March 4, 1969 McCLEERY B. CUNNINGHAM 3,430,543

METHOD OF MAKING A WOUND MULTI-PLY PAPER TUBE

Filed May 27, 1965 Sheet 1 of 4

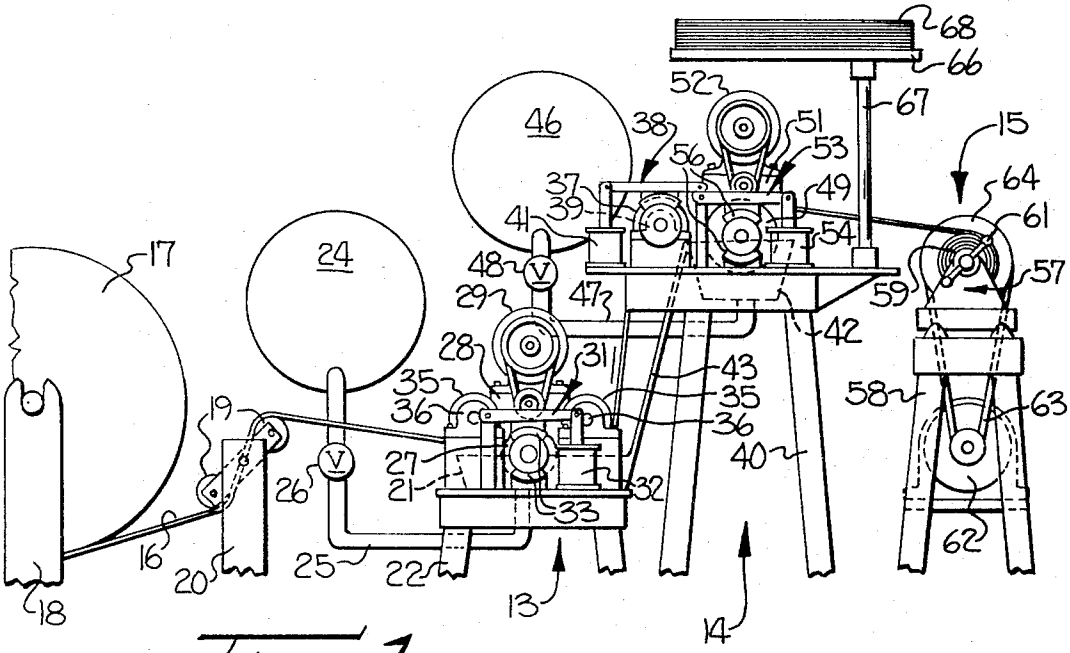


Fig-1

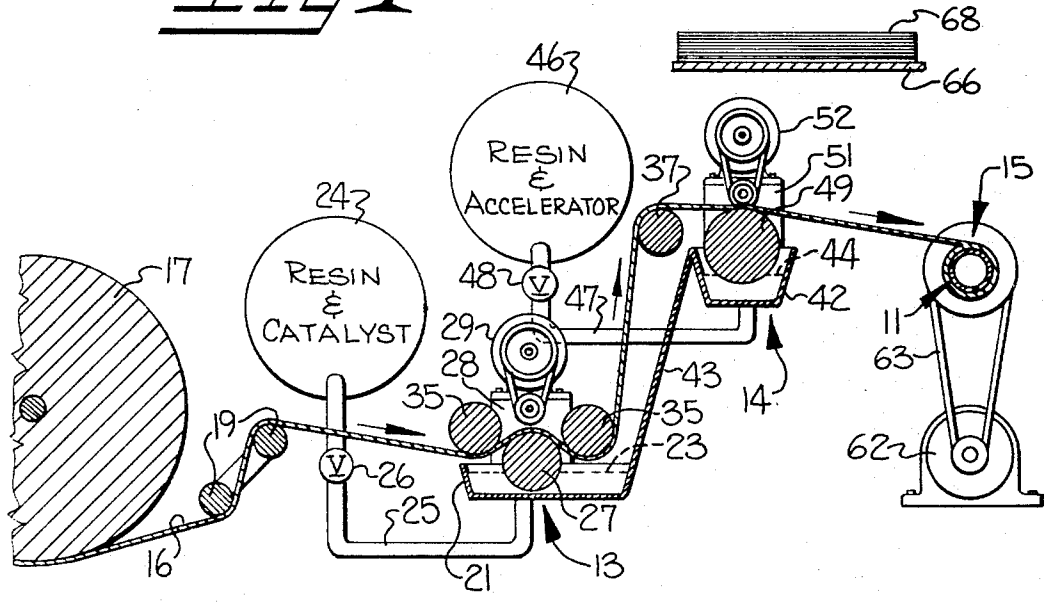


Fig-2

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Filed May 27, 1965 Sheet 2 of 4

