

March 26, 1963

P. F. MARSHALL

3,082,591

APPARATUS AND PROCESS FOR MANUFACTURING WRAPPED YARNS

Filed Oct. 18, 1961

2 Sheets-Sheet 1

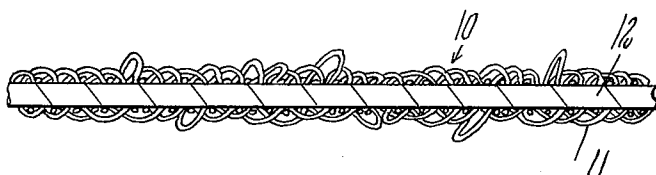


Fig. 1.

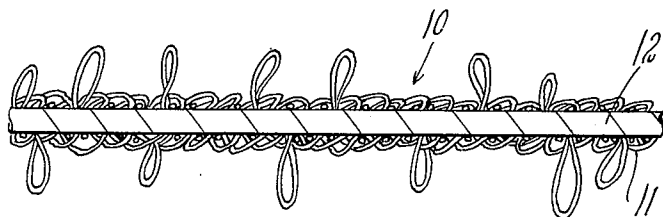


Fig. 2.

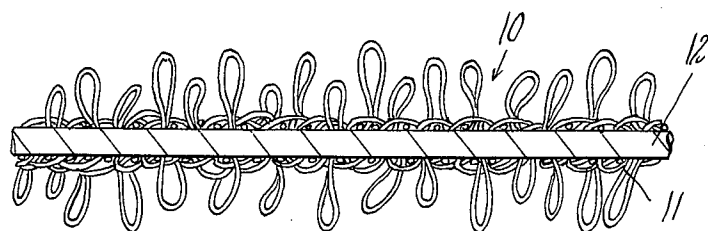


Fig. 3.

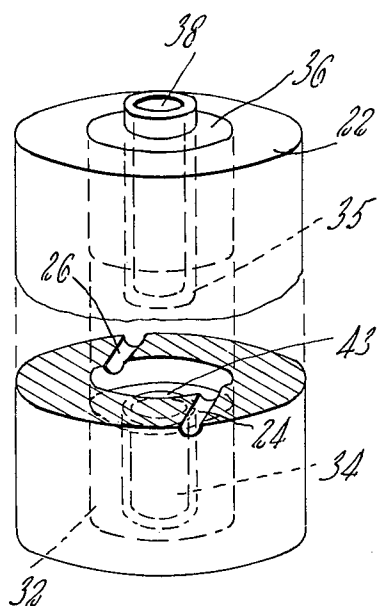


Fig. 4.

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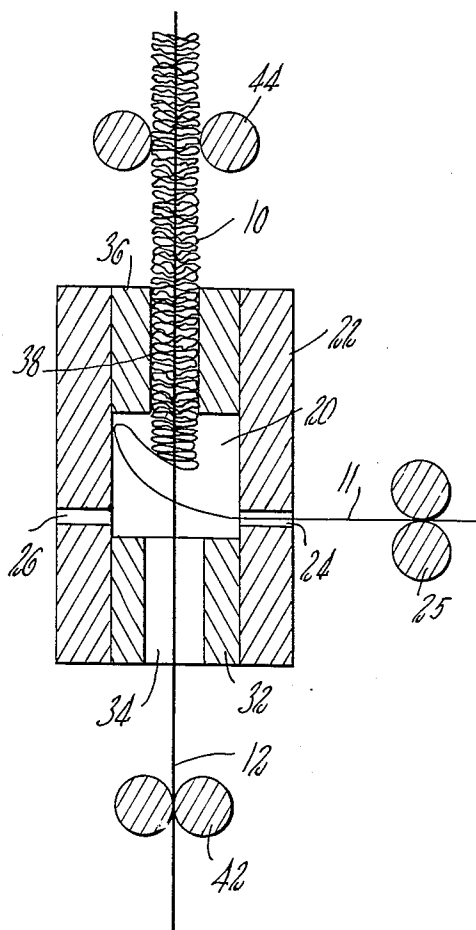


Fig. 5.

