July 14, 1942. C. A. BAILEY 2,289,862

APPARATUS FOR ENAMELING WIRE

Filed May 19, 1939

Fig. 1.

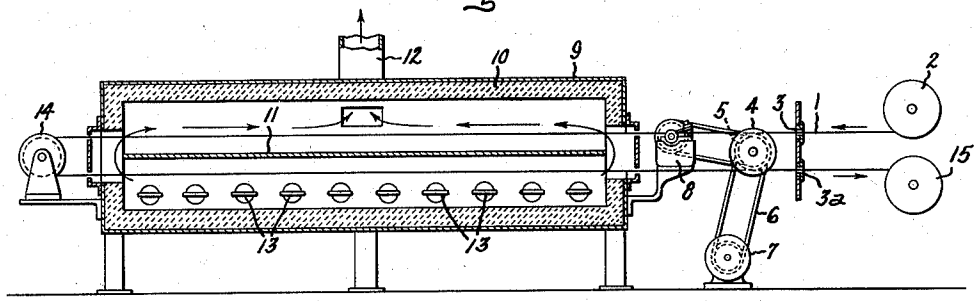


Fig. 2.

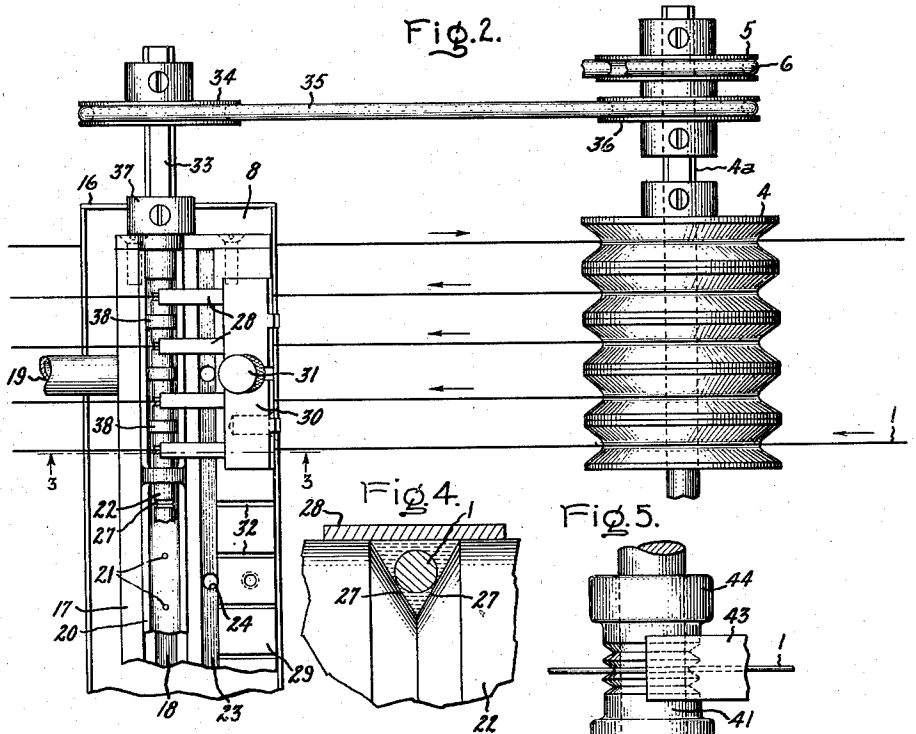


Fig. 4.

Fig. 5.

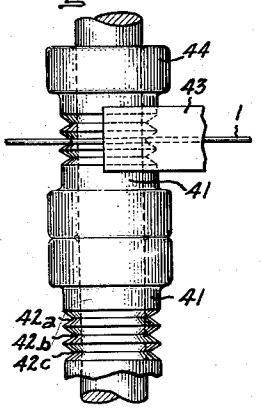
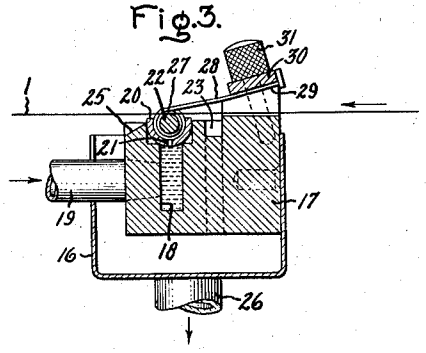


Fig. 3.



