ELECTRICAL APPARATUS AND METHOD OF MAKING SAME

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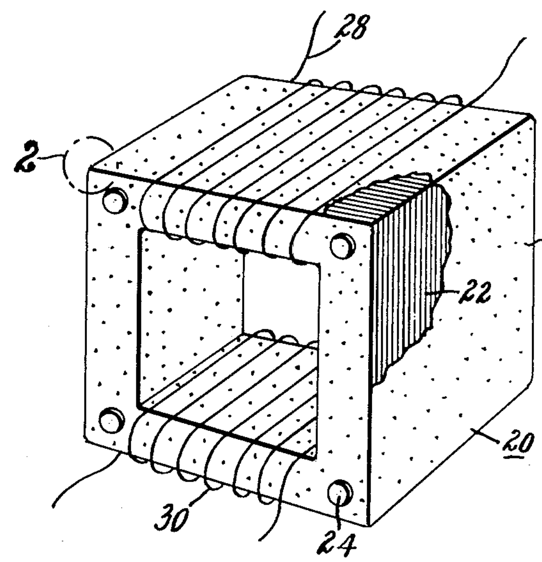

Fig. 1

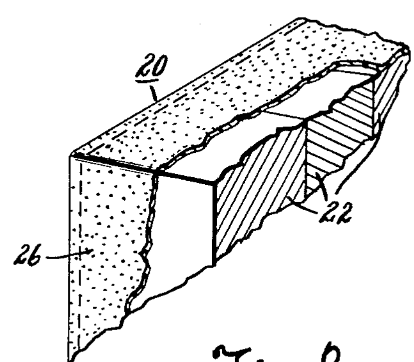

Fig. 2

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ELECTRICAL APPARATUS AND METHOD OF MAKING SAME

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This invention relates to insulated cores for electrical apparatus and is particularly concerned with insulated cores having a coextensive insulating coating thereover including an epoxy resin.

One of the objects of the invention is to provide an electrical core of laminated structure which has a coextensive insulating coating thereover as applied by suspending a heated core in a fluidized coating material whereupon the coating is uniformly disposed in a coextensive layer on the core.

In carrying out this object, it is a further object to utilize a fluidized bed of epoxy containing materials in conjunction with mica in predetermined quantities to aid in toughening the coating and improving the adhesion thereof.

A still further object of the invention is to provide a method for coating laminated articles with an epoxy containing particles including mica wherein a fluidized bed of particles of the coating material are used as a means for depositing the particles on a heated and suspended article to be coated.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein preferred embodiments of the present invention are clearly shown.

In the drawings:

FIGURE 1 is a view, in perspective, of a laminated electrical core with windings thereon wherein a portion is broken away to show the coating.

FIGURE 2 is an enlarged fragmentary sectional view of a corner of the core shown in FIGURE 1 with a portion of the coating broken away.

In electrical apparatus, laminated cores are frequently used to improve the electrical characteristics of the unit and these cores are frequently wound with conductors having very thin insulating coatings thereover. The insulation on these conductors frequently cuts away due to vibration and tension at the edges of the core to short out the conductors and reduce or destroy the electrical characteristics of the apparatus. Laminated cores are generally made from a plurality of stamped sheets of soft iron and these stampings have sharp edges that readily bite into thin insulating layers. In order to obviate these difficulties, it has been past practice to utilize heavy insulating layers on or between conductors wound onto laminated cores. These heavy insulating layers are not only expensive to produce but also tend to space the conductor farther away from the core and thereby reduce the electrical efficiency of the magnetic circuit.

The present invention is directed to a laminated electrical core for use in electrical apparatus wherein the core is provided with a coextensive and very thin coating of a tough and strong insulating material wherein bare conductors may be wound thereover so long as the turns are spaced from one another or wherein very thinly insulated conductors may be wound thereover without the danger of the insulation being cut through or failing. This provision increases the efficiency of the core and reduces the over-all cost of the apparatus in which the core is utilized.

