Jan. 13, 1959 H. B. LIT ET AL 2,868,159

WIRE COATING APPARATUS

Filed Nov. 17, 1955

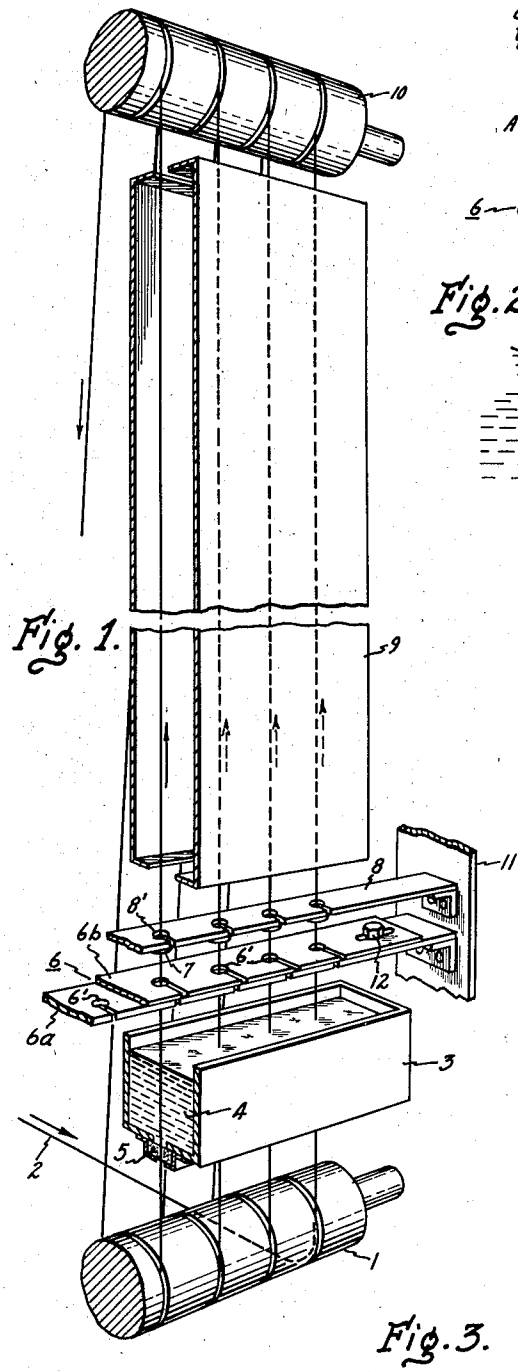

Fig. 1.

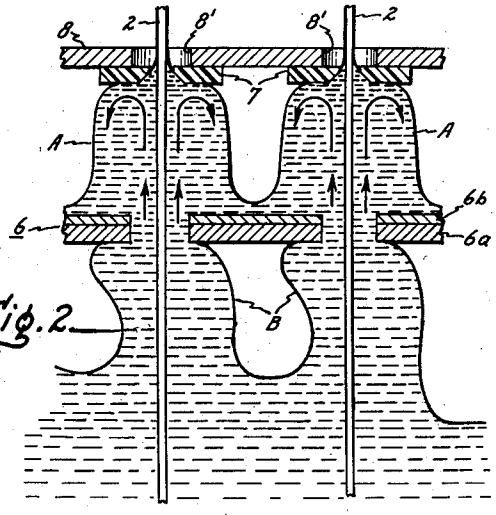

Fig. 2.

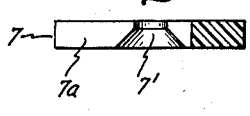

Fig. 3.

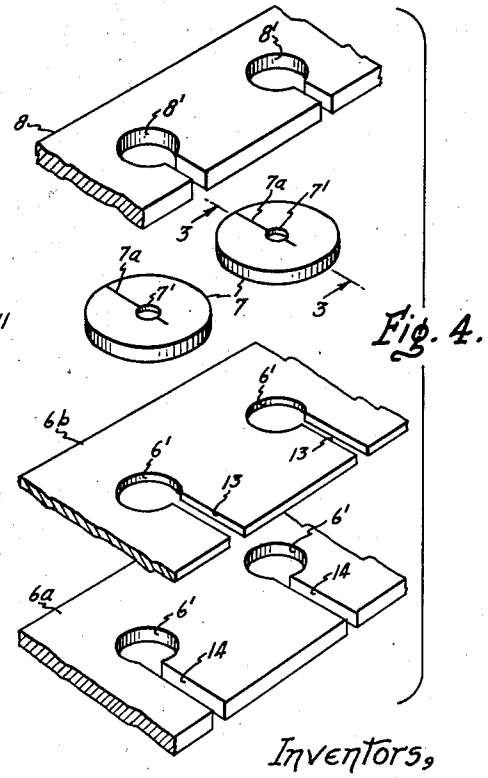

Fig. 4.