Inventor:
Carl A. Bailey,
by Harry C. Dunham
His Attorney.

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APPARATUS FOR ENAMELING WIRE

Carl A. Bailey, Scotia, N. Y., assignor to General Electric Company, a corporation of New York

Application May 19, 1939, Serial No. 274,554

8 Claims. (Cl. 91—51)

This invention relates to an apparatus for coating wire or other metallic conductors with a liquid coating composition such as an enamel, varnish, lacquer or the like. The invention is especially concerned with the application of viscous coating compositions to wire; such highly viscous compositions including the product resulting from condensing an aldehyde, such as formaldehyde, with a hydrolized polymerized vinyl ester, such as the hydrolysis product of polyvinyl acetate.

An object of my invention is to provide an improved apparatus for coating wire or other elongated metallic conductors with a uniform coating of enamel or the like whereby the thickness of the coating can be easily and definitely controlled.

Another object of my invention is to provide means for coating wire with viscous resinous compositions of such viscosity in concentrations practical for use in enameling wire, that they are not suitable for application by means of the usual type of wire-coating apparatus which heretofore has been available.

A further object of my invention is to provide an improved combination coating-applicator and die which will not clog due to the presence of lint or other foreign matter on the wire and which can be used advantageously in connection with a horizontal baking oven.

These objects are attained in accordance with the present invention by passing the wire to be coated through a substantially triangular aperture or die formed by the grooves of a slowly-rotating grooved roller and a spring finger pressing upon the roller surface and cooperating with the grooves to form said aperture.

In the accompanying drawing, Fig. 1 shows an apparatus partially in cross-section with which my improved coating-die may be used; Fig. 2 is a plan view of the coating means showing the improved die and its relationship to adjacent portions of the apparatus; Fig. 3 is a cross-sectional view of the mechanism shown in Fig. 2 taken along the line 3—3; Fig. 4 is an enlarged view of a single V-grooved roller and the cooperating spring finger showing the approximate position of the wire in the groove during the coating operation; Fig. 5 is a modification of my improved die structure.

Electrically insulated metallic wires wherein the insulation is of the "organic enamel" type have heretofore been manufactured by passing the wire continuously through a bath of coating enamel, varnish or the like, and then vertically upward through a heated oven wherein the solvent is evaporated and the coating material hardened. Although such practice proved satisfactory for coating wire with the ordinary oleo-resinous varnishes, it is not particularly suitable for the application of highly viscous materials. In certain instances these highly viscous enamels or varnishes have been diluted to the desired lower viscosity by the addition of appropriate solvents. This practice, however, results in lowering the base content of the enamel or varnish solution to such an extent that the resulting film is too thin to uniformly and completely cover the wire thus necessitating the application of numerous coats with a corresponding increase in cost of production when the wire travels through the bath at a reasonable rate. Furthermore, the use of these dilute solutions is attended by an increased loss of solvent during the baking step and a decrease in the quality and quantity of the final insulating coating.

My invention not only eliminates the difficulty heretofore encountered in using viscous coating materials in an undiluted condition for the coating of wire but also results in a uniformly coated wire wherein the coating is of substantially equal thickness around the entire circumference of the wire. It is particularly applicable to coating small wire where any slight irregularity, caused for instance by the presence of foreign matter, will not clog the die forming part of my invention.

With reference to the drawing and in particular Fig. 1, the numeral 1 indicates the wire or other metallic conductor which, as shown in the drawing, is drawn from a pay-off reel 2 through an eyelet 3 and over a sheave or group of sheaves 4. Sheaves 4, as shown in Fig. 2, are mounted on shaft 4a along with pulley 5 which in turn is connected through belt 6 and pulley 7 to a suitable source of power (not shown). The sheaves are capable of independent rotation on shaft 4a in such a manner as to take up any slack present in the wire without placing the wire under such tension as to cause breakage during operation of the device. The sheaves ordinarily rotate at a slower speed than shaft 4a. After leaving the sheave 4, the wire 1 passes through coating device 8 described more in detail hereinafter.

