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METHOD OF APPLYING INSULATING COATING

Filed Dec. 4, 1957

Fig. 1.

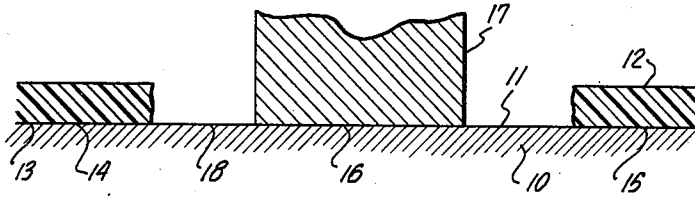


Fig. 2.

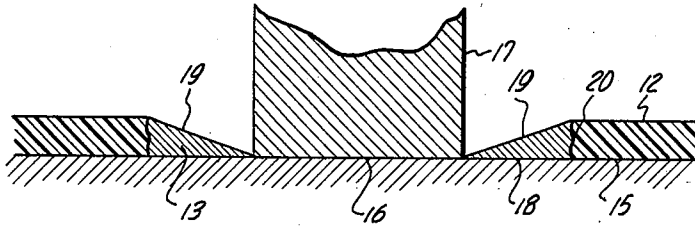


Fig. 3.

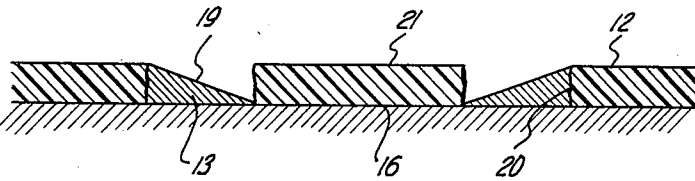


Fig. 4.

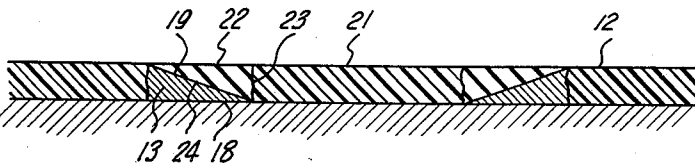


Fig. 5.

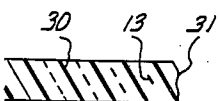


Fig. 6.

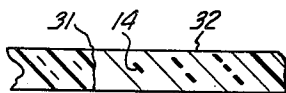


Fig. 7.

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METHOD OF APPLYING INSULATING COATING

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5 Claims. (Cl. 117—232)

This invention relates generally to the application of insulating coatings of uniform dielectric character to electrical equipment, and more particularly, to a method in which adjoining coated areas are seamed without discontinuity in dielectric characteristics by laying down overlapping layers of two different components of plastic coating at a boundary zone between the two areas and kneading the two components to produce a seamed layer which matches the color and thickness of the adjacent coatings.

This application is a continuation-in-part of application Serial No. 541,310, filed October 19, 1955, and now abandoned.

In the construction of dry type transformers, it is essential that the insulation of the coils from each other and from the transformer core be as nearly perfect as possible. The transformer must be rated at a maximum voltage which corresponds to the weakest point in the insulation. The most common and oldest process for insulating such coils is by wrapping in tape and subsequently impregnating with varnish. Such coatings cannot be made solid enough at the concave surfaces of long coils; they are never perfect at spots where leads penetrate them, and they usually have weak spots where the coil was supported during the impregnation process.

A coating of the coils by a dipping process can produce a complete and very uniform encapsulation of a small coil, but dipping is not suitable for large coils, particularly those requiring many supports in addition to the connection leads themselves. Furthermore, dipping processes are limited as a practical matter to the production of thin layers of insulation, and hence are only suitable for low voltage devices.

Coating by casting, press-molding, or extrusion can be made uniform irrespective of the shape of the surface coated, and it can be made practically perfect at spots where the leads leave the coil; these processes do not, however, avoid imperfections at the areas where the coils are supported during the coating process. It has been the practice in such processes to support the coils during coating on supports which were made of the same type of insulating material, such supports being left embodied in the final coating. The objection to this method is that it produces discontinuities in the dielectric characteristics of the coating at the locality of the support, and it is generally found that the breakdown voltages for such points are much less than for the rest of the insulation.