It is understood that this invention may be used with equal facility in any number of electrical applications

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such as on relay cores, transformer cores, dynamoelectric machine armatures and stators and, in fact, in any application wherein a laminated core which requires a winding thereon is to be used, or, in fact, on any metal object that requires a tough, relatively thin wear and tear resistant insulating coating.

Referring specifically to the drawings, FIGURE 1 shows a laminated core at **20** fabricated from a plurality of separate plates of soft iron **22** each of similar cross section stacked together and held in place by means of a plurality of rivets **24** passing through the plates. Over the core **20** is disposed a coextensive covering of an insulating material **26** to be described in detail hereinafter. Over this insulating material is wound a pair of conductors **28** and **30** on opposed legs of the core. In this instance, the core may be a transformer core and the conductor **28** may be the primary winding while the conductor **30** may be the secondary winding. The conductors may be bare wire or ribbon or, if a heavier winding is desired, may be lightly insulated wire such as varnished wire or equivalent where the turns are wound one upon another wherein several layers are present, it being understood that any type of winding well known in the art may be used.

Referring to FIGURE 2, an enlarged fragmentary corner of the core **20** is shown wherein the laminations **22** are enlarged and wherein the coextensive insulating covering **26** is shown in more detail. It will be seen that this covering **26** covers all edges of the core with a tough, firmly adhered layer that prevents the wire from cutting into the layer and shorting out on the sharp edges of the laminations of the core.

Specifically, this coating material is, in the preferred embodiment, a solid phase epoxy resin fortified with mica in order to provide the necessary toughness to the film. The specific application of the film and the means for incorporating the mica therein are both of utmost importance to the success of the invention.

To set forth the procedure involved in compounding a material for the coating process, the following examples are set forth.

Example I

The coating composition in this instance comprises:

	Parts by weight
Epoxy resin	70
325 mesh mica	30
Dicyanodiamide hardener	9

This material is prepared as follows for use. The epoxy resin is heated to a temperature of about 400° F. to melt the same, and, when flowable, the mica is thoroughly mixed therein. Thereafter, the mixture is permitted to solidify and is then ground or crushed so that all of the material will pass a 60 mesh screen. The dicyanodiamide hardener (in a suitable mesh size, preferably 60–200) is next blended into the epoxy-mica mixture and the material is ready for use.

Example II

The coating mixture in this instance comprises:

	Parts by weight
Epoxy resin	80
325 mesh mica	20
Dicyanodiamide hardener	9

Here again, the epoxy resin is melted and the mica is dispersed therethrough after which the mixture is permitted to harden and is ground so that all of the mixture will pass a 60 mesh screen, preferably 60–200 mesh. The hardener is blended through the powder mixture and the material is ready for use.

In each of Examples I and II, it may be desirable to ball-mill the epoxy-coated particles of mica for several hours prior to the incorporation of the hardener therein. This densifies the particles and improves the mixture. Ball-milling may be carried out in a standard ball mill with #3 granite chips with the mill rotating at 30 r.p.m.

As an alternative method for coating the mica, the melting and grinding operations may be eliminated and the mica may be coated entirely by ball-milling together the mica and epoxy resins. The same conditions previously noted for ball-milling should be used and the mill should be run for about seven and one-half hours or until such time as the coating is complete.

In Examples I and II, the epoxy resin is preferably a solid phase resin having an equivalent weight of about 175, or stated differently, the resin has an epoxide equivalent of about 900. The equivalent weight in this instance is the number of grams of epoxy resin which will esterify completely one gram molecular weight of a monobasic acid. The epoxide equivalent may be defined as the grams of resin containing one gram equivalent weight of epoxide. It is understood that other epoxy resins having varying equivalent weights, for example, of about 150 to 210, may be used (or epoxide equivalents of about 500 to 3500), but, in each instance, the resin must be a solid in order to perform the mixing function with the mica. The hardener may be any suitable amine type hardener or may be one of the formaldehyde resins, for example, uncured phenol formaldehyde, urea formaldehyde or melamine formaldehyde resin. These are all well known curing or hardening agents for epoxy resins and they may be used as the entire curing agent or as a portion of the curing agent, as desired. It is to be understood that, as the equivalent weight or epoxide equivalent of the epoxy resin varies, the hardener is preferably also varied to cause the reaction to occur within a given time period and these variations are well known in the art. The epoxy resins in all cases are well known commercial resins generally formed by reaction between bisphenyl A and epichlorohydrin.

