

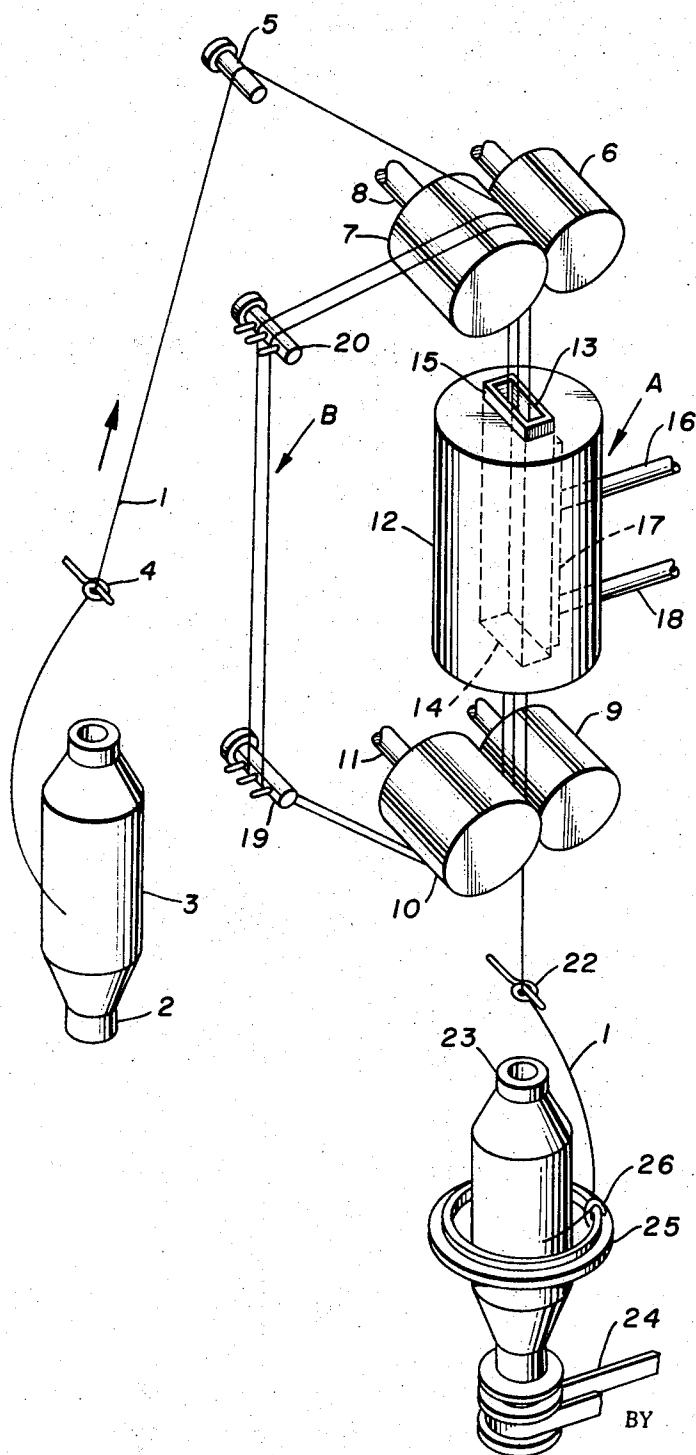
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MANUFACTURE OF TEXTURED FILAMENT YARNS

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MANUFACTURE OF TEXTURED FILAMENT YARNS

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ABSTRACT OF THE DISCLOSURE

Twist-curved textured yarn is treated to render the same more voluminous and dimensionally stable. In such treatment the textured yarn is fed from a source of supply to a point of packaging. During its travel the yarn is relaxed while it is being heated in at least two separate stages. Between each of the stages, the yarn is stretched while the same is being cooled.

The present invention relates to the manufacture of textured filament yarns. More particularly, it relates to the manufacture of twist-curved textured filament yarns having an excellent balance of bulk and stretch qualities.

Continuous multifilament man-made yarns have outstanding strength but lack absorbency, cover, stretch and insulating power in fabrics found in yarn spun from staple fibers. Many ways are known for imparting some of these desirable properties of spun yarn to continuous filament yarn. In the trade the term "texturing" has been applied to various techniques for imparting such properties to filament yarn. Virtually all texturing processes depend on the susceptibility of thermoplastic yarns to be heat-set when deformed and to have the lasting tendency to retain the deformed shape.

