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Biancamaria

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[54] **ACCURATELY DIMENSIONED SMOOTH-SURFACED MULTI-LAYER CARDBOARD TUBES AND METHOD OF AND APPARATUS FOR MAKING THE SAME**

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Related U.S. Application Data

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[30] **Foreign Application Priority Data**

Feb. 7, 1968 France 68.139051

[52] **U.S. Cl.** ..... **229/4.5,** 93/83, 138/144, 138/150, 156/188, 161/268, 229/3.5 R, 229/93

[51] **Int. Cl.** **B65d 3/04**

[58] **Field of Search** ..... 229/4.5, 93, 3.5 R; 138/141, 144, 150, 140; 93/94 R, 80, 83, 94 FC; 156/188, 195; 161/268, 270

[56] **References Cited**

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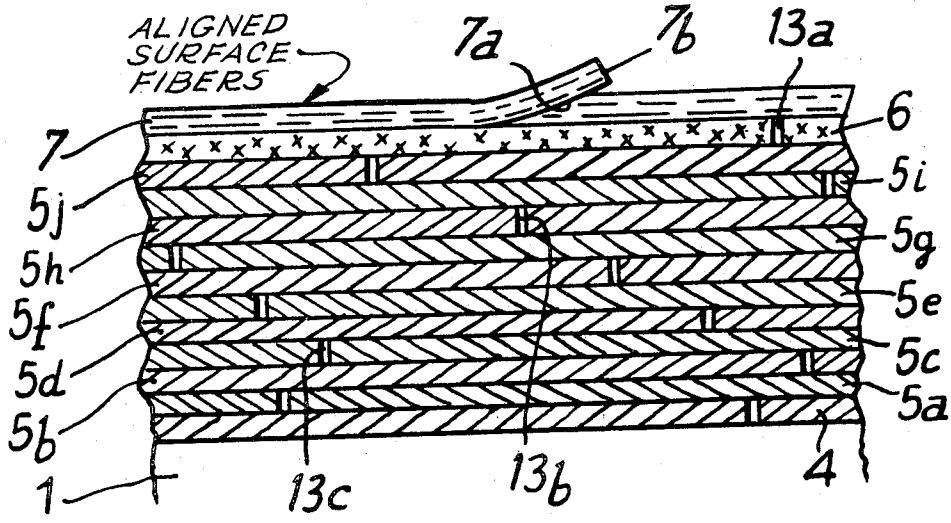
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Attorney, Agent, or Firm—Edwin E. Greigg

[57] **ABSTRACT**

In order to obtain helically wound multi-layer cardboard tubes of accurate diameter and very smooth external surface, the tubes are coated with a thermosetting resin and forced through the bore of a heated jacket to cause (1) curing of the resin and (2) reduction of the tube diameter to the precise desired dimensions. This reduction is taken up by a radially compressible layer of the tube.