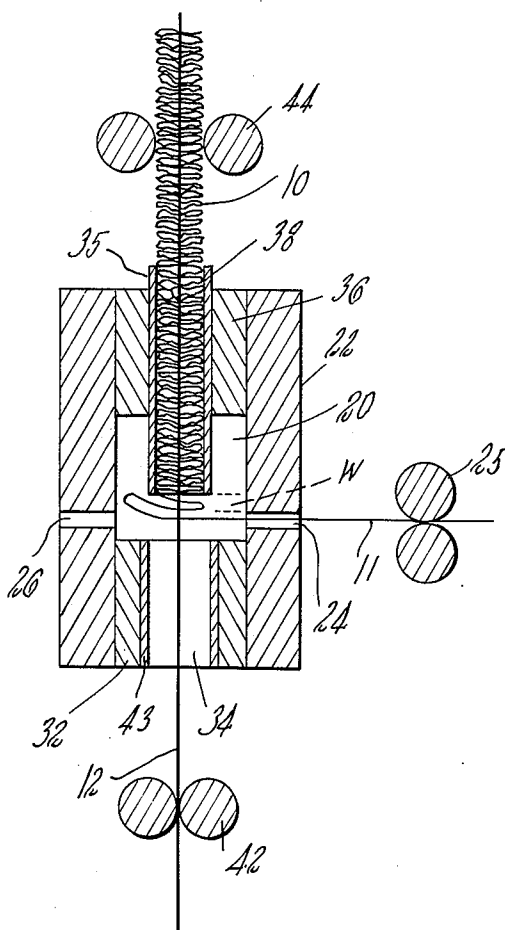


Fig. 6.

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APPARATUS AND PROCESS FOR MANUFACTURING WRAPPED YARNS

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Filed Oct. 18, 1961, Ser. No. 145,848

6 Claims. (Cl. 57-6)

This invention relates to a process and apparatus for manufacturing a novelty yarn. More particularly, it relates to a process and apparatus for preparing a novel wrapped yarn comprising a central core wrapped with filamentary material in a series of looped configurations about the axis of said core.

This application is a continuation-in-part of my copending application Serial Number 15,017, filed February 29, 1960, now Patent No. 3,041,812, which in turn is a divisional application of my application Serial Number 858,694, filed December 10, 1959.

Novelty yarns, useful in the production of textured or "visual effect" fabrics or used in strand form alone for decorative ties, etc., are typified by products such as boucle yarns, slub yarns, loop yarns, and the like. In general they are prepared by feeding at different rates two yarns into a twisting device which wraps one yarn, which is overfed, around another yarn which is held under tension, or by overfeeding one yarn to form loops which are held between a pair of tensioned binder yarns twisted together. Core yarns are similarly prepared by wrapping a covering strand more or less completely around a core by means of a rotating hollow spindle.

All such yarns are prepared in a rotating or spinning device that wraps one type of filamentary material around another with a true wrap or twist. The process suffers from known limitations and deficiencies inherent in rotating mechanical devices, wherein problems of friction and lubrication become critical at high speeds, and constant maintenance and supervision are necessary. The yarns so prepared have taken many forms but in general have either had too low a bulk factor for many uses, have been too expensive to manufacture, were not attractive, or were subject to a combination of these and other factors.

It is an object of this invention to provide an improved process for the manufacture of wrapped novelty yarns. It is a further object of the invention to provide a process for the manufacture of such yarns wherein the degree of uniformity of wrapping can be readily varied. It is a further object of the invention to provide an improved apparatus for the production of such yarns. Other objects of the invention will appear more fully from the following description and claims.

In general, the yarns of the invention include at least one continuous core strand and one or more continuous wrapping strands. The wrapping strand is characteristically disposed about the core strand in a multi-layered manner, the layers being formed from loops of wrapping strand which are wrapped around the core strand in the form of a closely-spaced, partially overlapping helix or series of helices, for a plurality of turns. Since a looped wrap is formed from a double strand, each wrapping may be considered to display an equal amount of right-hand and left-hand twist around the core strand. The wrapping strand is thereby "falsely wrapped" around the core strand, and possesses no true twist around the core. In this manner, the wrapping strand imparts no torque to the core strand, and a stable, non-kinking wrapped yarn can be made using but a single wrapped strand.

