July 30, 1963 C. ALLEN, JR., ETAL 3,099,190

STRIP WINDING APPARATUS

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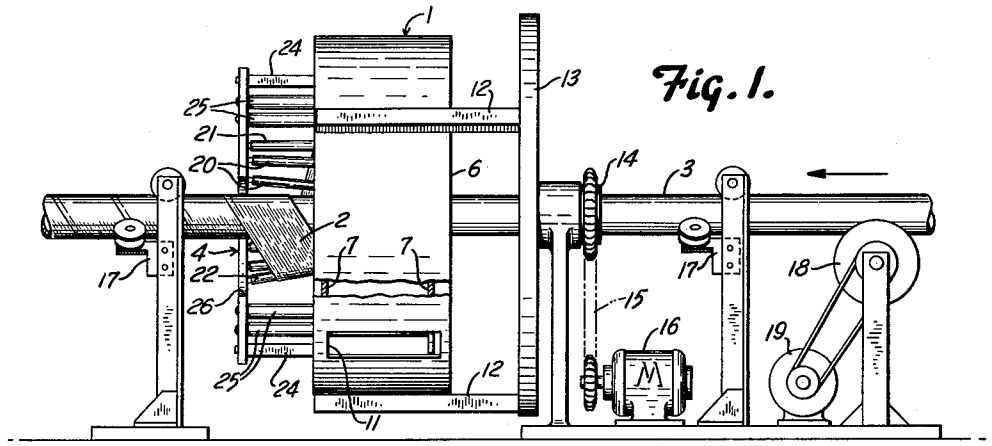

Fig. 1.

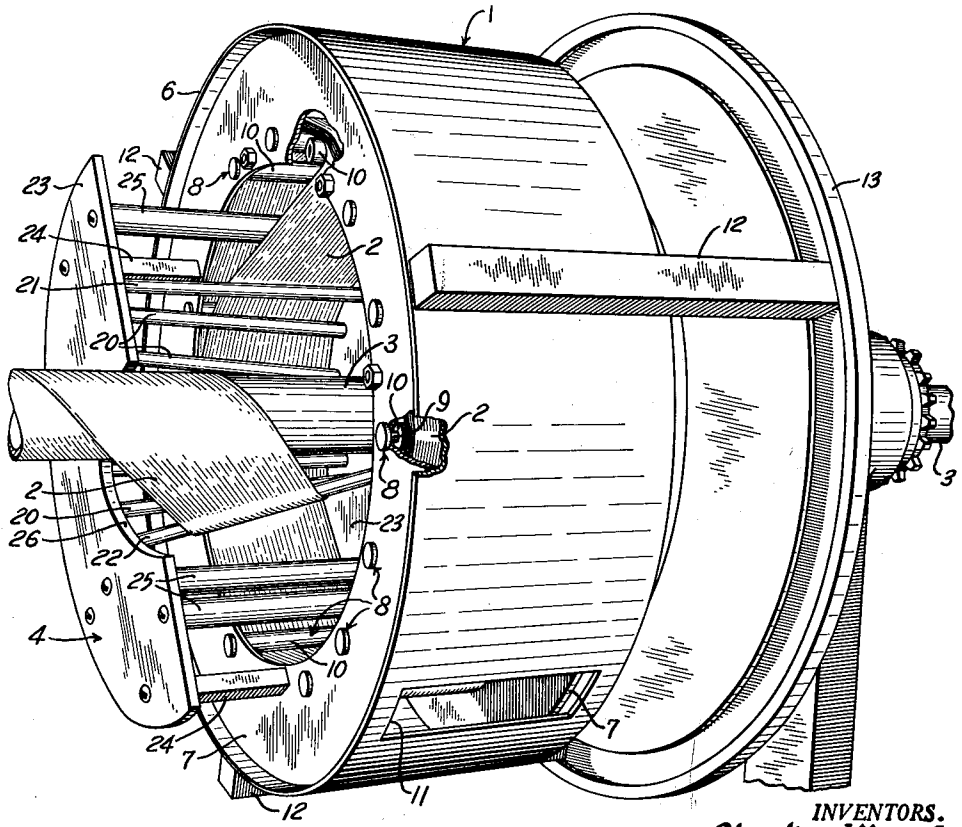

Fig. 2.

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Fig. 3.