From the coating device 8 the wire enters oven 9 the walls of which are provided with heat insulation 10. The oven 9 is divided into upper and lower compartments by plate 11 of stainless steel or other suitable material and is of such length that the coating is thoroughly hardened

during the passage of the coated wire through the upper compartment and back through the lower compartment. An exhaust 12, provided in the upper compartment of oven 10, serves to remove the solvent and other vapors from the interior of the oven during the baking operation. Heat is provided by heating elements 13 mounted in the lower compartment of oven 10. The coated wire after leaving the coating device 8 passes through the upper and relatively cooler compartment of oven 9 to return sheave or group of sheaves 14 after which it passes back into the oven and through the lower compartment in closer relationship to the heating elements 13. This arrangement permits a gradual increase in the temperature to which the coating material is subjected with a corresponding decrease in the formation of bubbles or other irregularities in the coating ordinarily caused by too rapid baking and superficial hardening of the originally liquid coating. Furthermore, by this arrangement, the maximum heat is applied near the end of the heat treatment to thoroughly bake and harden the coating enamel or varnish after most of the volatiles have been removed. The apertures through which the wire 1 enters and leaves oven 9 are of such dimensions as to minimize the loss of heat from the oven through these openings.

After the wire leaves the lower compartment of oven 9 it is passed around one of the sheaves 4 and through the coating device 8 and oven 9 a sufficient number of times to obtain an insulating coating of the desired thickness after which it is directed through eyelete 3a to take-up reel 15.

The coating device proper which is broadly indicated in Fig. 1 by the numeral 8 is shown in greater detail in Figs. 2, 3 and 4. This device comprises an overflow sump 16 of elongated rectangular shape on which is suitably mounted a well member or block 17. The block 17 is provided with a T-shaped groove or well 18 containing the enamel or other coating material which is introduced into this well through inlet pipe 19 under a pressure head of approximately 7 or 8 inches of coating material. The well 18 need not be of the particular cross-sectional shape shown but may vary in shape so long as it accommodates the receptacle 20 which, as shown in Fig. 3, is sweated into the upper part of the T-shaped well. The receptacle 20 which is shown as being of semi-circular cross-section is provided at the bottom with a number of apertures 21 through which the enamel enters the receptacle from the well 18 due to the slight pressure head on the enamel or varnish supply.

Within receptacle 20 and extending the entire length thereof is rotatably mounted a roller or cylindrical rod 22 in such a position as to dip into the enamel supply entering receptacle 20 through apertures 21. Any excess enamel overflowing the edges of the receptacle 20 flows into the sump 16 either through overflow trough 23 and drains 24 connecting this overflow trough with sump 16 or directly to sump 16 over beveled edge 25 of member 17. A return pipe 26 connected with sump 16 carries this overflow back to the source of supply (not shown) and from there to suitable pumps, filters, etc. and finally back through inlet pipe 19 to well 17.

The grooved roller or rod 22 is provided with a number of preferably V-shaped grooves 27 equal to the number of strands of wire passing through the apparatus. The slow rotation of this roller in the direction of travel of the wire, transfers the coating material to the wire as the wire passes through the groove and at the same time carries any lint or other foreign matter away from the actual wire-coating zone. This mode of operation is particularly advantageous in the coating of small size wire where, because of the comparatively small die opening, the presence of even a small amount of foreign material around or in a fixed non-movable die opening will seriously impair the efficiency of the apparatus and unless removed immediately will result in a non-uniform coating of the wire or even in the complete absence of coating material on certain portions of the wire.