7 Claims, 6 Drawing Figures



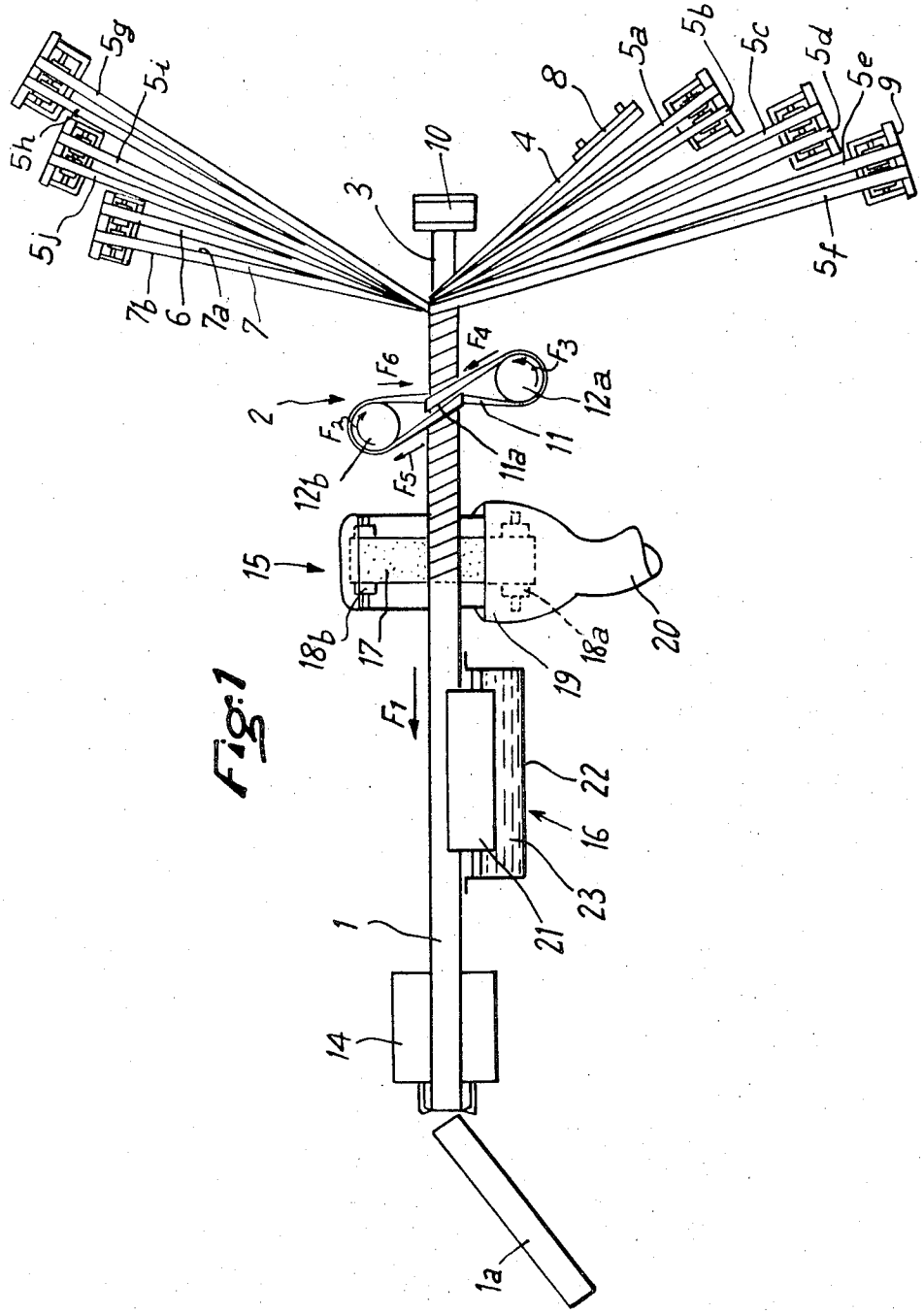

5g
5i
5h
5j
7b
6
7a
7
3
10
4
8
5a
5b
5c
5d
5e
9
5f
F6
F4
F3
2
F2
12b
F5
11a
11
12a
15
18b
17
18a
19
20
F1
22
16
23
21
1
14
1a