There exists a recognized interrelationship between certain sought after properties in textured yarn. Bulk and stretch are both desirable qualities in textured yarns. Stretch textured yarns are characterized by high elongation and rapid recovery but show only moderate bulk per unit weight. On the other hand, certain yarns are tailored to exhibit high bulk; but the gain of such property results in sacrifice to stretch.

To obtain a balance of bulk and stretch it is known to heat-set previously imparted crimp in stretch yarn in a partially extended condition. The resulting modified stretch yarn has found acceptance in a variety of fabrics.

Stretch yarns are textured so that they are twist-curved. Twist-curved textured yarn is a lively-stretch yarn characterized in that the filaments in a relaxed state exhibit a continuous coil. Ordinarily, twist-curved textured yarn is made by a three step process. In the first step, the yarn is twisted a desired amount. While in the twisted condition, the yarn is heat-set during the second step. That is, the yarn is heated and cooled while twisted so that the twist shape is preserved until the yarn in a different shape is again heated to or above the setting temperature. Finally the yarn is detwisted. The twist imparted and set in the yarn can be a true twist or a false twist. For economic reasons, the latter type of twist is preferred. False twisting is a well-known method by which the yarn is twisted and untwisted in one operation, the yarn being heat-set when twisted.

Twist-curved textured yarn has the tendency, commonly called torque, to return to the twisted condition extant when it was heat-set. The presence of torque in the yarn gives rise to certain handling problems in converting the yarn into fabric. In the known processes for obtaining a balance of bulk and stretch as referred to above, sufficiently elevated temperatures are employed during the heat setting of the yarn in the partially extended condition such that the torque is virtually destroyed.

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It has been found that one can obtain an improved balance of bulk and stretch by heating and cooling twist-curved textured yarn under particular conditions that do not totally nullify the torque of the yarn but do render the yarn more voluminous and dimensionally stable.

It is an object of the present invention to provide for the manufacture of twist-curved textured yarn having an excellent balance of bulk and stretch.

Another object is to provide a method for treating twist-curved textured yarn to render same more voluminous and dimensionally stable without destroying the torque thereof.

In accordance with the method of the invention twist-curved textured yarn is longitudinally fed from a source to a point of packaging. The yarn can be a single end or can be composed of a plurality of ends, preferably of opposite and substantially balanced torque. Between the yarn source and packaging, the yarn is relaxed about 5–30% while it is being heated, preferably with steam, in at least two separate stages. The temperature attained by the yarn during the heating step is at least 80° C., preferably about 110–175° C. Between each of the multi-stage heating steps, the yarn is stretched without being permanently attenuated while the same is being cooled to at least 50° C. or less, preferably 30–125° C., lower than the temperature attained by the yarn during the heating steps.

Generally speaking, apparatus for treating the yarn includes means for feeding twist-curved textured yarn at a predetermined first speed and means for forwarding the yarn at a predetermined second slower speed. In the yarn path between the feeding means and the forwarding means, means is provided for heating the yarn. Guide means are used for returning the yarn a plurality of times from the forwarding means through a cooling medium to the feeding means. Finally, a suitable take-up device is employed to collect the treated yarn in a uniform manner.

First, a source of twist-curved filament yarn is provided. The yarn is composed of thermoplastic man-made continuous monofilament or multifilaments. It is necessary that the yarn be textured so that it is twist-curved. As indicated above, twist-curved textured yarn is a lively stretch yarn made by heat-setting twist therein and reducing the twist with the result that the yarn exhibits a torque. When the yarn is heat-set so as to twist-curl texture the same, it is preferred that the filament yarn has a twist of about 30–150 turns per inch. The temperature at which the yarn is heat-set will vary in accordance with the composition of the yarn. For nylon-66 yarn a heat-setting temperature of 180–250° C. has been found to give good results. For nylon-6, a lower heat-setting temperature can be employed.

The twist-curved yarns are of textile grade and are made by conventional procedures. Nylon is the preferred polymer from which the yarn is made. Nylon is a long-chain synthetic polymeric amide which has recurring amide groups as an integral part of its main polymer chain. Specific types of nylon in addition to the two previously mentioned types include nylon-610, nylon-4, nylon-7, nylon-11 and fiber-forming copolymers thereof. Other thermoplastic fiber-forming resins from which the yarn can be made include polyethylenes, polypropylenes, polyurethanes, polymers of vinyl acetate and vinyl chloride, polymers of acrylonitrile, linear polyesters of aromatic dicarboxylic acids and dihydroxy compounds such as polyethylene terephthalate, and others.

