

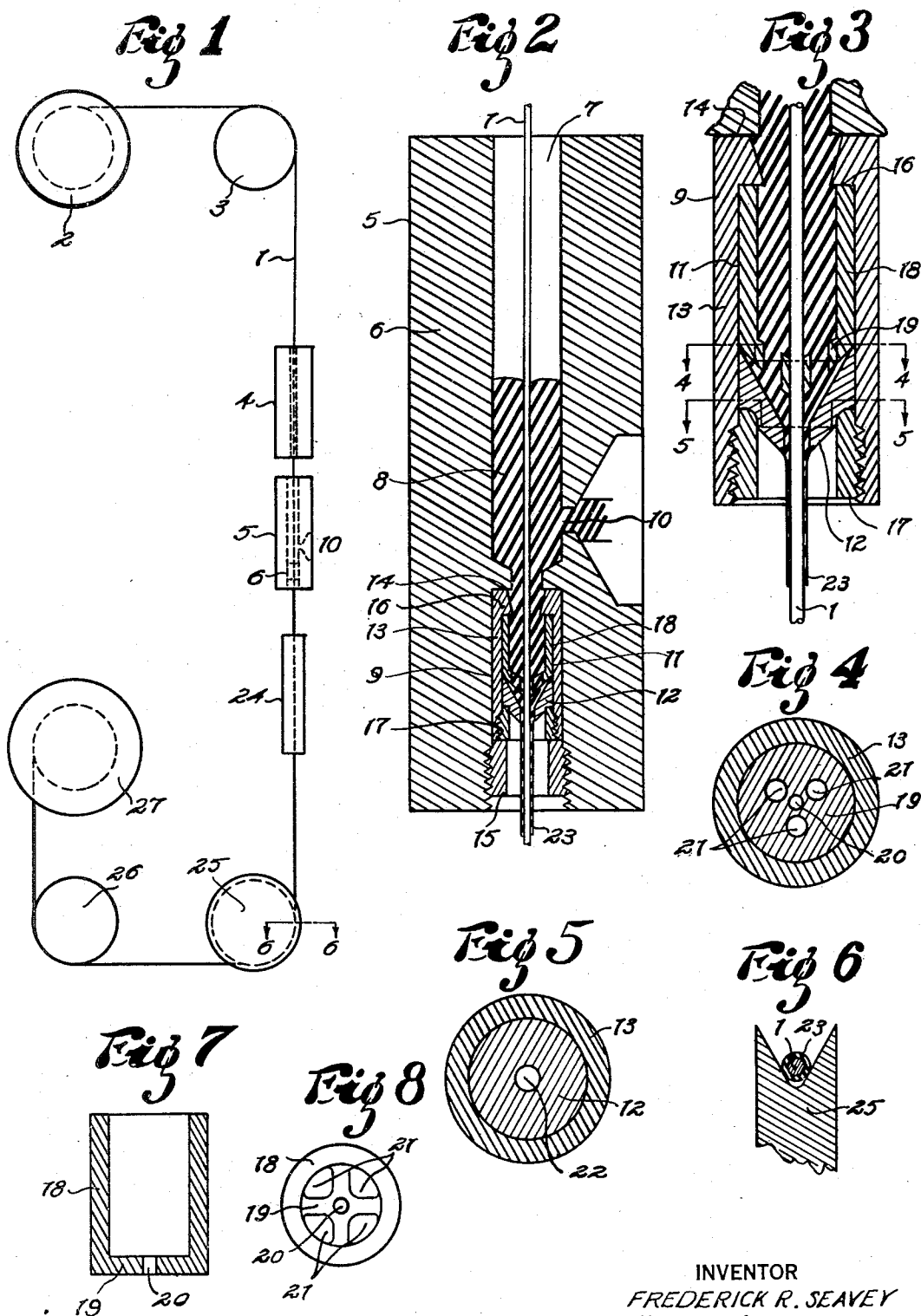
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COATING METHOD AND APPARATUS

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COATING METHOD AND APPARATUS

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This invention relates to coating elongated objects such as filaments or strips with protective or decorative materials, and is particularly directed to the provision of an improved method and means for carrying out such coating operations, for example in the insulation of wire with thermoplastic compositions.

A variety of thermoplastic compositions have become available which provide excellent properties in many respects for use as the protective sheath on wires. However, the methods and apparatus heretofore available for applying such coatings have not been sufficiently simple and effective to enable production at an attractively low cost. Also, it has been impossible to avoid defects in coating by the prior methods.

