Nov. 26, 1957 E. J. FLYNN 2,814,581

SELF-SUPPORTING ELECTROMAGNETIC COIL

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Fig. 1.

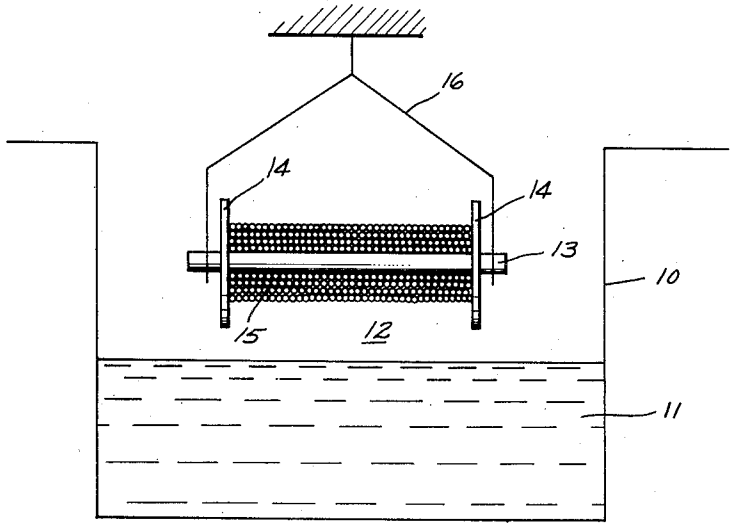
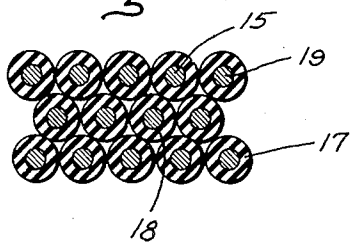


Fig. 2.



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SELF-SUPPORTING ELECTROMAGNETIC COIL

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7 Claims. (Cl. 154—80)

This invention relates to self-supporting electromagnetic coils. More particularly, the invention relates to a method for quickly producing electromagnetic coils of improved space utilization.

A self-supporting coil is one in which adjoining insulating surfaces are bonded together to produce a unitized rigid product. Such coils are presently produced by applying a coat of thermoplastic cement, such as polyvinyl butyral, over insulated wire, winding the wire into a coil, and heating the coil to obtain softening of the butyral resin. This produces a solid coil retaining the shape of the form on which it was wound. This method enables coils of various configurations to be obtained.

The present invention has as one of its objects the simplified preparation of a self-supporting coil structure.

Another object of the present invention is to provide a self-supporting coil structure in which the primary insulation itself furnishes the base for bonding together adjacent turns of the coil.

A still further object of the invention is to provide a method whereby a self-supporting coil structure may be fabricated without subjecting the coil to appreciable heat during the processing thereof.

The above and other objects will be understood from a perusal of the following specification and annexed drawing wherein Fig. 1 illustrates a coil being subjected to the action of a solvent vapor to bring about solvent welding of the insulation of abutting coils; and

Fig. 2 is an enlarged section of some of the abutting coils of Fig. 1 showing the surfaces welded together during the treatment illustrated in Fig. 1.

Briefly stated, in accordance with one of its aspects, the present invention provides a method of producing a self-supporting electromagnetic coil which comprises forming an electromagnetic coil of wire insulated with a resin, contacting the resin surfaces with a vapor having a softening effect on the resin until the adjoining surfaces of the resin are softened and merged with each other, and evaporating residual solvent from the resin.

In Fig. 1, a vat 10 contains a solvent fluid 11, such as trichloroethylene, or other volatile solvent as hereinafter described, which readily vaporizes to produce a vapor saturated atmosphere in the region between the surface of the liquid and the top of the vat. An electromagnetic coil 12 comprising a core member 13, end retainers 14, and a plurality of coils of conductor 15 insulated with a resin 17 of a type to be more particularly described hereinafter is maintained in the vapor region by a sling 16. Since the vapor of the liquid 11 exerts solvent action upon abutting coils of the electromagnet 12, the insulation of the conductors 15 becomes solvent welded where contact is made with abutting coils. As best shown in Fig. 2, the insulation of a single conductor 15 can have as many as six welded abutting coils provided the coil in question is completely surrounded by other coils. Thus, a center coil, designated 18, has six welded surfaces whereas an outside or inside coil, as designated at 19, can have as few as two abutting surfaces.