When originally heat-set, the yarns forming the source of twist-curved textured filaments for the process of the present invention can have a Z-twist or S-twist. Preferably Z-twist-curved yarn is plied with S-twist-curved yarn with the result that the torque forces of the yarns oppose each other so that the resultant thread bundle appears to be torqueless.

The twist-curved textured filament yarn is fed from the source of supply through a heated zone at a controlled speed to provide a predetermined heating and overfeeding of the yarn therethrough. This can be accomplished by employing two pairs of yarn forwarding rolls, the second pair of which is operated at speed such that the yarn is moved thereby at about 70-95% of the linear speed at which the yarn is fed by the first pair of rolls. Between the two pairs of rolls the tension of the yarn is reduced corresponding to the selected percent of overfeed while the yarn is heated preferably to 110-175° C. The temperature that the yarn attains while relaxed between the two pairs of rolls is controlled by correlating the temperature of the heating means used to heat the yarn and the speed at which the yarn moves through the environment of the heating means.

The heating of the yarn while relaxed is preferably accomplished by the use of pressurized steam. Thus, the yarn is passed through a steaming chamber or the like with a controlled overfeed and speed properly correlated with the temperature of the steam.

After being heated under such controlled conditions, the yarn is fed through a cooling zone at a controlled increased speed to provide a predetermined cooling and stretching of the yarn. This can be accomplished by guiding the heat-treated yarn from the second set of forwarding rolls back to the first set of forwarding rolls through a path remote from the influence of the heater. Ambient room temperature is ordinarily sufficient to cool the yarn. However, the yarn may be cooled in a more positive manner such as using a coolant at this point in the process. As can be seen, the yarn undergoing cooling is moved at a speed equal to substantially that at which the yarn is forwarded to the heating zone. Since the first set of rolls is normally operated at speed 5-30% greater than the second set, the yarn is lengthened by a like amount as it is being cooled. The yarn is usually tensioned during the cooling step at about 0.10-0.40 gram per denier.

After being heated and cooled in the two just described zones, the yarn is relaxed at least one more time while it is being heated under similar and controlled conditions. This is accomplished by passing the yarn through the same or like heating zone under similar conditions. If the yarn is heat treated for the third or additional time, the yarn is cooled while being stretched between each heat treatment while employing the same or similar conditions used in the above-described cooling zone.

Finally the yarn is packaged in a uniform manner using any suitable package builder.

The attached drawing illustrates schematically apparatus for carrying out the invention.

Thermoplastic yarn is indicated by numeral 1. The yarn is composed of a plurality of ends of man-made filaments that have been molecularly drawn and twist-curved textured. When textured, individual ends of the yarn had been highly twisted with the twist being heat-set in a conventional manner and then being removed. Yarn ends having opposite and equal torque movements were plied using a low plying twist to form a balanced ply yarn construction. It is not necessary that the textured yarn to be treated have a balanced ply, say of an S-twist-curved end and a Z-twist-curved end. These ends can be processed alone, although it is preferred to provide as a source of yarn to be treated yarn composed of multiple ends of opposite and equal torque moments. As shown, yarn 1 is wrapped on a holder 2 in the form of a package 3. The holder may be rotated to insert additional twist prior to treatment, if desired. The source of the yarn need not be from such a package since it is sometimes desirable to use yarn being directed from a texturing machine without any intermediate packaging.

Yarn 1 is withdrawn over an end of holder 2 led through guide 4 and over guide 5. Other guide arrangements, of course, can be employed. From guide 5 the yarn is passed through a rotatably arranged thread advancing

means comprised of two nip-forming rolls 6 and 7 that are used to withdraw the yarn and to supply same for subsequent treatment at a controlled supply rate. Roll 7 is shown to be positively driven through shaft 8 coupled with suitable driving means not shown.

From rolls 6 and 7 yarn 1 is fed downwardly through heating zone A to a lower pair of nip-forming rolls 9 and 10 that are used to move the yarn through the heating zone at a controlled overfeed. The lower pair of rolls rotate at a predetermined peripheral speed less than the peripheral speed of the upper pair of rolls. Thus, the yarn going through the heating zone is under low but controlled tension. The tension allows the twist-curl texture to be partially manifest. However, the tension will not ordinarily be so low that the yarn is permitted to freely relax such that the full bulkiness of the yarn is realized before heat treatment. Roll 10 is positively driven through shaft 11 coupled with suitable driving means not shown.