Heretofore, two principal methods, extrusion and liquid deposition, have been used in coating wire and similar objects. In the extrusion method the wire is drawn through a die through which the plastic composition is at the same time forced by pressure. An important deficiency encountered in this procedure is the difficulty of producing a concentric coating particularly since the wire may be displaced from its intended position by excess pressure on the plastic at one side. In the liquid deposition method, the wire is successively passed through a liquid coating bath and then through a heated chamber to remove solvent and harden the coating, and the cycle is repeated a sufficient number of times to produce a coating of the desired thickness. This method is particularly disadvantageous in that it involves numerous repetitions of the coating and drying treatments, a considerable loss of solvent, and difficulty in controlling the quality and uniformity of the coating. Rather expensive apparatus is required by both prior methods.

An object of this invention is the provision of an advantageous method and apparatus for coating elongated objects.

A further object of the invention is to provide a method for the coating of wire and similar filamentary or strip material continuously at the desired thickness and symmetry.

A further object of the invention is the provision of an improved coating die assembly whereby the desired thickness and symmetry of the coating applied to an elongated object may be readily controlled and maintained.

Another object of the invention is to provide a method and apparatus, greatly simplified with respect to the prior art, for the application of a thermoplastic sheath to wires and similar elongated objects.

Still another object of the invention is an improved method and apparatus for providing a drawn coating on wire and similar objects, which coating is of uniform thickness, concentricity, and density and has a smooth and glossy surface.

Other objects will be apparent from the following detailed description and drawing, in which:

Figure 1 is a diagrammatic elevation of coating apparatus comprising an embodiment of this invention;

Figure 2 is an enlarged sectional view of a coating head embodying this invention;

Figure 3 is a further magnified sectional view of a die assembly embodying this invention;

Figure 4 is a sectional view taken on line 4—4 of Figure 3;

Figure 5 is a sectional view taken on line 5—5 of Figure 3;

Figure 6 is an enlarged sectional view taken on line 6—6 of Figure 1;

Figure 7 is a vertical section of an alternate internal guide means in accordance with this invention; and

Figure 8 is a plan view of the guide means shown in Figure 7.

The foregoing objects are accomplished in accordance with this invention, generally stated, by causing the object to be coated to pass successively through the coating material while the latter is in a highly viscous state, through internal guide means submerged in the coating material, and through a shaping orifice adjacent to and aligned with the guide means. External means are provided in a position relatively remote from the die which in conjunction with the internal guide facilitates the accurate adjustment of the path of the object through the die orifice and thus enables the obtainment of a coating which is concentric or has some other desired symmetry. As the wire passes through the plastic mass, a portion of the latter adheres to and advances with the wire. This adhering material is then stripped from the wire by the internal guide means, through which the plastic and the wire pass separately. Thereupon, the plastic and the wire become reunited and are caused to pass together through the die orifice in the proper desired relationship.

The internal guide means may desirably consist of a suitably shaped metal piece provided with a closely-fitting but non-binding perforation for the passage of the uncoated wire and with a number of apertures, surrounding the perforation, for

the passage of the plastic coating material. While the die, likewise desirably of metal, may have the usual funnel-shaped form, the orifice diameter is preferably somewhat greater than the diameter of the coated wire and is so designed that it is capable of rigid mechanical assembly with the guide means, the wire opening in the guide being aligned with the die orifice, generally being coaxial therewith.

Since the wire is drawn through the coating head under tension and there is no interfering element or force, such as pressure on the plastic coating material, to cause any deviation, the path of the wire through the die is established as the straight line joining the internal and external guide means. By placing the external guide relatively remote from the die, it becomes possible to make very fine adjustments with ease and accuracy in the positioning of the wires, since relatively large displacements of the external guide may be made to accomplish very slight displacements of the wire within the die.

Once the external guide has been fixed in position relative to the die assembly, the coating process may be carried on continuously without any significant deviation of the product from the symmetry which is desired. As the coating operation proceeds, the supply of plastic coating material is continuously maintained in the coating chamber. It is to be observed, however, that the plastic in the coating head is not forced through the die by external pressure but is drawn through by the advancing wire.

An adequate supply of coating material at the die orifice is insured by the provision of sufficiently long contact of the wire with plastic in the reservoir chamber. That is, the height of the plastic column therein permits the development of sufficient adhesive force that the desired amount of plastic is carried along with the wire. This force may be augmented if desired, by providing that the entering wire has a lower temperature than the plastic; in such case, plastic solidifies around the wire and exerts a piston-like action. The diameter of the supply column is sufficiently large relative to the wire diameter that no undue restraint is placed by the side walls on the passage of the plastic.

In contrast to extrusion-coated articles which generally are greater in diameter than the die orifice, a coated article produced in accordance with this invention preferably has a diameter which is substantially less than that of the die orifice. This is a result of providing conditions such that the plastic is drawn through the die by the wire and the drawing force continues to act on the plastic on emergence of the coated wire from the die. The surface tension of the plastic may likewise be effective at the die orifice. The process and apparatus of this invention therefore have the advantage not only of producing accurately centered insulated wire, but also of providing a uniformly thick and compact coating having a glossy surface and enhanced physical properties.

