United States Patent [19]

Witzig

[11] **3,869,325**

[45] **Mar. 4, 1975**

[54] **METHOD OF MAKING A CONVOLUTE TUBE**

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[22] Filed: **Sept. 21, 1972**

[21] Appl. No.: **291,134**

Related U.S. Application Data

[62] Division of Ser. No. 835,393, June 23, 1969, Pat. No. 3,704,730.

[52] **U.S. Cl.** ..... **156/192,** 93/94 R, 156/218, 156/289, 156/291

[51] **Int. Cl.** **B31c 1/00**

[58] **Field of Search** ..... 156/184, 187, 192, 203, 156/218, 289, 291; 93/94 R; 138/144, 146; 117/68.5

[56] **References Cited**

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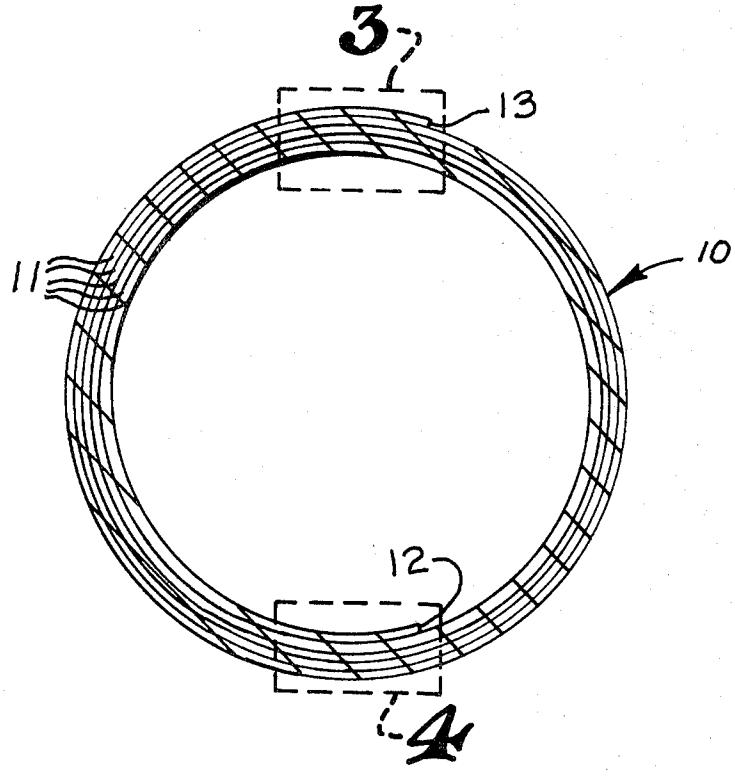
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[57] **ABSTRACT**

An elongate, convolutely wound, adhesively secured tube and method for making same from elongate sheet material and being characterized by eliminating the necessity of having a high moisture content in the adhesive for holding the wound tube together following winding, wherein the method includes applying relatively slow acting, low moisture adhesive to a major portion of a first surface of the sheet material, applying relatively fast acting adhesive to a minor portion of the first surface substantially adjacent a first longitudinal edge thereof into a convolute tube with the first longitudinal edge forming an outside trailing edge and the fast acting adhesive acting to immediately secure the trailing edge to the outer surface of the convolute tube to retain the convolute tube in the wound condition during activation of the slow acting, low moisture adhesive.