Between the two sets of rolls a steam chamber 12 is employed. The chamber has a yarn entry port 13 and a yarn exit port 14 between which steaming chimney 15 extends. A source of steam (not shown) is provided. The steam is moved through a conduit 16 to a plenum chamber 17. The steam escapes into the chimney through a plurality of openings extending between the chimney and the chamber. The steam exhausts through ports 13 and 14 with some of the steam being returned to the source through conduit 18. Insulation in chamber 12 minimizes heat loss to the surroundings.

From rolls 9 and 10 the yarn is led through cooling zone B over guides 19 and 20 to be returned to the nip of rolls 6 and 7. Since the latter rolls are operated at a faster speed than the former, the yarn will be extended by an amount proportionate to the difference in the periphery speeds thereof. As the yarn passes from the bottom rolls to the upper rolls the yarn is attenuated; but the extension of the yarn is below the point where the yarn would be elongated resulting in a permanent reduction in the cross-sectional area of the yarn.

Again the yarn is fed downwardly through the heating zone under the same heat and tension conditions employed in its first pass therethrough. The yarn may be packaged at this point or, as illustrated, the yarn can be passed through cooling zone B and heating zone A additional times. Finally the yarn is led through guide 22 and is taken up in an orderly arrangement by a suitable type of package builder. As shown in the drawing, the yarn is taken up by a ring twisting assembly comprising a bobbin 23 adapted to be driven by belt 24 and a vertically reciprocable spinning ring 25 carrying a ring 26. Thus, the yarn is twisted a selected amount as it is wound on the bobbin. When additional twist is not desired, a coner or other types of builders can be employed in place of the ring twister.

The twist-curved textured yarn has many desirable properties. It has reduced shrinkage and, thus, has been stabilized against the tendency of ordinary twist-curved yarn to retract in length when fabric made therefrom is heated during some stage of the production thereof. The textured yarn to retract in length when fabric made therefrom is heated during some stage of the production thereof. The yarn has greater bulk. For example, yarn heated by the present invention has from about 40-80% greater bulk as compared to similar twist-curved yarn which has not been treated by the multi-stage heating and cooling process of the invention. The improved bulk is not obtained at considerable sacrifice of stretch, and the yarn has good stretch characteristics. The yarn has the ability to accept a slight longitudinally applied stretch and thereby to become easily extended a considerable length without permanent elongation thereof. For example, the yarn can be easily elongated from its untensioned or relaxed length and immediately recover from this elongation. The yarn is not rendered torqueless by the treatment. It still has

the tendency (although less) to produce a twisting in the individual threadlines to form kinks and curls.

The following is an example of the above-described yarn treatment. Obviously the invention is not limited thereto.

Example

The yarn used was prepared by melt spinning and cold drawing nylon-66. One end of 70 denier/34 filaments was false twisted so that it had 76 S turns per inch. The twist was set by heating it to a surface temperature of 250° C. and cooling it after which the twist was released. A like end was Z-twist-curved textured. The two ends were plied together with a ply twist of 0.5 turn per inch, and the plied yarn was wound on a bobbin.

Apparatus corresponding to that in the attached drawing was used to treat the plied yarn. The yarn was unwound for treatment and passed through a pair of feed rolls at a speed of 511 yards per minute. From the feed rolls the yarn was moved through a steaming zone to a pair of withdrawal rolls at a speed of 465 yards per minute. The yarn was contacted with steam at 225° C. and exhibited a temperature as it exited the chamber of 120° C. The yarn was guided through the surrounding atmosphere back to the feed rolls. Thus, the yarn was stretched and cooled. Just before reaching the feed rolls the yarn had cooled to 27° C. Again the yarn was passed through the steaming chamber and through the surroundings to the feed rolls for a third passage through the steaming chamber. After the third heat treatment the yarn was collected on a conventional ring twister assembly.

The yarn showed improved voluminosity and dimensional stability. The skein shrinkage of the yarn by the treatment was reduced from 32 to 12%. The threadline volume was increased 140%. The yarn had a stretch of 115%. The individual ends composing the yarn showed torsion. The denier of the finished yarn was 2.8% higher than that of the supply. The yarn had an average elongation of 27% and the tenacity averaged 4.0 grams per denier.

The advantages of the invention are many. The method results in the manufacture of twist-curved textured yarn having a favorable balance of bulk and stretch. The device can be run at high speeds. The inherent properties of the treated yarn are such that they impart numerous and desirable properties in fabrics made therefrom.

Many different embodiments of the invention may be made without departing from the spirit and scope thereof. We claim:

1. A method of treating twist-curved textured yarn having a torque to render same more voluminous and dimensionally stable comprising:

- (a) longitudinally feeding twist-curved textured yarn from a source to a point of packaging;
- (b) between the yarn source and packaging, relaxing the yarn while the same is being heated in at least two separate stages; and
- (c) between each of the stages, stretching the yarn while the same is being cooled.

