March 4, 1969 E. WENNERLUND ET AL 3,430,351

METHOD OF DRYING OBJECTS SUCH AS ELECTRICAL MACHINES AND ELECTRICAL INSULATING MATERIAL

Filed June 7, 1967 Sheet 1 of 3

Fig. 1

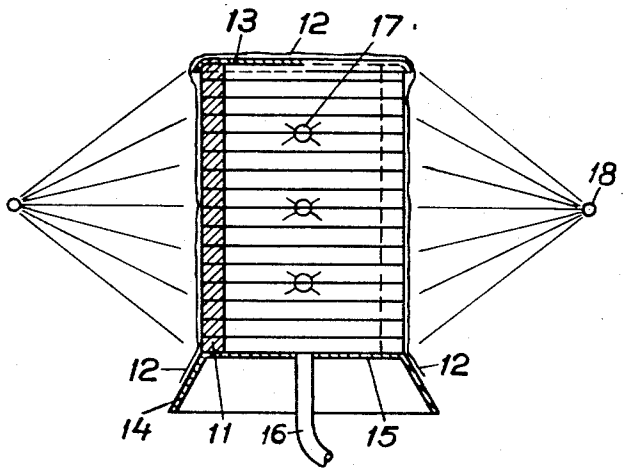

Fig. 2

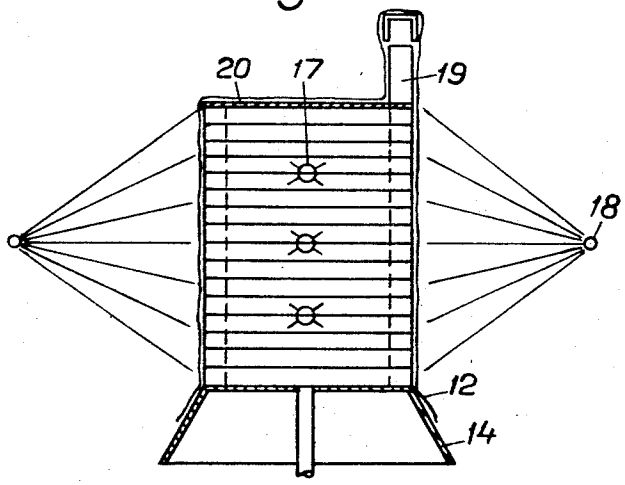

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Fig. 3

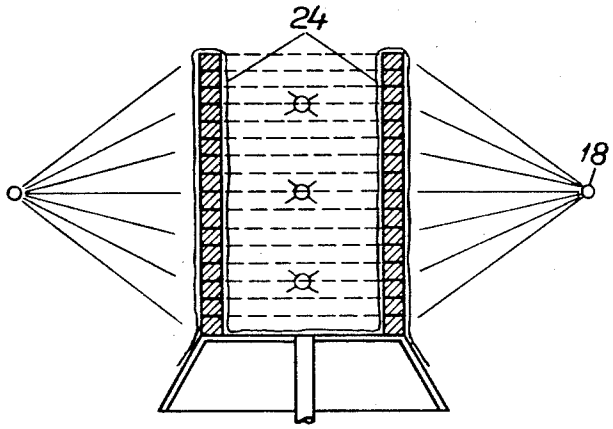

Fig. 4

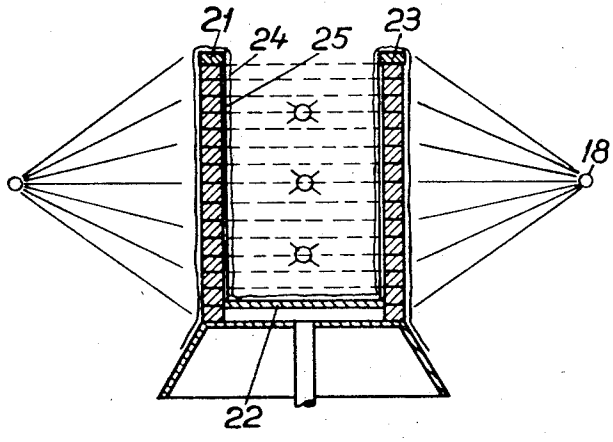

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Fig. 6

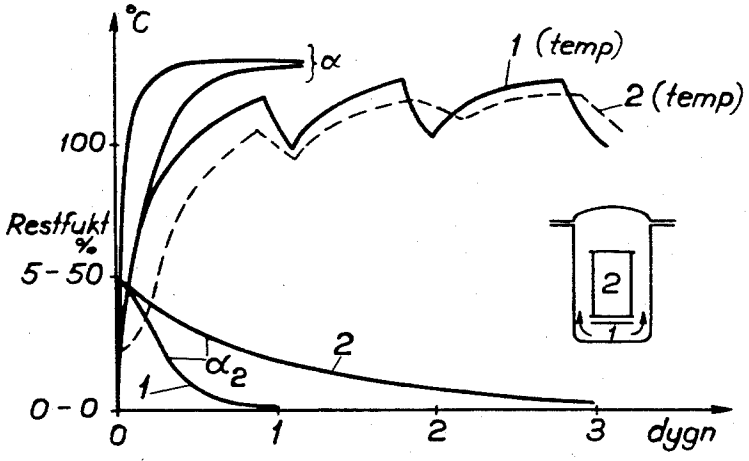
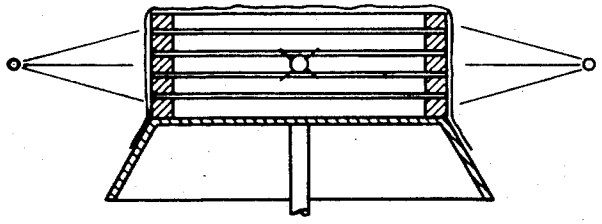


Fig. 5



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METHOD OF DRYING OBJECTS SUCH AS ELECTRICAL MACHINES AND ELECTRICAL INSULATING MATERIAL

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U.S. Cl. 34—5 6 Claims
Int. Cl. F26b 3/30

ABSTRACT OF THE DISCLOSURE

A method of drying objects, particularly electrical machines and electrical insulating material, where such objects are enclosed entirely or partially together with a wall, base or the like in a casing of flexible material in order to obtain a closed space in which the objects are dried under vacuum by means of external and/or internal heating.

BACKGROUND OF THE INVENTION

Field of the invention

The present invention relates to a method of drying objects, for example electrical machines and electrical insulating material.

The prior art

Electrical coils, for example for transformers, electrical insulating details of various types contain for example pressboard, Bakelite, paper, varnish impregnation, and the like with a moisture content often 5 percent by weight or more and this moisture content must be reduced, often to less than 0.5 percent by weight, in order to obtain satisfactory properties for the coil, such as low dissipation factor (tg δ).

Woodwork, machine parts, motors, generators, bricks and other similar objects have before drying a moisture content of 5–10 percent by weight or more and must be dried in order to obtain the required properties. This is also the case with other objects, such as foodstuffs, and the like.