It has also been attempted to provide adequate insulation with great dielectric uniformity by applying several coatings to the coil, one on top of the other, perhaps shifting the support areas from one coating to another. Inevitably, this method of coating has failed to escape from the problem of the dielectric characteristics of the insulating layers, so that there has always remained one or two points in the insulation at which breakdown could occur at a voltage much less than for all the rest of the insulating covering.

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The susceptibility of such transformer coils to breakdown wherever a slight discontinuity occurs in the insulation has presented so insurmountable an obstacle that, at the present time, dry type transformers of considerable size and high voltage are rare, and, where they exist, are expensively over-insulated. There has not heretofore been known any method for fully encapsulating a large dry type transformer coil in a uniform insulating coating of sufficient thickness to withstand a high voltage.

It is, therefore, an important object of the present invention to provide a method for fully encapsulating large transformer coils in a thick plastic coating having uniform dielectric characteristics over its entire area.

It is an associated object of the invention to provide such a method in which a heavy coil may be supported at several points, and over a substantial area, to prevent its being deformed under its own weight, while the coating is applied; and, to provide also that the areas of support may be subsequently coated without any substantial dielectric discontinuity at the boundary zone between the areas first coated and the support areas subsequently coated.

It is another important object of the invention to provide a method for applying an insulating coating in two successive steps to first and second areas of the coil, and producing a joinder or seam at the boundary between the two coated areas which joins the two coatings without any appreciable or significant discontinuity in dielectric characteristics.

The foregoing and other objects of the invention are accomplished by using an insulating plastic coating comprised of two ingredients, which, upon mixture, produce a coating which cures itself or may be cured by heating. For example, two rubber mixtures may be employed, one vulcanizable mixture and one non-vulcanizable mixture containing an accelerator of vulcanization. A much preferred material for the practice of the present invention is silicone rubber. Silicone materials of unusually stable and good electrical insulating properties are obtainable in two component systems, provided in separate containers. Alone, neither component will set up to a resilient mass. When the two components are mixed, combination of the catalysts promotes vulcanization of the mixture. The mixture may be vulcanized without additional heat or pressure, by curing at room temperature for several hours. However, if desired, more rapid vulcanization may be accomplished by heating the material. It is advantageous for the successful practice of the present invention that the two materials be distinguishable from each other in color, or in some similar manner, so that a first mixture may be duplicated in a second mixture by matching color.

An example of a two component silicone elastomer of excellent dielectric properties is RTV Silastic, a product of Dow Corning, said material being eminently suitable for use in the instant process. This material is prepared by mixing fluid dimethyl or methylphenylsiloxanes with from .5 to 25% by weight of an aliphatic silicate such as ethyl orthosilicate, ethyl polysilicate, allyl orthosilicate or propyl orthosilicate and as a curing catalyst metal salts of carboxylic acids such as lead octoate, dibutyltindiacetate, cobalt naphthenate, tin octoate, and the like as described in detail in British Patent No. 764,246 published on December 19, 1956. With reference to Example 5 of this patent, the siloxanes and quartz can be mixed, the mixture divided into two parts, and the silicate mixed to one part and the catalyst mixed with the other part. The two mixtures will thus be approximately of equal volume with each being non-curing separately, but on intermixing of the two mixtures a cure will set it. Such material is available in various con-

sistencies from liquid to thick putty-like dough. For the present application, it is desirable to utilize the two components with an identifying coloring, for instance one white component and one red component, so that the character of the mixture can be closely estimated by its color. Preferably, the two components are mixed to a dough-like consistency, usually in equal parts of each component, and applied to a high voltage coil in a thick uniform layer.

The invention and its advantages may best be understood from the following description of a preferred specific embodiment, read in connection with the accompanying drawings, in which

Figure 1 is a sectional view in a plane normal to the surface of a coil and a support member, after a first area has been coated with insulating plastic;

Figures 2 to 4 are sectional views like Figure 1, and showing successive steps in the process of applying the insulating coating to a second area and producing a continuous seam between said first and second coated areas;

Figure 5 is another sectional view like Figures 1 to 4 showing the final product of a surface coated by continuous uniform layer of insulating plastic; and

Figures 6 and 7 show another species of the invention. In Figure 1, a coil indicated generally by the numeral 10 has a surface 11 to be coated by a uniform insulating layer free of dielectric discontinuities. It is assumed that the coil is too large to be supported from its connecting leads and dipped into a vat of liquid plastic insulating material. Instead, a heavy layer of insulating plastic, 12, has been applied over most of the coil surface referred to hereinafter as the first area 15. The plastic coating, 12 is comprised of a two component system, which components are indicated by the light and heavy cross-hatching, 13 and 14.