In accordance with a preferred embodiment of this invention, wire 1, or other object to be coated, is drawn from supply reel 2 and, after suitable cleaning and straightening if necessary, is delivered to grooved drum 3, which may desirably be heated as by means of an electrical resistance coil, thus to serve as preheating means for the wire. The wire is then passed through a heating tube or oven 4 which is maintained at a desired operating temperature, for example by the circula-

tion of a heating fluid through a surrounding jacket or by any other suitable means.

The wire then advances to coating head 5, which desirably consists of a metal block 6 provided with a preferably vertical substantially cylindrical opening 7, which constitutes a reservoir for plastic 8 and contains the die assembly 9 through which the wire passes, and connected opening 10 for the supply of plastic. Any of a variety of suitable methods may be employed for providing a constant supply of plastic material 8 into opening 10; for example, the plastic may be introduced as a consolidated viscous mass produced by advancing a preformed rod or strip through a heating zone or by advancing the material, originally in the form of granules, through a heating zone by mechanical means well known in the art, such as a worm feed, gear pump, or reciprocating piston.

A preferred die assembly 9 consists of a wire guide 11 and a die 12, which may be assembled essentially as shown. Die housing 13 is securely fastened in position against annular shoulder 14 of block 6 by means of lock-nut 15, while guide 11 and die 12 are locked in position against shoulder 16 by lock-nut 17. As shown, the wire guide 11 preferably consists of a metal cylinder 18 open at one end and partly closed at the other by an end member 19 which is provided with central perforation 20 for the passage of the wire and surrounding apertures 21 for the passage of the plastic material. Perforation 20 forms a close but non-binding fit about the uncoated wire 1 and is locked in the assembly in alignment with the center of the die orifice 22. An alternative form of internal wire guide means is shown in Figures 7 and 8.

Block 6 is maintained at the desired operating temperature, for example by means of a thermostatically controlled electric resistance heater, and may be provided with suitable thermal insulation. Wire 1 enters opening 7, which is open to the atmosphere and has a diameter of one-half inch, and passes through a column, about four inches long, of plastic material 8. As the wire proceeds through opening 20 of internal guide means 11, the adherent material being stripped therefrom, the plastic is advanced separately through circular openings 21, of one-eighth inch diameter. This separation of the plastic, preliminary to the application of the final coating, may at times be of particular advantage in that a thin film of plastic, wiped on the wire surface during passage through the guide, may enhance conditions for the reception of the main body of the coat immediately thereafter, in providing a final mixing of the plastic composition, and in the improved conditions provided for heat transfer to the plastic so as to minimize temperature gradients therein. The wire and surrounding plastic are drawn through the coating chamber between the guide end member 19 and the die 12 and then through the die orifice 22.

The wire provided with coating 23 leaves the die and is cooled to solidify the plastic by passage through a cooling means 24, which for example may consist of a tube, carrying a water spray or through which cool air or water is circulated, so arranged as to produce no significant deviation of the wire from its intended path. The wire then advances to external guide means, placed relatively distant from the die 12, such as sheave 25.

It will be observed that the path of the wire 1

through die 12 is determined, once guide 11 and die 12 have been assembled and locked together, by the position of the external guide means 25. The latter is therefore preferably made adjustable so that the setting may be varied, but provision is made so that once the proper setting has been established it can be rigidly maintained. Since the distance between the internal guide perforation 20 and the die orifice 22 is generally small, of the order of a few hundredths of an inch, while the distance from the die 12 to the external guide 25 may amount to several feet, for example two to six feet, it will be apparent that means are provided for the accurate establishment of the proper path of the wire 1 through the die 12. For example, the distance between the guide perforation 20 and the die orifice 22 may be 0.06 inch and the distance from die 12 to guide 25 may be 60 inches; a one-inch displacement of guide 25 is then required in order to effect a displacement of 0.001 inch in the same direction of the path of the wire through die 12.

From the guide means 25, the coated wire is led over capstan 26 which is rotated at constant speed, to take-up reel 27. If desired, a suitable tension control device, of known construction, may be provided between guide 25 and capstan 26 for the purpose of insuring that the tension with which the wire is drawn through the apparatus by capstan 26 is within a desired range.

As an illustration of conditions which have been found to yield excellent results, 22 B. & S. gauge copper or iron wire may be coated with a suitable ethyl cellulose composition by drawing the wire through the apparatus at the rate of about 3600 feet per hour. The wire is preheated to a temperature of 175°-200° C. prior to its entry into coating head 5 and the plastic in the coating chamber is maintained at a temperature of 240°-245° C. Using a die orifice 22 of 0.052 inch diameter, an accurately centered coated wire is produced having a diameter of 0.042 ± 0.001 inch. Similar conditions may be used in coating 20 gauge wire, a die orifice 22 of 0.067 inch diameter being employed to produce coated wire having a diameter of 0.057 inch.

