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VARNISHING ARMATURES AND THE LIKE

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This invention relates to the treatment of electrical elements to provide them with insulating varnish.

The invention is applicable particularly to the varnishing of electrical windings such as rotors or armatures, to effect both coating and impregnation of the winding with varnish, for which reason it may be described with particular reference thereto.

A customary practice in the varnishing of armatures has been to dip them in varnish for a comparatively long period of time to permit the varnish to penetrate as completely as possible into the interstices of the armature elements by gravity of capillary action. Sometimes this is done by placing the armatures in a tank, evacuating the tank, running the varnish into the evacuated tank, and then applying pressure to the varnish bath. The armatures are then suspended vertically to drain off excess varnish. Thereafter they are baked to evaporate the varnish solvent and to oxidize the varnish film, or in the case of heat-convertible resin varnishes to cure the resin film.

Such practices have not been wholly satisfactory, partly because the distribution of varnish is imperfect, due, for example, to insufficient penetration in some areas, to imperfect distribution, as by excessive draining of varnish from some areas and accumulation of excess in others during the steps of drainage and the early stages of baking, or for other reasons. Particular difficulty has arisen from the tendency for the solvent to evaporate promptly at the surface of the armature so that a more or less hardened, or cured, surface layer of varnish is formed that retards escape of solvent from the varnish in the interior of the armature, and in consequence of this voids may appear in the winding that impair the electrical properties and may even cause the armature to be rejected. As a result it has been necessary to bake the armatures for long periods of time, even as much as 48 hours. Relatively long drainage, say one-half hour, is necessary also, and large amounts of unrecoverable varnish are lost by drainage. In addition to such time-consuming operations and the possibility of imperfect results, this practice has been objectionable also because parts such as shafts, screw threads and the like that do not require varnish are covered also, and the varnish film must be removed from them before the armatures can be placed in use, which necessitates hand operation with attendant delay and increased cost. All of these factors combine to

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render the existing practice wasteful of time and varnish, unduly expensive, and generally unsatisfactory.

The varnishing, or impregnation of other elements of electromagnetic machines, such as stators, various types of coils, and the like, is attended by similar and related disadvantages.

Attempts have been made to varnish armatures by rotating them in a bath of varnish in such manner that only the body of the armature is immersed, and then effecting draining while rotating the armature. In some instances the armature has been preliminarily heated, but to a relatively low temperature, say not over about 200° F., because of the danger of curing the thermo-setting synthetic resins which are used in some of these varnishes, and also to avoid premature evaporation of the solvent. Penetration of varnish throughout the windings has generally been found to be very poor, and attempts to bake such dipped armatures, whether with or without rotation, have been unsuccessful and impracticable for the reason that in this instance also, the varnish dries at the surface and traps the solvent interiorly.

It is among the objects of this invention to provide a method of varnishing, or impregnating with varnish, electrical windings, such as armatures, and other elements of electromagnetic machines, which is simple, easily practiced, economical, and more efficient than prior practice, which effects substantially complete retention of varnish, and which in comparison with prior practice eliminates varnish losses, greatly shortens the baking time, and produces superior results with greater certainty and regularity.

A further object is to provide a method in accordance with the foregoing object which is applicable particularly to effecting with greater certainty and regularity more uniform and complete impregnation of electrical windings than has been attained by the practices prior to my invention.

Other objects will appear from the following description.

I have discovered, and it is upon that that the present invention is predicated, that electrical windings, such as armatures, may be varnished more rapidly, more satisfactorily and more economically than according to the above-described prior practices by heating them to a temperature such that when coated with electrical varnish the solvent will be caused to evaporate promptly from the film or coating of varnish, then immersing them in varnish, and then baking while

retaining the varnish coating in substantial entirety. Generally speaking, the armature, or other winding, is heated to a temperature at least approximately that of the boiling point of the solvent used in the varnish, and it may be heated high enough to initiate curing of heat-convertible varnishes. The thus heated article is then coated with varnish, as by dipping it in a bath of varnish from which it is preferably withdrawn before it has cooled to any substantial extent, i. e., while it is still in a highly heated condition, and it is then baked. In this way the winding is coated and impregnated with varnish substantially free from solvent which is baked in place with no substantial loss of varnish.

More in detail, both the solvents and the resins used in making electrical varnishes vary widely. Hence, the temperature to which the winding or other article is heated initially will depend upon the particular varnish that is used, and particularly upon the solvent which it contains, as well as upon the mass of the article. Accordingly, specific temperatures or ranges of temperature applicable to all types of these elements and to all varnishes can not be stated. Due regard will be given, of course, to the varnish-forming constituents to avoid premature reaction or hardening. This factor of the invention is illustrated, however, by the case of impregnating armatures with a varnish containing a heat-convertible phenol-formaldehyde type condensation product and petroleum naphtha as a solvent, in which case it suffices to heat the armatures to about 275° to 300° F.