4 Claims, 7 Drawing Figures



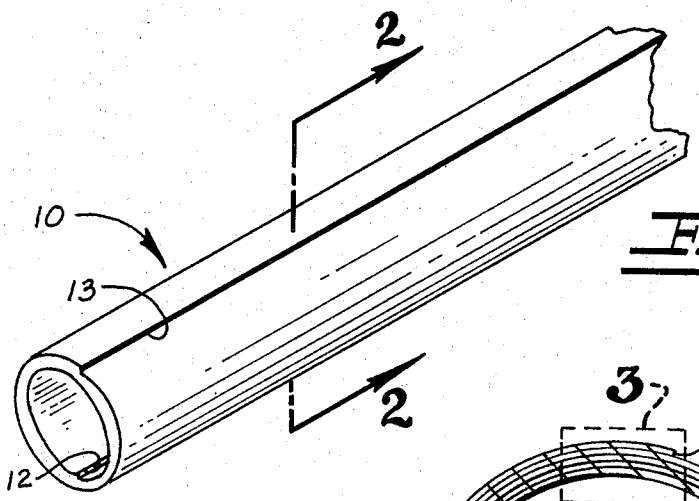


Fig-1

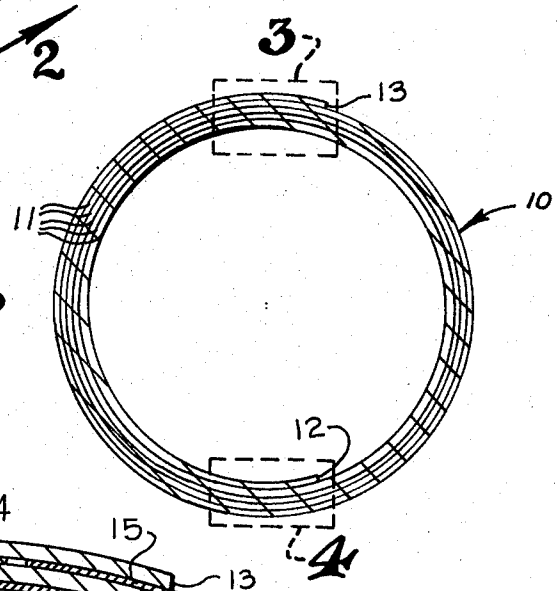


Fig-2

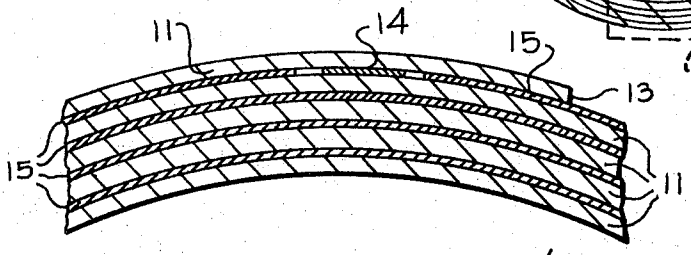


Fig-3

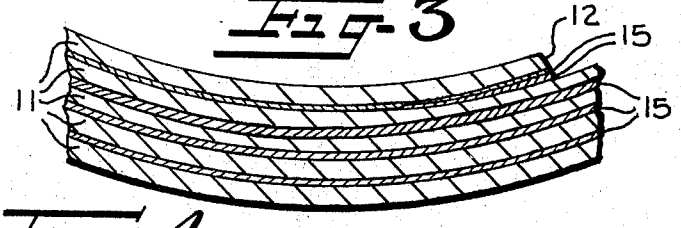


Fig 4

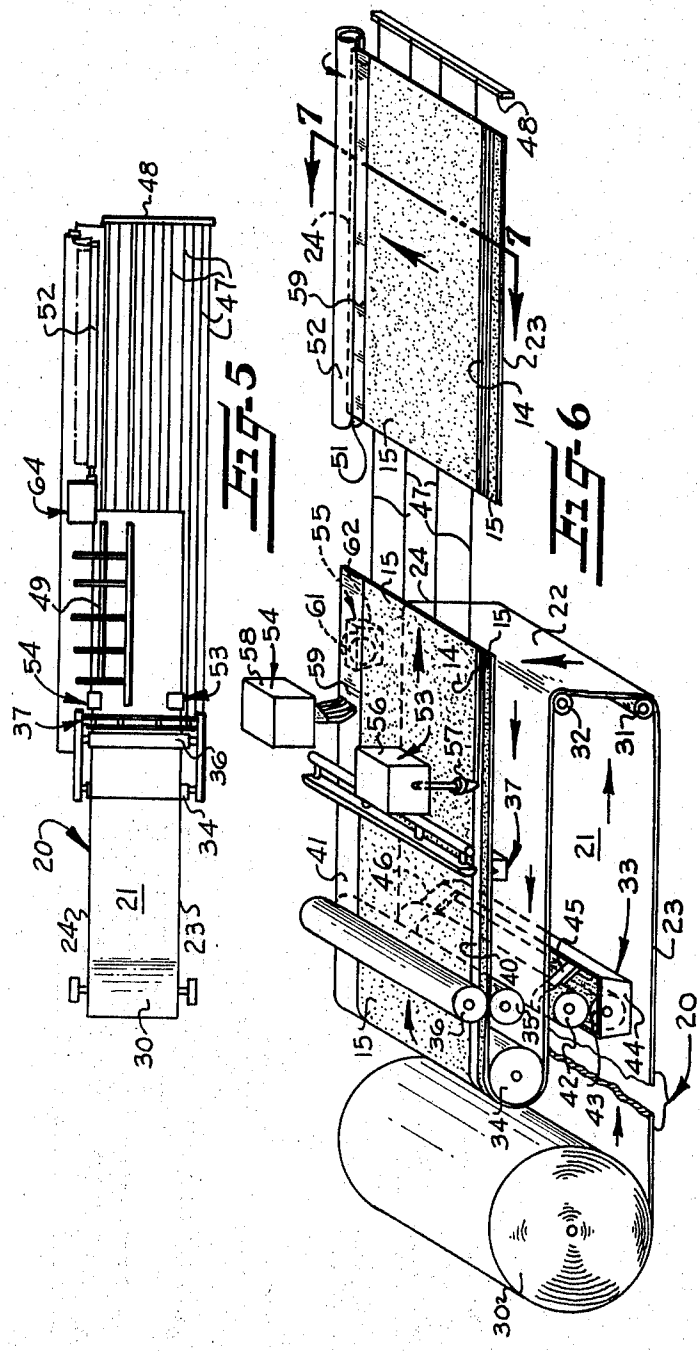


FIG-5

FIG-6

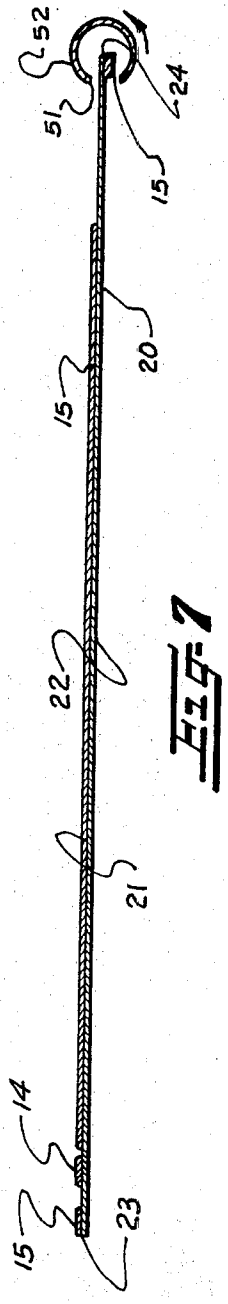


FIG-7

METHOD OF MAKING A CONVOLUTE TUBE

This application is a division of application Ser. No. 835,393, filed June 23, 1969, now U.S. Pat. No. 3,704,730.

This invention generally relates to elongate tubes made from elongate sheet material such as paper and the like, but more particularly to elongate convolutely wound tubes and an improved method for making same.

Heretofore, methods for making convolutely wound tubes from elongate sheet material such as paper and the like generally included applying an adhesive to one surface of the sheet material and convolutely winding a predetermined length of the elongate sheet material transversely of the length thereof into a convolute tube with the adhesive permanently bonding the convolute tube in the wound condition. Typically, as when forming a convolute tube from paper, an adhesive having a high moisture content (about 80–85% by weight) was employed which wet the sheet material and wet fastened the convolute windings in overlying relation to hold the tube in the wound condition immediately following winding and during activation of the adhesive as by drying the wound tube in an oven or the like.

It is readily apparent that the wetting of the paper by the adhesive presents many problems in the manufacture of convolute tubes. In particular, the additional drying step substantially increases the cost of producing such convolute tubes and the facilities for drying consume valuable space. In addition, the wetting of the paper by the adhesive causes a loss of strength in the paper which limits the rate at which the paper may be convolutely wound and the manner in which the wound tube may be handled until drying is complete. Furthermore, the convolute tube produced is not completely satisfactory in that the adhesive is dispersed throughout the thickness of the wall of the tube rather than between convolute windings and in many cases on both the inner and outer surface thereof.