Fig. 1

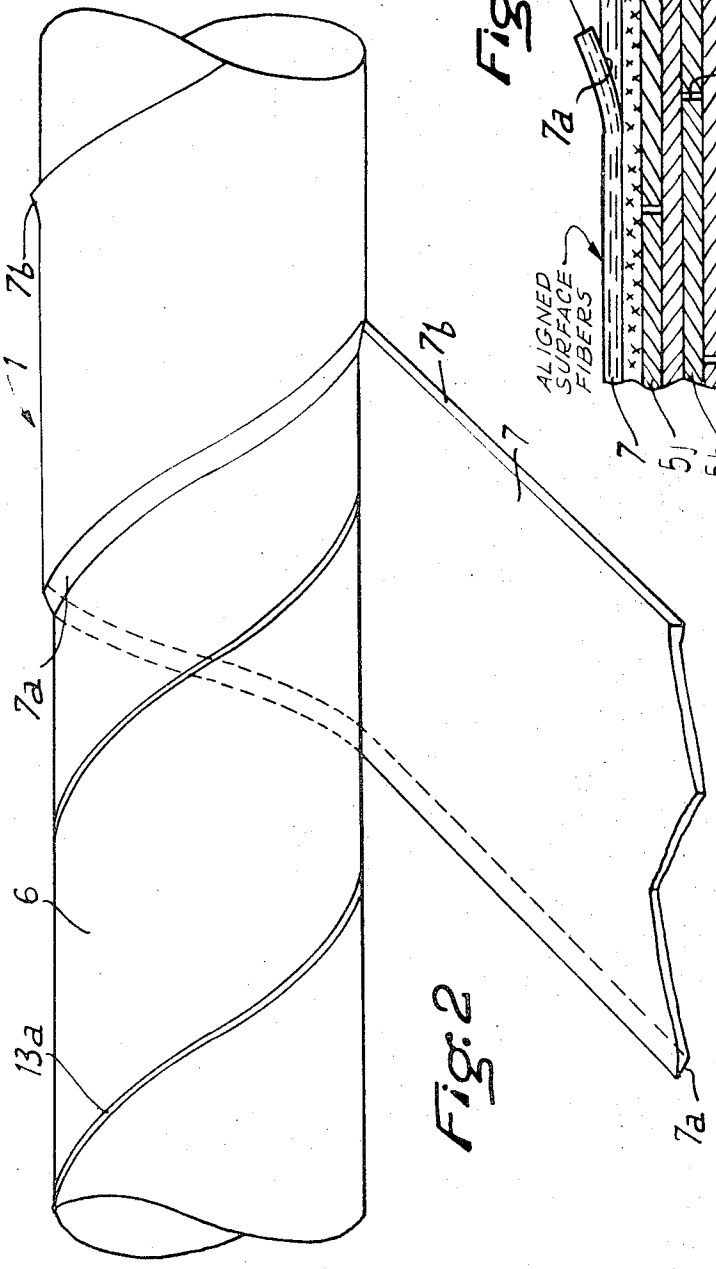

7b
1
7b
7
7a
6
13a
7a

Fig. 2

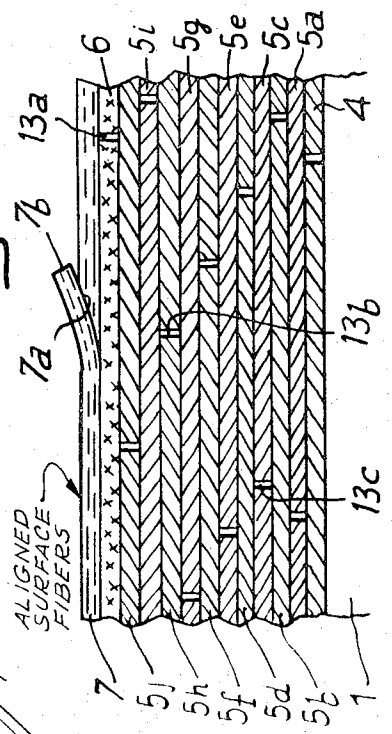

6
5i
5g
5e
5c
5a
4
13a
7b
7a
13b
13c
ALIGNED SURFACE FIBERS
7
5j
5h
5f
5d
5b
1

Fig. 3

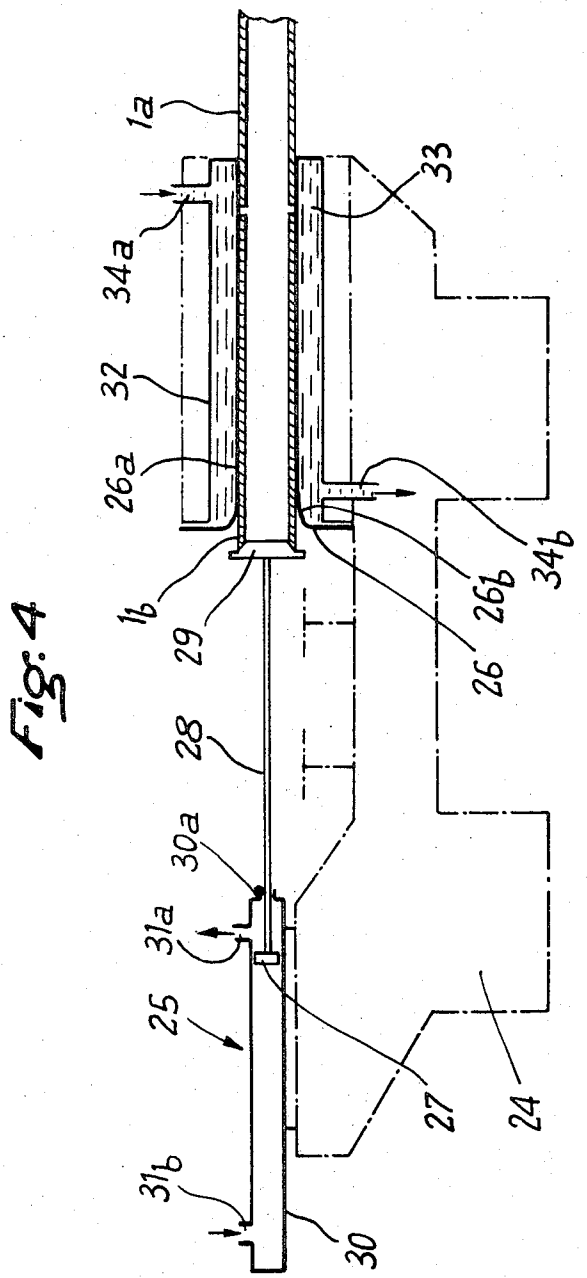


Fig. 4

Fig. 5

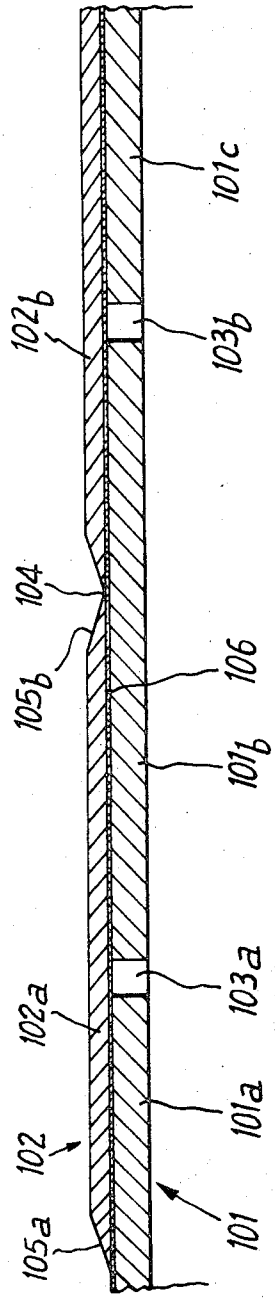
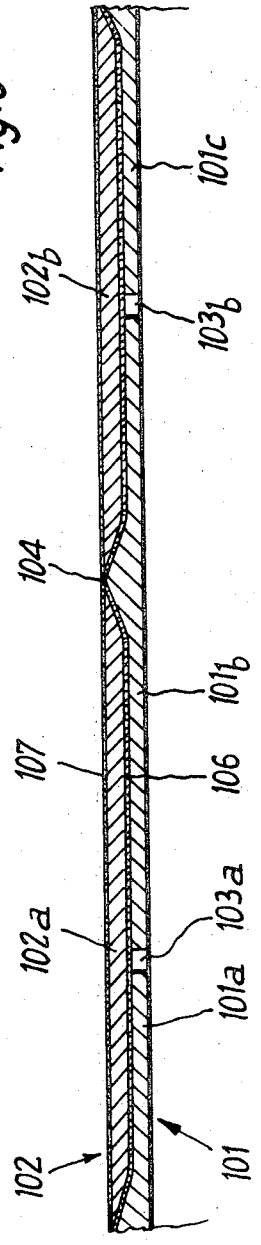

101c
102b
103b
104
105b
106
101b
103a
102a
101a
102
105a
101

Fig. 6


101c
102b
103b
104
101b
107
106
103a
102a
101a
102
101

ACCURATELY DIMENSIONED SMOOTH-SURFACED MULTI-LAYER CARDBOARD TUBES AND METHOD OF AND APPARATUS FOR MAKING THE SAME

This application is a divisional application of application Ser. No. 797,487, filed Feb. 7, 1969. now U.S. Pat. No. 3,580,146.

