

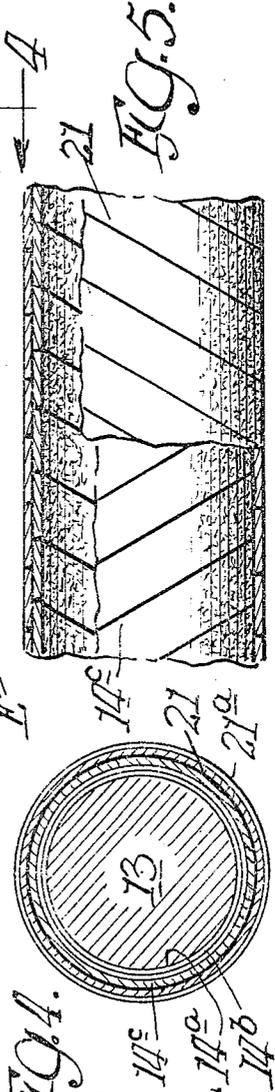
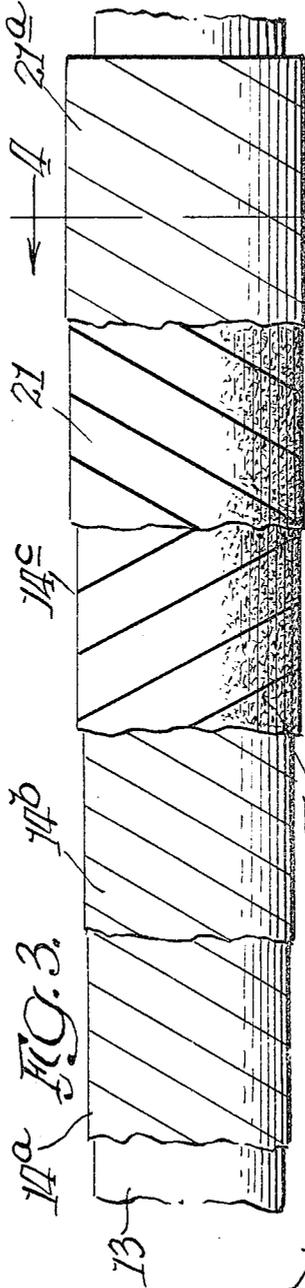
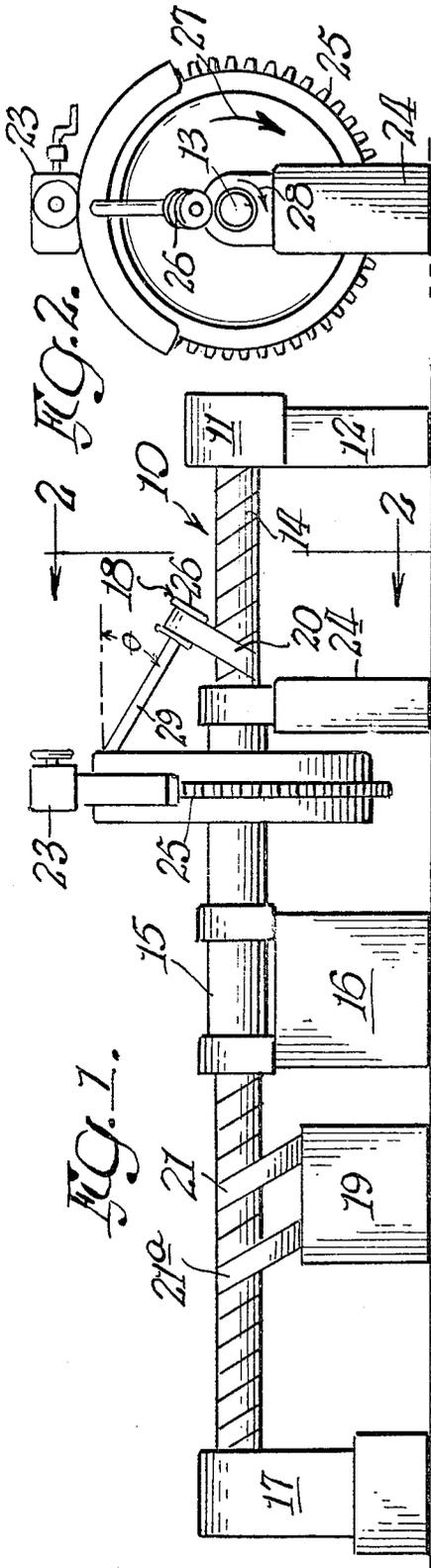
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H. T. BLAIR ET AL

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METHOD OF MAKING A SPIRALLY-WOUND TUBE

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Inventors
 Hugh T. Blair
 Richard L. Hatton
 by Dawson, Tilton, Killion
 Lungmus & Alexander Attys

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METHOD OF MAKING A SPIRALLY-WOUND TUBE

Hugh T. Blair, Deerfield, and Richard L. Hatton, Elmhurst, Ill., assignors to Resinite Corporation, Chicago, Ill., a corporation of Illinois

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This application is related to our copending application Serial No. 121,882, filed July 5, 1961, now abandoned.