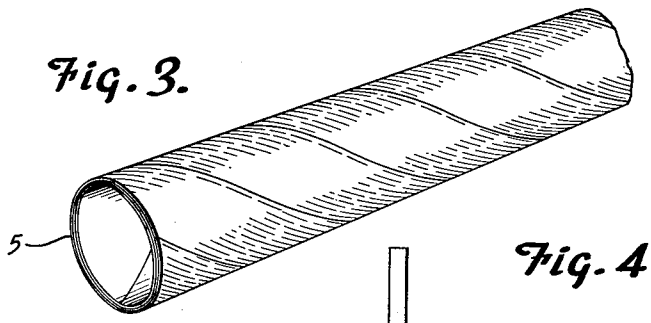


Fig. 4.

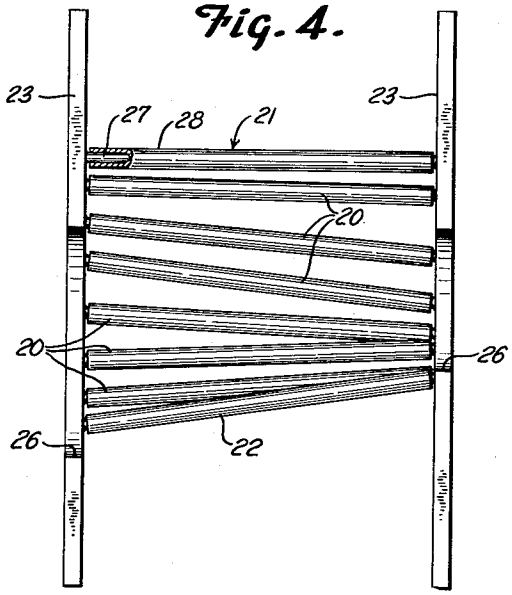


Fig. 5.

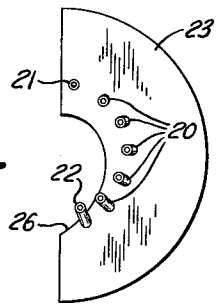


Fig. 6.

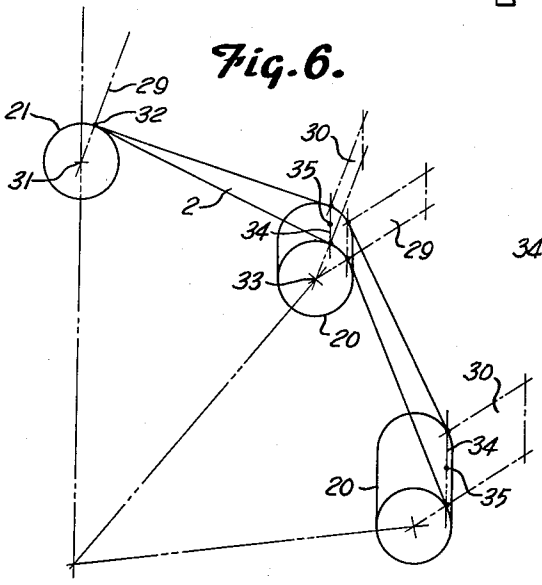


Fig. 7.

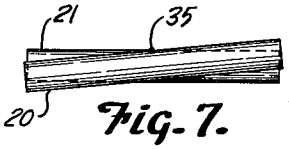
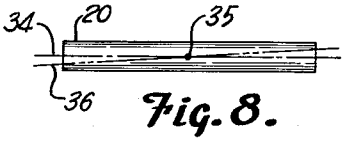


Fig. 8.



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3,099,190

STRIP WINDING APPARATUS

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3 Claims. (Cl. 93—80)

This invention relates to strip winding apparatus and is particularly directed to apparatus for spirally winding upon a tubular form a woofless strip or web of resin having longitudinally extending reinforcing fibers to provide a protective cover or a tubular pipe-like member.

Apparatus for wrapping a strip or web of material upon a tubular form may include an annular reel containing a coil of the wrapping web with the tubular form moving coaxially through the reel. The web is withdrawn from the reel over suitable spiral directing or twisting roller mechanism and spirally wrapped around the tubular form by simultaneous rotation of the reel and coaxial movement of the tubular form. For example, a pipe wrapping machine generally of this variety is shown in Patent 2,011,172 to J. Coleman et al.

Recent attempts have been made to form self-supporting plastic pipe and the like by similarly spirally wrapping of a resin impregnated fibrous strip upon a mandrel or form and after curing or setting of the resin, the wrapping is removed to provide a self-supporting tubular member. In the formation of such products, an appreciable twist is imparted to the web during the wrapping operation to establish the desired angular or spiral winding of the web. When the web is woofless, the strength and cohesion transversely of the web are practically non-existent. As a result, appreciable splitting and roping as well as resin flaking results during the winding process.

