May 19, 1964 J. R. SHOUP 3,133,709

BARREL CAM

Filed Nov. 6, 1961

2 Sheets-Sheet 1

Fig. 1.

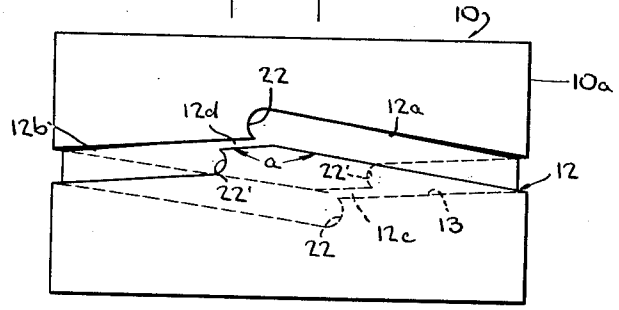


Fig. 2.

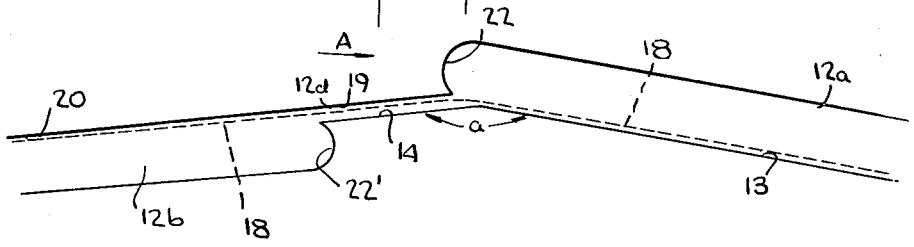


Fig. 2A.

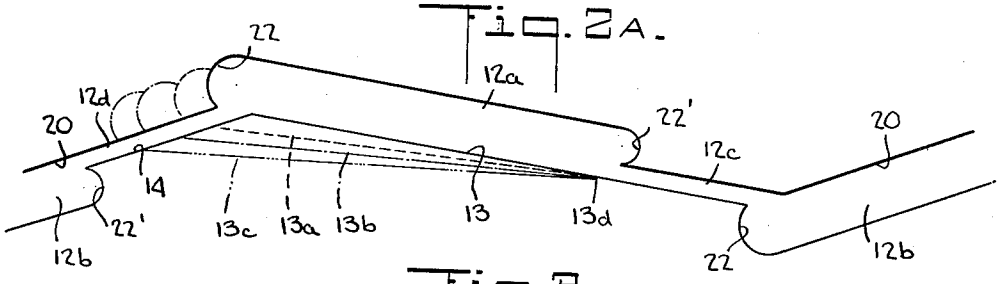
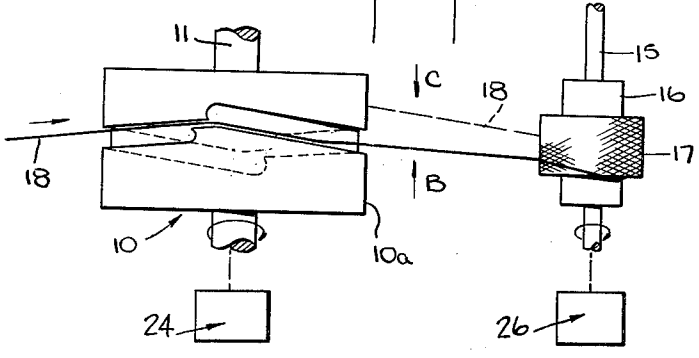


Fig. 3.



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Fig. 4.