With the aforementioned in mind, it is an object of this invention to provide an improved convolutely wound tube and method for making same from elongate sheet material such as paper and the like wherein an initially low moisture adhesive may be used to permanently bond the convolute tube in the wound condition, thus, avoiding a drying step following winding.

Another object of the invention is to provide an improved convolutely wound tube and method for making same from elongate sheet material such as paper and the like wherein a means is provided for holding the convolute tube in the wound condition immediately following winding to allow the use of an initially low moisture, slow acting adhesive to permanently bond the tube in the wound condition.

By this invention, it has been found that the above objects may be accomplished by providing a method of making convolutely wound, adhesively secured tubes utilizing the steps of applying relatively slow acting, low moisture adhesive to a major portion of the first surface of the sheet material, applying relatively fast acting adhesive to a minor portion of the first surface of the sheet material substantially adjacent the first longitudinal edge thereof, and convolutely winding a predetermined length of the elongate sheet material transversely of the length into a convolute tube with the second surface of the sheet material forming the outside surface of the tube and with the first longitudinal edge having the relatively fast acting adhesive adjacent thereto forming the outside trailing edge of the tube for immediate adherence of the trailing edge portion to the outer surface of the convolute tube to retain the convolute tube in the wound condition during activation of the slow acting, low moisture adhesive to permanently bond the convolute tube in the wound condition.

The improved convolutely wound, adhesively secured tube formed by the above method comprises a plurality of overlying convolute windings of the sheet material and including inside and outside edges formed by the longitudinal edges of the sheet material, a fast acting adhesive bonding the last convolute winding to the next underlying convolute winding, and a slow acting, initially low moisture adhesive bonding the remainder of the convolute windings in overlying relationship, the fast acting adhesive retaining the convolute windings in overlying relationship during activation of the slow acting, low moisture adhesive after winding of the tube.

Some of the objects of the invention having been stated, other objects will appear as the description proceeds, when taken in connection with the accompanying drawings, in which:

FIG. 1 is a perspective view of a portion of an elongate convolutely wound tube produced in accordance with the present invention;

FIG. 2 is an enlarged sectional view taken substantially along the line 2—2 of FIG. 1;

FIG. 3 is an enlarged view of area 3 of FIG. 2 illustrating the bonding of the last convolute winding to the next underlying convolute winding;

FIG. 4 is an enlarged view of area 4 of FIG. 2 illustrating the bonding of the inside edge to the inside surface of the convolute tube;

FIG. 5 is a somewhat schematic top plan view of a convolute winding machine which may be used in making the convolutely wound tube of the present invention;

FIG. 6 is a somewhat schematic perspective view of a method of making elongate convolutely wound tubes with the convolute winding machine of FIG. 5 in accordance with this invention; and

FIG. 7 is an enlarged sectional view taken substantially along the line 7—7 of FIG. 6.

Referring now to the Figures wherein like reference characters are used throughout to indicate like parts, there is shown in FIGS. 1–4 an elongate convolutely wound tube generally designated at **10** of this invention and may be formed from any elongate sheet material, such as paper, plastic and the like. However, the method of making the convolutely wound tube **10** disclosed herein is particularly adapted for paper in view of the shortcomings of the prior art methods previously referred to wherein a high moisture adhesive is used to hold the wound tube together immediately following winding.