The wire may be coated at substantially higher speeds by raising the temperature of the plastic and of the preheated wire, for example to about 250°-265° C. Another permissible variation consists in omitting the preheating of the wire, particularly at relatively low coating speeds or in coating very fine wire.

The excellence of the coated wire produced in accordance with this invention has been substantiated by a variety of tests. For example, a coating having a dielectric strength of 800-900 volts per mil is readily attainable, as contrasted to a value of 100 volts per mil obtained with impregnated double-cotton insulation. Tests of the present produce have likewise shown it to possess adequate resistance to impact, abrasion, and cold flow, and excellent flexibility at ordinary and sub-zero temperatures. All these properties are adequately retained after storage for an extended period of time under ordinary or adverse conditions.

The method and apparatus of this invention are particularly adapted for the coating of wire and similar elongated objects with suitable thermoplastic compositions. The latter may desirably be based on a cellulose ester, such as cellulose acetate or cellulose acetate-butyrate, or on a cellulose ether, such as ethyl or benzyl cellulose, or on a synthetic resin such as polystyrene or poly-

vinylidene chloride. The composition may be suitably plasticized, if necessary, with preferably a non-volatile solvent for the base, such as a dialkyl phthalate or a triaryl phosphate (particularly adapted for use with cellulose ether), and it may also contain small amounts of a resin, lubricant, dye, pigment, or other desired modifying agent.

In certain cases, a lowering of the coating temperature may be effected by plasticizing the composition with a small proportion of volatile solvent. For such use, cooling means 24 may be preceded or replaced by means for removing volatile solvent, for example, a heating tube through which warm air or other fluid may be circulated.

In commercial operations, a number of units as described above may be mounted side by side, for supervision by a single operator. Further advantage and simplicity may then be had by the provision of a common plastic supply for a number of coating units.

The method of this invention may furthermore be applied in coating two or more wires simultaneously within a single sheath. Likewise, individually sheathed wires may be united, as by twisting, following their emergence from neighboring coating units.

Since various modifications within the spirit of this invention may be made in the specific embodiments which have been described, the detail description is to be considered as illustrative of and not limiting the invention, except in accordance with the appended claims.

I claim:

1. The method of coating an elongated body comprising, drawing the body through a column of viscous plastic whereby plastic for forming the coating is carried along with the body, separating substantially all said plastic from the body, advancing said plastic in a plurality of individual streams spaced about the body, and reuniting the said streams of plastic as a coating surrounding the said body.

2. The method of coating wire, comprising drawing the wire through a column of viscous plastic whereby plastic is carried along with the wire, passing the wire through an internal guide while advancing substantially all said plastic as a plurality of individual streams separate from and spaced about the said wire, then reuniting the said streams of plastic as a coating surrounding the said wire, and withdrawing the coated wire in contact with an external guide, the said guides maintaining the wire in the desired position within the said coating.

3. Apparatus for coating an elongated body with a uniform layer of plastic material comprising, a container for plastic material in communication with the atmosphere, guide means circumferentially secured therein and consisting of a member which is solid save for a central passageway for the body and surrounding apertures for the plastic, and a shaping orifice on said container adjacent to and aligned with the said guide means.

4. Apparatus for coating an elongated body with a uniform layer of plastic material comprising, a container for plastic material in communication with the atmosphere, guide means circumferentially secured therein consisting of a member which is solid save for a central passageway for the said body and surrounding apertures for the plastic, a shaping orifice adjacent to the said guide means, and means external to and relatively remote from the said container

cooperating with the said guide means for controlling the alignment of the body through the said orifice.

5. In apparatus for coating wire, a chamber for plastic material open to the atmosphere at one end and having a shaping orifice at the opposite end, a guide member circumferentially secured in the chamber adjacent to the orifice which is solid save for a closely-fitting passageway for the wire and surrounding apertures for the plastic, said passageway and orifice being coaxial, means for supplying plastic to the said chamber, and means for drawing the wire and surrounding plastic through the said member and orifice.

6. Apparatus for coating an elongated body with plastic material, comprising a columnar container open at one end and having a shaping orifice at the opposite end, and guide means

therein consisting of an internal sidewall member having a base, adjacent the said orifice, which is solid save for a passageway for the body and surrounding apertures for the plastic, said passageway and orifice being coaxial.

7. Apparatus for coating an elongated body with plastic material, comprising a cylindrical container open at one end and having a shaping orifice at the opposite end; a closely-fitting cylindrical sleeve in said container; an end member in said sleeve, adjacent to the said orifice, having a central perforation for the passage of the body and surrounding apertures for the passage of plastic; means for supplying plastic into the said container; and means for withdrawing the said body and surrounding plastic from the said orifice.

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