Fig-3

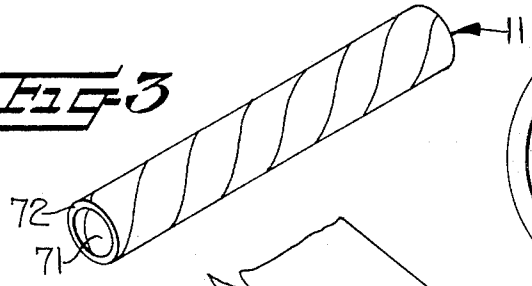


Fig-4

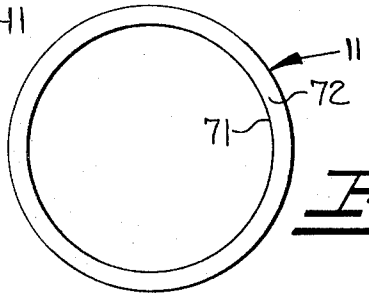


Fig-5

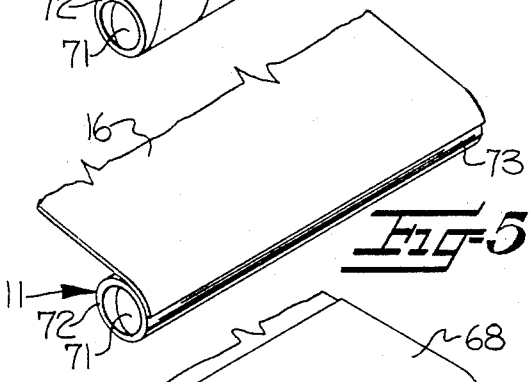


Fig-6

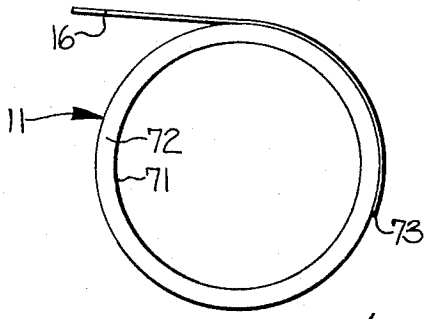


Fig-7

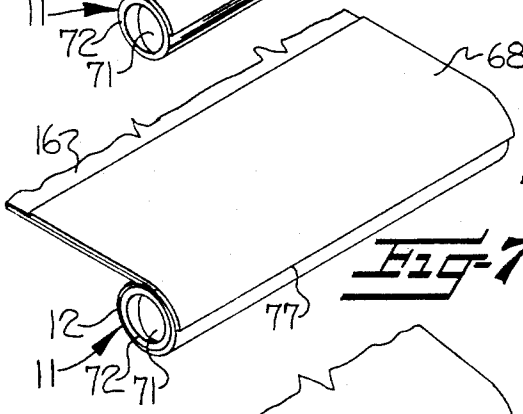


Fig-8

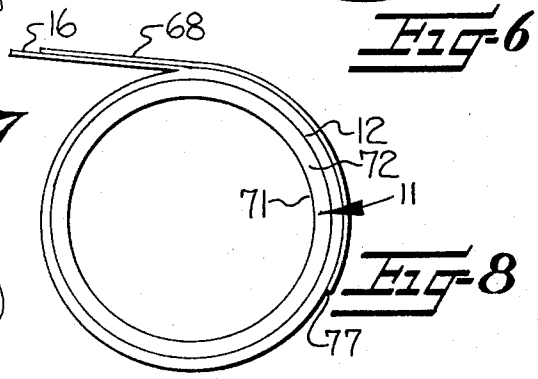


Fig-9

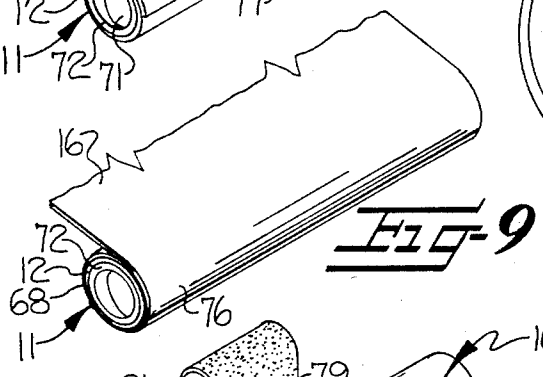


Fig-10

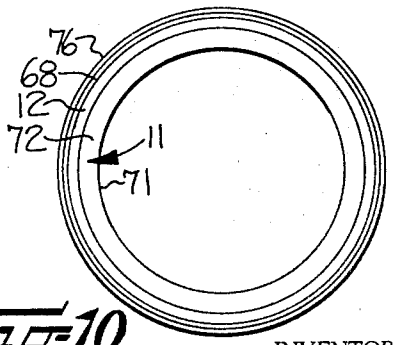
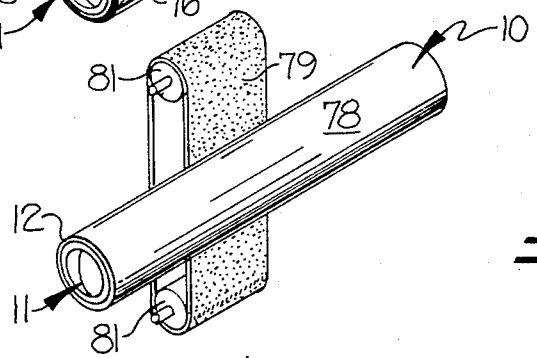


Fig-11



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Filed May 27, 1965 Sheet 3 of 4