BACKGROUND OF THE INVENTION

It is well known to make cardboard tubes from a plurality of strips or "layers" of fibrous material, suitably glued, which are wound around a mandrel in a helix with a pitch approximately equal to the width of one strip. The successive superposed strips are offset relative to one another in the longitudinal direction of the tube.

Usually, for the manufacture of such tubes winding machines are used in which each of the strips is stored on a reel and passes, with the exception of the first, through a glueing bath before being wound around a fixed mandrel at a fixed angle relative to the axis thereof and slightly offset relative to the preceding, underlying strip. The tube thus formed is caused to rotate about the mandrel and is simultaneously longitudinally advanced by an endless belt turning about said mandrel.

In this manner a continuous tube is obtained which is cut into separate tubes of a given length by a severing device located at a distance from the winding head of the tube winding machine.

The surface condition of such a tube depends, in the first place, on the material constituting the outside layer, but is also affected by the setting of the tube winding machine. Since it is not possible to regulate the pitch of the winding in a perfect manner so as to obtain accurately abutting adjacent turns of the helically extending strip, small tolerances have to be accepted. For this reason it may occur that adjoining edges of two consecutive spiral turns are positioned either with a slight gap or with a slight overlap.

Similarly, it is necessary to accept a small tolerance in the outside diameter of the tube. Such a tolerance is a function of the tolerances of the thickness of the strips and of the tension applied to the said strips. Such tubes, with the imperfections noted, are acceptable for the majority of uses.

When, however, tubes of the aforenoted type are intended, for example, for the reeling of thin sheets or films, such as plastic films or any other product which may be easily damaged by defects in the surface of the tube, particularly when its material is sensitive to humidity or to heat, it is essential to use precisely gauged tubes having a perfectly smooth surface void of any irregularity or any helically extending depression.

Presently known processes relating to the manufacture of precisely gauged smooth tubes involve prohibitive expenses.

OBJECTS AND SUMMARY OF THE INVENTION

It is an object of the invention to provide an improved, helically wound, multi-layer cardboard tube having a very smooth external face and an exact, predetermined diameter.

It is a further object of the invention to provide an improved method of manufacturing helically wound, multi-layer cardboard tubes having a very smooth external face and an exact, predetermined diameter.

It is a further object of the invention to provide an improved apparatus for the manufacturing of helically wound, multi-layer cardboard tubes having a very smooth external face and an exact, predetermined diameter.

Briefly stated, according to the invention, first a multi-layer, helically wound rough tube of continuous length is prepared, preferably on a mandrel-type tube winding machine of known structure. One of the layers is of a low density material and is thus substantially compressible in a radial direction. Then the rough tube is externally coated with a thermosetting resin, cut into predetermined lengths and dried. Finally, the rough tubes are forcibly introduced, by means of a pusher head, into the bore of a heated matrix to reduce the circumference of the tube to the desired precise diameter and to cause polymerization of the resin coating. The diameter of the bore is smaller than that of the rough tubes. The circumferential shrinkage of the tubes is taken up by said low density layer which is compressed radially under the external, radially inwardly directed force generated by the cooperation of said pusher head and said bore.

The invention will be better understood and further objects as well as advantages will become apparent from the ensuing detailed specification taken in conjunction with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagrammatic view of a tube winding machine and some of the treating stations according to the invention;

FIG. 2 is a perspective view illustrating the winding of the outer layer of a rough tube according to the invention;

FIG. 3 is a partial longitudinal section on an enlarged scale of the rough tube of FIG. 2;

FIG. 4 is a diagrammatic view of a surfacing machine to ensure the precise gauging and the finishing of the tube surface according to the invention;

FIG. 5 is a partial longitudinal section on an enlarged scale of the last two layers of a rough tube according to another embodiment of the invention, and

FIG. 6 is a view similar to FIG. 5, showing the embodiment in a finished condition.