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United States Patent Office 2,868,159 Patented Jan. 13, 1959

2,868,159

WIRE COATING APPARATUS

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Application November 17, 1955, Serial No. 547,372

4 Claims. (Cl. 118—125)

The present invention relates to apparatus for applying coating compositions such as enamels, varnishes, lacquers and the like to elongated articles such as wire. More particularly, the invention is concerned with a die arrangement for the application of a viscous solution of a resinous composition, such as polyvinyl formal, to a wire for the purpose of providing an electrical insulating film thereon.

In applying a varnish coating to wire as heretofore carried out by the known applicator and die devices, it has been difficult to obtain a uniform coating which is substantially concentric with the wire, and, accordingly, in order to assure a sufficient minimum thickness completely around the wire it has been necessary to apply an excessive number of coats of varnish. Such procedure is time consuming and wasteful of materials, and substantially reduces the production capacity of the coating apparatus.

It is an object of the invention to provide an improved wire coating apparatus which overcomes the above disadvantages of the known coating devices.

It is another object of the invention to provide means for applying uniform coatings of resinous insulating varnish on a wire which are substantially concentric with the wire.

It is a further object of the invention to provide a wire coating apparatus which is adapted to uniformly and concentrically coat with a viscous liquid material a plurality of wire portions arranged adjacent each other.

It is still a further object of the invention to provide means for controlling the flow of the liquid coating material in the vicinity of the die in order to thereby produce a uniform coating on the wire.

To attain the above objects, the present invention provides an apparatus for coating elongated material such as wire and the like which comprises a means for supplying liquid coating material to be applied to the wire, die means for reducing the thickness of the coating material on the wire and for removing the excess liquid material therefrom as the wire is moved relative to the die means, and means for providing a symmetrical flow of the liquid coating material around the wire in the vicinity of the die means, whereby a coat of uniform thickness is produced by the die means on the wire as it passes therethrough.

In a preferred embodiment of the invention, the die consists of an apertured disk which is mounted on the wire and moves along therewith until restrained by an upper stop member through which the wire freely passes and which allows limited transverse movement of the die disk during the coating operation, and baffle means is arranged a predetermined distance from the stop member for the purpose of controlling the flow of the liquid material so as to provide a symmetrical flow of the liquid material around the wire in the vicinity of the die.

The invention will be better understood from the following description taken in conjunction with the accompanying drawing, in which:

Fig. 1 is a perspective view partly in section of a wire coating apparatus embodying the present invention;

Fig. 2 is a cross-sectional view in elevation of a detail of the wire coating arrangement of the present invention;

Fig. 3 is a cross-sectional view of a die member taken along the line 3—3 of Fig. 4; and

Fig. 4 is an exploded view of the component parts of the die and baffle arrangement of the present coating apparatus.

Referring now to the drawing, and particularly to Fig. 1, there is shown an apparatus for coating a wire with a series of applications of insulating enamel and hardening by heat each coat after it has been applied. For this purpose there is provided a lower guide sheave 1 having grooves to which wire 2 is led from a pay-off reel (not shown), the wire 2 passing from sheave 1 upwardly through vessel 3 containing a supply of the resinous viscous varnish to be applied to the wire. Wire 2 enters the bottom of vessel 3 through a pad 5 of felt or the like which aids in retaining the coating liquid 4 in the vessel 3 at the wire inlet. After emerging from the vessel 3 wire 2 passes upwardly through aligned apertures 6′ in a composite baffle plate 6 consisting of superposed apertured plates 6*a* and 6*b*. The wire then passes through die disk 7 and apertured upper restraining plate 8, and thence moves upwardly through a baking or drying oven 9 of any suitable or conventional type wherein the varnish coating applied by the die 7 to the wire is heat-hardened. Thereafter, wire 2 passes around sheave 10 and back to guide sheave 1 to a groove spaced axially from the initial receiving groove. Then wire 2 passes through the apparatus in repeated stages in the manner described and as illustrated in Fig. 1 until a coating of the desired thickness is finally built up. The coated wire is ultimately conducted to a take-up reel or other storage means (not shown).