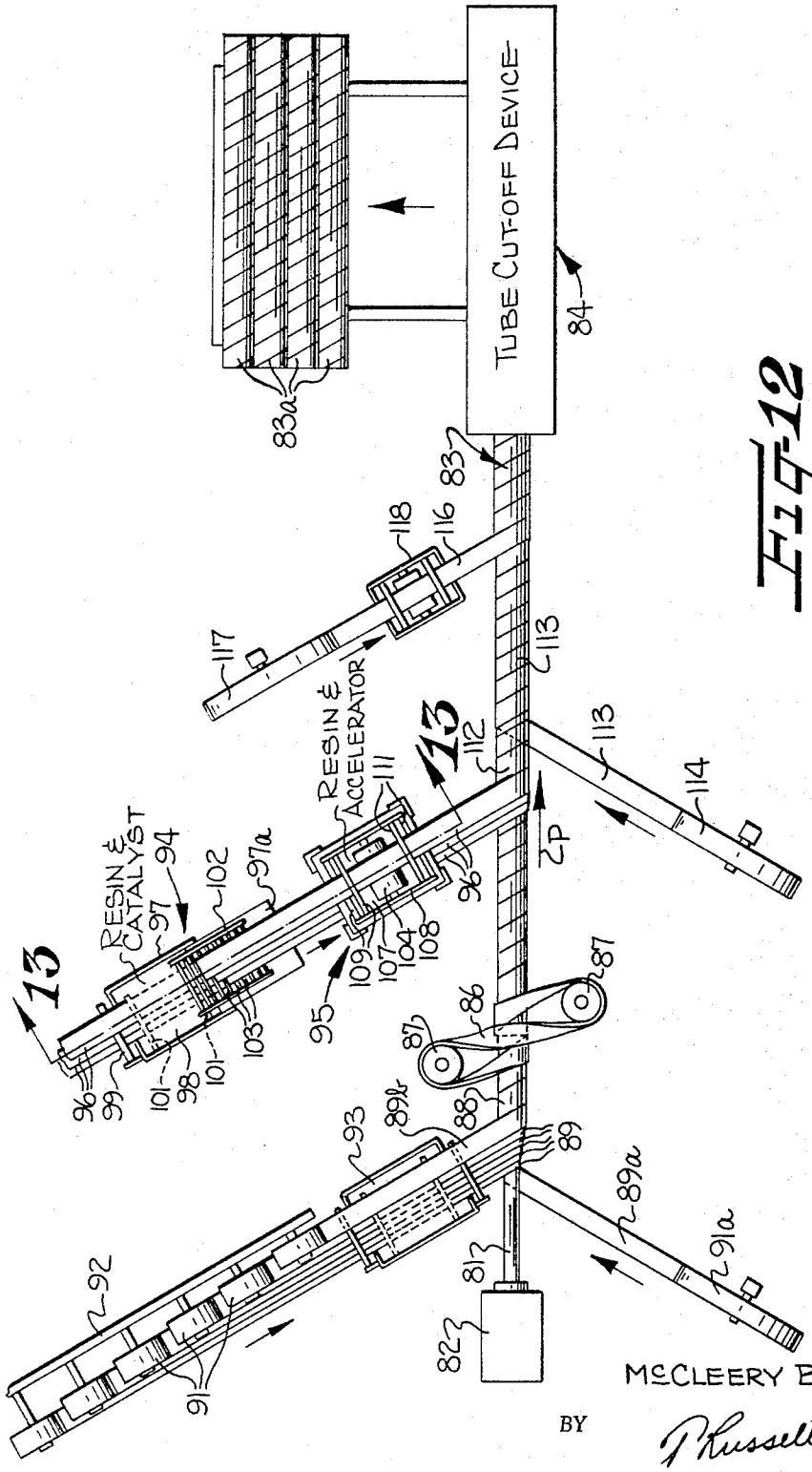


FIG-12

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METHOD OF MAKING A WOUND MULTI-PLY PAPER TUBE

Filed May 27, 1965 Sheet 4 of 4

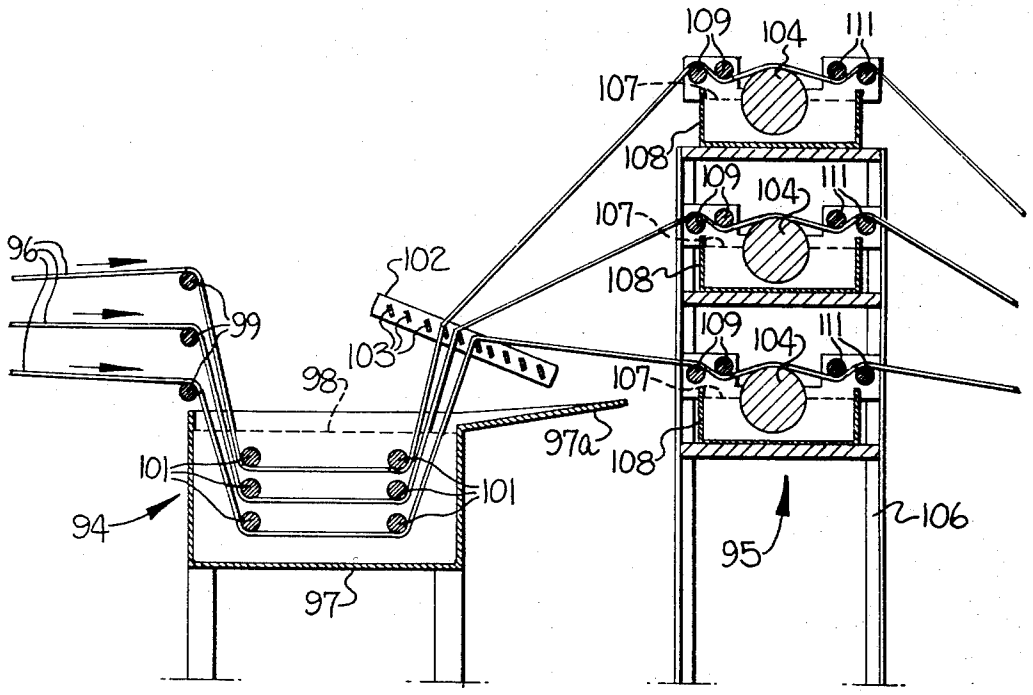


Fig-13

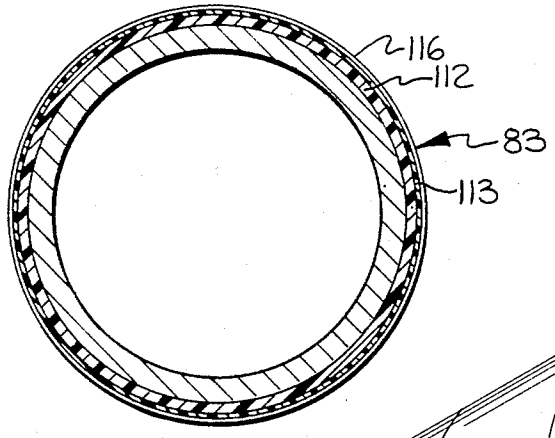


Fig-14

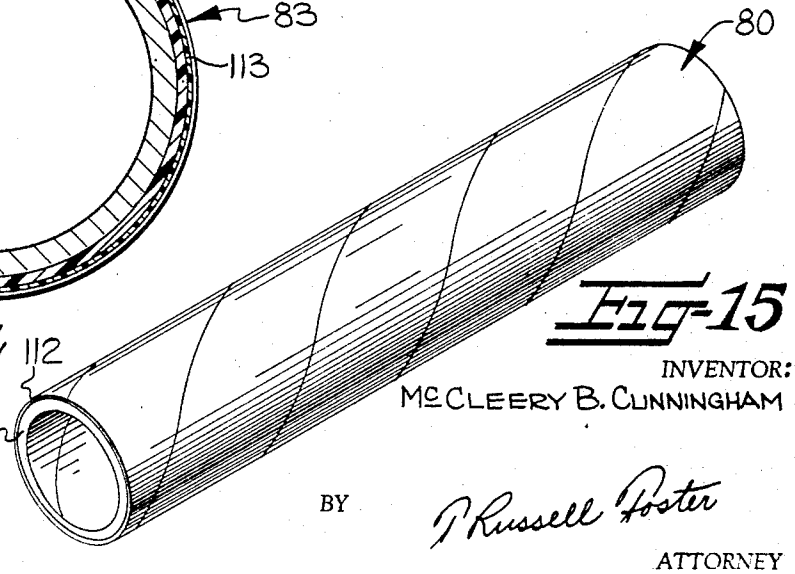


Fig-15

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United States Patent Office 3,430,543
Patented Mar. 4, 1969

3,430,543

METHOD OF MAKING A WOUND MULTI-PLY PAPER TUBE

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Filed May 27, 1965, Ser. No. 463,467
U.S. Cl. 93—94 2 Claims
Int. Cl. B31c 3/00, 13/00

ABSTRACT OF THE DISCLOSURE

A method of making a paper tube by spirally winding a plurality of paper plies on a mandrel with adhesive therebetween and simultaneously winding on the wound paper plies a plurality of plies of paper impregnated with a self-curing resinous material on which are superimposed at least one ply of release material and at least one adhesively coated ply of paper following which the resinous material is permitted to cure to form a tubular core having a hard outer surface when the release material and adhesively coated ply are removed.

This invention relates to paper tubes and more particularly to a method of making a wound multi-ply paper tube having a portion impregnated with a resinous material to produce a new and novel resulting product.

Paper tubes, both spirally and convolutely wound, are in common use today as carriers or cores for web material such as paper, cloth, fiber glass, plastic film and the like. When used for winding film material such as polyethylene, cellophane and the like, such cores are required to have a hard, smooth and cut-resistant surface in addition to having relatively high strength. As is well known, considerable wear and abrasion occurs on the peripheral surface of these cores, particularly when they are composed of paper. This wear considerably shortens the useful life of such cores so that they are generally discarded after a single use. It has been found that imperfections in the core surface would not only be damaging to the fragile film wound thereon, but irregularities in the surface are transmitted throughout all of the wraps or plies of film material wound thereon with a resultant deformation of the material. Furthermore, the severe stresses to which such cores are subjected during winding and handling are often in excess of that which such cores are capable of handling. While ordinary paper has qualities such as low cost and light weight which make it attractive for the manufacture of such cores, its relatively low strength and softness is a distinct disadvantage when it is used for such cores. It has been necessary to resort to the use of expensive materials other than paper such as metal, plastic and the like to obtain the desired core strength and core surface hardness.

Accordingly, a primary object of this invention is to provide a new and novel process for producing a plastic reinforced paper tube or core having a smooth, hard, cut-resistant outer surface.