A second area of the coil 10, indicated by the numeral 16, cannot be coated at the first coating step because it is covered by a support member, 17, which may, for example, be a pedestal or a part of a jig support.

Between the areas, 15 and 16, there is a boundary zone 18 which is left uncoated by the first coating 12 but is also not covered by the support member 17. This peripheral area or boundary zone between the first and second areas, 15 and 16 respectively, may be of a width a little greater than the thickness of the coating 12.

The next step, illustrated in Figure 2, is the coating of the boundary zone 18 with a part layer of only one of the plastic components, 13. It is much preferred that the first boundary coating 19 be applied before the first coating 12 has cured, and, consequently, before the support member 17 has been removed. It is also a much preferred species of the invention to apply the coating 19 in a layer which gradually diminishes in thickness from the first coating 12 to the edge of the uncoated second area, 16. This leaves no exposed and cured edge at the junction 20 between the first coating 12 and the first boundary coating 19.

After the coating 12 has completely cured, and there has been sufficient intermigration of components at the junction 20 to thoroughly integrate the first area coating 12 with the edge of the boundary coating 19, the support member 17 is removed, since the coil 10 may now be supported at some other part, which has already been coated by the first coating 12.

As seen in Figure 3, the next step is to apply a mixture of components 13 and 14 to the second area 16 to form a second coating 21 over the area formerly covered by the support member 17. The coating 21 should be carefully mixed to match the coating 12, which may be checked by color matching; or may be taken from the same mix as was used for coating 12, and should be spread to the same thickness as coating 12.

Next, and preferably before the second coating 21 has completed curing, a second boundary layer 22 con-

sisting of the second plastic component, 14, is applied at the boundary area, 18 and overlapping the first boundary coating, 19. It is most convenient to apply the second coating 22 so that it comes up to the surface level of the first and second coatings 12 and 21 as illustrated in Figure 4. There is thus an automatic measuring of about 50% for each of the two components, 13 and 14, at the boundary layer.

If the layers 19 and 22 were now left to stand, there would be some intermigration of the components 13 and 14 both at the junction 23 between the second area 21 and the second boundary layer coating 22, and at the junction 24 between the two boundary layers 19 and 22. Unfortunately, curing in such a manner produces serious insulating defects at the seam between the first and second coatings, 12 and 21. It is, therefore, an important feature of the invention to manually or mechanically intermix the two layers 19 and 22 at their point of application on the boundary surface 18. A simple method of doing this is simply to use a putty knife and carefully knead the two layers 19 and 22 together until a uniformity of color indicates that the boundary zone 18 is covered by an insulating layer of the same composition as the first and second layers 12 and 21.

The second boundary coating 21 and the boundary zone layers 19 and 22 may then be allowed to cure, producing a uniform, thick, insulating coating as illustrated in Figure 5.

In another form of the invention, the coating is applied in a mixture 30 gradually diminishing in one component 13 as in Figure 6, so that curing diminishes to the boundary 31. When the second coat is applied, it is applied in a second mixture 32 which gradually diminishes in component 14 to the boundary 31, as in Figure 7. These two are then mechanically intermixed at boundary 31 to produce a uniform coating as in Figure 5.

The method of applying an insulating coating, described above, has been found suitable for entirely incapsulating a heavy coil in an insulating layer thicker than one-eighth of an inch. Moreover, when the steps of the method are carefully followed, the insulating strength of the coating at the seam over the boundary area 18, is not appreciably different from that of the first and second coatings 12 and 21. Also, tests indicate that there is no sudden change in dielectric characteristics at the junctions 20 and 23. Instead, the coil insulation exhibits a substantially uniform resistance to voltage breakdown, and does not betray any local concentration of stress in the dielectric.

It will be obvious that the method of coating described may be used for coating electrical equipment and the like other than coils in a transformer. Also, it is evident from the foregoing description that those skilled in the art of electrical insulation and of applying insulating plastic coatings will be able to make various changes and modifications in the method without departing from the spirit and scope of the invention as defined by the following claims.