The twisting of the web further results in uneven lateral distribution of the tension in the web which may move across the roller mechanism and result in an uneven overlap of the adjacent spirals in the final product. A fixed roll can be employed to eliminate this movement. However, resin deposits tend to build up upon the fixed roller and result in splitting of the tape adjacent the built-up portions.

The present invention provides a guide assembly between the reel and the tubular form or mandrel for imparting a twist to the tape or web without the disadvantages of the prior art structures. The structure of the present invention permits relatively large wrapping or winding angles without the splitting or roping and maintains an even distribution of the tension across the web to an extent which allows rapid and highly satisfactory wrapping.

In accordance with the present invention, a rotating distribution reel or cylinder is provided with the mandrel relatively moved longitudinally or axially through the center of the reel. A series of circumferentially spaced guide rollers are interposed between the take-off from the rotating distributon reel and the tubular form. The guide rollers are arranged to progressively increase the twist until at the discharge to the pipe the desired winding angle is established. Each of the rollers imparts a very slight twist and thus establishes the final desired winding angle in slow incremental changes.

To obtain the advantages of the present invention, the adjacent rollers are mounted such that a plane defined by the axis of each roller and the tangency line formed where the web leaves the roller is parallel to the plane defined by the axis of the next adjacent roller and the tangency line formed where the strip first engages such adjacent roller. This parallel plane arrangement results in the rollers functioning to maintain even distribution of

the tension across the width of the strip and insures winding of the tape upon the tubular form without splitting, roping or resin breaking.

The present invention thus provides a new and novel guide for strip winding apparatus which is particularly adapted for winding of woofless web or strips of resin impregnated unidirectional fibers onto a suitable tubular member or form.

The drawings furnished herewith illustrate the best mode presently contemplated for carrying out the invention.

In the drawings:

FIG. 1 is a side elevational view of a pipe forming apparatus incorporating a web twisting cage constructed in accordance with the present invention;

FIG. 2 is an enlarged perspective view of the winding apparatus shown in FIG. 1;

FIG. 3 is a perspective view of a tubular member formed with the apparatus shown in FIG. 1;

FIG. 4 is an enlarged view of a winding cage constructed in accordance with the invention and shown in FIGS. 1 and 2;

FIG. 5 is a view taken on transverse plane 5—5 in FIG. 4;

FIG. 6 is an enlarged view of a pair of rollers incorporated in the winding cage 3 and illustrating the relative position maintained between successive adjacent rollers;

FIG. 7 is a diagrammatic illustration of the relative angular position of the first and second cage rollers; and

FIG. 8 is a top view of the second cage roller shown in FIG. 7.

Referring to the drawings and particularly to FIGS. 1 and 2, the illustrated embodiment of the invention generally includes a rotatable distribution reel or drum 1 within which a coil of web 2 is secured. A winding mandrel 3 is movably mounted coaxially within the drum 1 to receive the web 2 as drum 1 rotates and the mandrel 3 is moved axially. A winding guide 4 forming a part of the present invention is interposed between the take-off from the drum 1 and the mandrel 3 and serves to properly guide web 2 and impart a selected twist to the web 2 as the web 2 moves from the drum 1 to the mandrel 3 to establish a desired or selected angle of winding.

The drum 1 is rotated and the mandrel 3 simultaneously moved axially through the drum to continuously wind web 2 upon the mandrel 3 with the adjacent spirals overlapping slightly.

The present invention is particularly directed to winding of a web 2 which consists of resin impregnated unidirectional fiberglass or the like. The web 2 is then a woofless strip having a lateral strength or cohesion which is practically non-existent. The web 2 is of any convenient width which is adapted to be superimposed upon the mandrel 3. After the resin is cured or set, a self-supporting tubular member 5 formed of plastic and reinforced by glass fibers results, as shown in FIG. 3.

The illustrated drum 1 includes an outer cylindrical shell 6 and a pair of axially spaced radial sidewalls 7 which project partially inwardly from the outer cylindrical shell 6 to form an inwardly opening annular shaped drum. A series of circumferentially spaced rollers 8 are disposed between the sidewalls at the inner periphery of the sidewalls to form and constitute a cylindrical winding form upon which the coil of web 2 is wound. The rollers 8 are parallel to the axis of the drum 1 and the mandrel 3 to allow removal of the tape over one of the rollers 8 without any twist or angular displacement of the tape. Each of the rollers 8 includes an inner core or mounting rod 9 which is secured at opposite ends to the sidewalls 7 in any suitable manner. A sleeve 10 is mounted upon each of the rods 9 for free rotation to minimize frictional

forces established as the tape is withdrawn from the coil of web 2.

