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METHOD FOR THE PRODUCTION OF A MULTI-PLY TUBULAR ARTICLE

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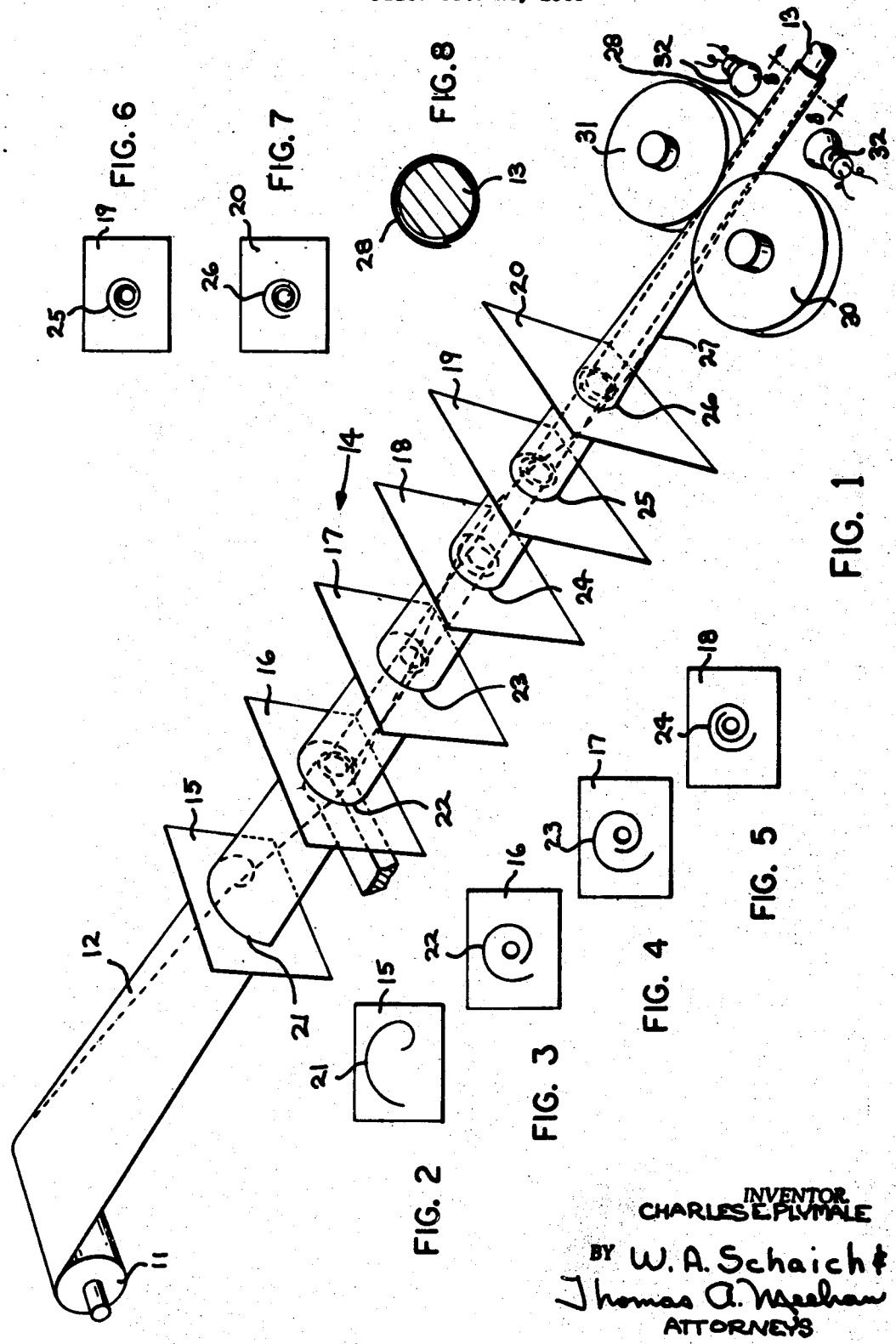

FIG. 1

FIG. 2

FIG. 3

FIG. 4

FIG. 5

FIG. 6

FIG. 7

FIG. 8

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METHOD FOR THE PRODUCTION OF A MULTI-PLY TUBULAR ARTICLE

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ABSTRACT OF THE DISCLOSURE

This application discloses apparatus and method for continuously convolutely winding a longitudinally moving strand of fibreboard into a multi-ply tubular article in which the strand is wound, by way of a spiral-like configuration of progressively increasing arc and diminishing radius, into a frusto-conical tube and the frusto-conical tube is then changed into a cylindrical tube on a mandrel which causes slippage between the winds of the strand.