Spring fingers 28 are so mounted above the roller as to cooperate with the V-grooves 27 to form a substantially triangular coating-die through which wire 1 passes. These spring fingers, which are an important feature of my invention and which need not be of flat rectangular shape as shown in the drawing but may be of any other suitable shape so long as that portion bearing upon the roller has a substantially flat surface or face, cooperate with the V-grooves 27 in roller 22 to form a small pool of enamel through which the wire must pass. The substantially triangular opening or die will produce an even or uniform coating of enamel on the wire after it passes from the die due to the running together of the three spaced portions of enamel as will be more fully brought out hereinafter. The resiliency of spring finger 28 allows any particles of lint or any uneven spots in the coating to freely pass through the die without injuring either the coated wire or the die members proper and as stated above any foreign particles will be carried away from this coating zone by the revolving roller. The apertures 21, previously referred to, are so spaced in the receptacle 20 that one aperture is provided for each V-shaped groove 27 in roller 22.

One end of the spring fingers 28 is rigidly mounted on the inclined surface 29 on one side of member 17 by means of bar 30 and set screw 31. A number of the bars 30 may be used depending upon the length of the coating device as a whole. As shown in Fig. 2, bar 30 serves to hold four of the spring fingers in place.

The wire 1 after leaving the sheaves 4 enters the coating device 8 through slots or guides 32 each of which is in line with one of the grooves 27 in roller 22 and with one of the sheaves 4. These slots or guides are of such width as to permit free movement of the wire, yet narrow enough to insure proper alignment of the wire in grooves 27.

The grooved roller 22 may be a single rod having a number of V-shaped grooves 27 machined therein or may be made up of a number of units each having a single V-groove, said units being fixedly mounted on a shaft 33. This shaft in turn carries a pulley 34 which through the means of belt 35 and pulley 36 is driven from shaft 4a on which the sheaves 4 are mounted. The relative speed of rotation of these roller units with respect to the speed of travel of the wire may be controlled by changing the relative size of the pulleys 5, 34 and 36. The speed of rotation of these rollers preferably is low as compared with the speed of the wire. Shaft 33 is also provided with collars 37 bearing against the ends of member 17 and serving to prevent any lateral displacement of shaft 33 and therefore rollers 22.

The flanges 38 in the form of equally spaced circumferential ridges or collars machined onto roller 22 during its manufacture support the

roller 22 by bearing on the inner surface of receptacle 20 and also serve to prevent the enamel entering receptacle 20 through apertures 21 from flowing to one or the other end of receptacle 20 in the event that the device as a whole is not level. The enamel or other coating composition collecting in receptacle 20 between flanges 38 is transferred to the pools of coating material beneath spring fingers 28 by the rotation of roller 22.

Fig. 4 is an enlarged view of a portion of grooved roller 22 and spring 28 showing the relative positions of the groove 27, spring 28 and wire 1 during the actual coating operation. The wire of circular cross-section bears lightly upon the V-shaped groove 27 at only two points, one on each leg of the V. Ordinarily, the spring finger 28 bearing on the surface of the roller does not come in actual contact with the wire 1 as it passes through the triangular-shaped aperture. This finger not only causes the formation of a small pool or bath of enamel behind the die through which the wire must pass but also removes any surplus enamel from the wire before it leaves the coating device and enters the oven 9. The quantity of enamel applied to the wire is determined by the depth of the V-shaped groove 27 in relation to the wire size and thus may be controlled by changing the size of the groove.

It will be observed that as the wire leaves the die aperture it is coated with three circumferentially spaced triangular-shaped portions of enamel. These portions, particularly on small sized wires, readily coalesce to form a layer or film of uniform thickness. In this respect my coating device represents a substantial improvement over prior art grooved roller coating devices wherein the groove is of semi-circular cross-section having a radius of curvature equal to or greater than the radius of the wire. In using such semi-circular grooves a considerable portion of the bottom surface of the wire tends to drag on the bottom of the semi-circular groove with the resultant deposit of a large portion of enamel on one side of the wire and substantially no coating on the opposite side. The triangular or similar shaped aperture on the other hand permits the application of a number of spaced portions of enamel to certain regions about the circumference of the wire which can much more readily flow together into a uniform continuous coating. Although I have described the coating roller as being provided with a substantially V-shaped die-forming groove, it is understood that grooves of varying shape may be used in practicing the invention. For example, the bottom of the groove may be slightly rounded or curved so long as the radius of curvature is less than the radius of the wire. It may also be flattened so long as the wire contacts the groove in the manner set out hereinbefore; that is, at certain isolated points between which substantially equal portions of enamel are applied to the wire.