The heating is preferably effected by infra-red radiation although it can be accomplished in various other ways known to the art, e. g., by currents induced in the article and of a frequency adapted to produce the desired heating to the necessary depth.

In most instances it is preferred to move the heated article through a bath of the varnish while rotating the article slowly therein because in this way uniform application of the varnish and rapidity of solvent removal are attained easily. Upon contact of the heated winding with the varnish bath the solvent begins to evaporate, or boil off, under the influence of the heat of the winding, promptly from the coating of varnish which adheres to it as it emerges from the bath. The net final result is to coat and impregnate the element with varnish that is substantially solvent-free. An important feature resides in rotating the armature or other winding so slowly in the varnish bath that the adherent varnish is not ejected therefrom. By slow enough rotation a single rotation of the armature through the varnish bath suffices in some cases to apply enough varnish for the intended purpose. Also, as indicated above, the winding should be removed from the bath while it is still highly heated, e. g., while still at a temperature above the boiling point of the solvent. The bath level is so adjusted that only the portion which is to be varnished moves through it, which avoids getting varnish on the shaft and other parts of armatures or other elements that do not require varnish.

The armature or the like is then removed from the bath (or the bath is lowered from the armature) and it is subjected to a baking temperature, preferably while continuing to rotate it slowly enough to avoid centrifugal ejection of any of the varnish. The heating is performed in any suitable way, for instance by infra-red radiation.

A very short pre-baking rotation may be applied, if desired.

The coating of solvent-free varnish soaks readily and uniformly into the windings of coils of armatures, stators and the like. Because there is little or no solvent to be evaporated from it, the difficulties encountered in baking in prior practice are completely avoided inasmuch as in the practice of the present process there is no formation of hardened skin at the surface and in any event the varnish which soaks in is substantially solvent-free. Also, the hardening of the varnish occurs throughout the winding, due to its retained heat, instead of from the surface inwardly as is the case in prior commercial practice. The result is that baking is accomplished in a fraction of the time needed when these elements are treated in accordance with the prior practices briefly reviewed above.

By actual experience I have found also that in addition to the foregoing major advantages elements treated in accordance with the present method exhibit better varnish distribution than when they are dipped according to prior practice, and a higher proportion of the varnish applied to the armature is retained by and penetrates into it. Generally speaking, there is no appreciable drainage in the practice of this invention, the coating being retained in its substantial entirety, and the prolonged drainage time necessary heretofore is eliminated. In fact, extended experience has shown that by rotating armatures during the coating and baking steps the drainage never amounts to more than a drop or two from an occasional armature. These results mean, of course, greater economy through the reduction of the time cycle and the fact that all of the varnish is used effectively instead of a substantial proportion being lost by drainage. Experience has shown also that there is no appreciable loss of varnish where the windings are dipped without rotation, into the bath but otherwise treated according to my invention.

If desired for any reason, the foregoing sequence of steps can be repeated, as by passing the baked armature while still hot directly to the same or another varnish bath, rotating it therein, and again baking while rotating it.

As an example, reference may be made to the varnishing of armatures for an aircraft fuel pump motor. These armatures had an over-all length of 5½ inches. They were treated with a thermosetting phenol-formaldehyde type varnish containing petroleum naphtha as the solvent. The armatures were heated to a temperature of about 300° F. during 15 minutes, rotated once at a speed of 1 R. P. M. in the varnish, rotated slowly for 2 minutes after removal from the varnish, and baked 6 minutes while rotating slowly. Upon removal from the baking oven the first two steps were repeated and the armature was then baked, while rotating it, during 12 minutes. The total time required was 45 minutes, which is to be compared with cycles of from 6 to 12 hours that have been required for this operation by the dipping and draining practice used previously. Moreover, no cleaning of the baked armature was necessary whereas the necessity for cleaning shaft extensions and other parts of these armatures varnished by prior dipping practice has constituted a serious production bottleneck.

Varnish loss by drainage in the prior dipping practice has constituted a major expense item. From a total of 25 armatures treated in accord-

ance with the present invention only 4 drops of varnish drained away.

Armatures treated as just described successfully pass the speed and heat test to which these devices are put before acceptance. Armatures treated in accordance with the prior dipping practice do not consistently pass that test after baking for 6 hours.

