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3,317,978

STRETCH YARN TEXTURING PROCESS AND APPARATUS

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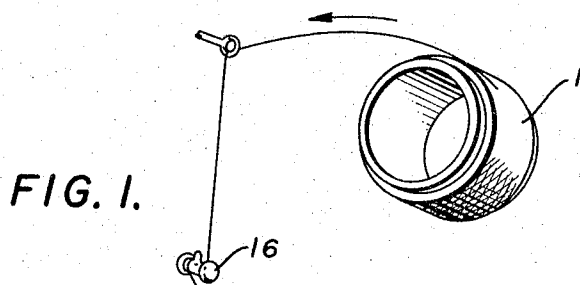


FIG. 1.

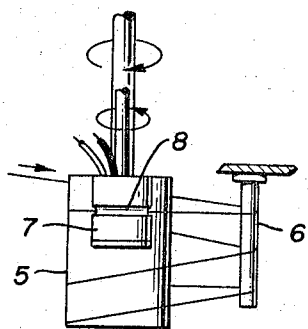


FIG. 2.

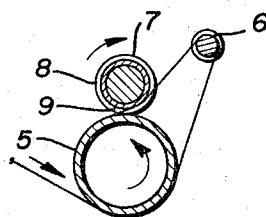
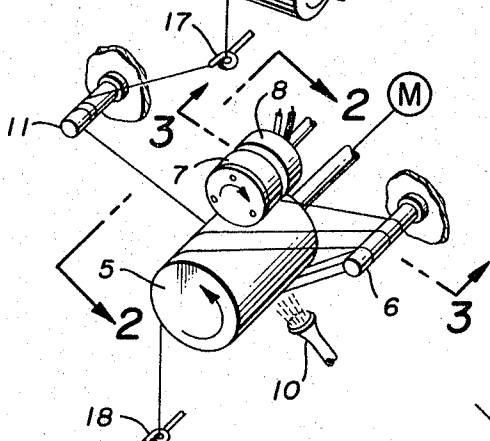


FIG. 3.

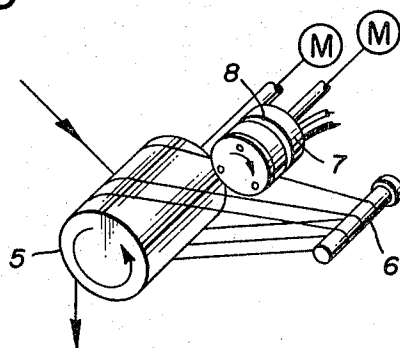


FIG. 4.

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3,317,978 STRETCH YARN TEXTURING PROCESS AND APPARATUS

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5 Claims. (Cl. 28—1)

This invention relates to texturing of continuous thermoplastic filaments and yarns and more particularly relates to a novel yarn texturing process and apparatus for yielding thermally textured yarns bearing high potential bulk and stretch. The process and apparatus have particular application to thermoplastic yarns of linear polymer structure such as nylon, polyester and the like.

Presently, there is commercial interest in and demand for textured yarns having dynamic springiness and liveliness. Yarns are textured by imparting a crimp, curl, coil, loop or other irregular configuration thereto. Fabrics and materials made from textured yarn have appealing properties of comfort, support, hand, cover, loft, elasticity, elongation and recovery. Such textured yarns are sometimes referred to as stretch yarns because of their dimensional extensibility and recovery power and are the foundation of versatile stretch fabrics, garments, hosiery, and materials.

The stretch yarn produced from the textured yarn of the present invention is of the helical or coiled type and is processed by application of differential "hot" or "cold" thermal conditions. It is known that when a thermoplastic yarn is heated to an elevated temperature and is stretched at the same time, the yarn becomes molecularly oriented and permanently retains its stretched length. This fact has been applied to produce latently coiled yarns by differential thermal treatment comprising essentially heating only one side of the yarns to an elevated temperature so that the portion heat treated permanently succumbs to applied stress or tension while the opposite side is kept below a transition temperature and is not changed. Yarns processed in the above manner become coiled when subsequently shrink treated. Coiled yarns have successfully been produced by pulling a heated yarn angularly over a stationary dull edge surface. In an endeavor to find other and better ways for coiling yarns employing the principle of establishing a temperature gradient across the yarn, suggestions have been proposed to employ rotating rolls. One proposal is to pass one side of a yarn over the surface of a cool rotating roll and to direct heated gas onto the opposite side thereof. Another idea suggests passing a yarn between the nip of a pair of rolls, one hot and the other cold, so that the yarn becomes flattened and acquires a potential crimp. The present invention utilizes the differential thermal heating principle in conjunction with rotating surfaces for coiling a yarn uniquely, advantageously, and differently from the suggested endeavors as is here explained.

It is an object of this invention to provide a process and apparatus for producing a latently textured yarn.

Another object is to provide a combined yarn draw-twist and texturing apparatus and a continuous process for drawing, texturing, twisting, and taking up a yarn.

