

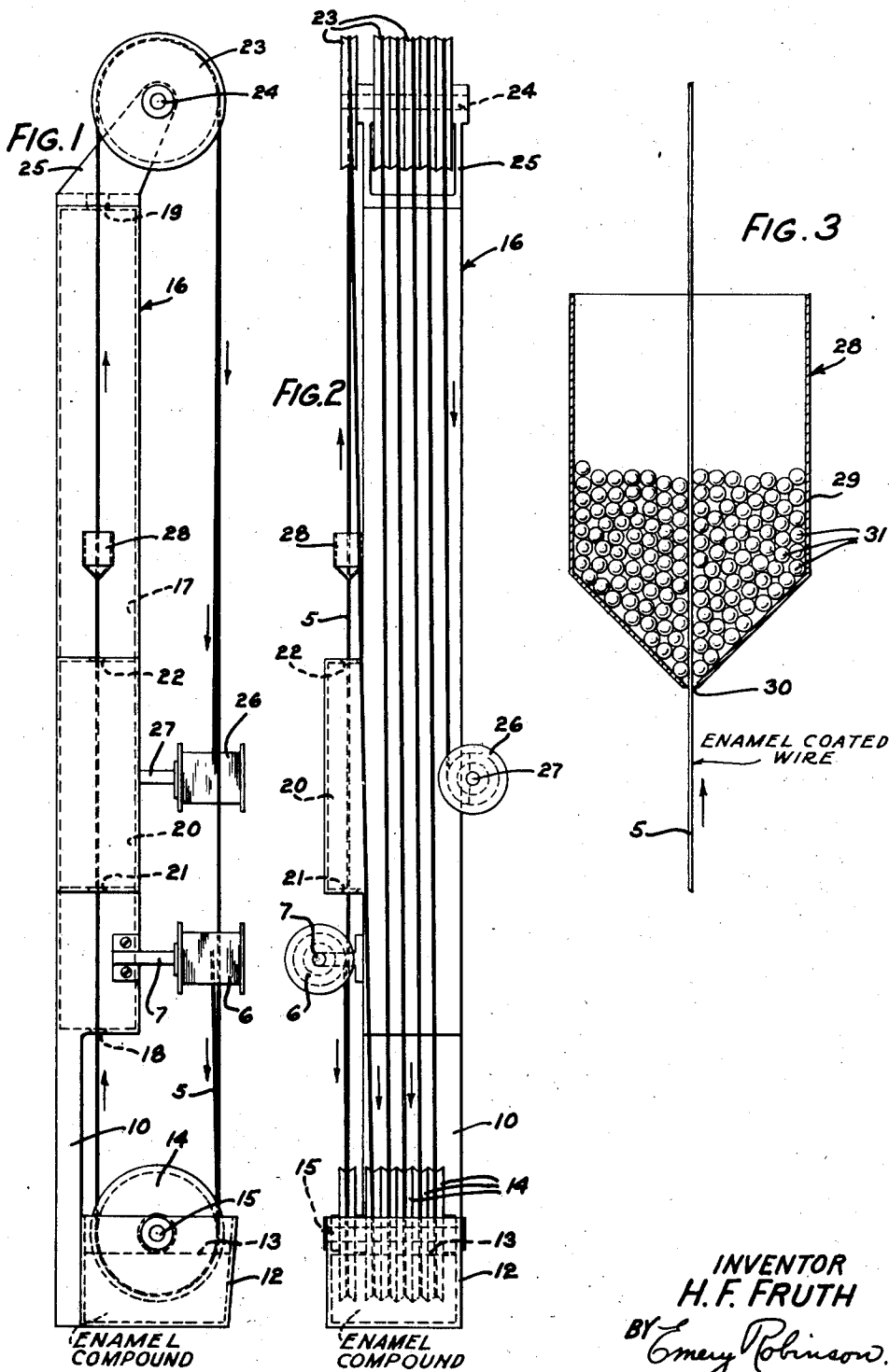
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MANUFACTURE OF ELECTRICAL CONDUCTORS

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MANUFACTURE OF ELECTRICAL CONDUCTORS

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This invention relates to the manufacture of electrical conductors and more particularly to methods for coating electrical conductors with enamel insulation.