Another object of this invention is to provide a new and novel treated paper tube, the major portion of which is composed of ordinary paper which may be reused repeatedly in the winding of fragile web materials such as plastic film and the like without damaging such fragile materials.

A further object of this invention is to provide a new and novel process for impregnating a paper tube with a resinous material to provide a smooth, hard, cut-resistant outer surface on the tube.

A still further object of this invention is to provide a new and novel process for impregnating a portion of a

paper tube with a self-curing resinous mixture which begins its self-curing action only after impregnation of the paper tube.

Still another object of this invention is to provide a new and novel process for impregnating only an outer layer of a paper tube with a resinous material in a manner such that substantially all of the advantages of a completely impregnated paper tube are obtained at a substantial reduction in cost, which permits the use of readily available material, and which process may be carried out in a simple and easy manner.

Another object of this invention is to provide a new and novel process for producing a spirally wound paper tube having one or more outer plies impregnated with a self-curing resinous mixture to provide a hard, smooth, cut-resistant outer surface on the tube and which permits the use of conventional spiral tube winding apparatus so that the entire tube may be produced continuously.

Other objects and advantages of the invention will become apparent from the following description taken in connection with the accompanying drawings.

The objects stated above and other related objects in this invention are accomplished by the provision of a composite multi-ply tubular member or core for winding web material which includes an ordinary paper tube of conventional multi-ply, convolutely or spirally wound construction. Paper which has been impregnated with a resinous mixture is wound on this paper tube to form a multi-ply outer layer. The resin in the outer layer is cured to provide a hard, smooth, cut and wear-resistant peripheral surface on the composite core. This multi-ply outer layer may be either convolutely or spirally wound on the paper tube and the paper forming this outer layer is preferably impregnated with a self-curing resinous mixture. The impregnation of this paper with a self-curing resinous mixture is preferably carried out by first impregnating the paper with a resin, preferably a polyester resin, and a catalyst for the resin and then subsequently impregnating the resin-catalyst impregnated paper with a mixture of the same resin and an accelerator for the resin. The outer layer is then covered with a layer of impervious release material and an outer wrap which are subsequently removed after curing to provide a finished tubular member or core. The well known chemical reaction between the resin, catalyst and accelerator cures the resin in the outer layer to form a composite core having an inner dry paper tube covered with a hard, smooth outer shell.

