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Gubinsky et al.

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[54] **YARN PACKAGING**

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[52] **U.S. Cl.** ....**57/157 F,** 57/55.5, 57/93, 57/95, 57/98, 57/157 R, 242/26.1, 242/159

[51] **Int. Cl.** **D01h 1/36**

[58] **Field of Search** ....57/34 B, 157 F, 55.5, 93, 95, 57/98; 242/159, 26.1

[56] **References Cited**

UNITED STATES PATENTS

3,357,655 12/1967 Iwnicki et al.........................57/157 X

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[57] **ABSTRACT**

During a constant tension programmed spindle speed drawtwisting operation, decreased twist insertion below a minimum acceptable value is compensated for by passing the yarn through fluid jet interlacing means prior to take-up.

7 Claims, 3 Drawing Figures

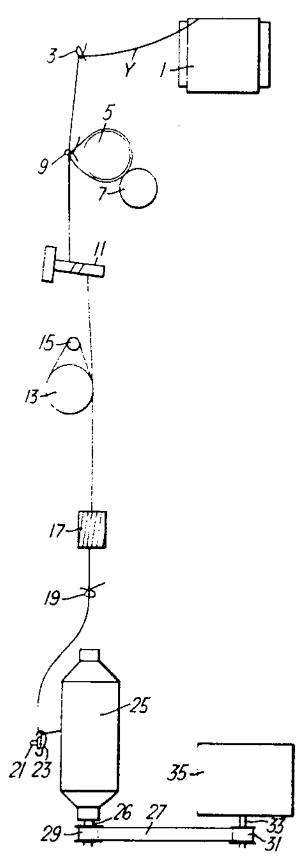


Fig. 1.

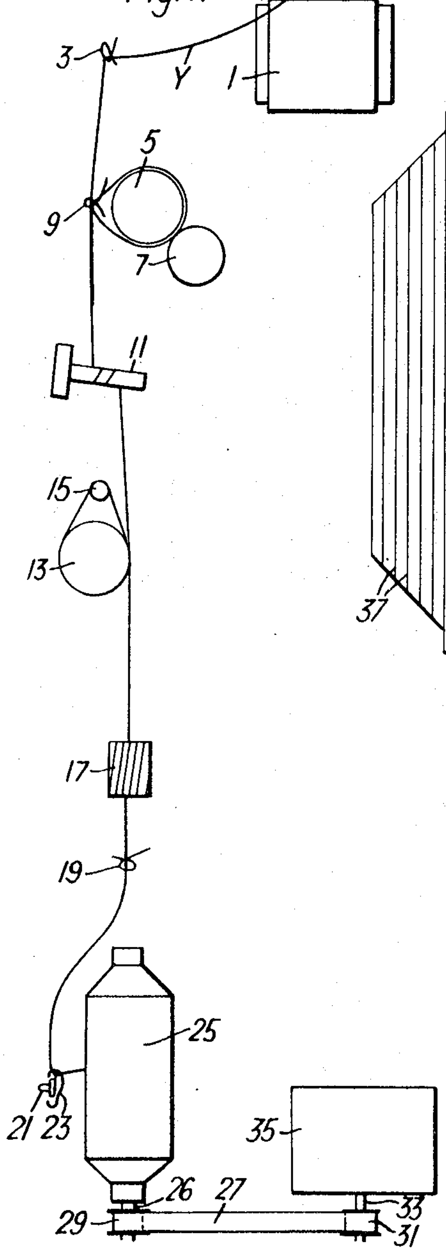


Fig. 2.