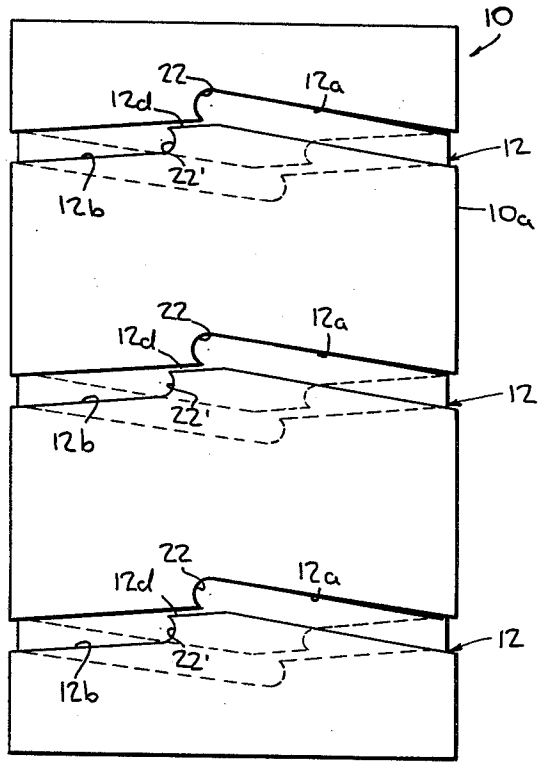
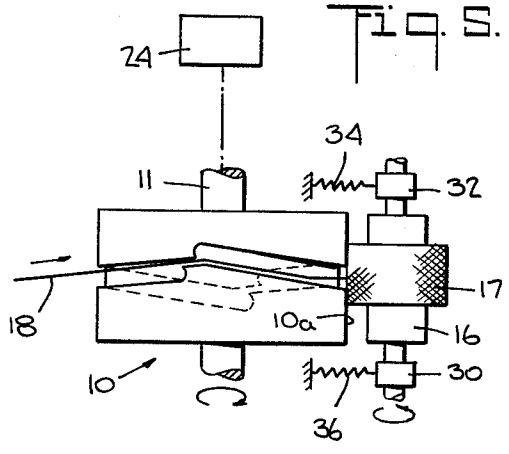


Fig. 5.



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3,133,709

BARREL CAM

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This invention relates to means for winding filamentary material such as yarns or the like onto tubes, spools or like cores, and in particular to means for guiding the material during the winding operation.

Filamentary materials in strand form, e.g. yarns, thin wires, etc., are generally wound onto spools or other cores such as cylindrical or conical tubes into the form of suitably shaped packages preparatory to further use. In the winding of textile yarns made of continuous synthetic filaments or of spun staple fibers, for example, the package-forming operation is usually effected with the aid of a ring rail or like reciprocatory guide device. Devices of this type are, however, disadvantageous in a number of respects, especially in that they impart a considerable twist to the yarn being wound, and frequently lead to the formation of packages of irregular shapes and yarn distribution and a relatively high degree of instability.

A further disadvantage stems from the fact that such winding of yarn into packages is usually sought to be carried out at high speeds. However, the operating speed of a reciprocally movable traverse such as a ring rail is necessarily limited by mechanical considerations. In the case of continuous filament yarn at the metier, of course, this places corresponding limitations on maximum filament extrusion speeds which can be employed, since obviously the rate of filament production cannot materially exceed the rate of take-up of the yarn. Consequently, yarn manufacturers are compelled to operate at less than maximum possible capacity and thus with less than the greatest possible efficiency and economy.

To overcome these defects and drawbacks, there have been developed devices, commonly termed "barrel cams," specially adapted for high speed and zero twist winding. By way of definition, "zero twist winding" as employed herein is intended to designated winding without imparting any additional twist, irrespective of whether or not the yarn or other filamentary material is already twisted prior to the commencement of the winding operation.

In general, a device of this type comprises a cylindrical member or drum adapted to rotate about its axis and provided with one or more peripheral helical grooves in its outer surface. Each such groove usually is divided into two halves which advance helically in opposite senses about the axis of the cylindrical member. Two basic groove designs are presently in use in existing cams, these designs being identified in the art as "straight return" groove, two sections or halves of the groove advance uniformly over their entire lengths and are of constant width throughout, usually about ¼ inch or sometimes ⅛ inch. In a "quick return" groove, on the other hand, two major sections of the groove advance uniformly over their entire lengths, but their adjacent ends are connected by relatively short helical minor or transition sections the helix angles of which differ from those of the major sections. If each transition section is considered to be the end of one major groove section which is connected to the start of the other major groove section, the arrangement in the known cams is such that the angles between the transition sections and the respective starts of the major groove sections are approximately 80 to 90 degrees.