Wire used to form electromagnetic coils is preferably insulated with a resin which does not deteriorate when maintained for prolonged periods of time at temperatures above 100° C. Examples of resins which are satisfactory for this purpose are the product of reaction of a partially or completely hydrolyzed polymerized vinyl ester and aldehyde as disclosed in Patent No. 2,085,995, W. I. Patnode et al., which is assigned to the same assignee as the present application; polyester resins such as the reaction product of ethylene glycol and terephthalic acid and various derivatives thereof as disclosed in Precopio and Fox Application S. N. 474,624, filed December 10, 1954, and assigned to the same assignee as the present application; and the various polyurethane resins which have been the subject of so many publications in recent years.

In a conventional process for insulating magnet wire with the above resins, the reaction product of formaldehyde and hydrolyzed polyvinyl acetate is dissolved in a solvent such as dioxane, ethylene dichloride, chloroform, furfural, or the like, and a copper conductor is coated by passage therethrough after which the coating is baked by passage of the wire through an electrically heated oven. Normally, it is desirable to make a number of passes through the coating and bake cycles. The present invention is applicable to magnet wire thus prepared.

According to the invention, the insulated magnet wire is wound upon a coil form to provide a coil with the desirable magnetic characteristics. The coil—preferably while still on the form—is then brought into contact with the vapor of a solvent for the resin. This may be effected by immersing the coil in the vapor inside a tank to which some of the liquid solvent has been added. A preferred solvent for this purpose is trichloroethylene, but other general solvents such as toluene, dioxane, mixtures of toluene and alcohol, ethylene dichloride, and the like, may be used. The temperature at which the solvent is maintained must be adjusted to the boiling point of the solvent and its solvent characteristics. In the case of trichloroethylene, immersion of the coil in the vapor for 2 to 5 minutes while maintaining a solvent temperature of about 80° C. is sufficient to bring about the softening of the resin to the point where abutting surfaces merge with each other and are bonded together. For the other solvents mentioned above, the temperature is slightly higher and the time of treatment slightly longer than is the case with trichloroethylene, but the process is otherwise the same. Trichloroethylene is preferred because its use reduces fire hazard to a minimum.

After treatment with solvent vapor, the coil is subjected to a heat treatment to remove the residual solvent. In the case of trichloroethylene, treatment at 80° C. for 5 to 10 minutes is sufficient. For other solvents, the temperature and time of treatment are adjusted to accord with the physical characteristics of the particular solvent used.

A coil produced by the method described above will readily maintain its shape during subsequent rough handling. By utilizing the basic insulation layer itself as the bonding surface, the best possible space utilization is obtained and the speed of production is increased. Standard magnet wire is used without further treatment. Thus, this invention provides an improved coil at a lower cost.

While the invention has been described with reference to a particular vinyl acetal material, it is emphasized that the invention is just as applicable to polyester materials, polyurethane resins, and other heat-stable magnet wire insulations. Therefore, the invention is limited only as may be necessitated by the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. The method of producing a self-supporting electromagnetic coil which comprises coating a conductor with a layer of insulating material, forming said coated conductor into a coil, contacting said coil with the vapor of a solvent for said insulating material until the surface of said insulating material is softened, and evaporating the solvent from said insulating material to leave adjacent turns of said coil bonded together.

2. The method of producing a self-supporting electromagnetic coil which comprises applying a coating of vinyl acetal resin as insulation to a conductor, forming said insulating conductor into a coil, contacting said coil with the vapor of a solvent for said vinyl acetal resin until the surface of said resin is softened, and evaporating the solvent from said resin to leave adjacent turns of said coil bonded together.

3. The method of claim 2 wherein the solvent is trichloroethylene.

4. The method of producing a self-supporting electromagnetic coil which comprises coating a conductor with an insulating layer of polyester resin, forming the conductor thus insulated into an electromagnetic coil, contacting the resin surfaces with the vapor of a solvent for said polyester resin until the abutting surfaces are softened and merged with each other, and evaporating the solvent from said resin to leave adjacent turns of said coil bonded together.

5. The method of producing a self-supporting electromagnetic coil which comprises forming an electromagnetic coil of wire insulated with a resin, contacting the resin surfaces with a vapor having a softening effect on said resin until the adjoining surfaces of said resin are softened and merged with each other, and evaporating residual solvent from said resin.

6. The method of claim 5 wherein the resin is a vinyl acetal material.

7. The method of claim 5 wherein the resin is a polyester material formed in part from the reaction of ethylene glycol with terephthalic acid.

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