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METHOD OF FORMING COIL INSULATION

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Fig.1.

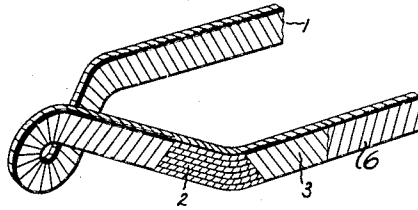
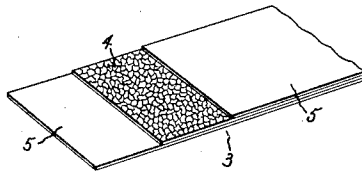


Fig.2.



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METHOD OF FORMING COIL INSULATION

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2 Claims. (Cl. 175—21)

This invention relates to electrical coils and more particularly to an improved method of producing a compact coil insulation of high dielectric strength which is oil-, dust-, moisture-, and abrasion-resistant.

According to certain methods generally followed at present in constructing electrical coils, absorbent fibrous materials, such as cotton, asbestos and the like, form part or all of the major coil insulation. These materials, no matter how thoroughly dried, contain some moisture rendering them more susceptible to electrical break down during use. To render the fibrous insulation more water repellant, such impregnants as asphalts or varnishes are used. The coil wrapped with such impregnated fibrous materials, however, is bulky and the insulating value of the impregnated fibrous material is low as compared with its thickness.

To overcome these disadvantages, it has been proposed to use tapes formed of cellulose acetate or other cellulose ester as coil insulation and various methods of applying this type of insulation have been suggested. For example, U. S. Patent 1,874,723 to Edward S. Dawson, discloses an insulated coil completely insulated with a cellulose ester tape sealed and shrunk onto the coil by heat treatment. It is therein suggested that the heat should be applied by passing a current through the conductors, by molding the coil structure in a steam heated mold, or by subjecting the coil to the action of a high frequency field for a few seconds. Although for certain purposes, the methods set out in this patent have proven satisfactory, their use has not always resulted in a coil having the desired maximum electrical properties. It has been found that these heating methods, difficult to control, may cause excessive bubbling of the cellulosic material resulting in undesirable voids in the insulation and causing assembly difficulties. Further, the comparatively thick cellulose ester tape used in practicing the patented method contains some volatile ingredients after the heat treatment is completed, which ingredients are harmful to the electrical properties of the coil as a whole.

It is, therefore, an object of my invention to provide a new and improved method of forming an insulated electrical coil, the major coil insulation of which has outstanding electrical properties and is free from voids and is sealed against oil, dirt, grease and moisture.

Another object of my invention is to provide a coil with a major insulation free from ingredients which may volatilize at operating temperatures

and which tend to lower the electrical value of the insulation.

A further object is to provide a positive method for producing an insulated coil which will not puff or deteriorate under heat and electrical stresses.

Further objects of my invention will become apparent to those skilled in the art from the following description of my invention taken in connection with the accompanying drawing in which Fig. 1 is a view in perspective of a portion of an induction motor field coil 1, with part of the outer layers of insulation removed, which has been insulated in accordance with my invention; and Fig. 2 shows a combination cellulose ester-mica tape used as part or all of the major coil insulation.

In carrying out my invention, suitable conducting bars or wires are first individually insulated in the usual manner with a number of layers or wrappings 2 of cellulose acetate, glass or other known insulating material, such as cotton, with or without the usual impregnants. The completely insulated conductors are formed then into coils of the proper shape as, for example, in the form of an induction motor field coil 1, as shown in Fig. 1.

The formed coil is next covered with a number of wrappings of the combination cellulose ester-mica tape 3, shown in detail in Fig. 2, and which suitably may comprise a layer of mica flakes or particles 4 sandwiched between two protective, or backing, sheets 5 of very thin plasticized cellulose ester or other cellulose derivative. Although I prefer to use a tape in which the mica layer is interposed between two sheets of cellulose derivative, it is within the scope of my invention that one of the sheets be omitted. The tape resulting from this omission is best wrapped onto the coil with the mica facing on the inside of the wrap so that the shrinkage of the cellulose acetate will closely bind the mica layer.

The combination tape 3 may be prepared by standard methods. For example, the mica particles may be dusted or sifted onto one face of a cellulose ester sheet plasticized with enough material, such as tricresyl phosphate or dibutyl phthalate, to insure flexibility of the final tape, which sheet previously has been coated with any suitable adhesive, such as a solution of a cellulose derivative or of a vinyl compound. If a second cellulose derivative layer is to be applied on top of the mica layer, the surface of this second sheet bearing on the mica layer should also be coated with an adhesive material. Obviously, additional mica and cellulose derivative layers may be added

although this can be done only at a sacrifice of the flexibility of the combination tape. After the cellulose-mica layers have been brought into proper relationship, the whole may be passed through heated rolls to unite firmly the various layers.