The terms "straight return" and "quick return" stem from the types of yarn movement engendered by the respective barrel cams. As is well known, when a barrel

came rotates with its axis substantially parallel to the spool axis, the yarn passing over the cam and received in a groove thereof is first shifted laterally of itself in one direction axially or lengthwise of the spool and then in the opposite direction as it is wound on the spool. The reversals of the lateral directions of movement of the yarn, which are essential for forming a "cross-wound" yarn package, occur relatively slowly in the case of the "straight return" groove and the yarn at each reversal more or less flops from its movement in one direction to its movement in the opposite direction. In the case of the "quick return" groove, however, the yarn is shifted at high speed, i.e. effectively snapped, from its movement in one direction to its movement in the opposite direction while within the bounds of the transition sections of the cam guide groove.

Each of these types of groove designs suffers from its own particular disadvantages, although each also has advantageous features. It will be apparent that a "straight return" groove is very simple and easy to cut as long as its width is sufficiently great and its depth sufficiently small. A groove having such dimensional characteristics does not, however, provide an adequate control over the yarn at the reversal points, since there is a considerable delay between the time when the yarn leaves one groove section and the time when it is "picked up" by, i.e. comes in contact, with the wall of, the other groove section. Since it is impractical from a machining standpoint to cut the entire groove narrow enough to give the desired good control at the reversal points, the simple "straight return" groove design per se is effectively useless because it fails to produce packages which have the desired stability and uniform size, shape and yarn distribution.

The "quick return" groove is more difficult and expensive to cut, but it can be so formed as to give an improved degree of control, i.e. a relatively quicker yarn pick-up, at the reversal points due to the provision of a reduced clearance at these points. The presence of the sharply angled transition sections of the groove, however, results in the provision of greatly reduced amounts of material defining the yarn contact surfaces at the ends of the yarn traverses when the yarn tension is highest. As a consequence thereof, rapid undercutting at the reversal points occurs, which calls for frequent overhauls and ultimately renders the entire cam inutile.

It is an object of the present invention, therefore, to provide a barrel cam construction in which the disadvantages and drawbacks of heretofore known barrel cams are effectively avoided.

It is another object of the present invention to provide a barrel cam construction which is characterized by at least one helical yarn guide groove of novel configuration and dimensions.

Still another object of the present invention is the provision of such a barrel cam in which two major sections of the groove terminate in and are interconnected by two transition sections which are disposed at the same helix angle as their associated major sections.

A related object of the present invention is the provision of a barrel cam as aforesaid which has a considerably longer useful life than heretofore known barrel cams due to the fact that the angle between each transition section and the start of the following major section of the yarn guide groove is much greater than in the heretofore known barrel cams so as to present a bearing surface at each of the reversal points which is considerably bigger than the bearing surfaces provided at the reversal points in the known barrel cam grooves.

It is also an object of the present invention to provide a barrel cam in which the transition sections of the yarn

guide groove are of substantially reduced widths as compared with the major groove sections.

Still another object of the present invention is the provision of barrel cams of this type which require less expenditures for replacement and maintenance.