The novel features which are believed to be characteristic of the invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and method of operation may be best understood by reference to the following description taken in conjunction with the accompanying drawings in which:

FIGURE 1 is a side elevation view, partially cut away, of apparatus employed in the practice of the invention;

FIGURE 2 is a sectional view of the apparatus of FIGURE 1;

FIGURE 3 is a perspective view of a spirally wound paper tube which is incorporated in the composite core of the invention;

FIGURE 4 is an enlarged end view of the tube of FIGURE 3;

FIGURE 5 is a perspective view similar to FIGURE 3 illustrating one step in the process of the invention;

FIGURE 6 is an enlarged end view of the tube of FIGURE 5;

FIGURE 7 is a view similar to FIGURE 5 illustrating another step in the process of the invention;

FIGURE 8 is an enlarged end view of the tube of FIGURE 7;

FIGURE 9 is a view similar to FIGURE 7 showing a further step in the process of the invention;

FIGURE 10 is an enlarged end view of the tube of FIGURE 9 at the completion of the step of FIGURE 9;

FIGURE 11 is a perspective view of the composite core of the invention illustrating an additional operation which may be performed on the core;

FIGURE 12 is a plan view of another apapratus used in the practice of the invention to produce another embodiment of the invention;

FIGURE 13 is an enlarged sectional view taken substantially along line 13—13 of FIGURE 12 in the direction of the arrows;

FIGURE 14 is an enlarged sectional view of a composite core produced by the apparatus of FIGURE 12 at one stage of its manufacture; and,

FIGURE 15 is a perspective view of a finished composite core produced by the apparatus of FIGURE 12.

As generally illustrative of the invention, there is shown in FIGURES 1, 2 apparatus for producing one embodiment of the plastic impregnated composite tubular member or core of the invention. The core produced in the apparatus of FIGURES 1, 2 is identified generally in FIGURE 11 by the numeral **10** and comprises a multi-ply wound inner paper tube designated generally by the numeral **11** in FIGURE 3 and a hard multi-ply outer layer **12** of resin impregnated paper.

The apparatus of FIGURES 1, 2 comprises a first paper impregnating station designated generally by the numeral **13**, a second impregnating station identified generally by the numeral **14** and a winding station identified generally by the numeral **15**. A web **16** of paper pulled from a supply roll **17** supported on pedestal **18** is arranged to be advanced through a pair of pivotally mounted tension rolls **19** mounted on pedestals **20**. The paper web **16** is subsequently advanced through the impregnating stations **13**, **14** for impregnation with a suitable medium as will be described hereinafter. In the preferred embodiment of the invention, the paper impregnating medium is a self-curing resinous mixture of a resin, catalyst and an accelerator.

Impregnating station **13** comprises a reservoir or trough **21** suitably supported on a stand **22**. The trough **21** is arranged to contain a bath **23** of a paper impregnating material which in the illustrated embodiment comprises a thermosetting resin such as a polyester resin and a catalyst for the resin. As is well known, the resin and catalyst selected are of the type which do not react or "set up" at room temperature over a prolonged period of time so the bath **23** remains in the fluid condition. The bath **23** is supplied from a suitable resin-catalyst supply source such as a drum **24** which is connected to the trough **21** by means of a conduit **25** having a metering valve **26** located therein.

An impregnating or "kiss" roll **27** is partially immersed in the bath **23** and is rotatably mounted at each end in bearings (not shown) supported on the stand **22**. The roll **27** is driven through a speed reducer **28** connected to a motor **29** which permits the speed of the roll to be controlled. A brake designated generally by the numeral **31** and preferably electrically operated by means such as a solenoid **32** is positioned on the stand **22** adjacent one end of the roll **27**. The brake **31** is of the well known type and is provided with shoes **33** which move into braking engagement wtih the roll **27** under spring action or the like when the solenoid **32** is deenergized.

Idler rolls **35** are rotatably supported at each end on the stand **22** in bearing pedestals **36** and position the advancing paper web **16** so that it is maintained in contact with the peripheral surface of roll **27** as shown.

As the web **16** advances through impregnating station **13**, it is directed upwardly in the direction of the arrows to a scraper roll **37**. A brake designated generally by the numeral **38** is associated with the scraper roll **37** which is supported at each end in bearing pedestals **39** positioned on a stand **40**. The brake **38** may also be electrically operated as shown by a solenoid **41**.

The impregnating station **14** is generally similar to the impregnating station **13** and comprises a trough or reservoir **42** which is connected to the lower reservoir **21** by means of a deflector plate **43** of sheet metal or the like. The plate **43** permits fluid dripping from the web **16** as it moves from trough **21** to trough **42** to be conducted back into the lower reservoir **21**.

The reservoir **42** contains a bath **44** of a second impregnating fluid which comprises resin of the type employed in the lower bath **23** together with an accelerator for the resin. The resin and accelerator in the bath **44** are selected so as not to chemically react or "set up" at room temperature over a prolonged period of time and therefore the bath **44** remains fluid. A suitable supply source for the bath **44** such as a drum **46** is provided as shown and communicates with the trough **42** by means of a conduit **47** including a valve **48** to maintain the bath **44** at the desired level.

An impregnating roll **49** is provided at the station **14** which is driven by means such as a speed reducer **51** and a motor **52** connected thereto. The roll **49** is partially immersed in the bath **44** as shown and is suitably supported at each end in bearings or the like (not shown) positioned on the stand **40**. An electrically operated brake designated generally by the numeral **53** and provided with a solenoid **54** and shoes **56** is associated with the roll **49** in a manner similar to the brake **31** for roll **27** and operates, when de-energized, to brake the roll **49**.