In the practice of the invention it will usually be desirable to apply some means for preventing alteration of the varnish bath by heat absorbed from the heated armatures, either to prevent premature and undesired thermo-setting or to avoid development of excessive viscosity through loss of solvent. Various ways of doing this will be evident to those skilled in the art. For instance, the armatures may be rotated in a varnish bath of the least practicable volume with maintenance of its level through periodic or continuous addition of fresh varnish, or a large volume of varnish may be used with circulation for cooling it to prevent undue temperature rise.

Although the invention has been described with especial reference to the varnishing of armatures, it will be understood from what has been said that it is equally applicable to the varnishing of other electrical windings that require impregnation with electrical varnish. For example, it may be applied to the varnishing of stators, and for this purpose the invention provides advantages in addition to those delineated above. To this end, the projecting, or free, ends of the winding are folded inwardly into the armature-receiving bore of the stator which is then treated as described above, preferably heating and baking with infra-red radiation. In this way only the winding and associated parts are varnished and the free ends of the winding, or leads, are neither coated with varnish nor are their insulating coverings heated to the temperature of the metal. In prior practices the leads became coated with varnish and they were exposed to the heat of the baking oven which tended to impair their insulating covering, both of which results are disadvantageous.

Although the method may be applied in various ways, it is now preferred to move the articles continuously through a heating chamber, the varnish bath, and a baking oven while rotating them as described above. In the case of stators and other electrical elements not provided with shafts, that may be done by means of rotatable adapters, as will be understood.

Additional examples illustrative of the benefits to be derived from the invention and of other modes of practice under it are as follows:

Example 2.—This involved vacuum cleaner armatures of approximately 1 pound weight. The standard practice of the company making them has been to impregnate them with a heat reactive, straight phenolic resin base varnish according to the following cycle:

Preheat for two hours to remove moisture
Dip and drain
Bake four (4) hours at 140° F
Bake five (5) hours at 275° F
Dip and drain
Bake four (4) hours at 140° F
Bake five (5) hours at 275° F
Total treatment time, over 21 hours.

When treated in accordance with the present invention, using that varnish and applying two dips and two baking operations, with rotation during all steps of the procedure, results equal, if

not superior, to the standard practice are accomplished in a total time of 59 minutes.

Example 3.—The standard practice with certain armatures weighing 15 pounds was to dip and bake twice, using a heat reactive, modified phenolic varnish, which required 24 hours with the disadvantages described above.

When treated in accordance with the present invention, using the same varnish and applying two dips and two bakes, with rotation throughout, the process is completed in 63 minutes. The results are greatly superior to those obtained in standard practice because of better and more uniform penetration, and because the varnished armatures are in substantially the same balance as before treatment.

Example 4.—Armatures weighing 23 pounds required over 24 hours for two dips and two bakes with a heat reactive, modified phenolic varnish when treated according to standard practice. Superior results were accomplished in less than 90 minutes through the practice of the present invention, using the same varnish.

Example 5.—Armatures weighing 1950 pounds required over 30 hours for two dips and two bakes with a heat reactive, modified phenolic varnish. Through the application of the present invention, using the same varnish, a better job was accomplished in 4 hours, 37 minutes. Particularly, penetration was better than had previously been obtained by the use of vacuum.

Example 6.—Stators weighing approximately 12 pounds are presently varnished in one plant by dipping them at room temperature in a black oleoresinous varnish for 15 minutes, draining over the tank for 75 minutes, and then baking under infra-red lamps for 60 minutes, which involves a total treating time of 2 hours, 30 minutes. Even after such long draining, further drainage continues in the oven so that at the conclusion of the treatment the stator has picked up only 13 grams of varnish base, practically all of which collects on the lower end of the stator during baking. The upper end retains just enough varnish to stain the windings, which are still loose in the upper sections of the slots.

By rotating the stator during the complete treatment, in accordance with the preferred embodiment of this invention the total treating time was but 34 minutes; there is no drainage of varnish in the oven; and 30 grams of varnish base are retained with uniform penetration and distribution so that the stator has equal quantities of varnish throughout and the coils are bonded throughout in the slots.

By applying the present invention, using the same varnish but without rotation, the total treating time is under 40 minutes; there is no drainage in the oven; and 30 grams of the varnish base are retained by the stator. In this case there is a somewhat heavier collection of the varnish in the lower end of the stator but the upper ends retain a substantial deposit and the coils are bonded better in the slots than by the previously used method.

Example 7.—Stators weighing 15 pounds and treated by dipping in a heat reactive, modified phenolic varnish, draining and baking required 6 to 8 hours treatment, and a substantial amount of varnish base drained onto the oven floor during the baking, and there was a heavier deposit of varnish on the lower end than on the upper end. The coils were not bonded uniformly in the slots.