More specifically, in accordance with a preferred aspect of the present invention, the novel barrel cam comprises a cylindrical drum or body made of metal or metal alloys, e.g. stainless steel, aluminum, plated cast metals, and the like, or of suitable high strength materials of, or having incorporated therein, synthetic plastics, e.g. resins, resin-impregnated laminated paper, etc. The body has a diameter between about 8 and 20 inches and is provided in its outer surface with a yarn guide groove the depth of which ranges according to the body diameter from about 3/8 inch to about 1 inch, the groove of a 12-inch diameter cam on the average being about 1/2 inch deep. The groove has two oppositely helical major sections interconnected by two minor or transition sections each colinear with a respective one of the major sections. Each of the major groove sections may be from about 3/16 to 3/8 inch wide, while each of the minor or transition sections may be from about 1/64 to 1/16 inch wide. The helix angle of each major groove section and its associated minor section about the axis of the cam body may range from about 7 to 13°, and preferably is between about 8 and 9°, so that the angle between each of the minor sections and the adjacent reverse major section is between about 166 and 154° and preferably between about 163 and 158°. Each minor section is preferably about 5/8 inch long, but it may range from about 1/4 inch to about 1 inch in length.

Thus, the groove designed according to the principles of the present invention is seen to be in effect a combination of the advantageous features of the known "straight return" and "quick return" grooves, whereby the groove can be easily cut, gives the desired limited yarn clearance and enhanced control at the reversal points, and has greater amounts of material at these points to permit repeated overhauling without any adverse effect on the operativeness of the cam while at the same time permitting increased running time.

It is further within the contemplation of the present invention that more than one yarn guide groove, each having the aforesaid characteristics, may be provided on each barrel cam body so as to permit a plurality of yarn packages to be wound at the same time. Each groove may, if desired, be provided with a suitably shaped lead-in groove. This embodiment is shown with three grooves in FIG. 4.

The foregoing and other objects and characteristics, as well as additional advantages, of the present invention will be more clearly understood from the following detailed description thereof when read in conjunction with the accompanying drawings, in which:

FIG. 1 is a side view of a barrel cam having a yarn or filament guide groove shaped in accordance with one embodiment of the present invention;

FIG. 2 is a diagrammatic illustration of the groove adjacent one of the transition sections thereof on an enlarged scale;

FIG. 2*a* is a developed view of the groove and illustrates the manner in which the present invention admits of repeated overhauling without affecting the groove functioning;

FIG. 3 is a side view of the barrel cam in operation during the winding of a yarn package;

FIG. 4 is a side view of a barrel cam having a plurality of yarn or filament guide grooves; and

FIG. 5 is a side view of the barrel cam in frictional rolling surface contact with a yarn package in operation during the winding of a yarn package.

Referring now in particular to FIG. 1, it will be seen that a barrel cam **10** according to the present invention is provided in its outer cylindrical surface **10***a* with an endless peripheral groove **12** which comprises two major sections **12***a* and **12***b* of opposite helical configuration and two minor sections **12***c* and **12***d*. As shown in FIG. 1, looking down at the cam **10** from the top of the figure, the major section **12***a* starts near the top of the cam and descends clockwise toward the lower region of the cam, while the other major section **12***b* of the groove starts near the bottom of the cam and rises clockwise toward the upper region of the same. The two minor sections **12***c* and **12***d* of the groove **12** are essentially continuations of the respective major sections **12***a* and **12***b*, and each may be considered as the end of one major section which is connected to the start of the other major section. The two minor sections **12***c* and **12***d* thus provide transitions between the two major sections.

In the illustrated embodiment of the invention, the minor sections of the groove **12** are shown as being considerably narrower than the major sections. While it is not essential that there be such a difference in width, it is, however, necessary from the standpoint of obtaining a better control over the yarn at the reversal points of the lateral movement thereof that the transition sections should be as narrow as possible, and at most about 1/16 inch wide. Theoretically, the narrower the minor sections **12***c* and **12***d* of the groove can be made, the better the control which can be exercised over the yarn, a result which will be more specifically discussed hereinafter in connection with the description of the operation of the barrel cam. In actual practice, of course, the minimum width attainable is limited by machining consideration.