The winding station **15** comprises generally a head **57** mounted on a stand **58**. The head **57** includes rotatable clamping means for a paper tube such as spaced chucks **59** which can be moved into engagement with the ends of a paper tube of the type shown in FIGURE 3 and identified by the numeral **11**. A handwheel **61** is provided for axially moving at least one of the chucks in the well known manner for clamping a tube **11** placed in the head **57**. Means are provided for rotating the chucks **59** which include a motor **62** connected by means of a belt **63** to drive pulleys **64** in any well known manner.

A shelf or platform **66** is suitably supported on the stand **40** of the impregnating station **14** by posts **67** or the like which supports sheets **68** of release material used in the assembly of the core **10** of the invention. These sheets of release material may be glassine, cellophane, wax paper or the like treated, if desired, with material such as silicone to enhance its release properties which is impervious to the resinous mixture used in the practice of the invention as will be explained hereinafter.

As specifically illustrative of the practice of the novel process of the invention, the embodiment of FIGURES 1–11 is directed to the construction of the core **10** which is hereinafter referred to as the convolute-type core. The term convolute-type indicates that the impregnated paper plies with which the core **10** is formed are convolutely wound rather than spirally wound on the paper tube **11**.

In order to form the core **10** with the apparatus of FIGURES 1, 2, a paper tube **11** shown in FIGURE 3 is provided, which in the preferred embodiment is a spirally wound multi-ply paper tube of conventional construction having a central bore **71** and a relatively thin side wall **72**. As is well known, the tube **11** is formed by spirally winding in helically overlapping relationship a plurality of paper plies with adhesive therebetween. It should be understood that the tube **11** may be either spirally or convolutely wound, but is preferably spirally wound due to the less expensive construction in comparison with the convolutely wound tube.

The paper tube **11** is positioned in the head **57** of winding station **15** for axial rotation and the handwheel **61** is rotated to securely clamp the tube **11** between the chucks **59**. After tube **11** is clamped in position, the paper web **16** is unrolled from the supply roll **17** and is advanced through the tension rolls **19** and over the impregnating roll **27** with the paper web being held against the roll **27** by means of the guide rolls **35** as shown. The brake **38** is reapplied so that the roll **37** resumes the scraping oper-

ation on web **16**. Preferably, the roll **27** is rotated by means of the motor **29** at a greater peripheral speed than the web **16** so as to impregnate the web thoroughly with the mixture of resin and catalyst in the bath **23**.

The resin-catalyst impregnated web **16** is then advanced upwardly in the direction of the arrow over the scraper roll **37** which at this time is braked by the solenoid operated brake **38** to scrape off the excess resin-catalyst on the underside of the web. The web **16** is advanced over the surface of the impregnating roll **49** as shown so that the resin-catalyst impregnated paper web **16** is now impregnated with the resin-accelerator mixture in the bath **44**. The roll **49** is also preferably driven at a selected peripheral speed greater than the web speed so as to thoroughly impregnate the web **16** with the mixture in the bath **44**.

As a result of the "kiss" type roll **27**, the scraping action of the roll **37** and the use of a "kiss" type roll **49**, virtually none or only a negligible amount of resin and catalyst is carried into the bath **44** and the mixture in the bath **44** does not react or "set up" as would occur when all three ingredients namely, the resin, accelerator and catalyst, are mixed. Thus, the elimination of catalyst in bath **44** is accomplished satisfactorily with the novel arrangement of the invention. It should be understood that during the impregnating of the paper web **16**, the solenoid brakes **31**, **53** at the impregnating stations **13**, **14** have been released so that the rolls **27**, **49** can be driven by drive motors **29**, **52**, respectively.

Referring now to FIGURES 5, 6, the end of the impregnated paper web **16** advancing from the impregnating station **14** to the winding station **15** is secured to the paper tube **11** by means such as gummed tape **73** preferably extending throughout the length of the tube.

The paper tube **11** is then rotated by energizing the drive motor **62** so as to wind the impregnated paper web **16** on the tube in a plurality of wraps to build up the multi-ply outer layer **12** on the tube as indicated in FIGURES 7, 8. Any desired number of wraps of the impregnated paper web **16** may be used in forming the outer layer **12** and by way of example, eight to twelve wraps have been found suitable. A very satisfactory core has been produced wherein paper tube **11** comprises at least 90% of the total thickness of the core **10** of the invention, but it should be understood that where greater strength is desired, the proportion of the total thickness of the core **10** formed by the outer layer **12** may be increased to the desired extent.

Just before the last few wraps of impregnated paper are wound on the tube **11**, impregnation of the paper web **16** is interrupted by first braking impregnating roll **27**. Impregnating roll **49** is subsequently braked when it is reached by the dry paper so that the paper web **16** advances over the surfaces of both rolls **27**, **49** without impregnation and a length of dry paper begins on the web **16** at the end of the last wrap of impregnated paper laid on the tube **11**. The interval between the braking of rolls **27**, **49** is to permit the impregnated length of web **16** to receive the mixture from both baths **23**, **44**. The brake **38** on the scraper roll **37** is released so that when dry paper is advancing over the roll **37**, the roll rotates freely.

Prior to beginning the wrapping of the last impregnated wrap on the paper tube **11**, a sheet **68** of release material is removed from the platform **66** and placed manually as shown in FIGURE 7 on the impregnated paper web being wound on the tube **11**. Rotation of the tube **11** is halted at this time to permit the application of this release material and as the underlying paper is impregnated, the release material adheres readily.

After application of the sheet **68** of release material, rotation of the tube **11** is resumed and the release material is wound up with the underlying paper web so as to completely cover the impregnated layer **12** with approximately one wrap of release material the length of which has been selected so as to meet this requirement. As a result of the braking of the rolls **27**, **49** as previously explained and the interruption in the impregnation of the paper web **16**, the impregnated portion of web **16** terminates approximately at the trailing edge of the sheet **68** of release material and continued rotation of the paper tube **11** wraps the dry portion of paper web **16** over the sheet **68** of release material as shown in FIGURE 9. In this manner, a suitable number of wrap of unimpregnated or dry paper are applied so as to serve as an outer wrap **76** for the multilayer structure shown in FIGURE 10.