Those stators when treated with the same var-

nish in accordance with the present invention and with rotation throughout required less than 40 minutes for the complete treatment. The results were superior inasmuch as the penetration was uniform throughout the slots and on both ends of the stators.

Applying the present invention but without rotation required less than 45 minutes and although the varnish deposit was somewhat heavier in the lower end of the stator than in the upper end the results were superior to those obtained by the conventional method because no drainage occurred in the oven and sufficient varnish was retained throughout to bond the windings in the slots.

It will be understood that the term "boiling point" as used herein and in the claims contemplates a temperature such as to cause solvent to boil off or evaporate from the varnish film to the extent necessary for the purposes of the invention and irrespective of whether the solvent has a fixed boiling point or boils over a range of temperature.

This application is a continuation-in-part of my copending application Serial No. 516,241, filed December 30, 1943.

According to the provisions of the patent statutes, I have explained the principle and mode of operation of my invention and have described what I now consider to represent its best embodiment. However, I desire to have it understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

I claim:

1. That method of varnishing a wound stator for an electromagnetic machine which comprises folding the leads of the winding inwardly into the armature-receiving bore of the stator, heating the stator to a temperature high enough to evaporate solvent from electrical varnish applied thereto, rotating the stator about the axis of said bore in a bath of said varnish while immersed to a depth sufficient to cover the stator coils, removing the stator from said bath while the stator is still in a highly heated condition, and continuing to rotate it while heating it to bake the varnish with retention in substantial entirety of the varnish coating.

2. That method of impregnating an electrical winding for an electromagnetic machine to fill the interstices between the elements of the winding with varnish insulation comprising the steps of heating the winding to a temperature high enough to evaporate solvent from electrical varnish applied to it, contacting the heated winding with said varnish whereby, by the heat of the winding solvent is driven from the varnish as it contacts the winding and the winding receives substantially solvent-free varnish base in a heated condition in which it coats and penetrates the interstices of the winding, terminating contacting the winding with varnish while the winding is still highly heated and promptly heating the winding with its retained substantially solvent-free varnish base to drive off any residual solvent and bake the varnish base with retention in substantial entirety of the varnish base received by the winding.

3. A method according to claim 2, said winding being rotated during said heating to bake the varnish base.

4. That method of impregnating an electrical winding for an electromagnetic machine to fill

the interstices between the elements of the winding with varnish insulation comprising the steps of heating the winding to a temperature high enough to evaporate solvent from electrical varnish applied to it, rotating the heated winding in contact with said varnish whereby, by the heat of the winding solvent is driven from the varnish as it contacts the winding and the winding receives substantially solvent-free varnish base in a heated condition in which it coats and penetrates the interstices of the winding, terminating contacting the winding with varnish while the winding is still highly heated and promptly heating and rotating the winding with its retained substantially solvent-free varnish base to drive off any residual solvent and bake the varnish base with retention in substantial entirety of the varnish base received by the winding.

5. That method of impregnating an electrical winding for an electromagnetic machine to fill the interstices between the elements of the winding with varnish insulation comprising the steps of heating and rotating the winding to a temperature high enough to evaporate solvent from electrical varnish applied to it, rotating the heated winding in a bath of said varnish whereby, by the heat of the winding solvent is driven from the varnish as it contacts the winding and the winding receives substantially solvent-free varnish base in a heated condition in which it coats and penetrates the interstices of the winding, removing the winding from said bath while the winding is still highly heated, and promptly heating and rotating the winding with its retained substantially solvent-free varnish base to drive off any residual solvent and bake the varnish base with retention in substantial entirety of the varnish base received by the winding.

6. A method according to claim 5, in which the baked article while heated is again contacted with varnish followed by heating again to bake the varnish base applied thereby.

7. That method of impregnating an electrical winding for an electromagnetic machine, to fill the interstices between the elements of the winding with varnish insulation comprising the steps of heating the winding to a temperature of about 275° to 300° F., then immersing the heated winding in a bath of electrical varnish to coat and impregnate the winding with varnish base substantially free from solvent, removing the winding from the varnish bath while the winding is at a temperature not below about 275° F., and promptly heating the thus impregnated winding to bake the varnish base with retention in substantial entirety of the varnish base applied to the winding.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
714,104	Ellis et al.	Nov. 18, 1902
1,314,889	Mogan	Sept. 2, 1919
2,061,388	Shou	Nov. 17, 1936
2,195,671	Ferngren	Apr. 2, 1940

FOREIGN PATENTS

Number	Country	Date
337,192	British	Oct. 30, 1930