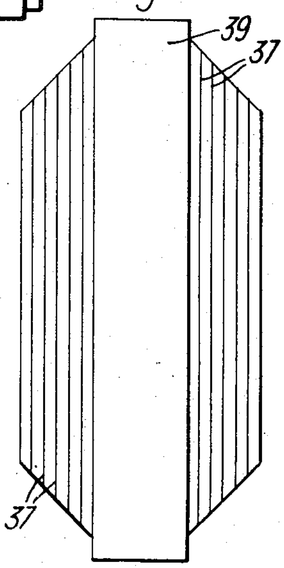
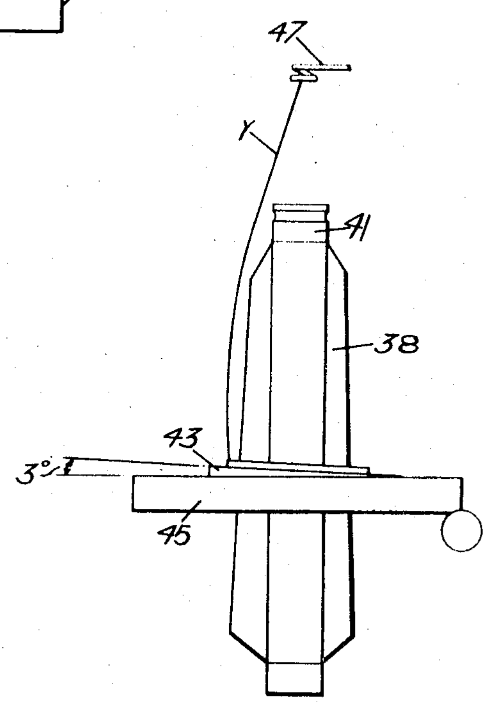


Fig. 3.



YARN PACKAGING

BACKGROUND OF THE INVENTION

The present invention relates to the packaging of continuous multifilament yarn. More particularly, the present invention relates to the drawtwisting of continuous multifilament yarn at high speeds utilizing a programmed, substantially constant tension, spindle speed process. Even more particularly, the present invention relates to a continuous, multistep, sequential process of spinning continuous multifilament yarn followed by drawtwisting and packaging at high speeds to produce a yarn package wherein the yarn is characterized by a substantially uniform tension and substantially uniform degree of cohesiveness throughout its length. The yarn is suitable for use in textile conversion operations such as knitting, weaving, and the like.

It has been the common practice in the textile industry, in such processes as weaving and warp-knitting, to use yarns which have been twisted to enable the yarns to be handled and processed as compact entities, without fear of their becoming dissociated into their constituent fibers or filaments and hence becoming snarled or weakened by fiber or filament breakage.

Sometimes the amount of twist imparted to the yarns has been quite considerable, for example from 7–30 turns per inch in multifilament yarns, and this twist insertion has been carried out by throwsters as a separate operation on the yarn as supplied by the producer. Lately, with the improved uniformity of the continuous filament yarns produced, and with increased knowledge as to the handling and processing of such yarns having only a low degree of twist, it has become common to use and process continuous filament yarns in the so-called "flat" state in which they are produced. A "flat" yarn is one possessing no more than the standard low degree of twist commonly inserted as an incident of its production by the yarn producer; and this twist may be only of between one-fourth turn per inch and one-half turn per inch. This small amount of twist is sufficient to impart to the yarn an adequate degree of compactness and of manipulability for at least a large proportion of subsequent textile processes.

It has recently been suggested in the art that spindle speed, instead of being maintained at a constant speed throughout the drawtwisting operation, be regulated in a predetermined manner in order to increase the speed of yarn travel through the drawtwisting operation, and hence increase the capacity of existing machinery.

Apart from regulating spindle speed in order to increase the winding-on speed of the yarn, e.g. yarn velocity can be increased from about **2,500** feet per minute to over **4,000** feet per minute by means of an appropriate programming of spindle speed, physical yarn characteristics, hence certain desired final yarn properties, can be controlled to varying degrees by primarily or secondarily regulating spindle speed so that the yarn is wound onto the spindle in accordance with a predetermined tension profile throughout the package build. For example, it is sometimes highly desirable to gradually increase or decrease the tension on the yarn during the winding operation to effect desired changes in package stability, yarn modulus properties and the like, or even to maintain a substantially constant tension on the yarn during packaging in order to produce a yarn of uniform dyeability and the like. As is known to those skilled in the art, the tension under which the yarn is wound is directly related to many properties of the drawn yarn. Therefore, proper regulation of balloon tension during the simultaneous drawtwisting and packaging operation is a highly desirable objective.