The elongate convolutely wound tube **10** of this invention, as illustrated, comprises a plurality of overlying convolute windings **11** of the sheet material, and includes inside edge **12** and outside edge **13** wherein the convolute windings **11** are adhesively secured in overlying relation. More particularly, a fast acting adhesive **14**, preferably a hot melt adhesive which is a mixture of 100% nonvolatile thermoplastic resin and/or resins and wax, such as manufactured by Imperial Adhesives, Inc., 6315 Wiehe Road, Cincinnati, Ohio, under the

name "THERM-O-LOK Resin 5002," is disposed substantially adjacent the outside edge **13** between the last convolute winding and the next underlying convolute winding and includes adhesive properties such as to retain the convolutely wound tube **10** in the wound condition immediately following winding. A slow acting adhesive **15**, initially having a low moisture content and preferably less than 65% by weight to prevent wetting of the sheet material and which may be a dextrine adhesive of solution or emulsion type, is disposed between a major portion of the convolute windings **11** and permanently secures them in overlying relation. A slow acting adhesive is chosen as the bonding adhesive for the major portion of the convolute windings **11** because such adhesives are characterized by their low viscosity prior to activation, the ease with which they may be applied in controllable quantities and their relatively low cost.

Thus, it can be seen that the combination of the fast acting adhesive **14** and slow acting, low moisture adhesive **15** provides for a convolutely wound tube **10** which does not require drying after winding, which employs a relatively inexpensive adhesive that is relatively easy to apply in controllable quantities to bond the major portion of the convolute windings **11** in overlying relation, and which tube is held in the wound condition immediately after winding and during activation of the slow acting adhesive **15** by a fast acting adhesive **14.**

Furthermore, it will be noted that the relatively slow acting, low moisture adhesive **15** is disposed immediately adjacent the outside edge **13** between the last convolute winding and the next underlying convolute winding to insure that there will be no free edges left on the outside surface of the convolutely wound tube **10.** Similarly, the relatively slow acting, low moisture adhesive **15** is disposed immediately adjacent the inside edge **12** between the first convolute winding and the next outer convolute winding to insure that there will be no free edges left on the inside surface of the convolutely wound tube **10.**

Referring now to FIGS. **5–7,** it will be observed that in making the elongate convolutely wound tube **10,** paper or other sheet material **20** having first and second opposed surfaces **21, 22** and first and second longitudinal side edges **23, 24** is drawn from a roll **30** or other suitable source of supply over guide rolls **31, 32,** through a first slow acting, low moisture adhesive applying station generally designated at **33** and over guide roll **34** by a pair of nip driving rolls **35, 36** which are intermittently driven by any conventional driving means (not shown) to pass a predetermined length of the sheet material **20** to a conventional cutting station generally designated at **37** where the sheet material **20** is cut into predetermined lengths in accordance with the length of the tube to be formed therefrom.

At adhesive applying station **33,** a slow acting, low moisture adhesive **15** initially having a low moisture content, preferably of the above described type, is applied longitudinally of the sheet material **20** to a major portion of the first surface **21** while leaving a longitudinally extending band **40** free of adhesive in close proximity to the first longitudinal edge **23** but spaced slightly therefrom and while leaving a second longitudinally extending band **41** free of adhesive immediately adjacent the second longitudinal side edge **24.**

In order to apply the slow acting, low moisture adhesive **15,** there is provided an applicator roll **42** in contact with the first surface **21** of the sheet material **20** transverse thereof and driven by the movement of the sheet material **20** and a transfer roll **43** which dips into a slow acting, low moisture adhesive bath **44** and transfers the slow acting, low moisture adhesive **15** from the bath **44** to the applicator roll **42** which applies the slow acting, low moisture adhesive **15** to the first surface **21** of the sheet material **20.** The applicator roll **42** is substantially equal to the width of sheet material **20** and has a pair of doctor blades **45, 46** cooperating therewith which continuously remove the slow acting, low moisture adhesive **15** from portions of the applicator roll **42** which causes the applicator roll **42** to leave longitudinal bands **40** and **41** free of adhesive on the first surface **21** of the sheet material **20.**

It will be noted that immediately adjacent the first longitudinal edge **23,** the slow acting, low moisture adhesive **15** is applied to the first surface **21** of the sheet material by the applicator roll **42.** As is readily apparent, the width of the adhesive free bands **40, 41** may be varied by varying the width of the doctor blades **45, 46** and in accordance therewith, the width of the band **41** free of adhesive immediately adjacent the second longitudinal edge **24** is preferably made substantially equal to the circumference of the inside surface of the convolute tube to be produced for reasons to become apparent in convolute winding of the sheet material **20.**