Another object is to provide an apparatus and a method for producing a latently coiled no-torque type bulked yarn especially suitable for making stretch garment materials.

Another object is to provide a high-speed method and simple apparatus for producing a drawtwisted and potentially textured yarn in one unified operation.

Another object is to provide texturing apparatus and process adapted to provide a potentially textured yarn without substantially changing its cross-sectional shape or its surface configuration.

The method and apparatus of the invention according to one embodiment comprises, in brief, leading an undrawn thermoplastic yarn from a suitable source thereof to a yarn advancing means. The yarn is forwarded from the advancing means driven at one rate of speed to a draw and texturing means driven at a faster rate of speed for attenuating the yarn therebetween and forwarding the yarn therefrom. The yarn, under a drawing tension while in the draw and texturing means, is heated at one side thereof to an elevated temperature below the melting point of the yarn to cause orientation to take place and is immediately sequentially cooled at its opposite side whereby a differential cross-sectional thermal gradient is imparted to the yarn. The textured yarn is collected on a take-up means. Preferably, a slight twist is applied to the textured yarn before collection. The potentially textured yarn when later subjected to a heat or steam treatment shrinks and bulks in reversible, tight, continuous helices and provides a springy, stretchable yarn.

A better understanding of the invention will be gained by referring to the more detailed description that follows and by reference to the accompanying drawing. In the drawing:

FIGURE 1 is a perspective view schematically showing the apparatus and method of the invention;

FIGURE 2 is a plan view looking in the direction of 2—2 of FIG. 1;

FIGURE 3 is a cross-section view taken through 3—3 of FIG. 1; and

FIGURE 4 is a perspective view showing a modified arrangement of the draw and texturing assembly of the invention.

Referring to the drawing, an embodiment of the apparatus and method of the invention is illustrated in FIG. 1. The novel texturing apparatus comprises a supply source of undrawn thermoplastic yarn such as nylon packaged on a bobbin 1, a nip roll assembly, a draw and texture assembly, a twist and take-up device, and a plurality of guide members positioned where needed to guide the yarn to the various components.

The nip roll assembly for advancing the yarn delivered thereto from bobbin 1 includes a pair of engaging feed rolls 2 and 3. Roll 2 is positively driven at a preselected rate of speed and roll 3 is an engaging idler roll.

The draw and texture assembly comprises a draw roll 5 driven at a higher peripheral rate of speed than feed roll 2 and a separator roll 6 positioned near the draw roll 5. Preferably, separator roll 6 is rotatably and slightly angularly mounted in relation to roll 5 to maintain separation of yarn wraps. A heater roll 7, which may be provided with a matte finish surface, is mounted in peripheral surface engagement with draw roll 5 and is driven by the latter. Heater roll 7 has a shallow circumferential groove 8 that defines a slot 9 formed between roll 5 and the heater roll. The width of the face of heater roll 7 can be smaller than the width of draw roll 5, and heater roll 5 is positioned at one side thereof. Draw roll 5 is maintained at a relatively low temperature by flowing a stream of cool air or other coolant onto the roll from a source of supply thereof illustrated as nozzle 10. A draw pin 11 is positioned in the yarn path between the feed and draw rolls for localizing the point of drawing of the yarn.

The twist and take-up device includes a bobbin 12 mounted on a spindle driven by belt drive means 13. A reciprocating traverse ring 14 having a traveler 15 mounted to orbit freely thereon surrounds bobbin 12 and is adapted to move back and forth axially of bobbin 12.

Heater roll 7 may be heated by electrical means, as shown, or by other suitable means and draw roll 5 may be cooled by other than the air means 10 shown.

The yarn is laced within the illustrated apparatus of

the invention as follows. A yarn end from bobbin 1 is passed around a snubbing guide 16, is forwarded between the nip of feed rolls 2 and 3, is led through a pigtail guide 17, wound contactingly around draw pin 11, and is then forwarded to the draw and texture assembly.

As shown in FIG. 1, the yarn end extending from draw pin 11 is passed contactingly around the bottom portion of draw roll 5, then contactingly around separator roll 6 and is threaded through slot 9 to complete one yarn wrap. Multiple wraps are taken around draw roll 5 and separator roll 6, in common, before the yarn is forwarded through a pigtail guide 18, through traveler 15 and wrapped around bobbin 12 for collection thereon.

It is important that the heater roll 7 be positioned relative to the draw roll 5 and the separator roll 6 so that the yarn extending from the separator roll 6 to slot 9 passes over a portion of the peripheral surface of heater roll 7 before passing through slot 9. Groove 8 is formed to make slot 9 large enough to permit passage therethrough of a chosen count of yarn without being squeezed or nipped, although only the necessary clearance need be provided.