This invention relates to tubular manufacture, and, more particularly, to a procedure for making a spirally-wound rigid tube.

It is an object of this invention to provide a novel tube of the spirally-wound character and a method of producing the same—the tube resulting from the practice of the invention being characterized by superior strength and versatility of application as compared with prior art tubes.

Another object is to provide a method of constructing the tube wherein strips or webs of impregnated material are spirally wound in opposite directions in adjacent layers and wherein unique pressure-providing means are utilized during the course of manufacture.

Still another object is to provide a novel spirally-wound tube and a method of its manufacture wherein fibrous strips are cross wound on a mandrel and overlaid with an oriented film capable of shrinking when subjected to heat, whereby an impregnant in the cross-wound strips is curable without the need for introducing the mandrel itself into the curing station.

Other objects and advantages of the invention may be seen in the details of construction and operation set down in this specification.

The invention will be explained in conjunction with the accompanying drawing, in which—

FIG. 1 is an elevational view of apparatus employed in the fabrication of spirally-wound tubes;

FIG. 2 is a sectional view of the apparatus seen in FIG. 1 such as would be viewed along the sight line 2—2 as applied to FIG. 1;

FIG. 3 is a fragmentary elevational view, partially broken away, showing the spirally-wound tube just prior to curing;

FIG. 4 is an end elevational view of the tube of FIG. 3; and

FIG. 5 is a fragmentary sectional view of a completed tube.

In the illustration given, and with reference to FIG. 1, the numeral 10 designates generally a spiral tube-winding machine. Provided as part of the machine is a housing 11 supported on a suitable pedestal 12. The housing 11 supports two or more spools of strip material (not shown), which are wrapped around a mandrel 13 (see FIG. 2). The spirally-wound web strip material issuing from the housing 11 is designated by the numeral 14 in FIG. 1 and is seen to have convolutions extending downwardly from left to right as viewed in FIG. 1.

In one embodiment of the invention, as seen in FIGS. 3 and 4, the innermost winding may be of kraft paper, while the next adjacent winding (proceeding to the outside) is advantageously constructed of an oriented film material such as polyethylene terephthalate, marketed under the trade name "Mylar" by E. I. du Pont de Nemours & Co., Wilmington, Delaware.

It is conventional practice to provide spirally-wound tubes of the nature designated at 14, and these may be provided either on a rotating mandrel, or a stationary mandrel (as contemplated here) in combination with a surface drive—a portion of the surface being drive provided within the housing 11 and another portion being provided at 15 mounted on the pedestal 16. The dis-

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charge end of the machine 10 usually includes a cut-off mechanism, schematically represented as at 17 for severing the spirally-wound tube in appropriate lengths.

Provided as part of the machine 10 is an opposite hand winder generally designated 18 and a "same" hand winder generally designated 19. Inspection of FIG. 1 reveals that the opposite hand winder provides a spirally-wound strip 20, the convolutions of which extend downwardly from right to left on the side in view, i.e., the opposite of the convolutions designated 14.

In the embodiment of the invention presented herein, the cross winding or the winding immediately adjacent the Mylar winding 14b is glass fiber designated 14c in FIG. 3. The fibrous underlayer of kraft in the embodiment illustrated is designated 14a.

The "same" hand winder provides an overlapping layer by virtue of a web strand 21, which again is glass fiber. This, it will be seen, corresponds in orientation to the convolutions initially provided and designated 14 in FIG. 1. Also provided from the winder 19 is a second winding which develops the layer designated 21a in FIG. 3 and in the embodiment illustrated is also of oriented polyethylene terephthalate. Thus, what is provided is a spiral tube having one intermediate layer equipped with a right-hand spiral and the next layer with a left-hand spiral, with the outermost layer being an oriented polyester film.

The opposite hand winder 18 can be seen in FIG. 2 as well, and includes a motor 23 mounted on part of the frame 24 provided as part of the surface drive 15. Mounted for rotation within the frame 24 is a gear 25 suitably driven by a motor 23 and which carries a spool 26 of web material to be wrapped about the tube produced by the machine 10 as at 14. It will be seen from the arrows 27 and 28 applied to FIG. 2 that the direction of rotation of the gear 25 is the same as that of the tube 14 (variously the mandrel 13, if such is employed as the rotation-inducing element). However, the speed of rotation of the ring gear 25 and its associated roll holder 26 is different, i.e., faster, than the rotation of the tube 14. As can be seen from FIG. 1, the spool or roll holder 26 is supported on a shaft 29 inclined at an angle θ to the axis of the mandrel 13. It will be apparent that the angle θ may be changed for various widths of tape and the speed of application thereof.