In essence, therefore, the present invention discloses the production of wrapped yarns wherein the wrapping

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is in the form of serially-connected loops, the loops being collapsed to lie generally perpendicular to the main axis of the core yarn. This process is accomplished by providing a generally cylindrical vortex chamber with a tangential fluid inlet thereto for pressurizing the chamber and creating a whirling body of fluid therein, the covering or wrapping strand preferably being introduced into said chamber through a tangential inlet thereto and passing from said chamber as the novel wrapped yarn of the invention through an axial outlet therefrom. The wrapping strand is drawn into the vortex chamber along the wall of the chamber. The core strand is preferably introduced through an axial inlet in the end of the chamber opposite to the outlet end. The covering or wrapping strand is continuously overfed into the chamber at a lineal rate greatly in excess of the withdrawal rate of the wrapped yarn, so that a portion thereof is continuously maintained in overfed condition within the vortex chamber, wherein the whirling mass of fluid acts upon it to form double loops and to wind said loops around the core strand.

The invention will be more clearly and specifically understood when discussed in connection with the accompanying drawings wherein:

FIGURES 1, 2, and 3 are longitudinal cross-sections of three types of yarn made according to this invention.

FIGURE 4 is a perspective view of the preferred apparatus of the invention.

FIGURE 5 is a cross section of the apparatus of my copending application Serial No. 15,017, with the addition of yarn control devices, showing a wrapped yarn being formed in accordance with that invention.

FIGURE 6 is a cross section of the apparatus of the present invention, with the addition of yarn control devices, showing the wrapped yarn of the present invention being formed.

Referring first to FIGURES 1 through 3, the core-constructed yarn 10 of the invention there shown includes a generally straight central core strand 12 having a wrapping strand 11 disposed thereabout.

The strands themselves may be strands of a wide variety of textile fibers, or other strands, either staple or continuous as is hereinafter more fully explained. For example, cotton, or wool yarns may be used in sizes from 10's to 200's cotton system, as may the synthetic fibers such as rayon, nylon, etc., either spun or continuous filament. Continuous strands of rayon, comprising a low twist bundle of filaments of size 1.5 to 20 denier per filament are especially useful in the invention because of the high bulking characteristic of such strands. Mixed fiber yarns may be used as well, and the physical and chemical characteristics of the central core strand 12 and the wrapping strand 11 may be quite different. It will be appreciated also that the invention is not confined to a core yarn in the ordinary textile sense, but that the core may be of wire or other filamentary material, such as twisted paper, plastic monofilament, metallic ribbon, and the like. In this manner, a bulky novelty yarn may be produced which has exceptionally high tensile strength due to the nature of the core filament employed.

It is also within the scope of the invention to use two or more strands as a core. Exceptionally bulky products are obtained when the core consists of one or more strands of inexpensive material such as cotton roving, combined with a strand of glass or nylon serving to give high tensile strength.

Apparatus suitable for the process of the present invention is shown in FIGURES 4 and 6. Referring to FIGURES 4 and 6, such apparatus may comprise a chamber 20 having a cylindrical wall 22 with a pair of tangential openings 24, 26, thereinto, and end walls 32, 36 having openings 34, 38. As a means for creating a longitudi-

nally-extended whirling body of fluid in said chamber, tangential opening 26 is connected to a source of fluid pressure such as an air pump, not shown. The wrapping strand 11 of FIGURE 6 may be fed into the chamber 20 through tangential opening 24, under control of a suitable tensioning device such as the pair of rolls 25, if desired. The core strand 12 is fed into the chamber 20 from a pair of rolls 42, or any suitable tensioning device, through opening 34 in the lower end wall thereof, while the wrapped core yarn 10 is removed from the axially-extended opening 38 by a suitable take-up device, such as the takeup rolls 44.

The difference between the apparatus of my application Serial No. 15,017 and that of the present invention is shown in the difference between FIGURES 5 and 6. It will be noted that FIGURE 6 has an added element an axially-extending control tube 35, which may be raised or lowered away from or toward the center line of the tangential openings 24 and 26. This adjustability is conveniently provided merely by having the control tube 35 fit snugly in the opening in the upper wall 36 of the chamber.

The function of this control element 35 will be discussed in more detail herein below.

In operation, to carry out the method of the invention, the core strand 12 is supplied from any suitable package, not shown, and is passed through guides or feed rolls 42 which, together with the take-up mechanism, insure that the core strand passes through the vortex chamber at a controlled velocity and under constant tension, so that it is essentially undistorted by the circulating air mass in the chamber. The core strand 12, of whatever composition desired, is fed through the inlet 34, passes through the vortex chamber, and is threaded through the outlet 38 to a pair of nip rolls 44.

