

UNITED STATES PATENT OFFICE

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PROCESS OF DRYING VARNISH FILMS

No Drawing.

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My invention relates to an improved method of treating insulating material and more particularly to a method of hastening the drying of varnish films that are applied to fibrous-insulated coils.

An object of my invention is to provide a novel method of decreasing the time necessary for drying insulating-varnish films applied to fibrous-insulated conductors, coils and other accessories entering into the manufacture of electrical machinery.

Another object of my invention is to provide a method of decreasing the time necessary for drying the insulating-varnish films that are applied to fibrous-insulated coils embedded in the slots of alternating-current generators which consists essentially in wrapping the coils with a fibrous material, such as silk or cotton tape, and impregnating the fibrous material with ozonized air, so that, when an insulating-varnish film is subsequently applied, its rate of drying will be accelerated, and a completely dried film will be produced in a comparatively short period of time.

In the usual process of drying insulating varnishes applied to fibrous-insulated coils, such as are provided in alternating-current generators, it has been the practice to wrap the conductors or coils with fibrous insulation, such as cotton or silk tape, and to heat the fibrous insulated coil in air, either before or after it has been placed in the slots of electrical apparatus, at a temperature of about 105 to 110° C., and, after cooling to about 70° C., the coil, or the rotor or stator, with the coils embedded in the slots, is dipped into an insulating varnish which is subsequently baked to dry the varnish film.

The drying of such varnish films, which are usually composed of a resin, a vegetable drying oil and a volatile thinner, is a time-consuming process. Space and equipment are utilized for long periods of time, making quantity production low and, consequently, increasing the operating costs.

Various methods have been tried to shorten the drying time without impairing the efficiency of the varnish, such as partial oxidation of the oils before they are mixed with

the varnish, or the addition of metallic driers, such as metallic soaps of oil or resin acids.

Elevated temperatures hasten the evaporation of the thinner and accelerate the oxidation of the oil, but such temperatures have a tendency to cause deterioration of the oil and resin, so that a film produced in this manner is often of an inferior quality, and care must be exercised to keep the temperature below the boiling point of the thinner, as the use of such a baking heat causes a rapid evolution of the vapors of the thinner, resulting in a crazed and blistered film.

When the fibrous-insulated conductors or coils are embedded in the slots of the stator or rotor of an alternating-current generator and the assembled parts are subsequently immersed in an insulating varnish, the drying of the varnish film on the impregnated fibrous insulation is unusually slow, because the varnish is deep in the slots where it is not readily accessible to the oxidizing action of the air and it has, therefore, been found very difficult to secure a completely dried varnish film in a reasonable length of time.

I have made the discovery that, if the stator or rotor with the fibrous insulated coils embedded in their respective slots, is first preheated in an atmosphere of ozonized air instead of dry air until the coils have attained a temperature of about 105° C. and then slowly cooled to about 70° in air or, preferably, in an atmosphere of ozonized air, and the stator or rotor, or the fibrous insulated coils alone, are then impregnated with an insulating-varnish, the drying of the varnish will be materially expedited.

The following experiments will serve to illustrate and explain the essential features of my invention. A test block having a slot lined with cloth similar to those on the rotor of an alternating-current generator were provided. Test bars of cold-rolled steel, each spirally wound with two layers of cotton tape .75 inches wide and .007 inches thick and each layer being overlapped one-half of its distance, were placed above each other in the slot. The insulated conductor was then inserted in the slot, and a fibre wedge was placed over the top bar.

Six blocks, prepared in this manner, were placed in an electrically heated oven, and ozonized air, having a concentration of .25% ozone, was passed through the oven at the rate of 7 liters per minute until they had attained a temperature of 150° C. The blocks containing the insulated coils were then cooled slowly to 70° C. in the same atmosphere. They were then dipped in an insulating-oil varnish composed of an asphaltic gum, a vegetable drying oil and a volatile thinner, for thirty minutes. After draining for ten minutes, the blocks were placed in an electrically heated oven maintained at a temperature of 105 to 110° C. and the resistance of each coil was measured at various intervals.

Six additional slotted blocks, having coils embedded in the slots, were impregnated with the same varnish after being prepared in a similar manner, with the exception that they were pre-heated in dry air instead of ozonized air.