Fig. 5 shows a modification of my coating apparatus characterized by the presence of a number of grooves for each strand of wire. In this modification I preferably use a number of rollers, segments or spools 41 provided with grooves 42*a*, 42*b* and 42*c* through one of which the wire passes. Flanges 44 on these spools or rollers serve the same purposes as flanges 38 shown in Fig. 2. Spring finger 43 comparable to spring finger 28 in Fig. 2 is then made of such width as to cover all of the grooves in one spool or roller. The center groove of the group of grooves, which may be of any number, is so positioned as to be substantially in line with slot or guide 31 so that, ordinarily, the wire 1 is passing through the pool of enamel or other coating material collecting behind the die opening formed by this particular groove and spring finger 43. However, in practice, an enlargement in the wire, caused for instance by a splice or the presence of foreign matter, will sometimes cause the wire to jump from this groove. By providing a number of closely spaced grooves in each segment or unit of the rotating roller, I prevent any serious damage to the coating as a whole since the wire will immediately fall back into either the original groove or one of the adjacent grooves due to the spring pressure of spring finger 43. With a roller having only one groove per wire strand, there is the possibility that the wire will ride the smooth surface of the roller near the groove for some time after jumping from the groove proper, thus resulting in a scraping action of the roller and spring finger on the wire and the accompanying injury or removal of the insulating enamel.

The size and depth of the grooves, as stated previously, are determined empirically and will depend upon the size of the wire to be received therein, the thickness of the coating desired, the viscosity of the coating material, and other variables. The rotational speed of the roller need only be sufficient to insure the transfer of an ample supply of coating material to the wire and a ready removal of foreign materials from the coating zone or die proper.

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

1. An apparatus for coating wire comprising a receptacle for coating material, a grooved roller mounted in said receptacle so as to be partially immersed in said coating material, and a flat spring member bearing on the surface of said roller and forming with said groove a coating aperture adapted to receive the wire to be coated.

2. An apparatus for coating wire comprising a container for coating material, a roller having a circumferential groove therein and dipping into the coating material in said container, means for passing said wire tangentially through said groove at the top of said roller, and a spring finger bearing upon said roller and serving to confine said wire in said groove during coating of the wire.

3. In a wire-coating device, a cooting die comprising a V-grooved roller and a spring member bearing on the grooved surface of said V-grooved roller and forming therewith a triangular-shaped opening adapted to apply a limited amount of coating material to a wire passing therethrough, said roller being so mounted in a bath of coating material as to convey said coating material to said opening upon rotation of said roller.

4. A wire-coating apparatus comprising a receptacle for the coating material, a rotatable roller partially immersed in said coating material, said roller having a substantialy V-shaped groove therein to receive a wire to be coated, and a flexible spring finger one end of which is rigidly fixed to a suitable support and the other end of which bears against the surface of said roller and forms with said groove a substantially triangular-shaped coating aperture for the wire.

5. An apparatus for coating wire with viscous coating material comprising a coating-applying rotatable grooved roller and a spring finger bear-

ing on the grooved surface of said roller to form therewith an aperture to receive said wire.

6. An apparatus for coating wire comprising a grooved rotatable carrier for a liquid coating material, means for supplying said coating material to said carrier, means for passing the wire through the groove of said carrier, and a member resting on the periphery of said rotatable carrier and cooperating with said groove to form an aperture for receiving the wire to be coated.

7. A wire coating device comprising a V-grooved roller, a flat member, one end of which bears upon the surface of said roller and forms with the groove a substantially triangular-shaped opening for receiving the wire to be coated and means for supporting said roller and said flat member for movement relatively to each other.

8. A die assembly for coating a metallic wire comprising a roller provided with a circumferential groove, a flat member bearing on the surface of said roller and means for mounting said flat member for movement toward and away from said groove, said groove and said member forming an aperture to receive the wire to be coated.

CARL A. BAILEY.