When the core strand is suitably tensioned between sets of rolls 42 and 44, compressed air is fed into the chamber through the tangentially-directed inlet 26 while the wrapping strand 11 is fed through the oppositely-disposed wrapping strand inlet 24. The metering rolls 25, feeding the wrapping strand 11, are frequently omitted in the process, but may be used if a closely controlled but varying rate of input is desired, as for the production of sculptured yarns.

Air is fed into inlet 26 at from about 10 to 100 or more pounds pressure. The preferred tangential direction of the air stream, coupled with the generally cylindrical shape of the chamber, creates a miniature tornado in the vortex chamber, with a rapidly revolving stream of air circling around the walls. The end of wrapping strand 11, drawn into the chamber through the inlet 24 by the rotating air mass, apparently impinges on the core strand within a fraction of a second after the process of feeding the wrapping strand is started. More wrapping strand is being drawn in, however, with the net result that the continually advancing wrapping strand passes the leading end, and a loop or bight is formed.

Under hypothetical ideal conditions, the advancing end of a loop thus formed would wrap spirally in the form of doubled loops around the core strand 12. One feature of the product of this invention, therefore, is the presence in the wrapping layer of incrementally doubled looped windings, generally perpendicular to the core strand axis.

Due possibly to the presence of some turbulence or pulsing in the airflow, however, and to the effect of slight irregularities in the core strand and wrapping strand, this idealized type of wrapping is apparently not often realized when the apparatus of FIGURE 5 is used. The greater the length of loop the more subject it is to forces which tend to twist it on itself, and the easier it is for a loop to be thrust through another loop, giving to the resulting, wrapped yarn a somewhat irregular, "wild" or fuzzy appearance.

Although a yarn of this type is very well suited to purposes where a novel and irregular effect is desired, as in

certain upholstery and apparel fabrics, there are many uses where a smoother yarn is desired, which is more uniformly and more tightly wrapped by the doubled configuration of the wrapping yarn.

I have found that this desirable control of uniformity may be accomplished by restricting the length of the loops formed in the wrapping yarn by the rotating mass of air in the vortex chamber. For this purpose, the control tube 35 is placed so as to project a substantial distance into the chamber 20, said distance being with respect to the long axis of the chamber. Apparently, with the control tube 35 positioned as shown in FIGURE 6, the looped wrapping action is concentrated at the lower end of the control tube, the average loop length is less, and the regularity and tightness of wrap is increased over the nature of the wrap described in my copending application Serial Number 15,017.

The degree of uniformity established by the use of the control tube 35 is borne out by observation on the nature of the product produced as the control tube is placed at different heights above the center of the tangential wrapping yarn inlet 24. In FIGURE 6, this distance is denoted as "W." When the distance W is of the order of one thirty-second to one-sixteenth of an inch, the wrapping is quite tight and uniform. As the adjustable control tube 35 is moved upward toward the roof of the vortex chamber 20, the maximum length of loop increases, and more pedicular twisting and inter-loop interference occurs, with a more randomized uniformity of wrap. If the control tube 35 is moved up until it is flush with the roof of the vortex chamber 20, the situation is essentially that of FIGURE 5, with the length of loop at a maximum. Another advantage of the process and apparatus of this invention is based on the rapidity with which an uncontrolled loop, as shown in FIGURE 5, will abrade the walls of the yarn chamber 20, even when the walls are made of quite refractory material. This abrasion is particularly noticeable when strong wrapping strand is used, such as glass or nylon. Under such circumstances, with a chamber constructed of glass or transparent plastic such as a polyacrylate, in an attempt to wrap a core strand with a glass wrapping strand at a rate of 100 yards of wrapped yarn per minute, equivalent to 800 yards of wrapping strand consumption per minute, definite wear in the chamber wall was noticed before the apparatus was in operation 20 minutes. Before one hour had elapsed, the chamber wall had such a deep groove worn by erosion that the resulting yarn was very irregular and the wrapping showed so many undesirable cuts, fray, and discontinuities as to be commercially unacceptable.

With the apparatus of FIGURE 6, however, and with a distance W equal to $\frac{1}{32}$ inch, an otherwise abrasive wrapping operation can be carried on for many weeks with no significant evidence of wall wear or erosion.