As shown in Fig. 1 restraining plate 8 and composite baffle plate 6 are rigidly secured to a suitable support 11, preferably at both ends of the plates. The top baffle plate 6*b* is slidably mounted on the bottom plate 6*a* and secured thereto in adjusted position by means of a threaded bolt 12 or any other suitable means. Die members 7 are shown in Fig. 1 in the operative positions abutting the underside of restraining plate 8 which they would have during the normal coating operation, it being noted that the showing of the column of coating liquid on which they would ordinarily rest, as shown in Fig. 2, has been omitted in Fig. 1 for the purpose of describing the present construction.

As more clearly illustrated in the detailed view in Fig. 4, the composite baffle plate 6 consists of a bottom plate 6*a* and a top plate 6*b* each having apertures 6′ with slots leading therefrom to the edges of the respective plates. As shown, the slots 13 and 14 of the respective plates are displaced from each other longitudinally of the plates 6*a*, *b* when the plates are arranged with their apertures registering with one another. Plates 6*a*, *b* are initially arranged with slots 13 registering with slots 14 to enable the various portions of wire 2 to be inserted into the aperture 6′, after which the upper plate 6*b* is adjusted and secured relative to bottom plate 6*a* so as to close off the passages formed by the registering slots 13—14, for reasons more fully explained hereinafter. In the illustrated embodiment, upper plate 6*b* is shifted and secured by bolt 12, so that the apertures 6′ in plates 6*a*, *b* are aligned and so that the wire can pass freely therethrough, but it will be understod that either or both plates may be made movable with respect to the other by suitable mounting means, if so desired.

As the wire 2 moves upwardly from the supply vessel 3 the apertured die disks 7 mounted on wire 2 are carried upwardly by the wire and the viscous coating material adhering thereto, and during the coating operation disks 7 engage the lower surface of upper restraining plate 8, the apertures 8' of which are smaller than the width or diameter of the die disks 7 so that the latter are prevented from further upward movement, while allowing free passage of wire 2 through the apertures. The apertures in plates 6 and 8 are sufficiently large so that the wire with a swaying movement during normal coating operations will not contact the edges of the openings. Die disks 7, however, are free to move with any swaying movement of the wire, and each die disk is thus, in effect, self-centering, i. e., it centers itself relative to the wire passing therethrough regardless of the movement or position of the wire.

Die member 7 is preferably a thin, flat plate weighing, for example, a few grams and is made of any suitable material, such as a metal or plastic which is not affected by the liquid coating composition. A particularly suitable die disk has been made from polytetrafluoroethylene. As shown in Fig. 3, the aperture 7' in the die disk flares downwardly to form a cone-shaped opening, in order to obtain optimum self-centering of the die member on the wire due to the hydraulic effect of the coating liquid entering the orifice, which contributes to a concentric, uniform coating on the wire. The flare angle of the orifice opening has been found to produce the best results if about 120°, but this may vary while still producing satisfactory results.

The size of the die opening depends among other factors on the desired thickness of coat, the wire diameter, and the viscosity of the varnish, and the particular size utilized is determined empirically. The dies in the apparatus illustrated preferably have apertures which are larger in each successive coating stage to accommodate the increased diameter of the coated wire as the coating is built up from stage to stage.

The dies 7 are preferably slit as shown in Fig. 4 to enable them to be inserted on the wires, it being noted that the slit 7*a* passes through the disk at one side of aperture 7' and is extended a short distance at the opposite side of the aperture so that the aperture is not distorted in separating the slit portions on inserting the die 7 on the wire 2.

While shown as circular the die member 7 may be of a different shape and size, providing it is sufficiently light, is of suitable material, is substantially flat at its lower surface, and is of sufficient width to accommodate the top of the liquid column as hereinafter described.