A number of layers or wrappings of this combination tape 3 are then applied to the entire coil 1 until the desired insulation thickness has been obtained. Because of the high plasticizer or softener content of the cellulose ester layers, the tape can be closely wrapped onto the coil without any tendency to bag or bulge even though such coils are of rectangular or irregular cross-section. Sacrifice tape, such as ordinary linen tape, is then applied to the coil to hold the combination tape in place and to protect it during the subsequent operations and the coil structure is introduced into a vacuum-tight chamber where it is subjected to a combined vacuum and heat treatment for such a time and at such a temperature as to remove all traces of the plasticizer and other volatile ingredients from the cellulose derivative layers and other portions of the coil structure. The primary object of this vacuum treatment is to remove the volatile plasticizers and solvents present in the cellulose derivative, which volatiles have been found to seriously impair certain desirable properties, such as the dielectric constant and heat resistivity of the tape. As an example of this heat and vacuum treatment, it may be stated that for ordinary coils, a cycle of four hours heating at 160° C. followed by five or six hours vacuum treatment at the same temperature will suffice to remove the volatile materials.

Following the vacuum treatment, the coil is subjected to further heating under pressure, preferably in the same enclosure employed for the vacuum treatment. For the purposes of the pressure treatment, I have found it essential to use a fluid medium in applying the direct pressure to the coil in order that the combination tape be forced into every crevice or other irregularity present in the underlying coiled conductor structure. Only by following this method have I been able to eliminate completely all of the voids with their accompanying detrimental effect on the electrical properties of the insulation. To accomplish this, a suitable highly viscous liquid, such as an oil-modified asphalt which has a relatively high viscosity at the coil treating temperature and which is heated to approximately the same temperature used in the vacuum treatment, is introduced into the chamber or tank and a pressure of the order of 100 pounds per square inch is applied to the fluid compound for about three or four hours.

By this treatment involving the consecutive use of heat, vacuum plus heat, and pressure plus heat, in treating the coil and the major insulation thereon, what little solvent remains in the mica tape adhesive is removed and the cellulose ester, due to the heat and due to the removal of the solvent and plasticizer therefrom, shrinks and tightly binds the mica onto the coil to produce a dry, solid insulated coil structure.

During the pressure treatment, the sacrifice tape also serves effectively to prevent the oil-modified asphalt, or other viscous medium, from coming in contact with and contaminating the underlying cellulose ester composite tape. This is important, as any impregnation of the cellulose tape by the asphalt mixture would not only

prevent the overlapping layers of tape from adhering one to another to form a dust and moisture proof seal but also would materially lower the dielectric constant of the insulating structure.

After the pressure treatment is completed, the sacrifice tape is removed and the coil is ready for use although I prefer to apply a layer of linen or other fibrous tape 6 over the cellulose ester-mica tape followed by several dips of varnish to protect the cellulose ester-mica tape during assembly of the motor or other electrical device in which the coil is to be used.

It is desirable that the cellulose ester sheets be as thin as possible in order that the proportion of the high dielectric constant mica will be high. Because thin sheets of the cellulose ester are used, ordinary methods of heat treating the coil are often so drastic as to destroy completely the cellulose ester backing without accomplishing the desired shrinking and binding action. I prefer to use thin cellulose sheets having a thickness of less than 1 mil and preferably about 0.8 mil.

By my above-described process, I am able to obtain a coil the surface of which is smooth and free from bubbles or other irregularities. Because of the materials used, the finished coil is provided with a high dielectric insulation, sealed against moisture, dust and oil, and is of reduced dimensions as compared with previous coils in so far as insulation thickness is concerned. Further, the improved coil has no tendency to puff when heated to operating temperatures as it contains none of the usual low melting point impregnants which tend to collect at certain points during use of the coil in a motor or the like at the expense of the insulating value of the remaining portions of the coil. A coil insulated in accordance with my improved method has been subjected to 100° C. and electrically stressed over 700 hours without the slightest evidence of puffing or deterioration under active corona conditions.

A further advantage of my process obtained from the fluid pressure step is that the coil loops are as adequately and uniformly compressed and sealed as are the slot portions of the coil. This is not possible with ordinary methods involving the use of heated steel molds and the like in the molding of the major coil insulation.

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

1. The method of providing an electrical coil with a dust-, oil- and moisture-resistant insulation of high dielectric constant which comprises applying a combination plasticized cellulose ester-mica tape over the entire surface of said coil, heating said taped coil to a temperature above the softening point of the cellulose ester but insufficient to affect injuriously the cellulose ester, subjecting said heated coil to a vacuum treatment to remove the volatile ingredients therefrom, immersing said heated coil in a heated viscous fluid medium, and applying pressure to said fluid medium effectively to force the combination tape into intimate contact with the coil, the cellulose ester-mica tape on said coil being protected from contact with the fluid medium during pressure treatment by means of a wrapping of sacrifice tape impervious to the heated fluid medium, said tape being applied to the coil over the cellulose ester-mica tape before immersion thereof in said fluid medium.

2. The method of providing an electrical coil

with an oil-, dust- and moisture-resistant insulation having a high dielectric constant which comprises applying to the coil a wrapping of tape comprising a layer of mica faced with cellulose ester plasticized with a relatively low boiling plasticizer therefor, applying a layer of fibrous protective tape over said cellulose ester-mica tape, heating said taped coil to a temperature of about 160° C., subjecting said heated coil to a vacuum treatment to remove substantially all

of the volatile material therefrom, immersing said vacuum-treated coil in a heated fluid medium incapable of penetrating the fibrous protective layer covering the cellulose ester tape, and subjecting said fluid medium to a superatmospheric pressure of such magnitude as to consolidate and compact the cellulose ester-mica tape on said coil.

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