The following table indicates the average comparative resistances of the insulating material on the coils which were pre-heated in ozone and those pre-heated in dry air during the same period of time:

Average hot resistance in megohms—temperature 105°–110°

Time	Preheated in ozone	Preheated in dry air
10 hours.....	2.12	1.76
20 hours.....	13.20	3.18
30 hours.....	44.40	9.80
40 hours.....	117.0	16.50

It is well-known that the resistance of such insulating material varies inversely with its temperature. However, as the oxidation and the drying of the varnish proceeds, the resistance gradually increases and the resistance is, therefore, a true indication of the drying of the varnish. The remarkable increase in the resistance of the insulating material which had been pre-heated in ozonized air shows that the oxidation and drying of the varnish proceeds much more rapidly than when it is pre-heated in air.

While I do not wish to be limited to any particular theory that now prevails or may be later developed, I am of the opinion that the increase of resistance is caused by the fibrous insulation retaining a considerable quantity of the ozonized air in the fibers: The ozone may be combined, either physically or chemically, with the fibers, or there may be a partial chemical and a partial physical reaction, but the experiments that I have made clearly demonstrate that the ozone or ozonated fibers aid materially in the oxidation and drying of the varnish.

The following additional tests of the drying time of varnishes applied to fibrous insulated coils which have been preheated in dry air, as compared with those which have

been preheated in ozonized air, indicates that a saving in time of 40 to 50% to produce the same drying effect may be attained by pre-heating the fibrous material in ozonized air:

Average saving in drying time by the use of ozonized air, as indicated by hot resistance measurements

Resistance megohms	Preheated in dry air	Preheated in ozonized air	Time saved	% time saved
5.....	23 hours.....	12 hours.....	11 hours.....	47.8
10.....	29 hours.....	17 hours.....	12 hours.....	41.4
15.....	37 hours.....	21 hours.....	16 hours.....	43.2
20.....	43 hours.....	22 hours.....	21 hours.....	49.9
30.....	51 hours.....	25 hours.....	26 hours.....	50.9
40.....	55 hours.....	29 hours.....	26 hours.....	47.2
50.....	59 hours.....	31 hours.....	28 hours.....	47.5

It will be seen from the above table that an average saving of time of 46.7% may be obtained by preheating the fibrous-insulated conductors in ozonized air.

The insulation varnish used was composed of an asphaltum gum, linseed oil and benzine in the following proportions:

	Per cent
Asphaltum gum.....	30
Linseed oil.....	15
Benzine.....	55

100

It will be understood, however, that my process is not limited to the particular insulation varnish used, as it may be utilized with any insulation varnish containing a suitable gum, such as asphalt, rosin ester or copal; a suitable vegetable drying oil, such as linseed or China wood oil; and a suitable thinner, such as benzine or turpentine. In the experiments made, the insulating varnish used is known as a "short oil" varnish. Such varnishes contain a comparatively small percentage of oil. When a "long oil" varnish containing a comparatively large percentage of oil is used, the preheating in ozonized air will be still more effective in reducing the drying time of the varnish film.

The treatment with ozonized air not only enables the vegetable fibrous material to become combined or saturated with ozone, but it also has the effect of increasing the tensile strength of the fibrous material, as is set forth in my copending application, Serial No. 206,133, filed on July 15, 1927, and assigned to the Westinghouse Electric & Manufacturing Company.

It will also be understood that, if desired, the drying time of the varnish film may be further expedited by drying it in ozonized air after the varnish has been applied, as described in application, Serial No. 205,504, filed by Leroy U. Spence on August 27, 1927, which is also assigned to the Westinghouse Electric & Manufacturing Company.

My invention is also applicable in hastening the drying of varnish films applied to fibrous-insulated coils wound upon each

other to a considerable depth, such as those used in transformers. The drying of an insulating varnish applied to electrical apparatus of this type, under ordinary conditions, is very slow. It has been found, however, that, when the fibrous-insulated coils are preheated in ozonized air and an insulating varnish is subsequently applied and baked, the drying of the varnish film is much accelerated.

The temperature at which the fibrous insulated conductors or coils are preheated in ozonized air may vary from any temperature above room temperature and the temperature at which the fibrous insulation begins to decompose. I prefer to use a temperature between 100 and 110° C. At temperatures below 70° C., the ozone does not have much effect upon the fibrous insulation, and, at temperatures above 135° C. it has the tendency to decompose the insulation. The ozone concentration may vary between 0.1 and 2 per cent and the time of preheating required may vary between one-half and thirty-two hours, depending upon the ozone concentration and the temperature.