With coils for transformers, for example, and other high voltage apparatus, the drying of the insulating material must take place in the form of vacuum drying at high temperatures in order to effectively remove the moisture from the insulating material. A process of this type used up to now is schematically shown in the accompanying FIGURE 6. A coil **2** is placed in a rigid chamber suitably containing a number of such coils. The coils are first heated for a while, after which they are vacuum treated and cannot therefore be heated. Thereafter heating is resumed, and so on. In the case shown the wavelike curves show temperature variations with this process. Complete drying (<0.5% moisture) takes in this case about 3 days. The unbroken curve is the temperature curve for part **2**, the dotted curve for part **1** in the coil shown in more detail in the figure.

In this conventional case the temperature reaches 100–120° C.

It is possible to alternate in the same furnace between heating and vacuum suction and this furnace normally has considerable volume so that a large number of coils can be placed in it for drying. It is obvious that such an arrangement impedes an otherwise continuous process and increases the time for the product to pass through and be completed in the factory, which results in economic losses.

The use of smaller furnaces of the type shown would mean that for different dimensions different types of furnaces would also have to be used.

SUMMARY OF THE INVENTION

The present invention provides a solution of these and other similar problems and in characterised in that the object is enclosed in a casing of flexible material, either completely, or with the casing closing against a wall, a base or the like, so that an enclosed space is formed to which leads at least one evacuating conduit in communication with an evacuating pump and that the space is evacuated while the object is heated from external and/or internal sources of heat and the humidity is dispersed from the object. By means of this method a simple and cheap way is obtained of heating during vacuum suction so that the drying time is reduced. At the same time the equipment is not confined to a certain dimension of the object. The equipment for carrying out this method is cheap and the production time can be kept down.

In a preferred embodiment of the invention the object is placed on a base provided with a cone or ring and at least one evacuating conduit opening inside and the object is covered with a cover of flexible material which seals against the cone or ring, after which evacuation or heating takes place. Such an arrangement allows very rapid drying and enables drying during transport on a conveyor belt at a pressure of less than 4, suitably less than 3 torr.