This invention relates to a tubular article of multi-ply construction of a sheet of material and to the method and apparatus for the production of such an article on a relatively continuous basis. More particularly, the invention relates to a tubular article of multi-ply convolutely wound fibreboard and to the method and apparatus for the production of such an article on a relatively continuous basis utilizing a single longitudinally moving strand of such material being fed from a roll, or other source of supply, of indefinite length thereof. The invention has utility in that the tubular article may be severed in a known manner into tubular bodies of predetermined length which may then be used in the manufacture of cylindrical containers, e.g. the so-called composite or fibre cans. It has been demonstrated that fibreboard, e.g. a sturdy grade of kraft paper, when wound into cylindrical form, may be used to advantage as a structural or load-bearing material in the construction of cylindrical containers in place of the various metallic materials which have long been used for such a purpose. The formation of the fibreboard into cylindrical configuration may be accomplished by means of winding processes commonly referred to as spiral winding and convolute winding which impart the cylindrical article with characteristic spirally-extending and longitudinally extending joints, respectively.

The convolutely wound fibreboard tube, an example of which is disclosed in U.S. Patent 3,202,566 to M. O. Schur, assigned to the assignee of this application, is considered to be structurally superior to the spirally wound fibreboard tube due to the fact that the longitudinally extending seam has greater resistance to failure caused by hoop stress resulting from internal pressure than does a spirally wound seam of a comparable weight and grade of fibreboard.

In practice, service conditions prevalent for fibre can applications normally require the use of a multi-ply fibreboard wall, usually a double-ply wall, to obtain adequate strength. Notwithstanding the apparent structural superiority of convolutely wound tubes, however, multi-ply tubes are predominantly formed by spiral winding due to the fact that, heretofore, there has been no satisfactory technique for convolutely winding such a multi-ply tube on a continuous basis. Continuity in the winding step is, of course, important if winding costs are to be maintained at a level competitive with the costs of multi-ply winding by well known continuous spiral winding techniques.

It is, therefore, an object of the present invention, to provide apparatus and method for convolutely winding a strand of sheet-like material into a tubular article of multi-ply construction on a relatively continuous basis. It is a

further object of the invention to provide the multi-ply article produced by means of such apparatus and method.

In accordance with the present invention, the leading portion of a strand of sheet-like material of indefinite length, for example from a supply roll thereof, is advanced longitudinally of itself by any suitable drive means toward a cylindrical mandrel along a path of travel generally parallel to and coaxial therewith. The portion of the strand advancing toward the mandrel is caused to assume an arcuate configuration in a direction transverse of the path of travel, which configuration is generally spiral-shaped. This is accomplished by placing a slotted member in the path of travel of the strand and by maintaining the width of the slot defining the strand passage commensurate with the width of the strand and the configuration of the slot in a spiral-like arcuate configuration. The means in the path of travel of the strand is maintained at a relatively substantial length along the path of travel and the configuration of the strand passage changes along the path of travel to progressively increase the arc of the spiral to of the order of at least 720°, at a rate sufficiently gradual not to tear or crease the strand, thereby to decrease the spacing between radially overlapping portions of the strand and to form a generally frusto-conical shaped tube.

In accordance with a preferred embodiment of the apparatus for practicing the present invention, the slotted means in the path of travel of the strand comprises a plurality of thin plate-like members disposed transversely of the path of travel and spaced apart from one another in a series extending therealong. The arc of the slot of each member of the series is incrementally greater than the arc of the slot of the preceding member by an amount depending largely on the distance therebetween. The use of a single member of substantial length in place of the plurality of plate-like members, for example, a die block with an arcuate passage therethrough, is also contemplated.

Subsequent to the convolute winding of the leading portion of the fibreboard strand into the form of a spiral-like arc of at least 720°, the strand will have the general appearance of a frusto-conical shaped tube and the leading portion of such tube is then passed onto the cylindrical mandrel which has a diameter corresponding to the desired diameter of the finished article. Continued travel of the frusto-conical tube over the mandrel will cause the radius of the interior wind thereof to contract until it is equal to the radius of the mandrel; continued movement will lead to slippage between the winds and the leading portion of the frusto-conical tube will assume the desired cylindrical configuration. It is, of course, important that there not be excessive friction between the winds of the frusto-conical tube if such slippage is to be obtained. Ordinarily this will be no problem where a relatively smooth-surfaced strand of sheet-like material is employed, for example, a good commercial grade of kraft linerboard. In cases where friction would otherwise be a problem, however, it is contemplated that satisfactory operation can be obtained, nonetheless, by coating the strand with a slip agent, many of which are well known in the art.

The changing of the shape of the frusto-conical tube to a cylindrical shape may be advantageously augmented by applying radial force against the tube as it moves along the mandrel, as by means of a plurality of rollers tangentially contacting the tube as it moves along the mandrel. The use of such rollers also serves to maintain the strand in a tightly wound state which is especially advantageous in that it facilitates bonding of the winds to one another by means of a heat-activatable adhesive preapplied to the strand in an easily deducible pattern, e.g. a "hot-melt"

adhesive, in conjunction with a heating step to activate the adhesive.