It is customary to provide electrical conductors with insulation by passing the conductor through a bath of suitable coating material, such as enamel, one or more times and to dry or bake the conductor after the application of each coating. In many instances the resultant coating is imperfect or possesses weak areas due to the initial condition of the surfaces being coated instead of to improper methods of applying the insulation. For example, wire may contain ridges, slivers and other surface irregularities which extend from the wire surface into the coating and in some cases project through the coating. When this wire is incorporated in electrical apparatus, such as cable or coils, where the wire turns are positioned closely together, these defective portions of the insulation may reduce the efficiency and the service life of the apparatus.

An object of the present invention is the provision of improved, economical and efficient methods for applying a continuous and uniform coating of enamel insulation on electrical conductors.

In accordance with one embodiment of the invention, a coating of thermosetting insulating enamel is applied on a wire and the coated wire is then baked until the enamel becomes tough but not brittle. The wire with the tough enamel coating is then drawn through a mass of hard and substantially spherical particles, such as shot or sand, to impact and deform any ridges or other projections extending from the wire surface into or through the enamel, after which a second coating of enamel is applied on the wire and the wire is then baked to fully harden both of the coating layers.

The invention may be more clearly understood from the following detailed description taken in conjunction with the appended drawing, in which

Fig. 1 is a side elevation of a wire coating apparatus suitable for practicing one embodiment of the invention;

Fig. 2 is a front elevation of the wire coating apparatus shown in Fig. 1, and

Fig. 3 is an enlarged view of a portion of the apparatus shown in Figs. 1 and 2.

In the wire coating art the term "enamel" is used broadly to define a composition which is applied to the wire in liquid form and which is capable of producing a substantially continuous

electrically insulating coating on the wire. Three general types of enamel are used, including the lacquer, varnish, and combination types. The lacquer type is thermoplastic, usually having a cellulose nitrate or cellulose acetate base, and forms a solid film directly upon evaporation of the solvent. The varnish type enamels are thermosetting and are probably used most widely. They generally contain an oil, resin, drier, and solvent. The oil may be linseed or castor oil, and the resin may be natural, such as copal, kauri, etc., or it may be synthetic such as Bakelite, glyptal, cumarone, etc. The driers are usually soaps of such metals as lead, cobalt or manganese and any suitable solvent. The drier contributes little if anything to the finished product but is necessary to reduce the consistency or viscosity of the enamel to a usable state, may be used. On evaporation of the solvent, these varnish type enamels form liquid films which are solidified by baking. The third type, or the combination type enamels, such as shellac base materials, form a solid film on evaporation of the solvent but baking at an increased temperature is necessary to provide the final film characteristics.

This invention can be employed with any of the above enamel types but is especially adapted to the varnish enamels and the following detailed description is directed to that class of material.

The invention can be practiced conveniently with the wire coating apparatus shown in the appended drawing which is adapted for coating an electrical conductor 5 or wire that is withdrawn from a supply spool 6 rotatably supported on a shaft 7 mounted on the apparatus.

The apparatus comprises a frame 10 of cast iron, which is anchored to a floor or other base (not shown). Secured to the bottom portion of this frame and also supported on the floor is an open tank 12 which contains a supply of enamel 13 which has been thinned with a solvent. The tank also contains a plurality of enamel applicator pulleys 14 for conducting the wire through the enamel bath. These pulleys, which are all of the same size, are freely supported on a shaft 15 extending across the open top of the enamel supply tank and the lower portion of each pulley periphery is immersed in the liquid enamel.