It has been found in accordance with the invention that the form and behavior of the column of viscous liquid formed by the liquid carried up by the wire 2 and the excess liquid removed by die 7 which flows back downwardly therefrom has a critical influence on the uniformity and concentricity of the coating applied by the die. Tests have shown that it is essential that this column of liquid and its flow pattern be symmetrical about the wire in order to provide uniform flow through the die and the application thereby of a concentric coating. It has been found, for example, that in die structures which are not symmetrical about the wire, or that where the column of liquid is excessively high, proper flow patterns cannot be obtained. In fact, any factor which tends to disturb a uniform and symmetrical flow pattern around the wire in the vicinity of the die will result in non-concentric coatings. It appears that where such a uniform flow pattern is not provided, the differential fluid forces in or about the die orifice cause a misalignment of the wire in the orifice with a resulting non-uniform coating.

In view of these observations, the present coating apparatus was designed to provide uniform symmetrical flow patterns of the coating liquid in order to attain more

uniform coating on the wire. By virtue of the arrangement described and shown there is produced during the upward movement of the wire 2 a column of liquid A (see Fig. 2), somewhat in the form of a truncated cone, around the wire between the die disk 7 and the lower baffle plate 6, which form has been found to provide considerably improved results in terms of concentric varnish coatings. As indicated by the arrows shown in Fig. 2, the flow pattern and fluid forces around the wire 2 are symmetrical therewith, particularly as compared with the liquid columns produced below baffle plate 6 and between plate 6 and the surface of supply receptacle 3. The flow pattern B shown below plate 6 has a characteristic S-shaped form encountered in the prior art devices in the absence of a baffle arrangement such as provided in accordance with the present invention for controlling the flow of the returning excess liquid below the die. Baffle plate 6 provides a base on which the column of a liquid A can rest in forming the desired pattern and serves to control the run-off of the excess liquid into the supply vessel 3. The spacing between restraining plate 8 and lower baffle plate 6 is of particular significance in making the column of liquid symmetrical, and the proper spacing can be determined generally by observation of the flow pattern of the liquid. In those cases where no baffle or base at all is provided, or where the spacing between plates 6 and 8 is too great, the characteristic S-shaped body of liquid is produced resulting in a non-concentric coating on the wire. Further, where the plates 6, 8 are too close together the fluid forces again are not uniform and produce undesirable results in the coating formed by the die.

A further important feature of the invention is that the wires, and therefore the apertures through which they pass, should be sufficiently far apart to avoid merging of the liquid columns, which also has been found to disturb the symmetry of the flow patterns.

The requisite spacing between plates and apertures depends on the viscosity and adhesiveness of the liquid coating composition used, the speed of movement of the wires and the rapidity of run-off of the liquid at the base of the liquid columns. It is essential in providing proper flow patterns to avoid any non-uniform hindrance to the run-off from the base of the columns A and off the baffle plate 6, and the absence of side plates or other interfering parts along the wire adjacent the die or at the baffle plate contributes to the ready and uniform flow of the liquid away from the column bases. To insure that the run-off of the excess coating liquid is uniform, the slot passages in the composite baffle plate 6 by slots 13, 14 when aligned are closed off by lateral shifting of one plate relative to the other in the manner already described.

To avoid the merging of the adjacent liquid columns, it may in certain cases be desirable to provide slots arranged equidistant between the adjacent apertures 6' in composite plate 6 to allow more rapid run-off, care being taken, however, that the slots are so arranged and of such size as to allow uniform run-off around each column base in order to maintain symmetrical flow forces around the wire.

In a typical arrangement which produces excellent results in accordance with the invention, a liquid coating composition composed of polyvinyl formal having a viscosity of 4,000–4600 centipoises at 30° C. is applied to wire of about 20–100 mils diameter with the spacing between upper and lower plates 6, 8 ranging from ¾ inch–2 inches with 1 inch being preferred, a lateral spacing between apertures in the respective plates of about ⅞ inch center to center, and a spacing of the lower plate 6 above the liquid reservoir level of about ½ inch–4 inches.

It is not essential that the apertures in each plate be aligned longitudinally of the plate, and they can be in staggered or other formation if desired, care being taken that sufficient spacing is provided between adjacent aper-

tures to avoid merging of the liquid columns and that at least the lower baffle plate 6 has sufficient area to provide an adequate base around each wire for controlling uniformly the run-off of the excess liquid.

Numerous advantages are obtained by the present construction as described. Since the coatings produced are more nearly concentric than heretofore obtainable by prior coating devices, a smaller number of individually applied coatings is required to provide insulation of the desired thickness. The prescribed tolerances for coating thickness can be more readily maintained. The saving of material and time in providing the requisite coating thickness is considerable.