In order to achieve the maximum increase in drawtwister capacity through use of programmed spindle speed techniques, in conjunction with a tension regulation process, particularly a constant tension process, the twist inserting function of the ring traveller should be reduced to a negligible valve so that the primary function of the traveller becomes to match the drawing speed to the increased winding-on speed of the yarn onto the spindle. However, as described hereinbefore, a standard low degree of twist of the order of about one-half turn per inch should be inserted into the yarn during drawtwisting to provide a degree of compactness and cohesiveness for manipulation during subsequent textile processes. Of course, where the degree of twist insertion is above the minimum required, there must be a corresponding reduction in the theoretical maximum winding-on speed. Indeed, even an increase of one-eighth to one-fourth turn per inch twist insertion markedly reduces drawtwister capacity in a relative manner as is obvious to those skilled in the art.

Thus, the present invention is particularly directed to the drawtwisting of continuous multifilament yarn at high wind-on speeds made possible through the use of programmed spindle speed while a substantially low, constant, degree of twist of the order of about one-fourth to one-half turn per inch, or less is being inserted into the yarn. The described process conditions are particularly applicable to a constant tension drawtwisting operation.

It would be expected that twist insertion rate would remain substantially constant during a constant tension programmed spindle speed drawtwisting process, reliance being placed on progressively increasing traveller speed from the initial lowest possible value as package diameter increases (with a correspondingly reduction in spindle speed) to compensate for the decrease in twist insertion rate which would normally occur in a constant traveller speed, decreasing spindle speed program. However, it has been found that in a constant tension — maximum wind-on speed process, twist insertion varies considerably from a mean preset value. For example, assuming that one-fourth or 0.25 turn per inch insertion rate is desired, actual twist along the packaged yarn length can be as low as about 0.21 turn per inch. From this, it is apparent that where maximum productivity is desired and twist level is to be at the minimum acceptable value, i.e. 0.20 or below turn per inch, for subsequent textile processing and conversion operations, actual twist insertion in the yarn will randomly decrease to a value below the minimum desired. Consequently, filament flaring and the like will occur at the points of lowest twist insertion during later processing because of lack of cohesion at those areas along the yarn's length. Generally, random lack of cohesion is not detrimental to final product physical properties, but does affect aesthetics which are as important in many textile products. For this reason, the yarn can not command the highest price in the marketplace.

One obvious technique to eliminate the above-described problem is to maintain a twist insertion rate sufficiently high so that the lowest value reached during twist variance is above the minimum acceptable value. Of course, this reduces proportionately the primary purpose of programmed spindle speed. For a predetermined spindle speed program, traveller speed must be increased during the winding operation to result in a higher twist level with an accompanying reduction in wind-on speed of the yarn.

Therefore, it is an object of the present invention to provide a drawtwister programmed spindle speed process wherein maximum desired yarn wind-on speed is realized.

It is another object of the invention to provide a programmed spindle speed process for a drawtwisting operation wherein fluctuation in twist insertion is reduced to a negligible value so that the system can be initially programmed for the minimum twist induced by the operation of the ring and traveller take-up at the windup speed employed.

An additional object of the invention is to provide a continuous, sequential process for rapidly spinning, drawtwisting and packaging continuous filament yarn.

A further object of the invention is to provide a programmed spindle speed process of high yarn wind-on speed suitable for use with all types of drawtwisting equipment.

Still a further object of the invention is to provide a constant tension programmed spindle speed process of high yarn wind-on speed for use in conjunction with the attainment of other programmed spindle speed objectives such as decreased ribboning or patterning on the yarn package.

SUMMARY OF THE INVENTION

In accordance with the present invention, continuous multifilament yarn is subjected to a constant tension programmed spindle speed drawtwisting operation utilizing a ring and traveller take-up mechanism in a manner so that a substantially uniform low degree of cohesiveness is inserted into the yarn while it is being twisted at a low value and wound at the highest available speeds, by a process which comprises compensating for the twist insertion variance in the yarn which occurs during the drawtwisting operation by interlacing said yarn by fluid jet means positioned prior to said take-up mechanism so that said yarn retains a cohesiveness at least equivalent to that obtained at the minimum acceptable twist insertion value when that value is decreased because of twist insertion variation.

In a preferred embodiment of the invention there is disclosed a continuous, sequential process wherein continuous multifilament yarn is spun and then drawtwisted as above disclosed utilizing air jet cohesiveness compensation in order that maximum yarn wind-up speeds are realized in a constant tension programmed spindle speed operation.