As previously stated, the helix angle of each major groove section and its associated minor section is generally between about 7° and 13°. Preferably, this angle is about 8.5°. Consequently, the angle *a* (see FIGS. 1 and 2) between the minor section **12***d* (at the end of the major section **12***b*) and the major section **12***a* at the start of the latter is generally between about 154° and 166°, and preferably is about 163°. It will be apparent from the foregoing, therefore, that at this reversal point of the yarn movement, which movement will be more fully described presently and is indicated in broken lines in FIG. 2, the groove **12** presents a yarn contacting surface, defined by the adjacent ends of the groove walls **13** and **14**, which is appreciably larger in area than the corresponding surface in any of the known barrel cams where the angle between each major groove section and its respective transition section is about 70 to 90°. The same holds true, of course, for the juncture between the start of the major section **12***b* and the transition section **12***c*. Thus, the yarn-produced wear or abrasion, which is maximum at the reversal points, is, by virtue of the groove constructions of this invention, spread over greater areas and is less concentrated than in the known barrel cams, whereby a barrel cam according to the present invention has a useful operating life which is considerably greater than that of any known barrel cam.

Reference will now be had to FIG. 3 for the operation of the barrel cam **10**. As shown, the cam **10** is mounted on a rotatable shaft **11** for rotation with the latter, the shaft **11** preferably being connected with any suitable drive means **24**. A second shaft **15** is located adjacent and extends parallel to the shaft **11** and supports a tube **16** constituting the core of a cross-wound package **17** of yarn **18**. In the illustrated embodiment of the invention, there is provided a separate drive **26** for the shaft **15** which is preferably synchronized with that of the shaft **11**, as by a variable speed transmission (not shown), in such a manner that the continuous increase in the outer diameter of the yarn package **17** is compensated for so as to maintain the winding uniform on the core **16**.

As will be readily understood by those skilled in the art, with the shafts **11** and **15** rotating in a clockwise direction as seen from the bottom of FIG. 3, corresponding to arrow A in FIG. 2, the yarn **18** passing over the

top of the barrel cam **10** and being wound up on the core **16** is displaced laterally of itself in the direction of the arrow B by the wall **13** of the major section **12***a* of the guiding groove **12**. Thus, the yarn **18** is helically wound onto the core **16** with all the turns of the yarn formed during a one-half rotation of the cam **10** being slanted relative to the axis of the core, say from the lower right to the upper left as shown in FIG. 3. The driving speed of the shaft **15** is, of course, so predetermined with respect to the speed of the metier feed rolls that the desired tension is maintained in the yarn **18**.

When the juncture between the wall **13** of the major groove section **12***a* and the wall **14** of the transition section **12***d* is disposed substantially opposite the core **16** or package **17** of yarn already wound thereon, the yarn **18** will be in the position illustrated in broken lines in FIG. 3. At this point, the direction of lateral traverse of the yarn is reversed due to the fact that the yarn now is transferred into contact with the wall **19** of the transition section **12***d* so that the latter begins to displace the yarn **18** in the direction of the arrow C shown in FIG. 3. The new turns of the yarn **18** during the second one-half rotation of the cam **10** are also helical about the core **16** but are slanted from the upper right to the lower left as seen in FIG. 3. The alternating layers of the yarn are thus cross-wound.

In view of the fact that, according to the present invention at least the transition section **12***d* is relatively narrow, i.e. at most about 1/16 inch wide, while at the same time the angle *a* is extremely large so that the bend around which the yarn must pass is correspondingly wide, the yarn upon passing about the aforesaid bend in the groove **12** is almost immediately picked up by the wall **19** of the transition section **12***d* and is under substantially continuous control during its direction reversal. Moreover, the initiation of the movement of the yarn in the reverse direction is smoothly effected, without any undue and sudden stresses being placed on the yarn, and with the wall **19** of the transition section **12***d* being colinear with the wall **20** of the second major groove section **12***b*, there is also no interruption in the control exercised over the yarn movement in the reverse direction as the yarn comes from the confines of the transition section **12***d* into the confines of the major groove section **12***b*.