Secured to the upper part of the frame, above the enamel tank, is a vertical oven 16 which is provided with a suitable heating means, such as gas or electricity (not shown). This oven is preferably of rectangular cross-section and con-

tains an elongated main baking chamber 17 with an opening 18 in its bottom wall and an opening 19 in its top wall through which the wire enters and leaves the chamber. Positioned along one side of the main baking chamber and offset therefrom is an elongated but relatively short auxiliary baking chamber 20. The auxiliary chamber is formed by extensions of the oven side walls and both chambers may be heated from the same source. The auxiliary chamber has a wire entry opening 21 in its bottom wall and a wire exit opening 22 in its top well. The auxiliary chamber is axially aligned with one end enamel applicator pulley (the left hand pulley in Fig. 2) and the main chamber is axially aligned with the rest of the applicator pulleys.

Mounted on top of the oven are a series of driven capstans 23 for moving the wire through the apparatus, one capstan being provided for and aligned with each enamel applicator pulley 14. The capstans are fixed to a shaft 24 which is journaled in a bracket 25 mounted on the oven and driven by any suitable means, such as an electric motor (not shown).

A take-up spool 26 for accumulating the coated wire is fixed to a rotatable shaft 27 supported on the oven wall and the shaft is driven by an electric motor or other means (not shown) in the usual manner.

Supported on the outside wall of the oven immediately above the wire exit opening 22 of the auxiliary baking chamber is an open-top receptacle 28 through which the wire passes after it leaves the auxiliary chamber. This receptacle (Fig. 3) may be formed of sheet metal with side walls 29 tapering inwardly and converging around a small opening 30 in the bottom of the receptacle for entry of the wire thereto. Supported in the receptacle is a mass of balls or loose particles 31 of metal, or other hard material, which partially fills the receptacle and engages the wire in its passage through the receptacle.

In the operation of the apparatus, the wire is withdrawn from the supply spool 6, under the action of the capstans 23, and first passes around one of the enamel applicator pulleys (left pulley in Fig. 2) in the tank 12 which immerses the wire in the liquid enamel. As previously explained, the wire as withdrawn from the supply spool may have ridges, slivers, or other projections on its surface and these irregular areas, depending upon their configuration, may accumulate very little or a substantial amount of the liquid enamel during passage of the wire through the bath.

The wire with the liquid enamel thereon then enters the opening 21 in the bottom end of the auxiliary baking chamber and passes through this chamber. Sufficient heat is applied to the wire in the auxiliary chamber to volatilize the solvent from the enamel and to advance the setting of the enamel to an "under-baked" stage wherein the enamel becomes tough and flexible but not yet brittle. This enamel condition depends primarily upon the quantity of heat applied to the wire and this factor is controlled by coordinating the temperature of the chamber with the chamber length and the wire speed or, in general, with the time period that the wire is in the oven. Removal of the solvent from the enamel and partial curing or setting of the enamel affects the coating on the slivers, etc. on the wire surface and when the wire leaves the auxiliary chamber, these surface projections may extend partially or completely through the coating.

The wire with the tough enamel coating there-

on then passes through the receptacle 28 in contact with the loose material in the receptacle. The moving wire engages the spheres or particles in the receptacle and also applies a stirring action thereto causing the spheres to impact the ridges, slivers, etc., which have a relatively thin or no enamel coating, in a suitable manner to flatten these projections down to the normal surface of the wire. The impacting and wiping motion of the particles on the plastic enamel also tends to wet the flattened areas with enamel. During this operation, the remaining portions of the wire surface are protected by their relatively thick and tough enamel coating and, because this coating is flexible and has not been fully matured, it does not tend to flake or chip off under the impact stresses.

The size of the spheres or particles employed in this operation can be varied somewhat, depending upon the size of the wire in process, the type of enamel used, and speed of the wire through the receptacle. Materials ranging in size from particles of sand to small steel shot have been used successfully and, in general, the particles should be of hard material, substantially spherical in shape and relatively small in size. Particularly good results have been obtained with spheres having a diameter about equal to the diameter of the wire under treatment.