2. A method of treating twist-curved textured filament yarn having a torque to render same more voluminous and dimensionally stable comprising:

- (a) providing a source of twist-curved filament yarn;
- (b) longitudinally feeding the yarn through a heated zone at a controlled speed to provide a predetermined heating and overfeeding of the yarn therethrough;
- (c) feeding the yarn through a cooling zone at a controlled increased speed to provide a predetermined cooling and stretching of the yarn;
- (d) feeding the yarn again through a heated zone at a controlled speed to provide a predetermined heating and overfeeding of the yarn therethrough; and
- (e) packaging the yarn in a uniform manner.

3. A method of treating twist-curved textured yarn hav-

ing a torque to render same more voluminous and dimensionally stable comprising:

- (a) providing a source of twist-curved textured filament yarn;

- (b) longitudinally feeding the yarn through a heated zone at a controlled speed to provide a predetermined heating and overfeeding of the yarn therethrough;

- (c) feeding the yarn through a cooling zone at a controlled increased speed to provide a predetermined cooling and stretching of the yarn;

- (d) feeding the yarn for the second time through a heated zone at a controlled speed to provide a predetermined heating and overfeeding of the yarn therethrough;

- (e) feeding the yarn through a cooling zone at a controlled increased speed to provide a predetermined cooling and stretching of the yarn;

- (f) feeding the yarn for the third time through a heated zone at a controlled speed to provide a predetermined heating and overfeeding of the yarn therethrough; and

- (g) thereafter packaging the yarn in a uniform manner.

4. A method of treating twist-curved textured yarn to render same more voluminous and dimensionally stable comprising:

- (a) providing a source of twist-curved filament yarn composed of a plurality of ends of opposite torque;

- (b) longitudinally feeding the yarn from the source to a point of packaging;

- (c) between the yarn source and packaging, relaxing the yarn in the presence of steam in at least two separate stages;

- (d) between each of the stages, stretching the yarn while the same is being cooled; and

- (e) packaging the yarn in a uniform manner.

5. A method of treating twist-curved textured yarn to render same more voluminous and dimensionally stable comprising:

- (a) providing a source of twist-curved filament yarn composed of a plurality of ends of opposite and substantially balanced torque;

- (b) longitudinally feeding the yarn through at least two separate heated zones at a controlled speed to raise the temperature of the yarn to at least 80° C. and to provide overfeed of the yarn therethrough of about 5-30%;

- (c) between each of the heated zones, cooling the yarn while at the same time increasing the speed thereof to substantially that at which the yarn is forwarded from the source; and

- (d) thereafter packaging the yarn in a uniform manner.

6. A method of treating twist-curved textured yarn to render same more voluminous and dimensionally stable comprising:

- (a) providing a source of twist-curved man-made thermoplastic filament yarn composed of two ends of opposite and substantially balanced torque;

- (b) longitudinally feeding the yarn from the source through at least two steam heating zones at a controlled speed to raise the temperature of the yarn to 110-175° C. and to provide overfeed of the yarn therethrough of about 5-30%;

- (c) between each of the heating zones, cooling the yarn to 50° C. or less while at the same time increasing the speed thereof to extend the yarn and to impart thereto a tension of about 0.10-0.40 gram per denier; and

- (d) thereafter packaging the yarn in a uniform manner.

7. A method of treating twist-curved textured yarn to render same more voluminous and dimensionally stable comprising:

- (a) providing a source of twist-curved nylon filament

- yarn composed of two ends of opposite and substantially balanced torque;
- (b) longitudinally feeding the yarn from the source at a first speed to a steam heating zone;
- (c) withdrawing the yarn from the heating zone at a second reduced speed to provide an overfeed of the yarn through the zone of 5-30% so as to reduce the tension of the yarn as the same moves therethrough and to raise the temperature of the yarn to 110-175° C.;
- (d) feeding the yarn through a cooling zone to cool the yarn to 50° C. or less while increasing the speed thereof to substantially that at which the yarn is forwarded from the source;
- (e) passing the yarn through the heating zone again under like conditions;
- (f) passing the yarn through the cooling zone again under like conditions;
- (g) passing the yarn through the heating zone for a third time under like conditions; and

- (h) thereafter packaging the yarn in a uniform manner.
8. The method of claim 7 wherein the nylon is nylon-66.
9. The method of claim 7 wherein the nylon is nylon-6.

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