An opening or window 11 is formed in the cylindrical shell 6 to permit initial winding of the web upon the rollers 8.

Three circumferentially distributed mounted brackets 12 are welded to the outer side of the cylindrical drum shell 6 and secured to a fly wheel 13 to rotatably mount the drum 1. A drive hub 14 is formed on the back side of fly wheel 13 and connected by a suitable chain 15 to a motor 16. The motor 16 is any suitable variety adapted to establish a constant rotational speed of the drum 1 to maintain a constant withdrawal of the web 2 from the drum 1 to the mandrel 3.

The mandrel 3 is a tubular core supported in opposite ends in similar bearing units 17. A drive wheel 18 is mounted in driving relation to the trailing portion of the mandrel 3. A constant speed motor 19 is coupled to the drive wheel 18 to continuously drive the wheel at a preselected constant speed. The mandrel 3 is therefore moved axially through the drum 1 at a constant speed for progressive spiral winding of the tape upon the mandrel.

In accordance with the illustrated embodiment of the invention, the guide 4 is constructed as follows.

Referring particularly to FIGS. 1, 2, 4 and 5, a series of rollers 20 are circumferentially spaced about the mandrel 3 between an initial take-off roller 21 and a discharge roller 32. The rollers 20–22 are secured between a pair of axially-spaced and semi-circular mounting plates 23 and extend through the drum 1. Mounting bolt assemblies 24 secure the mounting plate 23 to the opposite sidewalls 7 of the drum 1 to properly position the rollers 20–22 within the drum 1. Auxiliary stabilizing bolt units 25 are shown extending through and joining the upper ends of the plate 23 to provide a stable assembly. Recesses 26 in the plate 23 accommodate mandrel 3.

The rollers 20–22 are similar to rollers 8 and each includes a core journal 27 and a sleeve 28 freely rotatable thereon, as most clearly shown in FIG. 4.

In accordance with the present invention, the initial take-off roller 21 is mounted exactly parallel to the drum roller 8 over which the web 2 is withdrawn from the drum 1. The adjacent intermediate roller 20 is circumferentially spaced from roller 21 and mounted at a diagonal with respect to the first roller to impart a slight twist to the tape 2 as it moves from roller 21 over the adjacent roller 20. The relationship between the mounting of the rollers is crucial and the construction in accordance with the present invention is most clearly illustrated in FIGS. 6–8.

Referring to FIG. 6, a radial plane 29 through roller 21 and a radial plane 30 through the immediately adjacent roller 20 are parallel to each other with the rollers 20–22 properly aligned and mounted. Radial plane 29 is formed by and includes the axis 31 of the initial roller 21 and the tape tangency line 32 formed at the line that the web 2 leaves the roller 21. The plane 30 is formed by and includes the axis 33 of the immediately adjacent roller 20 and the tangency line 34 at the line that the web 2 initially engages such adjacent roller 20. The present invention states that these two planes must be substantially parallel.

Referring to FIG. 7, the first roller 21 and the adjacent roller 20 are shown as viewed from the line of the tape 2. The pivot point 35 of the second roller 20 is at the midpoint of the two rollers 20 and 21 and thus at the midpoint of the width of tape 2. This relationship is maintained for all subsequent displacement of the rollers 20.

Referring to FIG. 8, a top elevational view of the roller 20 shown in FIG. 7 is illustrated. The true tangency line is shown at 36. In actual practice, the angular displacement of the next succeeding roller 20 tends to lift one edge and lower the opposite edge of the tape 2 and actually shifts the tangency line such as typically shown at 37. Generally, unless exceptionally large twist is imparted between adjacent rollers, the displacement does not appreciably or practically effect the operation and functioning of the invention and the tangency line 36 can be employed in designing the apparatus.

The successive and adjacent rollers in the series of rollers 20–22 are arranged in like relation to each other. The successive rollers 20 and 22 are thus diagonally offset with respect to the previous roller to increase the winding angle and to thereby impart a preselected twist to the web 2. Each pair of rollers preferably provides a relatively equal angular displacement or twist in the web 2 although in actual practice a relatively complicated roller system is required therefor.

The number of rollers 20 which is employed is determined by the permissible or desirable stress which can be tolerated in web 2.