After the wire leaves the receptacle, or burnisher, it travels over one of the driving capstans 23 at the top of the oven (left-hand capstan in Fig. 2) and then passes through the enamel bath a second time, in contact with one of the applicator pulleys 14, where it receives a second coating of enamel. The wire next travels upwardly through the main oven chamber 17, entering through the opening 18, wherein the wire and enamel are heated sufficiently to completely cure the second coating and to complete the curing of the first coating. The wire travels at the same speed through the auxiliary and the main baking chambers and the main chamber can either be heated to a substantially higher temperature or made longer than the auxiliary chamber in order to apply a greater quantity of heat to the wire in the main chamber. It is more convenient to heat both chambers to the same temperature, actually to have them joined together, and to make the main chamber longer than the auxiliary chamber. With certain commonly used varnish type enamels, good results are obtained when the two oven chambers are maintained at the same temperature and the main chamber is about three times as long as the auxiliary chamber.

The second coating of enamel covers any areas on the wire surface that are bare after the wire passes through the burnisher and the resultant coating is complete and adequate for some fields of service. However, additional insulation is required on some types of wire and any number of additional coatings of enamel are applied on the wire by conducting the wire successively through the enamel bath and through the main chamber of the baking oven the desired number of times.

The above described apparatus and methods are especially adapted to the use of varnish type enamels which are mixed with a solvent before they are applied on the wire, form a liquid film when the solvent is removed, and solidify when baked. When the invention is used with lacquer type, or thermoplastic enamels, it is desirable to add an excess of solvent before applying the enamel and to only partially remove the solvent in

the auxiliary baking chamber. With some of the combination enamels, the solvent can be removed completely in the auxiliary chamber and the resultant solid film is sufficiently flexible for the burnishing operation.

It will be apparent that other modifications and adaptations of the above specifically described procedures are feasible, and it is to be understood that the invention is restricted only by the scope of the appended claims.

What is claimed is:

1. A method of insulating wire comprising the steps of applying liquid enamel on the wire, heating the wire only sufficiently to form the enamel into a tough and flexible coating, subsequently drawing the wire through a mass of small and hard particles, then applying a second coating of enamel on the wire, and finally again heating the wire to form the enamel into a hard coating.

2. A method of insulating a wire conductor having an irregular surface comprising the steps of coating the wire with insulation, baking said coating only until said insulation forms into a tough film, subsequently drawing the wire through a mass of hard particles to engage and flatten the surface irregularities, applying a second coating of insulation on the wire, and finally rebaking the coated wire to form the enamel into a hard coating.

3. A method of insulating wire having projections extending from its surface comprising the steps of applying enamel on the wire, heating the enamel until the enamel becomes tough and discontinuing said heating before the enamel becomes hard, drawing the wire with the tough enamel coating thereon through a mass of small particles to engage and flatten the projections, applying a second coating of enamel on the wire, and finally rebaking the coated wire until all of the enamel thereon becomes hard.

4. A method of insulating wire having projections on its surface comprising the steps of applying a liquid coating of enamel on the wire, baking the coated wire only sufficiently to form the enamel into a flexible film, drawing the coated wire through a mass of spherical particles to flatten the projections and wet the flattened areas on the wire surface with flexible enamel, subsequently applying a second coating of enamel on the wire, and finally rebaking the coated wire until the enamel becomes hard.

5. A method of insulating wire having projections on its surface comprising the steps of applying a coating of enamel on the wire, heating the wire sufficiently to form the enamel into a tough coating but not sufficiently to make the enamel hard, drawing the wire with the tough enamel coating thereon through a mass of particles to flatten the projections on the wire surface, said particles being substantially spherical in shape and having a diameter on the order of the diameter of the wire, applying a second coating of enamel on the wire, and finally rebaking the coated wire to completely harden the enamel.

6. A method of insulating wire having projections on its surface comprising the steps of applying a coating of thermosetting enamel on the wire, heating the coated wire sufficiently to partially cure the enamel and form the enamel into a flexible film, drawing the coated wire through a mass of particles to flatten the projections on the wire surface and wet the flattened areas with partially cured enamel, said particles being substantially spherical in shape and having a diameter on the order of the diameter of the wire, applying a second coating of enamel on the wire, and finally rebaking the coated wire to fully cure the enamel and form the enamel into a hard coating.

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