Beyond the cutting station **37,** the sheet material **20** having been cut into predetermined lengths is advanced on a platform formed from a plurality of longitudinally extending and laterally spaced wires **47** whose near ends are suitably connected to the frame of the cutting station **37** (not shown) and whose far ends extend over a transverse bar **48,** by means of advancing pins (not shown) operatively associated with the platform and carried by pressure frame **49** (FIG. **5**). This advancement of the cut lengths of the sheet material **20** moves the second longitudinal edge **24** thereof into an aligned longitudinally extending groove **51** of a mandrel **52** which extends parallel with and longitudinally of the sheet material **20.**

Disposed intermediate the cutting station **37** and mandrel **52** and cooperating with the sheet material **20** as it is advanced to the mandrel **52** is a fast acting adhesive applying station **53,** a lubricant applying station **54,** and a second slow acting, low moisture adhesive applying station **55.**

The fast acting adhesive applying station **53** includes a container **56** having a fast acting adhesive **14** stored therein and a nozzle **57** extending therefrom and disposed directly above the longitudinal band **40** free of adhesive substantially adjacent the first longitudinal edge **23** of first surface **21** and is adapted to apply a fast acting adhesive **14** in discrete quantities longitudinally of band **40** during passing of the sheet material **20** thereunder.

The lubricant applying station **54** may be of any conventional design and could include a housing **58** in which a block of wax **59** or other type solid lubricant is placed with the bottom surface of the block of wax **59** gravity loaded into wiping engagement with the longitudinal band **41** free of adhesive immediately adjacent the second longitudinal edge **24** of the sheet material **20.** While there is illustrated the application of a solid lubricant, liquid lubricants or combinations of solid and liquid lubricants may be employed and applied by depositing drops on the band **41.**

The second slow acting, low moisture adhesive applying station 55 is disposed in cooperation with the second surface 22 of the sheet material 20 immediately adjacent longitudinal edge 24 and includes an applicator roll 61 which dips into a slow acting, low moisture adhesive bath 62 and applies a slow acting, low moisture adhesive 15 on the second surface 22 of the sheet material 20 along a portion immediately adjacent the second longitudinal edge 24 for reasons to be later explained.

With the second longitudinal edge 24 of the sheet material 20 in the groove 51 of mandrel 52, as shown in the right-hand portion of FIG. 6 and in FIG. 7, the mandrel 52 is rotated by a driving mechanism generally indicated at 64 to impart a predetermined number of revolutions to mandrel 52 to convolutely wind the sheet material 20 into the convolute tube 10 and is wound with the second surface 22 of the sheet material 20 forming the outside surface of the convolutely wound tube 10 and with the first longitudinal edge 23 having the fast acting adhesive 14 substantially adjacent thereto forming the outside trailing edge 13 of the convolutely wound tube 10 and immediately adhering the trailing edge portion to the outer surface of the convolutely wound tube to retain the convolutely wound tube in the wound condition immediately after winding and during activation of the slow acting, low moisture adhesive 15 which permanently bonds the major portion of the convolute windings 11 in overlying relation. Therefore, immediately after winding, the convolutely wound tube 10 may be stripped from the mandrel 52 and the convolute winding machine made ready for the winding of a subsequent tube.

It will be readily apparent that the longitudinal band 41 free of adhesive immediately adjacent longitudinal edge 24 becomes the inside surface of the convolute tube and is disposed directly against the mandrel 52 during convolute winding and thus, the lubricant 59 applied thereto facilitates in the stripping of the convolutely wound tube 10 from the mandrel 52. Upon removal, it will be noted that the second longitudinal edge 24 held in the groove 51 of the mandrel 52 is not adhesively secured to the convolute windings during winding but upon removal from the mandrel 52 will be secured to the next outer convolute winding by the slow acting, low moisture adhesive 15 applied on the second surface 22 of the sheet material 20 immediately adjacent the longitudinal edge 24 and insure that there will be no free edges on the inside surface of the convolutely wound tube 10.

From the foregoing description, it can be appreciated that this invention has eliminated the necessity of having a high moisture content in the adhesive for holding the convolutely wound tube in the wound condition immediately following winding and thereby avoiding a subsequent drying step.