It is important that the lower end of the control tube be maintained at a significant distance above the center line of the wrapping strand inlet 24. If the distance W is decreased to approximately zero, there is a tendency for the wrapping strand to be sucked up directly into the control tube 35, through which air is being exhausted and through which the core strand is passing, before the circulating mass of air revolving in the chamber has an opportunity to cast the wrapping strand into looped formation.

The apparatus of FIGURE 6 is preferably small in dimensions. A typical chamber, as shown in FIGURE 6, is constructed of a piece of quartz tubing, $\frac{1}{2}$ inch in diameter by $\frac{3}{4}$ inch long, outside diameter, with walls $\frac{1}{8}$ inch thick to form a cylindrical center chamber 20 which is $\frac{1}{4}$ inch in diameter and $\frac{1}{4}$ inch in height. This cylindrical piece of quartz tubing forms the outer walls, 22, of the apparatus. The upper and lower walls of the chamber, 36 and 32, are conveniently formed from pieces of $\frac{1}{4}$ inch outside diameter rubber tubing, which accommodate the control tube 35 and a length of thin-walled brass tubing 43, said brass tubing serving a sleeve or

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lining for the rubber end wall 32. The control tube 35 may be a length of 4 millimeter Pyrex glass tubing, while the brass tubing lining the lower opening 34 is conveniently of $\frac{1}{8}$ inch inside diameter.

The following examples will serve to illustrate the function of the apparatus and process of the present invention. In all examples, the apparatus of FIGURE 6 was employed, with the exception that the wrapping yarn control rolls 25 were not utilized.

Example I

A 70 denier—34 filament— $\frac{1}{2}$ Z twist nylon strand was wrapped around a core strand of the same composition, at an air pressure of 90 pounds per square inch. The speed of the core strand as measured at the wind-up was 539.2 feet or 179.7 yards per minute. The final product was 399 denier, of which 70 denier was core strand and 329 denier wrapping strand. This indicates that about 4.7 yards of wrapping strand were wrapped around each yard of core strand, a consumption of about 845 yards of wrapping strand per minute.

The distance W from the lower end of the control tube 35 to the projected midline of the inlet tube 24 was about $\frac{1}{16}$ of an inch. The resulting yarn was rather uniformly wrapped, like the yarn of FIGURE 1.

Example II

A 20 denier—7 filament— $\frac{1}{2}$ Z-twist nylon strand was wrapped around a 30 denier—10 filament— $\frac{1}{2}$ Z-twist nylon core strand at an air pressure of 80 pounds per square inch. The speed of the core strand measured at the wind-up was 315 feet or 105 yards per minute. The final product was 353.6 denier, of which 30 denier was core strand and 323.6 denier was wrapping strand. This indicates that about 16.2 yards of wrapping strand were wrapped around each yard of core strand.

The distance W from the lower end of the control tube 35 to the projected midline of the inlet tube 24 was about $\frac{1}{16}$ of an inch. The resulting yarn was rather uniformly wrapped, like the yarn of FIGURE 1.

Example III

A 75 denier—30 filament—3 S-twist viscose rayon strand was wrapped around a 260 denier—17 filament—1 Z-twist nylon core at an air pressure of 80 pounds per square inch. The speed of the core strand measured at the wind-up was 315 feet or 105 yards per minute. The final product was 1474 denier, of which 260 denier was core strand and 1214 denier was wrapping strand, indicating that about 16.2 yards of wrapping strand were wrapped around each yard of core strand.

The distance W from the lower end of the control tube 35 to the projected midline of the inlet tube 24 was about $\frac{3}{16}$ of an inch. The resulting yarn showed a somewhat fuzzy and irregular surface, like the yarn of FIGURE 2.

Examples IV, V, and VI were all run using an elastic yarn for a core. All three examples were run with the elastic core under tension during the wrapping operation in the cell. In each case the input speed of the core yarn to the cell was 125 feet per minute, while the output speed of the wrapped yarn from the vortex tube was 630 feet per minute, indicating a core tension stretch factor of five times. Air pressure was 80 pounds per square inch in all cases.

Elastic-cored yarns such as these will relax after being wrapped while the core is in the extended state in the vortex chamber. Data are given in each example for tensioned denier and relaxed denier of the wrapped product.

Example IV

A 20 denier—7 filament— $\frac{1}{2}$ Z-twist nylon strand was wrapped around a 125's count extruded round rubber strand (approximately 292 denier), with the core strand stretched to five times its normal length.