DESCRIPTION OF THE APPARATUS AND THE ARTICLE MADE THEREWITH

Turning now to FIG. 1, first a rough tube 1 is prepared from which, ultimately, precisely gauged and smooth lengths of cardobard tube such as 1*a*, (FIG. 1) or 1*b*, (FIG. 4) are obtained. Tube 1 is made by the helical winding of a plurality of suitably gummed strips, thirteen in the example shown, each strip representing a fraction or "layer" of the thickness of the wall of the tube.

The winding is performed in a tube winding machine 2. The machine incorporates a fixed mandrel 3 on which there are first wound a base strip 4 and ten intermediate strips 5*a*, 5*b*, 5*c*, 5*d*, 5*e*, 5*f*, 5*g*, 5*h*, 5*i* and 5*j*, constituting a basic tube onto which are then wound a penultimate strip 6 and a final strip 7. Each of the strips is stored on a reel; the strip 4 is disposed on a simple reel 8 while all the others are held on two-spindle reels, such as reel 9 carrying strips 5*e* and 5*f*.

In the example illustrated, said two-spindle reels are each provided with a gumming device to coat the lower face of each strip with adhesive. Any other gumming means may be used; for example, both surfaces of each strip may be coated with the exception of the first strip 4 and the last strip 7.

The first eleven strips, that is, strips 4 and 5*a* – 5*j* form the basic tube and are made of fibrous material, such as kraft board, and are of substantially equal widths. The strip 6, forming the penultimate layer is of a low-density fibrous material, for example, felt board, having a normal thickness. The strip 7 constitutes the outside layer and is made of a dense material having long fibers, such as absorbent paper. The strip 7 is only slightly gummed; it has a width slightly greater than that of the other strips and is provided with a chamfered edge 7*a* opposite to the direction of advance of the tube (FIGS. 2 and 3). Said chamfered edge is the result of an abrading operation.

Each strip approaches the mandrel tangentially and is wound thereon in such a manner that it is out of alignment therealong relative to the preceding, underlying strip.

The article thus prepared constitutes the rough tube 1 which is driven so that it rotates about the mandrel 3 and is axially advanced in the direction of arrow F1 away from the head 10 by an endless belt 11 following a course 11*a* about the tube. Belt 11 is driven by two driving pulleys 12*a* and 12*b*, the axes of which are perpendicular to that of the mandrel. The directions of motion of the pulleys and the belt flights are indicated by the arrows F2, F3, F4, F5 and F6.

The winding pitch is controlled in such a manner that adjacent edges of two consecutive turns of any layer, with the exception of the final strip 7, are as close as possible without risking overlapping. Stated in different terms, the only tolerance to be accepted will merely vary the size of a slight spacing, such as 13*a*, 13*b*, 13*c* (FIGS. 2 and 3). Since the strip 7 is broader than the others, the adjacent edges of its successive turns overlap: the simple edge 7*b* of the strip 7 covers the chamfered edge 7*a*. It is to be noted that the tolerance discussed hereinabove may vary only the size of the slight overlap of the edge 7*b* on the beginning of the chamfer.

With the tube winding machine 2 there is associated a cutting station 14 in which a saw or knives sever the tube 1 into predetermined lengths such as 1*a* (FIG. 1).

Between the tube winding machine and the cutting station 14 there are disposed a sanding station 15 and a coating station 16. For sake of clarity, the stations 15 and 16 are shown in elevation while the tube winding machine 2 is shown in a plan view in FIG. 1.