The coating operation may be performed by placing a suitable quantity of the mica fortified epoxy mixed with the hardener in a compartment or tank wherein a fluid vehicle such as air or other nonreactive gaseous fluid is blown through a bed of the particles causing the particles to become fluid-like in nature and to be suspended in a turbulent cloud or layer wherein the powder is maintained suspended by means of the ascending flow of fluid. The electrical part or core to be coated is heated to a temperature of preferably about 400° F. (above the melting point of the epoxy resin used) and is suspended in this fluidized resinous material. Particles of the resinous material which impinge on the hot core are at least superficially melted at their points of contact with the core and are adhered thereto whereby the entire core is coated uniformly with the powder. The period of time through which the fluidizing process is carried out determines, to a large degree, the thickness of the coating to be deposited. After the core is removed from the fluidizing chamber, it is preferably heated to a temperature in the order of 400° F. for about one hour to fully cure the coating and to densify the same. We prefer to utilize coatings in the order of from .018 to .020 inch thick although coatings from .015 to .025 are generally satisfactory for the purpose of insulating the core. It is understood that these figures may vary by choice for different applications. Apparatus for applying fluidized coatings from solid powdered material are well known and are readily purchased on the market.

The mica is an important addition as it is this ingredient which improves edge strength and toughness of the film. It has been found that similar epoxy films placed on cores without the mica therein do not have the edge strength nor the coverage and are not as rugged as films including the mica. Furthermore, the mica acts as a filler and reduces the cost of the coating while improving its physical characteristics. In all cases, the mica must be coated with the epoxy or no satisfactory coating can be formed.

When following the procedures noted herein, the hardener is preferably not added to the epoxy-mica mixture until the time it is to be fluidized whereby no chemical reaction is initiated until such time that the fluidized particles impinge upon the hot core at which instant at least a partial chemical reaction occurs which is caused to go to completion by the subsequent curing of the core.

The use of the fluidizing bed as a means for depositing the coating on the core is very important since, while spraying of particles onto the core, dipping the core in a varnish, or other means of applying the coating to the core can be used, the fluidizing process provides more uniform films than are possible by other methods whereby the efficiency of the electrical apparatus is improved and the cost of the coating is reduced. Furthermore, fluidizing makes possible a film of controlled thickness wherein the thickness is easily controlled by the period of immersion in the fluidized bed. Fluidizing apparatus for accomplishing the desired results is well known in the art and is extensively used.

A specific application of the present invention is disclosed in copending application S.N. 737,801, filed concurrently herewith and assigned to the assignee of the present invention.

While the embodiments of the present invention as herein disclosed constitute preferred forms, it is to be understood that other forms might be adopted.

What is claimed is as follows:

1. In a method for applying a coextensive insulating coating having an epoxy resin base including a mica filler therein onto the surface of an electrical core, the steps of; mixing the mica and epoxy resin by melting the epoxy resin and incorporating the mica therein, grinding the solidified epoxy resin with the mica therein to a suitable mesh size to form a filled epoxy powder, mixing the filled epoxy powder with a suitable hardener in sufficient quantities to subsequently harden the filled epoxy powder, and then suspending a hot core to be coated in a fluidized bed of said filled resin powder wherein the core is heated to a temperature sufficient to cause at least partial melting of filled epoxy particles that impinge thereon, maintaining the heated core in the fluidized bed of filled epoxy particles for a time sufficient to obtain a coextensive coating of the desired thickness and then removing the coated core from the fluidized bed and consolidating the coating thereon by further heating at a temperature sufficient to complete the chemical reaction of the hardener on the epoxy resin whereby an insulated core is obtained having a coextensive coating of a tough and wear-resistant epoxy resin thereover and thereafter winding a coil of wire onto the core.

