquid or modification thereof in place, a suitable temperature being about

280° F. The raw or modified cashew nut shell liquid can be applied and set on copper conductors which have a covering of cotton or other material thereon, and set in place by the aid of heat. In either case, that is when the raw or heat modified liquid is applied to bare conductor and also when applied to fabric covered conductor, the copper of the conductor serves in the nature of a catalyst to aid in the setting of the liquid to a dry, resin-like solid which has electrically insulating and heat and solvent resistant qualities. This action of copper is disclosed in my copending application Serial No. 372,521, filed June 20, 1929, patented December 22, 1931, No. 1,838,077, of which this application is a division, and was originally disclosed in my application Serial No. 127,709, filed August 6, 1926, patented August 27, 1929, No. 1,725,794. This same action of copper can be used to set the various varnishes and the materials taken up with solvent on copper, in pieces or in a continuous process.

The cashew nut shell liquid can be used with natural drying oils such as linseed oil, or China wood oil; with gums or resins such as coumerone, copal, East India gum; with pitches, mineral, animal or vegetable; or with any number of said materials, to make insulation. An example of such follows: three and one-half parts of cashew nut shell liquid and one-half part of linseed oil are heated to about 600° F., when this temperature is reached heating is discontinued and cold linseed oil, one-half part, is added; as the mix reaches about 550° F., in cooling, one percent of litharge is added as a drier and the mix held at this temperature for about fifteen minutes, whereupon it is allowed to cool further to about 450° F., and one per cent of manganese resinate is added. In making coating material, an equal volume of varnoline solvent can be added to the mix at about 300° F. This preparation, with or without the solvent, is useful in making electrical insulation coatings, dippings, impregnations, and molded compositions. In the last above example, China wood oil can be used to replace all or part of the linseed oil; also fish oil, resins, gums, pitches, or waxes, can be added or substituted, such as copal or the others mentioned particularly elsewhere herein; also a mixture of China wood oil and copal in equal quantities can be used to replace the linseed oil; also linseed, China wood oil and the copal can be used in equal amounts in place of the straight linseed oil used. Also many other variations of mixtures of the materials named can be used both in proportions to and in kind with the cashew nut shell liquid.

In any of the above examples where raw or heat treated cashew nut shell oil is used; and with or without natural drying oils, waxes, pitches, gums or resins; formaldehyde, paraform, or the hexamethylenetetramine can be used to aid in setting the product, quantities suitable being about one to ten per cent, or more or less, and preferably added at about 100° F. to 115° F., a suitable setting temperature being about 285° F.

The above examples are given merely as such and are not to be considered as limiting the use and application of the methods and products of the invention because variations in percentages of the materials used, in the time and temperatures of the different heating steps and in the sequences these steps, and in the mode of application and use of the products of reaction can be made by one skilled in the art to suit different needs.

The products of the invention generally, are useful in making both hot and cold molded compositions, particularly in the solid state, which latter is obtained by increasing the length of time and/or temperature of one or more of the heating steps or otherwise varying the heating to suit different needs. Fillers can be mixed with the products of the invention in a liquid state or in a plastic state preparatory to forming molded composition; also a primary solid or presolid product can be comminuted and mixed with a filler or filler and binder such as product in the liquid or plastic state or other binder, and the material pressed and heated to complete the reaction for producing a final solid product.

In any or all of the products of the invention, such as those hereinbefore cited, driers and/or accelerators can be used to speed up the rate of setting. Such materials can be litharge, red lead, copper oleate, manganese resinate, and particularly in the advanced stages of the product, such as in molded compositions, lime, barytes and so on can be used both as filler and accelerator. Sulphur also can be used in the various products of the invention to react with the cashew nut shell liquid and to modify the reaction products.

Having thus described my invention, what I desire to protect by Letters Patent and claim is:

In combination, an electrical conductor of copper and insulation thereon made of cashew nut shell liquid material and which is the result of the catalytic effect of the copper of said conductor on said cashew nut shell liquid material under the influence of heat.

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