In other embodiments of the invention, constant ring rail linear rate of traverse and/or constant time per ring rail stroke drawtwister machines are utilized in a manner to reduce ring tilt patterning and ribboning in conjunction with the high speed, constant tension programmed spindle speed process to produce yarn packages of high stability.

DESCRIPTION OF THE DRAWING

FIG. 1 is a diagram of apparatus used to practice one embodiment of the invention for the drawtwisting of continuous filament yarn;

FIG. 2 is a yarn package formed by a constant linear rate of ring rail traverse drawtwister and

FIG. 3 is a yarn package formed on the spindle of a constant time per ring rail traverse stroke drawtwister.

DETAILED DESCRIPTION OF THE INVENTION

The present invention relates to the drawtwisting of continuous filament yarns.

Apart from its twist inserting function, the ring traveller has the ability and function to match the drawing speed to the winding-on speed of the yarn on the drawtwist bobbin. It has now been appreciated that if the twist inserting function of the ring traveller is reduced to its secondary function, rather than its primary one, and the traveller is employed solely to match the drawing speed to the winding-on speed and to impart sufficient tension to the yarn to pull it, or at least to assist to pull it, from the draw roll, then the rotational speed of the traveller can be greatly reduced from that normally required and a concomitant gain achieved in the winding-on speed and consequently in drawtwister productivity.

The latter gain follows from the relationship between traveller speed, spindle speed and yarn speed, which is given by the equation

$$T = S - V/2\pi r$$

when

T = Traveller speed, r.p.m.
S = Spindle speed, r.p.m.
V = Yarn Velocity, feet/minute
r = Package winding radius, feet.

In order to maintain the traveller speed constant at the practical minimum value, it is desirable to wind the yarn on to the drawtwister bobbin with a build each traverse stroke of which is at a constant package winding radius, such radius increasing progressively throughout the build, and concomitantly, the spindle speed has to be reduced progressively as that radius increases.

If one were not concerned with the secondary function of yarn regularity, particularly as it relates to balloon tension during drawtwisting, the traveller could merely be set at a predetermined low speed sufficient to insert the desired twist into the yarn.

Because traveller speed is proportional to the tension on the yarn by the equation

$$K = t^2/r$$

where K is a constant and t and r are as defined above, traveller speed must be increased during the drawtwisting operation in a constant tension program. In order to operate at maximum efficiency, the difference between traveller and spindle speeds is still maintained as high as possible, only limited by machine limitations and the increase in traveller speed required for tension regulation and minimum twist insertion value, for example, of the order of 0.20 turns per inch. Of course, depending upon subsequent use, twist insertion level may vary form as low as about 0.15 turns per inch to as high as 1 to 5 and more turns per inch. Because of variation in twist insertion rate which occurs during operation, the twist level randomly falls below the minimal acceptable value for which the machine is set for maximum productivity.

In accordance with the invention, fluid jet i.e. air jet, interlacer is positioned between the draw roll and the ring and spindle take-up device to impart a degree of inter-filament cohesiveness to the yarn to compensate for the decrease in twist insertion below the minimum acceptable value. Because the twist insertion levels of concern are relatively low, it will be appreciated by those skilled in the art that the yarn can be considered as being characterized by a substantially uniform level of twist for practical purposes even where the upper limit of twist variation is compounded by the interlacement effect.

Interfilament cohesion may be determined by the "hook-drop" test of U.S. Pat. No. 2,985,995 or a needle pull test wherein coherency may be determined by tensioning a selected length of yarn under a weight equivalent to predetermined fraction, i.e. two-tenths, of the average filament denier in grams, inserting a selected needle through the yarn with at least one-third of the fibrils on each side of the needle, increasing the yarn tension until it equals the average fibril denier in grams and measuring the distance the yarn has travelled over the needle, a shorter distance indicating a higher coherency factor with comparative testing.

FIG. 1 illustrates one apparatus arrangement for practicing this embodiment of the invention.