While a particular construction has been shown and described in order for providing the improved results in coating wires and the like, it will be evident that means other than those shown may be utilized to obtain the the desired results. For example, it is not intended that the invention be limited to the provision of a plate to provide the necessary control of the excess liquid run-off, since other means such as fluid forces, baffle members of various shapes, and other types of liquid control means could be used to produce the results desired. While the invention has been found particularly advantageous in producing coatings of uniform thickness on wire of circular cross-section, it is believed that similar improvements can also be produced in accordance with the invention on wire of rectangular or other shape.

Accordingly, while the present invention has been described with reference to particular embodiments thereof, it will be understood that numerous modifications may be made by those skilled in the art without actually departing from the scope of the invention. Therefore, the appended claims are intended to cover all such equivalent variations as come within the true spirit and scope of the invention.

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

1. Apparatus for coating an elongated article with liquid coating material comprising, in combination, means for applying the liquid coating material to the elongated article; die means for reducing the thickness of the coating of liquid material on the elongated article and removing the excess liquid material therefrom while the elongated article is moved substantially vertically upward through said die means; and baffle means for providing a symmetrical flow of the liquid coating material around the elongated article in the vicinity of said die means, said baffle means having a substantially horizontal surface portion spaced a predetermined distance from said die means and extending continuously around the elongated article for controlling the flow of the excess liquid material removed by said die means, whereby a concentric coating of uniform thickness is produced by said die means on the elongated article.

2. Apparatus for coating a wire and the like with liquid coating material comprising, in combination, means for applying the liquid coating material to the wire; apertured die means adapted to be mounted on the wire coaxial therewith and movable therewith during the coating operation and operable for reducing the thickness of the coating of liquid material on the wire and removing the excess liquid material therefrom as the wire moves substantially vertically upward through said die means; stop means for limiting the upward movement of said die means; and baffle means for providing symmetrical flow of the liquid coating material around the wire in the vicinity of said die means, said baffle means comprising plate means arranged substantially horizontal and spaced a predetermined distance from said stop means and extending continuously around the wire for controlling the flow of the excess liquid material removed by said die means, whereby a concentric coating of uniform thickness is produced by said die means on the wire.

3. Apparatus for coating a wire and the like with liquid coating material comprising, in combination, means for applying the liquid coating material to the wire; die means adapted to be mountd on the wire co-axial therewith and movable therewith during the coating operation and operable for reducing the thickness of the coating on the wire and removing the excess liquid material therefrom; stop means for limiting the axial movement of the die means while allowing free passage of the wire; and baffle means for providing symmetrical flow of the liquid coating material around the wire in the vicinity of said die means, said baffle means comprising a composite baffle plate spaced a predetermined distance from said stop means for controlling the flow of the excess liquid material removed by said die means, said composite baffle plate comprising superposed plate members having corresponding apertures and slots extending therefrom to the edges of the plate members, said plate members being displaceable relative to each other and said corresponding apertures and slots being so arranged that the slots in the superposed plate members are out of register when said apertures are in register.

4. In a wire coating apparatus, a plate-like die member having an aperture with a minimum diameter slightly larger than that of a wire adapted to pass therethrough, said aperture narrowing in the direction of passage of the wire, said die member being adapted to move with the wire during the coating operation; stop means comprising an upper apertured plate through which the wire is adapted to pass freely upwardly while limiting the upward movement of said die member and while allowing transverse movement of said die member so that it is constantly centered relative to the wire, said die member reducing the thickness of the coating of said liquid material on the wire and removing the excess liquid material therefrom; and baffle plate means spaced a predetermined distance below and substantially parallel to said upper plate for providing a symmetrical flow of the liquid material around the wire in the vicinity of said die member, said baffle plate means comprising a pair of superposed apertured plates through which the wire is adapted to pass and having slots extending from their apertures to the edge of the plates, said plates being relatively shiftable for putting said slots out of register with each other while said apertures are in register.

References Cited in the file of this patent

UNITED STATES PATENTS

Re. 19,758	Underwood	Nov. 12, 1935
267,044	Waring et al.	Nov. 7, 1882
2,366,077	Wildy et al.	Dec. 26, 1944
2,407,337	Kolter	Sept. 10, 1946