I claim:

1. A method for applying a coating of uniform dielectric strength to a piece of electrical equipment, which method includes: supporting said equipment to expose a first area while a second area is covered by said support; mixing a self-curing mixture of two different colored plastic components, each of said components being non-curing separately and self-curing when combined, and applying a uniform coating of said mixture to said first surface area, except for a border zone between said first and said second surface areas; applying a coating of one of said components to said border zone before said first area coating has cured, said zone coating diminishing in thickness from said first area coating to the edge of said second area; supporting said equipment on said first area and uniformly coating said second area with

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the same mixture used to coat said first area; applying a coating of the second of said components to said boundary zone, said coating diminishing in thickness from said second area coating to the edge of said first area coating, and forming with said first boundary zone coating a layer of substantially the same thickness as said first and second area coatings; kneading said two boundary zone coatings to produce a boundary zone coating of the same thickness and color as said first and second area coatings; and curing any uncured parts of said coating.

2. A method for applying a coating of uniform dielectric strength to a piece of electrical equipment, which method includes: supporting said equipment to expose a first area while a second area is covered by said support; mixing a self-curing mixture of two different plastic components, each of said components being non-curing separately and self-curing when combined, and applying a uniform coating of said mixture to said first surface area, except for a border zone between said first and said second surface areas, said zone having a width greater than the thickness of said coating; applying a coating of one of said components to said border zone before said first area coating has cured, said zone coating diminishing in thickness from said first area coating to the edge of said second area; curing said first area coating; supporting said equipment on said first area and uniformly coating said second area with the same mixture used to coat said first area; applying a coating of the second of said components to said boundary zone, said coating overlaying said first boundary zone to form a layer of substantially the same thickness as said first and second area coatings; and kneading said two boundary zone coatings to produce a boundary zone coating of the same thickness and composition as said first and second area coatings.

3. A method for applying a coating of uniform dielectric strength to a piece of electrical equipment, which method includes: supporting said equipment to expose a first area while a second area is covered by said support; mixing a self-curing mixture of first and second plastic components, each of said components being non-curing separately and self-curing when combined, and applying a uniform coating of said mixture to said first surface area, except for a border zone between said first and said second surface areas; applying a coating diminishing in the first of said components from said first area coating to the edge of said second area; curing said first area coating and partially curing said boundary zone coating; supporting said equipment on said first area and uniformly coating said second area with the same mixture used to coat said first area but diminishing in the second of said components at the edge of said boundary zone coating, and forming with said first boundary zone coating a coating of substantially the same thickness as said first and second area coatings; kneading said boundary zone coating to produce a coating of the same thick-

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ness and color as said first and second area coatings, and curing uncured parts of said coatings.

4. A method for encapsulating an electrical unit with a coating of uniform dielectric strength, comprising the steps of supporting said unit at a support area to thereby cover the same and to expose another area, applying a uniform coating of a two component self-curing mixture to said another area except at a border zone defined between said support and another area, each of said components being non-curing separately and self-curing when combined, applying a coating comprising one of said components to said border zone before said another area coating has cured, supporting said unit at said another area and uniformly coating said initial support area with said mixture, applying a coating comprising the other of said components to said border zone and forming with said one component at said border zone a coating of substantially the same thickness as said uniform coatings, kneading said border zone coating to produce a coating thereof of the same thickness and composition as said uniform coatings at said support and another area, and curing uncured parts of said coatings.

5. A method for encapsulating an electrical unit with a coating of uniform dielectric strength, comprising the steps of supporting said unit at a support area to thereby cover the same and to expose another area, applying a uniform coating of a two component self-curing mixture to said another area except at a border zone defined between said support and another area, each of said components being non-curing separately and self-curing when combined, applying a coating of one of said components to said border zone before said another area coating has cured with said one component coating diminishing in thickness from said another area coating to the edge of said support area, supporting said unit at said another area and uniformly coating said initial support area with said mixture, applying a coating of the other of said components to said border zone in superposed relation with said one component coating to form therewith a layer of substantially the same thickness as said uniform coatings, and kneading said border zone layer to produce a coating thereof of the same thickness and composition as said support and another area coatings.

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