Undrawn yarn Y is withdrawn over one end of supply package **1**, through thread-guide **3**, by the action of feed roll **5**. The feed roll is surface-driven by drive roll **7**; and the yarn makes a plurality of wraps around the periphery of feed roll **5**, the wraps being kept apart by threading the yarn through thread-guide **9**.

From the feed roll **5**, the yarn is stretched by passing it with a plurality of wraps around snubbing-pin **11** and drawing it therefrom, at a rate several times that of the peripheral speed of feed roll **5**, by draw roll **13**. The yarn makes a plurality of wraps around the periphery of draw roll **13**, the wraps being kept apart by separator roll **15**.

From the draw roll **13**, the yarn is taken to the wind-up, via filament-interlacing air jet **17**. Compressed air is provided to the jet (by pipe means not shown in the drawing); and the tension on the yarn is such that although the filaments are separated from one another in the jet and interlaced, no loops are formed in them. The wind-up comprises the standard ring spindle, consisting of balloon guide **19**, ring **21** and traveller **23**, with take-up package **25** rotatably driven by spindle **26**. The spindle is driven by belt **27** which is passed in driving engagement with wharl **29**.

The driving end of belt **27** is a pulley **31** on a shaft **33** rotating within bearings in the diagrammatically depicted device **35** for programming spindle speed variation in accordance with a constant balloon tension profile.

In one exemplary process carried out in accordance with this embodiment of the invention, a yarn package as depicted in FIG. **2** wherein parallel layers **37** of yarn in the yarn package are shown diagrammatically, starting with the longest traverse length nearest to the barrel of the container **39**, was built using a constant linear rate of traverse drawtwister operated in accordance with a constant tension programmed spindle speed, long-to-short (linear length of ring traverse decreases as the package is built) package winding cycle.

As a specific example of this embodiment of the invention, nylon 6,6 continuous multifilament yarn is drawtwisted on a Rieter constant linear rate of traverse drawtwister using a constant tension programmed spindle speed process. Spindle speed is reduced from 11,800 rpm at the beginning of the cycle to 8,000 rpm at the end of the package cycle. Traveller speed is initially set at 90 feet per second and raised throughout the package build to maintain a substantially uniform balloon tension of about 0.1 grams per denier on the yarn and a twist level of 0.20 turns per inch. A long-to-short package build is used to produce a package as depicted in FIG. 2. Twist level varies to a minimum value of about 0.17 turn per inch. The interlacing air jet, which can be of any of a number of designs such as those described in U.S. Pat. Nos. 2,985,995; 3,110,151; 3,364,537 or 3,115,691, is positioned as depicted in FIG. 1 of the drawing so as to maintain a constant coherency level equivalent to 0.20 turns per inch as determined by the hook-drop or needle-pull test, even when the twist level falls to about 0.17 turns per inch which is previously found to be the minimum twist level obtained during processing without air jet intermingling. Tension can be set, if desired, as low as 0.01 grams per denier to as high as 1 gram per denier and higher.

With reference to the continuous spin-draw sequence or spin-draw-relax-draw sequence, the total draw ratio employed will be within the range normally employed for the yarn being processed, such as about 1.5:1 to 8.5:1 for continuous filament yarn. This total draw is determined from the point of initial yarn take-up. When an intermediate relaxation step is employed the first draw step is typically within the range of about 1.01:1 to 6:1; the yarn will be allowed to relax about 1 to 15 percent and then drawn additionally at a draw ratio of about 1.01:1 to 8:1 during the drawtwisting operation. If desired, the relaxation step may be omitted and the yarn is spun, drawndown to an initial take-up and then drawtwisted in a continuous operation.

In commercial drawtwisting operations, it is conventional to tilt the traversing ring assembly with respect to the axis of the spindle in order to improve package stability. However, "ring tilt" markedly increases the evidence of "patterning" in the package build. "Patterning" occurs because of the nearly exact coincidence of adjacent individual yarn wraps at certain radii of the build and spindle to traveller speed relationships. When a sufficient number of what would normally be adjacent wraps have superimposed during winding, ridges and grooves forming ribbon patterns of different magnitude appear periodically on the package.

In addition to increasing package stability, "ring tilt" is used to aid in the regulation of tension on the yarn during packaging. Therefore, the present constant tension programmed spindle speed process is especially suitable for employment with tilted ring drawtwisting operations.