In the example illustrated, the sanding station 15 is constituted by an endless abrasive belt 17 tensioned between two rollers 18*a*, 18*b*, one of which provides the drive. The whole unit is contained in a casing open towards the tube to be treated and linked by a conduit 20 to a dust-removing vacuum unit (not shown). The belt 17 bears upon the external surface of the tube 1, and "erases" the rough, helically extending portions formed by the edge 7*b* of the outside strip 7 and, at the same time, straightens out or aligns its long fibers. On leaving the sanding station 15, the outer surface of the still rough tube 1 is thus uniform and felted.

Next, the tube 1 arrives at the coating station 16. In the example shown, this station comprises a roller 21 partially immersed in a bath 22 containing the coating liquid 23. The latter is constituted by an aqueous solution of thermosetting resin to which a polymerization catalyst is added. Good results are obtained with a phenol resin in aqueous solution having a pH value in the vicinity of 8.5 and containing 35–50 percent of dry extract and using a lactic acid solution as the catalyst. Preferably, a lubricating agent is added to the solution to prevent the adhesion of the treated surface to metals. Such a lubricant may be, for example, a 35 percent silicone emulsion mixed in with the resin solution in a proportion of 1 percent by volume. The coating operation is controlled in such a manner as to obtain a substantially uniform deposit of, for example, 140 gr/m^2.

The number and the thickness of the layers, the adhesive and resin coatings, are calculated in such a manner as to obtain an external tube diameter 1 – 2 percent greater than the nominal diameter desired for the finished tubes.

From the outlet of the cutting station 14 the lengths 1*a* are advanced into a drier, not shown, heated to a temperature below the polymerization temperature of the resin (for example 100° C) yet sufficient to cause evaporation of the solvents.

Finally, the dried lengths are conveyed to a surfacing machine (FIG. 4) which comprises stand 24 on which there are coaxially arranged a hydraulic jack 25 and a steel die or matrix 26. Th jack 25 comprises, in a known manner, a plunger 27 integral with a rod 28 terminating in a head 29. The plunger 27 reciprocates in a cylinder 30, one end of which has a fluid-tight opening 30*a* through which the rod 28 extends. The cylinder is further provided at each of its ends with an aperture 31*a* and 31*b* serving alternately for the admission and the discharge of the actuating fluid. The total stroke of the plunger 27 is greater than a cut tube length. The matrix 26 is formed of a cylindrical jacket having an inner wall 26*a* which has a length substantially equal to a cut tube length. One end of inner wall 26*a* facing jack 25 terminates in a conically flaring inlet opening 26*b*. The jacket further has an outer wall 32 which, together with inner wall 26*a*, defines an annular space 33 in which a heated fluid circulates. This fluid is introduced into annular space 33 through a channel 34*a* and taken out through a channel 34*b*. The outer wall 32 is thermally insulated; the fluid therein is circulated with a speed that is sufficiently great to ensure a substantially uniform and constant temperature of the inner wall 26*a* of the matrix. This temperature should correspond to the polymerization temperature of the resin used at station 16. The inner wall 26*a* is accurately dimensioned; its bore — taking into account its heat expansion — corresponds to the desired nominal external diameter for the finished tubes. Further, the internal surface of inner wall 26*a* is chromed so that the lubricant added to the resin suffices to prevent the adhesion of the resin to the hot metal.

OPERATION OF THE SURFACING MACHINE

In view of the foregoing structural description of the surfacing machine the method practiced therewith will be easily understood:

First, the plunger 27 is in a withdrawn position adjacent the aperture 31*b* and the head 29 is spaced from