In the drawings and specification, there has been set forth a preferred embodiment of the invention, and although specific terms are employed, they are used in a generic and descriptive sense only and not for purposes of limitation.

What is claimed is:

1. A method of making convolutely wound, adhesively secured tubes of at least two plies from elongate sheet material having opposed first and second surfaces and first and second longitudinal side edges and being characterized by eliminating the necessity of having a high moisture content in the adhesive for holding the wound tube together immediately following winding and thereby avoiding a subsequent drying step, said method comprising the steps of,

applying relatively slow acting, low moisture adhesive to a major portion of the first surface of the sheet material while leaving a first longitudinally extending band free of slow acting, low moisture adhesive in close proximity to the first longitudinal edge but spaced slightly therefrom allowing the slow acting, low moisture adhesive to be also positioned immediately along the first longitudinal edge, and while leaving a second longitudinally extending band free of slow acting, low moisture adhesive adjacent the second longitudinal side edge of the sheet material,

applying relatively fast acting adhesive along the first longitudinally extending band free of slow acting, low moisture adhesive on the first surface of the sheet material,

applying a lubricant along the second longitudinally extending band free of slow acting, low moisture adhesive on the first surface of the sheet material,

applying relatively slow acting adhesive on the second surface of the sheet material along a portion adjacent the second longitudinally extending edge, and

convolutely winding a predetermined length of the elongate sheet material transversely of the length into a convolute tube with the second surface of the sheet material forming the outside surface of the tube and with the second longitudinal edge having the lubricant adjacent thereto on the first surface and the adhesive adjacent thereto on the second surface forming the leading inside edge of the tube and the first longitudinal edge having the relatively fast acting adhesive adjacent thereto forming the outside trailing edge of the tube for immediate adherence of the trailing edge portion to the outside surface of the convolute tube to retain the convolute tube in the wound condition during activation of the slow acting, low moisture adhesive to bond the convolute tube in the wound condition.

2. The method, as set forth in claim 1, wherein the second longitudinal band free of slow acting, low moisture adhesive which contains lubricant thereon is of a width substantially equal to the circumference of the inside surface of the wound convolute tube.

3. The method, as set forth in claim 1, wherein the fast acting adhesive is a hot-melt adhesive and wherein the slow acting, low moisture adhesive has a moisture content of substantially less than 65% by weight when applied avoiding the necessity of a subsequent drying step after winding of the convolute tube.

4. A method of making convolutely wound, adhesively secured tubes from elongate sheet material having opposed first and second surfaces and first and second longitudinal side edges and being characterized by eliminating the necessity of having a high moisture content in the adhesive for holding the wound tube together immediately following winding and thereby avoiding a subsequent drying step, said method comprising the steps of,

applying relatively slow acting, low moisture adhesive to the first surface of the sheet material while leaving at least one longitudinally extending band free of slow acting, low moisture adhesive substantially adjacent the first longitudinal edge,

applying relatively fast acting adhesive along the longitudinally extending adhesive free band on the first surface of the sheet material, and

convolutely winding a predetermined length of the elongate sheet material transversely of the length into a convolute tube with the second surface of the sheet material forming the outside surface of the tube and with the first longitudinal edge having the relatively fast acting adhesive adjacent thereto forming the outside trailing edge of the tube for immediate adherence of the trailing edge portion to the outer surface of the convolute tube to retain the convolute tube in the wound condition during activation of the slow acting, low moisture adhesive to bond the convolute tube in the wound condition,

said step of applying relatively slow acting, low moisture adhesive to the first surface of the sheet material including leaving a second longitudinally extending band free of slow acting, low moisture adhesive adjacent the second longitudinal side edge of the sheet material,

said step of convolutely winding the elongate sheet material into a convolute tube including forming the inside leading edge of the tube from the second longitudinal side edge of the sheet material,

applying a lubricant along the second longitudinally extending adhesive free band on the first surface of the sheet material; and

applying relatively slow acting adhesive along the second longitudinally extending edge on the second surface of the sheet material for adhering the leading inside edge of the sheet material to the inside surface of the convolute tube when wound.

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