The ring assemblies of conventional drawtwister traverse the spindle in accordance with one of two alternate ring traverse control parameters.

On the one hand, a constant rate of linear travel of the ring is employed. Typically, the length of ring traverse gradually decreases during the build to produce a cylindrical mid-section as illustrated by FIGS. 1 and 2 of the drawing. Ring tilt patterning or ribboning is reduced by measures such as alternating between 2 or more spindle speeds, scrambling the spindle speed about a mean value at certain traveller to spindle speed ratios and the like.

On the other hand, a drawtwister, the ring assembly of which operates in accordance with a constant time per stroke (a stroke being the movement of the ring in one direction only and with the selection of different times for the up and sown strokes being desirable at times), can be employed. Usually, an accelerated up or down stroke (with the other stroke being at a constant speed) is utilized to produce the tapered mid-section package as depicted in FIG. 3 of the drawing. In this manner, patterning which does occur is spread out over a number of layers which reduces the visibility thereof in the full package.

FIG. 3 depicts a yarn package being wound by a ring spindle apparatus comprising a traversing ring rail 45 carrying a ring 43 which is angled at 3 degrees to the horizontal, and a bobbin 41 mounted for rotation on an upstanding rotatable spindle (not shown) centrally disposed within the ring. Yarn Y from e.g. the draw roll of a drawtwister is led downwardly through balloon guide 47 and thence through a traveller (not shown) rotatable around ring 43. The yarn is wound into a build 38 in which adjacent coils overlap each other at certain points, due to the "ring tilt" applied to the ring, and such overlapping imparts extra stability to the build, particularly at the tapered end-portions. The accelerated up-stroke in conjunction with constant time per stroke, even though the length of stroke still decreases from inside to outside of the package, combine to produce a stable package with minumum visible incidence of patternings and characterized by the tapered mid-section of package build 38.

Various modifications of the invention will appear obvious to those skilled in the art. For example, it will be apparent that the interlacing means may comprise one or more fluid jets in series where desired, as by the use of the alternate false twist technique described in U.S. Pat. No. 3,116,588 or the interlacing effect may be accomplished using pairs of oppositely acting fluid torque jets, as contemplated by Long, U.S. Pat. No. 2,673,442. Although the invention is exemplified by operations on nylon yarns, other yarns such as polyester, acrylonitrile, polyolefin and the like can be similarly packaged.

What is claimed is:

1. In a process for drawtwisting and winding a continuous multifilament yarn at a predetermined substantially constant, traveller-inserted twist level, using a ring-traveller-spindle take-up mechanism operated in accordance with a constant balloon tension-increasing traveller speed program, the improvement which comprises compensating for decrease in twist insertion value below a predetermined minimum twist insertion value which occurs during the drawtwisting operation through the inherent operation of the drawtwisting process and machinery used therefor, by interlacing said yarn by fluid jet means positioned prior to said take-up mechanism so that said yarn is characterized by a cohesiveness along its entire length at least equivalent to said minimum twist insertion value without decreasing the winding rate of said yarn.

2. A continuous, sequential process for producing and packaging a drawn continuous multifilament yarn which comprises spinning a continuous multifilament yarn; drawing said yarn; wind said yarn at a substantially constant tension-increasing traveller speed program onto a package by means of a ring-traveller-spindle device at a low substantially constant predetermined traveller-inserted twist insertion level to insert at least a minimum acceptable twist insertion value into said yarn and interlacing said yarn immediately prior to said winding by fluid jet means to compensate for decrease in twist insertion value below said minimum level which occurs during the winding operation through the inherent operation of the winding process and machinery used therefor to produce a yarn characterized by a cohesiveness along its entire length at least equivalent to that produced by said minimum twist level in said yarn.

3. The process of claim 2 wherein said yarn is drawn, relaxed, and drawn a second time prior to winding.

4. The process of claim 1 wherein the ring traverse stroke decreases progressively throughout the package build.

5. The process of claim 4 wherein the package build is characterized by a tapered midsection.

6. The process of claim 1 wherein said yarn is a nylon yarn.

7. The process of claim 1 wherein said predetermined twist level is about 0.15 to 1.0 turns per inch.

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