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In the extended state the wrapped product was 178 denier, of which 58 denier was core and 120 denier was wrapping. On release, the yarn contracted to 110% of the original length of the core strand, with a denier of 809 of which 266 denier was elastic core and 543 denier was wrapping. This indicates that about 27 yards of nylon were wrapped around each yard of core strand.

The distance W from the lower end of the control tube 35 to the projected midline of the inlet tube 24 was about $\frac{1}{16}$ of an inch. The resulting yarn was rather uniformly wrapped, like the yarn of FIGURE 1.

Example V

Two wrapping strands, both 75 denier—30 filament—3 S-twist viscose rayon yarns were wrapped around a round extruded rubber core strand of 44's count (approximately 2300 denier), with the core strand stretched as in Example IV.

In the extended state the wrapped product was 1356 denier, of which 460 denier was core strand and 896 denier was wrapping strand. On release, the wrapped yarn contracted to 115% of the original length of the core strand, with a denier of 5,896 of which 2,000 denier was elastic core strand and 3,896 denier was wrapping strand. This indicates that about 26 yards of wrapping strand were wrapped around each yard of core strand.

The distance W from the lower end of the control tube 35 to the projected midline of the inlet tube 24 was about $\frac{3}{16}$ of an inch. The resulting yarn showed a somewhat fuzzy and irregular surface, like the yarn of FIGURE 2.

Example VI

A 300 denier—60 filament—2 $\frac{1}{2}$ S-twist viscose rayon strand was wrapped around the same 125's count rubber core as was used in Example V, again with a five-times stretch factor.

In the extended state the wrapped product was 2251 denier, of which 460 denier was core strand and 1791 denier was wrapping strand. On release, the yarn contracted to 140% of the original length of the core strand, with a denier of 8037, of which 1643 denier was core strand and 6393 denier was wrapping strand. This indicates that about 21.3 yards of rayon were wrapped around each yard of rubber core.

The distance W from the lower end of the control tube 35 to the projected midline of the inlet tube 24 was about $\frac{3}{16}$ of an inch. This high separation gave a yarn that had a decidedly fuzzy and "wild" surface, like the yarns of FIGURE 3.

Having thus described my invention, what I claim is:

1. Apparatus for manufacturing core-constructed yarn comprising a generally cylindrical chamber, a longitudinally-adjustable cylindrical tube mounted inside said chamber and concentric therewith, means for creating a longitudinally-extended whirling body of fluid in said chamber including a tangential opening in said chamber and means for applying a pressurized fluid to said opening, means for feeding a wrapping strand into said chamber including an opening in a side wall of said chamber, means for feeding a core strand into said chamber including an opening in an end wall of said chamber, and means for removing said core-constructed yarn from said chamber including an opening in the other end wall of said chamber, said cylindrical tube passing through said other end wall.

2. The apparatus according to claim 1 wherein the opening for feeding the wrapping strand is tangential to the chamber.

3. The apparatus according to claim 2 wherein the tangential opening for applying a pressurized fluid and the tangential opening for feeding a wrapping strand are substantially oppositely disposed on the walls of the generally cylindrical chamber.

4. A method of making a wrapped cored yarn which

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comprises continuously passing at least one core strand axially through a generally cylindrical body of fluid whirling about a central axis, continuously overfeeding at least one continuous wrapping strand into said body of fluid generally tangentially thereof, continuously maintaining an overfed portion of said wrapping strand within said body of fluid to form doubled-back loops in said wrapping strand, winding said loops in doubled configuration around and in intimate contact with said core strand, continuously collecting and passing the wrapped core strand through a longitudinally extending cylindrical tubular constriction concentric with and of lesser diameter than the diameter of the cylindrical body of fluid while confining it within the constriction to control the degree of uniformity and tightness of the looped wrapping of said core strand, and thereafter continuously removing said yarn from the constriction.

5. The method of claim 4 wherein the wrapping strand is collapsed in intimate contact with said core strand in the general form of closely spaced and partially over-

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lapping helices, said helices being characterized by an equal number of right-hand and left-hand turns about said core strand.

6. The method of claim 4 wherein the wrapping strand is generally collapsed in intimate contact with said core strand in the general form of closely spaced and partially overlapping helically wrapped regions composed of wound loops, said helically wrapped regions being interspersed with other loops in pedicled form extending radially from the central axis of said core strand.

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