Substantially the same procedure is repeated when the juncture between the major groove section **12***b* and the second transition section **12***c* arrives opposite the core **16** or the now cross-wound layers of yarn **18** thereon. Thus, the yarn is smoothly shifted from its contact with the wall **20** of the groove section **12***b* into contact with the wall **21** of the transition section **12***c*, the wall **21** being colinear with the wall **13** of the first major groove section **12***a*. The reversal of the yarn movement is, therefore, effected smoothly, permitting the yarn to be again traversed in the direction of the arrow B. As a result, the ultimate package **17** is highly stable and uniform in size, shape and yarn distribution, the advantages of these characteristics being well known to those skilled in the art and requiring no explicit recitation herein.

In lieu of employing separate drives for the barrel cam **10** and the yarn core **16**, it is possible, in accordance with the present invention, to employ the positively driven cam itself as the means for rotation of the core and the yarn package **17** thereon. This embodiment is shown in FIG. 5. In such a case, the shaft **15** is journaled for free rotation in a rockably mounted bearing frame **30** through **36** which is biased so as to maintain the peripheral surface of the core **16** or package **17** in contact with the peripheral surface **10***a* of the cam **10** and enabling the yarn core **16** to be rotated by virtue of the frictional drag of the cam against the core or package. With this arrangement, of course, the cam and yarn package rotate in opposite directions, so that the yarn **18** passes counterclockwise about the core **16** as seen from the bottom of FIG. 3 and from FIG. 5.

It is deemed advisable to point out that with a groove **12** as illustrated the respective rounded ends **22** and **22'** of the major groove sections **12***a* and **12***b* serve no function as far as the operation of the barrel cam and the guiding or traversing of the yarn are concerned. These groove section ends are natural consequences of the formation of the groove sections **12***a* and **12***b*, which is preferably effected by means of a drill-type cutter having the desired diameter, say 1/4 inch. For the transition sections **12***c* and **12***d* which are relatively short and narrow, however, i.e. on the order of about 5/8 inch long and about 1/16 inch wide, it is preferred to use a straight saw-type cutter, since a 1/16 inch drill will break under the strain of extended operation. Once the groove **12** is formed as just stated, it is only necessary to dull the sharp edges therein so as to prevent snagging of the yarn and possible damage to the yarn package.

In this connection it is to be especially noted that the construction of the groove according to the present invention ensures that optimum clearance at the reversal points can be maintained even after the cam has been overhauled from four to six times. This is best illustrated in FIG. 2*a* which is a developed view of the entire groove. Referring specifically to the major groove section **12***a*, for example, it will be understood that it is the junction of the wall **13** thereof and the adjacent wall **14** of the minor groove section **12***d* which is abraded or undercut the most by the passing yarn, as a result of which it becomes necessary at times to overhaul the cam by cutting away the abraded portion of this groove wall junction. Three such cuts are illustrated on an exaggerated scale in FIG. 2*a* by the dash line **13***a*, the single dot-dash line **13***b*, and the double dot-dash line **13***c*. The various cuts are all started at about the same point **13***d* of the wall **13** where the minor groove section **12***c* joins the major groove section **12***a* and the lead of the mill or cutter is so adjusted that at each run starting with a 0 (zero) cut at the point **13***d*, about 0.025 to about 0.1 inch of material is removed at the junction of the walls **13** and **14**. As clearly shown, even after a number of such operations, which in actual practice may be as many as four to six or more depending on the various cam dimensions, there remains enough of the wall **14** to serve the transition function previously served by the entire wall. Stated in other words, the minor groove section **12***d* remains intact over the remaining length of the wall **14**, and the clearance for the yarn is at precisely the same value at which it was in the original groove, since the remaining portion of the wall **14** is still at the same distance from the wall **19** as it was before the overhaul.

It will be apparent that the groove **12** may be formed in different ways than as described above. The choice of any particular method, however, will depend on the type of material of which the cam is made and its physical strength characteristics, on the diameter of the cam, on the desired groove section widths, on the operating characteristics of available tools, etc. The bottoms of the grooves or groove sections may be flat or curved, and the grooves may be suitably lined or otherwise smoothed to reduce the friction on the yarn.