2. In a method for applying a coextensive insulating coating having an epoxy resin base including a mica filler therein onto the surface of an electrical core, the steps of; mixing the mica and epoxy resin by melting the epoxy resin and incorporating the mica therein, grinding the solidified epoxy resin with the mica therein to a suitable mesh size to form a filled epoxy powder, mixing the filled epoxy powder with a suitable hardener in sufficient quantities to subsequently harden the filled epoxy powder, and then suspending a hot core to be coated in a fluidized bed of said filled resin powder wherein the core is heated to a temperature sufficient to cause at least partial melting of filled epoxy particles that impinge thereon, maintaining the heated core in the fluidized bed of filled epoxy particles for a time sufficient to obtain a coextensive coating of the desired thickness and then removing the coated core from the fluidized bed whereby an insulated core is obtained having a coextensive coating of a tough and wear-resistant epoxy resin thereover and thereafter winding a coil of wire onto the core.

3. In a method for applying a coextensive insulating coating having an epoxy resin base including a mica filler

therein onto the surface of an electrical core, the steps of; mixing the mica and epoxy resin in a ratio of 20 to 30 parts mica to 70 to 80 parts resin by weight, grinding the solidified epoxy resin with the mica therein to a suitable mesh size to form a filled epoxy powder, mixing the filled epoxy powder with a suitable hardener of suitable mesh size and in sufficient quantities to subsequently harden the filled epoxy powder, and then suspending a hot core to be coated in a fluidized bed of said filled resin powder wherein the core is heated to a temperature sufficient to cause at least partial melting of filled epoxy particles that impinge thereon, maintaining the heated core in the fluidized bed of filled epoxy particles for a time sufficient to obtain a coextensive coating having a thickness in the order of .015 to .025 inch thereon and then removing the coated core from the fluidized bed whereby an insulated core is obtained having a coextensive coating of a tough and wear-resistant epoxy resin thereover and thereafter winding a coil of wire onto the core.

4. In a method for applying a coextensive insulating coating having an epoxy resin base including a mica filler therein onto the surface of an electrical core, the steps of; mixing the mica and epoxy resin by melting the epoxy resin and incorporating the mica therein, grinding the solidified epoxy resin with the mica therein to at least 60 mesh size to form a filled epoxy powder, mixing the filled epoxy powder with a suitable hardener having a mesh size of at least 60 and in sufficient quantities to subsequently harden the filled epoxy powder, and then suspending a hot core to be coated in a fluidized bed of said filled resin powder wherein the core is heated to a temperature sufficient to cause at least partial melting of filled epoxy particles that impinge thereon, maintaining the heated core in the fluidized bed of filled epoxy particles for a time sufficient to obtain a coextensive coating having a thickness in the order of .015 to .025 inch thereon and then removing the coated core from the fluidized bed and consolidating the coating thereon by further heating at a temperature sufficient to complete the chemical reaction of the hardener on the epoxy resin whereby an insulated core is obtained having a coextensive coating of a tough and wear-resistant epoxy resin thereover and thereafter winding a coil of wire onto the core.

5. In a method for applying a coextensive insulating coating having an epoxy resin base including a mica filler therein onto the surface of a metal object, the steps of; intimately mixing the mica and epoxy resin for incorporating the mica therein, grinding the solidified epoxy resin with the mica therein to at least 60 mesh size to form a filled epoxy powder, mixing the filled epoxy powder with a suitable hardener having a mesh size of at least 60 and in sufficient quantities to subsequently harden the filled epoxy powder, and then suspending a hot metal object to be coated in a fluidized bed of said filled resin powder wherein the object is heated to a temperature sufficient to cause at least partial melting of filled epoxy particles that impinge thereon, maintaining the heated object in the fluidized bed of filled epoxy particles for a time sufficient to obtain a coextensive coating having a thickness in the order of .015 to .025 inch thereon and then removing the coated object from the fluidized bed and consolidating the coating thereon by further heating at a temperature sufficent to complete the chemical reaction of the hardener on the epoxy resin whereby an insulated object is obtained having a coextensive coating of a tough and wear-resistant epoxy resin thereover and thereafter winding a coil of wire onto the core.

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