If transparent material, such as plastic, is used for the cover a radiation lamp such as infrared-rays can be used as heat source so that a temperature of 130–150° C. can be maintained at the same time as the moisture extracted is rapidy evacuated.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is more fully described in the accompanying drawings where FIGURE 1 shows the coil being dried with the use of a pressure plate, FIGURE 2 a coil with outwardly directed output connections and pressure plate, FIGURE 3 a coil without the use of pressure plate and FIGURE 4 with the use of a pressure plate. FIGURE 5 shows the drying of pressboard rings. FIGURE 6 (see also above) illustrates the drying time.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIGURE 1 shows a coil **11** for a transformer with a plastic bag or plastic cover **12** fitted over the coil **11** and a pressure lid **13** placed over this. The plastic bag, which has been sealed by the usual longitudinal or crosswelding or glueing, is closed by a cone or ring **14** attached to a base **15** into which one or more evacuating tubes **16** open. Inside and outside the coil are placed infrared lamps **17**, **18**, or other heat sources. Inside the coil these may be of any type, but outside their rays should be able to penetrate the transparent plastic cover **12**, and a temperature of 130–150° C. can rapidly be obtained during evacuation of the space bounded by the casing. The pressure can be reduced below 4 torr, suitably below 3 torr.

The plastic may be of several types, preferably somewhat temperature resistant. Polyamide or other transparent material may be mentioned as examples. The plastic itself is not heated by the penetrating rays, only indirectly through the object. Under suction the plastic cover is drawn towards the object, but although the latter has sharp edges the flexibility and elasticity of the plastic allows the load to be distributed over the material of the cover and it is thus not damaged.

When under vacuum, the cover **13** presses down the coil and effects the desired pressure on this.

Since it is possible to reach temperatures of 130–150° the water vapour disperses more easily and a moisture content below 0.5 percent by weight is easily achieved in the material to be dried.

High frequency heating can also be used with this process.

The drying time when the above-mentioned infra-rays **17**, **18** are used can be reduced to 15–17 hours (see α_1 and α_2 in FIGURE 6), where α_1 shows the temperature at two different points in the object and α_2 the remaining moisture in the insulating material at corresponding points **1** and **2**, respectively.

It is also possible to omit the inner source of heat **17** and use only the heaters **18** when a plastic cover **12** is used.

FIGURE 2 shows a coil with output connections **19** and pressure plate **20**. In this case also an internal heating source **17** and an external heating source **18** have been used, together with a cone **14** sealing against the plastic cover **12**.

FIGURE 3 shows the drying of a coil which is subjected to radial forces from both sides. Both external and internal heating are used. In this case pressure plates have not been used since the axial forces should be kept low.

In FIGURE 4 two pressure plates **21** and **22** have been used to effect axial pessure. The force is transmitted mechanically from the plate **22** to **21** through, for example, bolts **25** inside the plastic bag. According to FIGURES 3 and 4 transparent material must be used in the cover **24** and also radiation lamps.

FIGURE 5 shows the drying of end insulations of pressboard for transformers.

In the conventional arrangement according to FIGURE 6 the times will be 54 hours heating and 18 hours drying: in the present arrangement a total drying time of 15–17 hours.

In principle the object can be heated by convection, radiation, high frequency, or current heat and, since each coil unit or insulation unit can be heated and vacuum-treated individually, short heating and drying times are possible.

As is clear from the above drying may be carried out on the conveyor belt system during the manufacturing process.

As an example of a method according to the invention, the following may be mentioned:

Primary and secondary coils for a transformer, 10 mv. a., are heated by means of external infra-rays. The drying time will be 15 hours at an even temperature of +130° C. The insulating material is paper, pressboard and Bakelite. Vacuum 4 torr–3 torr. The vacuum can be initiated before the current to the heaters is turned on, thus providing further increased efficiency.

The low moisture content gives the dissipation factor tg δ a low value.

The invention can be varied in various ways within the scope of the following claims.

What is claimed is:

1. Method of drying an object comprising the steps of placing the objects upon a support provided with at least one evacuating conduit leading from it to at least one evacuation pump, covering said object with a layer of thin, flexible material, sealing said layer to the support at peripheral parts of the support, whereby said layer and support forms a sealed chamber except for the conduits, heating the objects and simultaneously evacuating the space in order to disperse humidity from the object.

2. In a method according to claim **1**, in which said support is provided with a downwardly directed flange around its periphery, the step of sealing comprising sealing said layer to the periphery of said flange, said evacuation conduits running from the central part of the support within the flange.

3. Method according to claim **1**, in which said cover is made of transparent material.

4. Method according to claim **1**, in which the heating is at least partly performed by external infrared-rays which heat the object through the casing wall while under vacuum.

5. Method of drying an object comprising the steps of placing the objects upon a support with a downwardly directed flange around its periphery, said support being provided with at least one evacuation conduit leading from it, placing at least one pressure plate upon said object and pressing the same against the support, covering said object and pressure plate with a layer of thin, transparent and flexible material, sealing said layer to the said flange where said layer and support form a sealed chamber except for the conduit, heating the objects by infra-red rays from the outside through the layer and simultaneously evacuating the space in order to disperse humidity from the object.

6. Method according to claim **1** in which the heating is carried out to 130–150° C.

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U.S. Cl. X.R.

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