The following example will serve to illustrate the principles of the present invention more clearly.

Example

Two ends of 55/0/15 dull cellulose acetate continuous filament yarn as extruded from the metier and having a tenacity of 1.15 grams per denier and an elongation of 26.5% are fed at a speed of 550 meters per minute across a duplex barrel cam made of "Synthane," a resin-impregnated laminated paper, and constructed with respect to each of its two grooves as shown in FIG. 1. The diameter of the cam is 12 inches, and the width of its outer peripheral surface is 7 inches. The yarn guiding grooves provided in the said peripheral surface of the cam are about

7/16 inch deep and 3/16 inch wide except at the transition sections where the width of each groove is 1/16 inch. The major helix angle of each groove is 8.5°, and the angle between each transition section and the start of the adjacent major groove section is 163°. The yarns are wound into packages without any twist and under a tension of about 5 to 10 grams. The winding is substantially uniform at all times and yields packages of high stability and free of bulges and grooves. The diameter of each cross-wound yarn package is about 7.5 inches, and its axial width about 2 11/16 inches.

It is to be understood that the foregoing detailed description is given merely by way of illustration and that many variations may be made in the invention without departing from the spirit thereof.

Having described my invention, what I claim and desire to secure by Letters Patent is:

1. Apparatus for winding filamentary strand material onto a core, comprising means supporting said core for rotation about its axis to permit winding of said strand material onto said core, and means for laterally traversing said strand material back and forth along said core during the winding operation, said traversing means comprising a cylindrical body mounted for rotation about its own axis and means for rotating said cylindrical body about said axis in the general direction of travel of said strand material at the point of contact of said strand material with said cylindrical body, said axis of said body being parallel to said axis of said core, and said body being provided in its outer peripheral surface with a continuous peripherally extending groove the two halves of which are uniformly helically curved in opposite senses about said axis of said body from one of their junctures to the other and each half of which is composed of a relatively wider major section and a relatively narrower minor section, each of said minor sections of said groove communicating at its leading end remote from the associated colinear major section with the major section of the other half of said groove and constituting a transition section between said major sections for effecting the reversal of the traversing movement of said strand material.

2. Apparatus according to claim 1, the helix angle of each of said halves of said groove being about 8.5°, and the angle between said halves of said groove at each of said junctures being about 163°.

3. Apparatus according to claim 1, each of said major sections of said groove halves being between about 3/16 inch and about 1/4 inch wide.

4. Apparatus according to claim 3, said cylindrical body being in frictional rolling surface contact with said core and ultimately with the layers of said strand material wound onto said core and constituting the means operable to rotate said core.

5. Apparatus according to claim 3, further comprising drive means operatively connected with said core for rotating the same in synchronism with said cylindrical body so as to ensure that the increase in diameter of said core due to yarn being wound thereon is compensated for during the rotion of said core.

6. Apparatus according to claim 3, said cylindrical body having a diameter between about 8 and 20 inches, and the width of said peripheral surface of said cylindrical body being between 6 and 10 inches.

7. Apparatus for winding a plurality of ends of filamentary strand material individually onto a core, comprising means supporting said core for rotation about its axis to permit winding of said strand material onto said core, and means for laterally traversing said ends of said strand material back and forth along said core during the winding opertion, said traversing means comprising a cylindrical body mounted for rotation about its own axis and means for rotating said cylindrical body about said axis in the general direction of travel of said strand material at the point of contact of said strand material with said cylindrical body, said axis of said body being parallel to said axis of said core, and said body being provided in its outer peripheral surface with a plurality of laterally spaced continuous peripherally extending grooves each composed of two halves, the two halves of each of said grooves being uniformly helically grooved in opposite senses about said axis of said body from one of their junctions to the other and each being composed of a relatively wider major section and a relatively narrow minor section, each of said minor sections of said groove communicating at its leading end remote from the associated colinear major section with the major section of the other half of said groove and constituting a transition section between said major sections for effecting the reversal of the traversing movement of said strand material.

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