When the end of the length of dry outer wrap **76** is reached, the rotation of the paper tube **11** is terminated and the paper web **16** severed transversely. The cut edge of the outer wrap **76** may then be suitably held in position using gummed tape or the like. It should be understood that prior to reaching the end of the length of the dry paper web during the wrapping of the outer wrap **76**, brakes **31**, **53** are released to resume impregnation of the paper web **16** and web **16** can be severed at the beginning of the impregnated web portion when the core **10** is completely wound and ready to be removed.

As the mixture of resin-catalyst-accelerator with which the paper web **16** has been impregnated is a self-curing mixture, the multilayer structure of FIGURE 10 comprising the paper tube **11**, outer layer **12**, release material **68** and outer wrap **76** can now be removed from the tube forming station **15** and set aside to permit the outer layer **12** to cure and harden. The release material **68** retains the resinous mixture in the outer layer **12** and the outer dry wrap **76** holds the release material in confining relationship with the underlying outer layer **12**.

Subsequent to the curing operation, the outer wrap **76** and release material **68** can then be cut off to expose the hard outer layer **12** which is now provided with a smooth, cut and wear-resistant outer surface. The portion of the impregnated paper web **16** forming the outer layer **12** terminates at the inner end of the release material **68** so that along this edge a cut is made to sever and remove all of the outer wrap **76** and release material **68**. Thus an edge is formed along this cut line which is identified in FIGURES 7, 8 by the numeral **77**.

In order to eliminate the edge **77** and provide an absolutely smooth outer surface on the outer layer **12** of core **10**, a grinding operation is preferably carried out on the exterior surface **78** of the finished core **10** as shown in FIGURE 11. This grinding or sanding operation can be carried out by any suitable means such as an abrasive belt **79** mounted on drive rolls **81** as shown. If desired, progressively finer belt surfaces can be used so as to improve the smoothness of the core surface **78**. If desired, the surface **78** may be further smoothed by recoating the ground surface **78** with a polyester-catalyst-accelerator mixture and permitting this coat to cure and harden at room temperature which generally is a fairly rapid operation. As a final operation, the ground core surface **78** can be buffed with a belt composed of a material such as leather to obtain a smooth glossy finish.

The finished core **10** therefore comprises the inner paper tube **11** and the outer layer **12** which presents a smooth, hard cut and wear-resistant surface so desirable when such a core is used as a winding core for fragile film materials such as cellophane and the like. As explained above, the outer layer **12** need only be a minor portion of the overall core thickness as the paper tube **11** reinforces the core outer layer **12** to provide a core having both an unusually hard outer surface and high strength.

A wide variety of resinous materials may be used with success in impregnating the paper web **16** to form the outer layer **12**. These resinous materials may be cured by the application of heat and/or pressure and any resinous material which will cure to a hard, durable condition can be used. However, in the specific embodiment illustrated, a self-curing mixture including resin gives a highly desirable result and the novel feature of the two-component system utilizing the two impregnating stations **13**, **14** has been

found to produce outstanding results in the practice of the invention as the resinous mixture in the troughs at each impregnating station will not cure or harden and therefore have an indefinite pot life to give highly attractive commercial advantages.

Among the resinous materials suitable for use in such a two-component system, polyester resins have been found to be very satisfactory. Such polyester resins can be defined as the poly-condensation products of unsaturated acids such as maleic and fumaric with dihydroxy alcohols such as ethylene glycol cross linked with a vinyl monomer such as styrene. These polyester resins can be polymerized at room temperature with catalysts such as benzoyl peroxide, cyclohexanone peroxide or methyl ethyl ketone peroxide together with accelerators such as dimethyl aniline or cobalt naphthenate.

In the specific embodiment illustrated, the polyester resin and catalyst form the bath **23** of impregnating station **13** and a polyester resin and accelerator form the bath **44** of impregnating station **14**. The mixture of the resin, catalyst and accelerator with which the paper web **16** is impregnated will spontaneously set up and cure to a solid mass within a time determined by the nature, amounts and proportions of the catalyst and accelerator, and the actual proportions of each ingredient in the mixture may be varied to obtain variation in the speed of this curing action.

In the operation of the invention using such a two-component system, highly desirable results have been obtained using a 3% benzoyl peroxide paste in the bath **23** and a 10% dimethyl aniline in the bath **44**. Monomeric styrene can be added to the system to decrease the viscosity to get improved penetration of the resin into the paper.

Other resins which may be suitable for such use in the invention include the so called epoxy or epichlorohydrin-bisphenol type of resin.

Referring now to FIGURES 12–15, there is shown an apparatus for producing another embodiment of a composite core constructed in accordance with the invention. This core, identified in FIGURE 15 by the numeral **80**, is similar to the core **10** of FIGURES 1–11, but has other characteristics which permit it to be produced in a more economical and continuous fashion. In the apparatus shown in FIGURES 12, 13, conventional spiral tube winding machinery is illustrated, which includes a mandrel **81** supported at one end in a head **82**. A multi-ply tubular structure **83**, as shown in FIGURE 14, is formed continuously on the mandrel **81** and is cut off into sections of predetermined length **83***a* by means of any suitable cutoff device designated generally by the numeral **84**. The cutoff sections **83***a* include the cores **80** of the invention.

As is well known, a continuous belt **86** is employed with the mandrel **81**, being wrapped around the mandrel as shown, which belt is driven by a set of "capstans" or pulleys **87**. A preform or dry paper tube **88** corresponding to the paper tube **11** of FIGURE 3 is continuously formed on the mandrel **81** by spirally winding a plurality of paper plies **89** of paper drawn from rolls **91** supported on a creel **92**. The inner and outer plies **89***a*, **89***b*, respectively, are wound dry with the intermediate plies **89** being advanced through a glue bath **93** so that all of the plies are adhesively joined together to form the tube **88** as it is rotated by the belt **86** against the surface of the mandrel.