It is believed that the invention will be better understood through the consideration of a specific example, and for that purpose the following is set down:

EXAMPLE

Exemplary of the products capable of being produced according to the invention is a rigid coil form suitable for carrying electrical wiring and serving as an inductor coil, etc. Such a form may be constructed of the glass fiber layers 21 and 21a when the same are suitable impregnated with an epoxy resin impregnant E. Such fibrous glass material already impregnated with an epoxy resin is commercially available as from Minnesota Mining & Manufacturing Company, of St. Paul, Minnesota, or the Houze Glass Co., of Point Marion, Pennsylvania.

To form a tube of this nature and cure the same apart from the mandrel 13, we provide the first winding 14a in the form of gummed kraft paper. Depending upon the amount of reinforcement needed initially, smaller or larger caliber paper may be employed. Over-lying the spirally wound kraft paper layer 14a is a layer of un-oriented, heat-set polyethylene terephthalate. Such a film is initially heat-set by being subjected to elevated temperatures of from 150-250° C. centigrade, and in this form is stable at temperatures up to the heat-setting temperature. Specifically, Du pont Mylar 571 may be employed. As can be appreciated from FIG. 3, the layers

14a and 14b are wound the "same" hand, and with the convolutions in one layer overlapping the convolutions in the adjacent layer to form a supporting core for the glass fiber tape layers 14c and 21.

Thereafter, at least one layer of Mylar of the oriented, non-heat-set type is provided as a wrapping. In this form, the film will shrink when subjected to temperatures of the order of about 70-80° C., and such temperatures are employed during the curing of the epoxy resin with which the glass fiber strips 14c and 21 are impregnated.

Following removal of the severed tube from the mandrel 13, the tube is cured by residence in an oven at about 150° C. for about one hour. During this period, pressure is applied to the cross-wound glass fiber layers 14c and 21 by virtue of the shrinkage of the outer Mylar layer 21a. It will be appreciated that where increased pressure is indicated, additional layers of Mylar may be applied, this product usually being commercially available in the order of one-half to three mils in thickness. The compressive action provided by the outer Mylar layer 21a forces the impregnant E through the interface between the cross-wound layers 14c and 21 so as to develop a uniform, compact, fully integrated rigid tube.

Upon completion of the cure, the inner supporting layers 14a and 14b are removed, as is the outer compressive layer 21a. It will be appreciated that other materials may be used in the inner supporting layers 14a and 14b which provide a release winding relative to the epoxy adhesive. Other plastic materials such as cellulose acetate, polycarbonate, or polyethylene may be employed to provide this release activity.

In a specific instance of the practice of the invention, for a 1/2" diameter tube, we use for the kraft supporting winding three layers of 0.10" kraft having a width of 1". For the release winding 14b, we employ one or two layers of 0.001" heat-set Mylar having a width of 1/4" to 1/2", which causes it to overlap and insures against leakage of the epoxy to the kraft.

By virtue of utilizing the compressive force of the outer Mylar wrapping, a rigid strong coil form can be developed from the windings 14c and 21, even when the glass fiber layers have thicknesses as small as about 0.020". Further, the glass fiber tape constructed core, when cured, has been found to possess a hoop stress of 175,000 p.s.i. and a flexural modulus of 9.6×10^6 p.s.i. It will be appreciated that the strength of the tube makes it advantageous in maintaining dimensional stability which is essential in a coil form.

While in the foregoing specification a detailed description of an embodiment of the invention has been set down for the purpose of explanation thereof, many varia-

tions in the details herein given may be made by those skilled in the art without departing from the spirit and scope of the invention.

We claim:

1. In the manufacture of rigid tubes, the step of: spirally winding first and second fibrous strips impregnated with a thermosetting adhesive about a mandrel in crossed relation to form an elongated tube, overwinding the said elongated tube with oriented non-heat-set polyethylene terephthalate film to provide a cure assembly wherein the said elongated tube is equipped with a film wrapping, removing the said assembly from said mandrel and heating the said assembly to a temperature sufficient to thermally set said adhesive and shrink said film wrapping about said elongated tube, and removing said film wrapping from said elongated tube.
2. The method of claim 1 in which said thermosetting adhesive is an epoxy resin.
3. The method of claim 1 in which said elongated tube is provided with an inner supporting spirally-wound layer of kraft paper.
4. The method of claim 3 in which a layer of polyethylene terephthalate is interposed between said kraft layer and said first and second fibrous strips.
5. A method of manufacturing rigid tubes, comprising spirally winding a cellulosic supporting strip on a mandrel, providing an overlying layer of polyethylene terephthalate on the first-mentioned layer to provide easy release of a subsequent overlying layer therefrom, spirally winding first and second fibrous strips impregnated with epoxy resin in crossed relation, overwinding the said first and second strips with a non-heat-set polyethylene terephthalate film to provide a cure assembly, removing the cure assembly from said mandrel and heating the assembly to a temperature sufficient to thermally set the epoxy resin and shrink the non-heat-set polyethylene terephthalate film about the cross-wound first and second fibrous strips, and, after curing, removing the fibrous supporting strip and polyethylene terephthalate windings.

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BERNARD STICKNEY, *Primary Examiner.*