The term "elevated temperature", as used in the claims, means any temperature above room temperature and below the temperature at which the fibrous material begins to decompose.

Various other modifications of my invention may be made by those skilled in the art without departing from the spirit of my invention. I desire, therefore, that only such limitations shall be imposed upon my invention as are required by the prior art and the appended claims.

I claim as my invention:

1. In the method of treating fibrous insulation, the steps which comprise preheating the fibrous insulation in ozonized air and then impregnating the same with an insulating varnish.

2. In the method of treating fibrous-insulated conductors, the steps which comprise preheating the fibrous-insulated conductors in ozonized air and then impregnating the same with an insulating varnish.

3. The method of treating fibrous-insulated conductors which comprises preheating the fibrous-insulated conductor in ozonized air, applying a varnish film, and then drying the varnish film, the ozone, combined with the fibrous-insulation, serving to hasten the drying of the subsequently-applied varnish film.

4. The method of treating fibrous-insulated conductors which comprises preheating the fibrous-insulated conductor in ozonized air, applying an insulating-varnish film to the fibrous-insulated conductor, and then applying heat to dry the varnish film.

5. The method of treating fibrous-insulated conductors embedded in the slots of electrical apparatus which comprises preheating said

electrical apparatus, with the fibrous-insulated conductors embedded in their respective slots in ozonized air and then immersing the same in insulating varnish.

6. The method of treating fibrous-insulated conductors embedded in the slots of electrical apparatus which comprises preheating said electrical apparatus, with the fibrous-insulated conductors embedded in their respective slots, in ozonized air, immersing the same in an insulating varnish, and heating to dry the varnish film.

7. The method of treating fibrous-insulated conductors which comprises preheating the fibrous-insulated conductor in ozonized air, applying a varnish film to the same, and then drying the varnish film in ozonized air at an elevated temperature.

8. The method of treating fibrous-insulated conductors which comprises preheating the fibrous-insulated conductor in ozonized air at a temperature of 70 to 135° C., applying a varnish film to the same, and then drying the varnish film.

9. The method of treating fibrous-insulated conductors which comprises preheating the fibrous-insulated conductor in ozonized air having a concentration of from 0.1 to 2 percent ozone at a temperature of from 70 to 135° C., applying a varnish film to the same, and then drying the varnish film.

10. The method of treating fibrous-insulated conductors which comprises preheating the fibrous-insulated conductor in ozonized air having a concentration of 0.1 to 2 percent at a temperature of 70 to 135° C. for from one-half to 32 hours, applying a varnish film to the same, and then drying the varnish film.

11. The method of treating fibrous-insulated conductors which comprises preheating the insulated conductor in ozonized air to strengthen the fibrous material and to saturate it with ozone, and applying an insulating varnish containing a resin, a vegetable drying oil and a volatile thinner to the insulated conductor, the ozonized air and ozonated fibers acting to expedite the oxidation of the oil and the drying of the insulating-varnish film.

12. The method of treating fibrous-insulated conductors which comprises preheating the insulated conductor in ozonized air to strengthen the fibrous material and to saturate it with ozone, applying an insulating varnish containing asphalt, a vegetable drying oil and a volatile thinner, and then continuing the heating at an elevated temperature, the ozonized air and ozonated fibers acting to expedite the oxidation of the oil and the drying of the insulating varnish.

13. The method of treating fibrous-insulated conductors which comprises preheating the same in ozonized air having a concentration of about 0.25 percent ozone until they have attained a temperature of about 105°

C., cooling the same to about 70° C., impregnating the insulated conductors with an insulating varnish, and continuing the heating at an elevated temperature until the varnish is dry.

- 8 14. The method of treating fibrous-insulated conductors which comprises preheating the same in an atmosphere of ozonized air having a concentration of about 0.25 percent ozone until they have attained a temperature of about 105° C., cooling the same to about 70° C. in the same atmosphere, impregnating the insulated conductors with an insulating varnish and continuing the heating at an elevated temperature until the varnish is dry.

In testimony whereof, I have hereunto subscribed my name this 30th day of December, 1927.

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P. B. COCHRAN.