the inlet 26*b* at a distance greater than the length of the cut tube 1*a*. Then, tube 1*a* is engaged at one end by the head 29. The driving fluid for the jack is then admitted through the aperture 31*b* and, as a result, the plunger 27 is driven towards the other end of the cylinder 30 whereupon the cut length 1*a* is forcibly introduced into the inner wall 26*a* of the matrix aided by the conical entry 26*b*. The space between the cylinder 30 and the inlet 26*b* is such that the plunger 27 reaches the end of the cylinder 30 when the cut length 1*a* has completely entered the inner wall 26*a*. In order to be received by inner wall 26*a*, the diameter of tube 1*a* undergoes a reduction which is made possible to a large extent by the radial compression of the penultimate layer 6 made of felt board. By virtue of the temperature of the inner wall 26*a*, the resin deposited on the outside surface of the tube undergoes a polymerization which gives said surface a very smooth finish and a certain degree of hardness. The driving fluid of the jack is then reversed by admitting it under pressure through the aperture 31*a*. Simultaneously, the aperture 31*b* is relieved of all pressure to allow the evacuation of the fluid filling the rear chamber of the jack. The plunger 27 withdraws and returns to its initial position in the vicinity of the aperture 31*b*. The cycle restarts when a new cut tube length 1*b* is engaged by the head 29. As tube 1*b* enters into the matrix, it displaces finished tube 1*a*, which is thus ejected.

DESCRIPTION OF AN ALTERNATE TUBE STRUCTURE

Turning now to FIGS. 5 and 6, there is shown a modified tube structure before (FIG. 5) and after (FIG. 6) treatment in the surfacing machine described in connection with FIG. 4. In these figures only a penultimate layer 101 and a final layer 102 are shown; both are wound helically. The basic tube structure is thus not shown.

The penultimate layer 101 is a strip of a low-density material, for example, felted board, between the consecutive turns 101*a*, 101*b*, 101*c*, of which there is shown a spacing 103*a*, 103*b*.

the final layer 102 is a strip of abosrbent paper, both edges 105*a*, 105*b* of which are chamfered. The width of this strip is such that its consecutive turns 102*a*, 102*b* do not overlap but define a smallest possible spacing 104.

The final layer 102 is glued to the penultimate layer by means of a coating 106 of a thermosetting adhesive resin.

The treatment of the advancing rough tube having a structure according to FIG. 5, is, with the exception of the sanding step, identical to that described hereinbefore. Thus, its treatment comprises coating with a thermosetting resin mixed with a polymerization catalyst, cutting the tube into lengths, drying and finally reduction of circumference and setting in a surfacing machine.

The shrinkage or reduction in circumference is, to a large extent, taken up by the penultimate layer 101 which is compressed under the effect of external forces (FIG. 6). This compression or collapse of strip 101 is irregular: it is greater along the central part of the final layer 102 than along the chamfered edges 105*a*, 105*b* thereof. At the same time, the spacings 103*a*, 103*b* between the turns of the layer 101 are reduced to a greater or lesser extent.

Since the diametrical reduction of the tubes takes place in the matrix under elevated temperatures, simultaneously with the polymerization of the external resin coating 107, a polymerization of the layer 106 of adhesive resin is also achieved. This last-named polymerization stabilizes the layer 101, the deformation of which, as shown in FIG. 6, becomes permanent, while the cured resin in the helical space or gap 104 between consecutive turns of the external layer 102 acts as a seal.

Again, very smooth and accurately gauged tubes are obtained.

What is claimed is:

1. A multi-layer, helically wound cardboard tube comprising, in combination:
   - A. a basic tube;
   - B. a compressed penultimate strip of low-density, compressible material helically wound about said basic tube, adjacent edges of consecutive turns of said strip disposed in a close, non-overlapping relation;
   - C. an outer strip of high-density material helically wound about and slightly glued to said penultimate strip; and
   - D. an external polymerized thermosetting layer coherently covering the outside of said outer strip.

2. A tube as defined in claim 1, wherein at least one edge of said outer strip is provided with a chamfer.

3. A tube as defined in claim 1, wherein the external face of said outer strip is provided with aligned fibers.

4. A tube as defined in claim 2, wherein both edges of said outer strip are provided with a chamfer said penultimate layer completely fills the space defined by the juxtaposed chamfers of adjacent edges of said outer strip.

5. A tube as defined in claim 4, wherein said penultimate strip and said outer strip are glued together by a polymerized adhesive thermosetting resin layer forming a seal at adjacent chamfered edges of said outer strip.

6. A tube as defined in claim 1, wherein said low-density material is fibrous.

7. A tube as defined in claim 1, wherein said high-density material is a dense material having long fibers.

* * * * *