It will be noted that the inner ply **89***a* is fed from a supply roll **91***a* on the opposite side of the mandrel **81** from the other plies and underneath rather than over the mandrel. This is to permit a suitable liquid lubricant such as wax to drip from a reservoir (not shown) onto the ply **89***a*.

As in the embodiment of FIGURES 1–11, paper impregnating stations designated generally by the numerals **94**, **95** are provided for impregnating a plurality of plies **96** of paper advancing in the direction of the arrows from a suitable source of supply such as a creel (not shown). As shown best in FIGURE 13, the impregnating station **94** comprises a trough **97** containing a bath **98** of resin and a catalyst for the resin and each of the paper plies **96** are advanced over guide bars **99** and through the bath **98** guided by bars **101**.

Excess resin-catalyst on the plies **96** is scraped off by means of a scraper **102** of conventional construction suitably supported over the trough **97** and an inclined trough extension **97***a*. The scraper **102** includes scraper bars **103**, each of which contact a ply **96** advancing thereover to scrape the excessive material from the plies and permit it to drip back into the bath **98**.

The paper plies **96** impregnated with resin and catalyst then advance to the impregnating station **95** where they are moved over freely rotatable impregnating rolls **104** arranged in a vertically stacked relationship as shown in FIGURE 13 on a stand **106**. Each of the rolls **104** is partially immersed in a bath **107** of resin and an accelerator for the resin as in the previous embodiment maintained in a trough **108**. Pairs of guide rolls **109**, **111**, are suitably supported on opposite sides of each roll **104** to guide the paper plies **96** in the desired direction and maintain the paper plies **96** in contact with the rolls **104**. Thus, the paper plies **96**, which have previously been impregnated with resin and catalyst at the impregnating station **94** are now impregnated with resin and accelerator in station **95** so that a self-curing mixture is soaked into all of the paper plies **96**.

The impregnated paper plies **96** are then wound spirally onto the paper tube **88** as shown in FIGURE 12 down from the belt **86** as the tube moves forwardly in the direction of the arrow P to form an outer layer **112** as shown in FIGURES 14, 15 corresponding to the outer layer **12** of the core **10** of FIGURE 11. A paper strip **113** of release material such as silicon coated glassine is unwound from a supply roll **114** and is spirally wound onto the impregnated outer layer **112** in a single ply as shown in FIGURE 12. The strip **113** acts to retain the resinous material in the layer **112** as in the embodiment of FIGURES 1–11.

In order to hold the strip of release material in spirally wrapped relationship with the underlying layer **112**, a strip **116** of gummed paper is unwound from a supply roll **117** and is spirally wrapped over the ply of release paper strip **113**. The gummed paper strip **116** is preferably moistened prior to winding by advancing the adhesively coated side of the gummed paper over suitably moistening means **118**.

Thus, the multi-ply structure **83** continuously formed on the mandrel **81** and pulled therefrom comprises four concentric portions—the spirally wound paper tube **88**, the impregnated layer **112**, the release material **113** and the outer gum strip wrap **116** as shown clearly in FIGURE 14.

As this continuously formed multi-ply structure **83** moves into the cutoff device **84**, sections **83***a* of predetermined length are severed therefrom and these sections **83***a* can be stored for a brief period of time until the layer **112** cures and hardens. After the layer **112** has cured and hardened, the outer wrap **116** and release material **113** can then be cut away in a manner similar to the embodiment of FIGURES 1–11 to provide the core **80** of FIGURE 15 having a hard, smooth cut and wear-resistant outer layer as has been previously described. Furthermore, this outer layer **112** is preferably ground and buffed also, if desired, to provide the smooth outer surface resired in the core produced in accordance with the invention.

With the novel construction of this invention, there has been provided a new and novel core for winding film material which core is characterized by outstanding crush strength and a surface having the desired degree of hardness, smoothness and resistance to wear so that the core serves ideally for winding readily deformable film material such as cellophane and the like. Due to the outstand-

ing strength of the core of the invention brought about by ordinary paper and resin impregnated paper combined in an unusual manner, only a relatively thin outer layer of resin impregnated paper need be provided on the composite multi-ply core with an attendant savings of expensive materials. This outer layer may also be formed by resin impregnation of other materials to provide a wide variety of surface appearance and strength characteristics. The core of the invention may be produced using a number of novel processes disclosed herein and in particular the core may be produced by a single sepiral tube winding operation commonly employed in everyday practice. An outstanding feature of the invention is the use of a self-curing mixture for impregnating the outer layer in the core wherein components of the mixture are located in two reservoirs so that all of the components remain in a fluid condition and are combined during impregnation of the paper so that they do not begin to "set up" or cure before the paper is wound into the core of the invention.

Having thus described the invention, what is claimed is:

1. A method of making a composite multi-ply tubular member comprising the steps of, spirally winding a plurality of plies of paper with adhesive therebetween to form a wound multi-ply paper tube, impregnating a plurality of plies of paper with a self-curing mixture comprising a resin, catalyst for said resin, and an accelerator for said resin, spirally winding said plurality of plies of impregnated paper on said paper tube to form an outer layer, spirally winding at least one ply of release material around said outer layer to retain the self-curing resinous mixture in said outer layer, spirally winding at least one adhesively coated ply of paper on said ply of release material, all of said spiral winding operations being performed simultaneously, and permitting said outer layer to cure and solidify to thereby form a hard, wear-resistant outer surface on said tubular member which is exposed when said release material and adhesively coated ply are removed.

2. A method in accordance with claim **1** wherein said plurality of plies of paper is first impregnated with a mixture of said resin and catalyst and subsequently impregnated with a mixture of said resin and accelerator.

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U.S. Cl. X.R.

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