The operation of the illustrated embodiment of the present invention is summarized as follows.

The tape 2 is wound upon the rollers 8 within the drum 1 to form a coil. The mandrel 3 and the guide 4 are concentrically assembled within the drum 1 as previously described. The inner end of web 2 is threaded from the drum 1 back over the take-off roller 8 and then upon the outside of the rollers 20–22 and the free end is secured to the mandrel 3. The motors 16 and 19 are simultaneously energized to provide synchronous movement between the rotation of the drum 1 and the longitudinal movement of the mandrel 3 through the drum 1. The movements are correlated such that the spiral wrapping about the mandrel 3 establishes a tubular member 5 having overlapping portions between the immediately adjacent spirals.

The rollers 20–22 serve to conduct and change the direction of the tape as it moves from the drum 1 to the mandrel 3. Each adjacent pair in the series of rollers 20–22 imparts a substantially equal twist to all transverse sections of the tape and thus maintains a constant width throughout the length of the laterally unsupported tape. This eliminates forces tending to move the tape axially of the rollers 20–22.

The illustrated embodiment of the invention includes the guide assembly supported within the tape supply. The assembly can also be mounted exteriorly of the tape supply which is then unwound from the outer circumference. The latter construction permits a larger supply of tape and thus requires less frequent shut-down of the winding apparatus for replacement of the tape. An exteriorly mounted assembly is however somewhat larger in size.

The present invention thus provides an improved strip winding apparatus which is particularly suited for spiral winding of a woofless strip or web at any desired wrapping angle.

Various modes of carrying out the invention are contemplated as being within the scope of the following claims particularly pointing out and distinctly claiming the subject matter which is regarded as the invention.

We claim:

1. An apparatus for winding a woofless web of unidirectional fibers impregnated with a resin in a spiral pattern to form a tubular member, comprising, a mandrel, cylindrical support means for supporting the web in coiled form, and a series of guide members separate from said support means and circumferentially distributed about the mandrel and serving to guide the web from said support means onto the mandrel, the first of said guide members having its axis parallel to the mandrel and successive guide members from said first guide member being tilted about the central incoming tangency point to impart a progressive twist in the same general direction to the web, and said guide members being arranged with the plane defined by the axis of each guide member and the tangency line formed at the discharge line of the guide member being substantially parallel to the plane defined by the axis of the next adjacent roller and the tangency

line formed where the web engages such adjacent guide member.

2. An apparatus for winding a woofless web of unidirectional fibers impregnated with a resin in a spiral pattern to form a tubular member, comprising, a mandrel, a generally cylindrical support member to support the web in coiled form, and a series of cylindrical guide rollers circumferentially distributed about the mandrel and serving to guide the web from the support member onto the mandrel, said series of rollers including a first roller to receive the web from the support member and including a last roller to discharge the web onto the mandrel, said series of rollers also including a plurality of intermediate rollers located between the first and last rollers, said first roller having its axis parallel to the axis of the mandrel and said intermediate rollers and said last roller being tilted about the central incoming web tangency point to impart a twist to the web, and said rollers being arranged with the plane defined by the axis of each roller and the tangency line formed at the discharge line of the roller being substantially parallel to the plane defined by the axis of the next adjacent roller and the tangency line formed where the web engages such adjacent roller.

3. An apparatus for winding a woofless web of unidirectional fibers impregnated with a resin in a spiral pattern to form a tubular member, comprising, a mandrel, a winding head including a generally cylindrical support member to support the web in coiled form with said support member being mounted coaxially of said mandrel, means for rotating said head, a series of guide rollers mounted on the head and circumferentially distributed about the mandrel, said series of rollers including a first roller to receive the web from the support member and including a last roller to discharge the web onto the mandrel, said series of rollers also including a plurality of intermediate rollers located between the first and last rollers, said first roller having its axis parallel to the axis of the mandrel and said intermediate rollers and last roller being tilted about a central incoming web tangency point to impart a progressive twist to the web in the same general direction, and said rollers being arranged with the plane defined by the axis of each roller and the tangency line formed at the discharge line of the roller being substantially parallel to the plane defined by the axis of the next adjacent roller and the tangency line formed where the web engages such adjacent roller.

References Cited in the file of this patent

UNITED STATES PATENTS

986,690	Clark	Mar. 14, 1911
2,001,546	Pourtier	May 14, 1935
2,011,172	Coleman et al.	Aug. 13, 1935
2,910,822	Bunch	Nov. 3, 1959