The convolutely-wound cylindrical article with the winds thereof bonded to one another may thereupon be cut into individual cylinders of a predetermined length which may thereupon be provided with internal and external barrier coatings and end closures to form a composite can, all in accordance with known processes and by means of known equipment.

For a further understanding of the invention, attention is directed to the following portion of the specification, the drawing, and the appended claim.

In the drawing:

FIG. 1 is a perspective view of a schematic arrangement of apparatus in accordance with the present invention and useful in the practice of a method in accordance with the present invention and in the production or manufacture of an article in accordance with the present invention;

FIGS. 2–7 are front elevational views of individual plate-like members of the plurality thereof illustrated in FIG. 1; and

FIG. 8 is a sectional view taken on line 8—8 of FIG. 1.

In accordance with the illustrated embodiment of the present invention there is provided a reel **11** of sheet-like material, e.g. fibreboard and particularly a tough relatively smooth grade thereof such as kraft paper or linerboard, for delivering a sheet, web or strand **12** thereof longitudinally of itself to a generally cylindrical mandrel **13**. As strand **12** advances toward mandrel **13** it is caused to be wound into the configuration of a generally frusto-conical tube by causing it to pass through means, indicated generally by reference numeral **14**, which extend across its path of travel. Means **14** defines an arcuate passage for strand **12** which, of course, must be of a width and thickness suitable for free movement of strand **12** therethrough, and which is of spiral-like arcuate configuration, the arc of which increases gradually along the path of travel to a value of the order of at least 720°. In the illustrated embodiment, means **14** comprises a plurality of thin plate-like members, shown as six in number and being noted by reference numerals **15–20**, respectively. The above-noted arcuate passage is defined by spiral-like arcuate slots **21–26** in members **15–20**, respectively, each of which is of an incrementally greater arc than the slot preceding it with the arc **26** of the last plate **20** in the series being of the order of at least 720°.

The frusto-conical tube **27** passing from means **14** would continue to diminish in diameter were it not for the presence of mandrel **13** over which tube **27** is caused to move. Mandrel **13** serves to induce slippage between the winds of tube **27** on a gradual basis commencing at the point that the minimum radius of the internal wind thereof is reduced to a value equal to the radius of mandrel **13**. Such slippage continues until tube **27** is reformed into a cylindrical tube **28** and the tight winding of the plies of tube **28** about mandrel **13** may be enhanced by means of diametrically opposed rollers **30** and **31** which rotate tangentially with respect to wound strand **12** and which are biased or urged toward mandrel **13**. One or both of rollers **30** and **31** may be positively driven by means not shown and in such event they will also serve as means for advancing strand **12** from reel **11** to mandrel **13**.

It is to be noted that mandrel **13** may also extend into means **14**, as shown, to serve as convenient means for mounting at least some of the individual plates, shown as plates **16–20**, inclusive, in fixed relationship to one another.

If a heat-activatable adhesive is pre-applied to strand **12** in a deducible pattern, the plies of cylindrical tube **28** may be bonded to one another by providing means, shown as radiant lamps **32**, for heating tube **28** to activate such adhesive. Adhesive activation may also be enhanced by the circulation of a heating medium through the portion of mandrel **13** that is radially aligned with lamps **27** in a well-understood manner.

It is believed that tthe best mode known to me to carry out this invention has been described above in terms sufficiently full, clear, concise and exact as to enable any person skilled in the art to make and use tthe same. It is to be understood, however, that it is within my contemplation that certain modifications of the above-described mode of practicing the invention can be made by a skilled artisan without departing from the scope of the invention and it is, therefore, desired to limit the invention only in accordance with the appended claim.

I claim:

1. The method of forming a tubular article of multiply construction by the convolute winding of sheet-like material on a relatively continuous basis comprising the steps of: advancing the leading portion of a strand of indefinite length of said material longitudinally of itself, said strand having a heat-activatable adhesive applied thereto in such a pattern as to result in bonding of the adjacent winds of the tube wound therefrom when said adhesive is activated; causing said leading portion to assume a spiral-like arcuate configuration in transverse section; progressively increasing the angle of the arc to a value at least of the order of at least 720° and decreasing the spacing between the winds thereof to form a frusto-conical shaped tube; advancing the frusto-conical shaped tube over a cylindrical mandrel; reforming the shape of the tube to a cylindrical shape on the mandrel by the application of radial forces against the exterior of the tube to induce slippage between the winds thereof; and activating the adhesive of the portion of the tube that has been reformed to a cylindrical shape by the application of heat thereto.

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