In operation, rolls 2 and 5 are driven at slower and faster speeds, respectively. Bobbin 12 is driven at a preselected speed for collecting the yarn and for applying a desired number of turns of twist thereto. The yarn is stretched between the feed and draw rolls with the attenuation and orientation of the yarn being concentrated in the area of draw pin 11. After being stretched the yarn traveling under tension about draw roll 5 and separator roll 6 is heated to a transition temperature at its one side as it travels in substantially the same direction as and over the rotating groove surface of the heater roll 7 and is immediately, sequentially cooled opposite the heated side thereof when contact is made with the cool surface of draw roll 5 traveling in the same direction. The term "transition temperature" as used herein covers a temperature range below the melting point of the yarn in which the yarn retains its extension. In the case of nylon which melts at 250° C., the transition temperature is in the range of from about 160° C. to 250° C. By heating and cooling the yarn sequentially a deep penetration of the yarn with heat being supplied at a transition temperature from one side thereof is effected before the yarn is quickly cooled at its opposite side to prevent the yarn from being totally heat treated at a transition temperature.

It is preferred that the speed of travel of the yarn and the peripheral speed of the surfaces of the heater roll 7 and the draw roll 5 be comparable to minimize and eliminate dragging the yarn or frictionally sliding the yarn across heater roll 7. When comparable speeds are employed there is less chance of the yarn being roughened, flattened, scorched, or burred when passing over the surface of groove 8 of heater roll 7.

As shown in FIG. 4, heater roll 7 may be driven independently from draw roll 5 with similar results being achieved. In this case, the heater roll 7 can be spaced sufficiently from the draw roll 5 to provide a clearance for passing a yarn therebetween without a nip being taken on the yarn.

The following examples typify manufacturing of a potentially helically bulked torqueless yarn in accordance with the invention.

Example I

A string-up of an undrawn nylon yarn having three filaments and an ultimate total drawn denier of 15 was made on the apparatus described in accordance with the outlined procedure. The temperature of the peripheral surface of the heater roll 7 was controlled at 250° C. and the peripheral surface of draw roll 5 was maintained at 50° C. The nip rolls 2 and 3 and draw roll 5 were driven to provide a 3.93 draw ratio of the yarn therebetween and the speed of the yarn traveling from the draw roll 5 in relation to the speed of rotation of spindle 13

was predetermined to impart approximately 0.27 turn per inch twist to the yarn. The apparatus was operated and the yarn was drawn, thermally textured, twisted, and packaged in one continuous operation. The yarn contacted 0.8 inch of the peripheral surface of the heater roll 5 at all times, was maintained at a temperature below 250° C. and was traveling at a speed of 800 yards per minute which was comparable to the peripheral speeds of the heater and draw rolls. The yarn while being heated by the heater roll 7 was under a tension of 7 g.p.d.

Example II

A string-up of yarn having 13 yarn ends or filaments and an ultimate total drawn denier of 40 was made in accordance with the described procedure. The apparatus was operated as in Example II and a drawn, potentially textured, and twisted yarn was packaged on a bobbin.

Ladies hose were then knit from the yarns of Examples I and II; the 15-3 yarn was used for the leg portions and the 40-13 yarn was used for forming the welt portions. The hose were then steam treated and relaxed, whereupon the hose bulked and formed helically reversible coils providing stretch hosiery.

Since the yarn when passing over the heated and cooled surfaces of the rolls 5 and 7 is traveling in substantially the same direction and at the same speed as the rolls, the yarn is not burned, scraped or in any manner surfacely reformed and because the yarn is not nipped or squeezed when passed between the rolls, the yarn is not flattened or reformed from its original surface configuration.

Advantages are provided by the rotatable heater in that good temperature control can be maintained because the yarn contacts a freshly heated portion of the heater roll 7 at all times. The yarn travels over a relatively large surface of heater roll 7 so that a deep penetration of heat is made into the yarn. The yarn does not become surfacely disfigured from the application of high temperature even though a relatively large length of the yarn contacts the heated surface of roll 7 because the yarn and the peripheral heater surface are traveling at the same speed. A deep penetration of heat through the yarn provides a highly bulkable yarn.

It will be understood that the process and apparatus apply to the texturing of monofilaments as well as yarns.

Although the invention has been described by reference to specific embodiments, it should be broadly construed and should be limited only to the scope of the claims appended hereto.

We claim:

1. Apparatus for drawing and texturing undrawn thermoplastic yarn comprising, driven feed roll means for forwarding yarn at one speed,

a draw roll assembly comprising,

a draw roll for forwarding a yarn delivered thereto from said feed roll means at a faster speed than said one speed,

a separator roll near said draw roll,

a heater roll having a heated surface driven in an opposite direction from and in close spaced peripheral adjacency to said draw roll providing a clearance therebetween of a size approximating the dimension of a yarn normally traveling therethrough to prevent a nip being exerted on the yarn,

said separator roll being positioned in relation to said heated surface such that a yarn, traveling from said separator roll into contact with said draw roll via said clearance, contacts at one side thereof the periphery of said heated surface substantially immediately prior to contact of the opposite side thereof with said draw roll.

2. Apparatus for drawing and texturing undrawn thermoplastic yarn as claimed in claim 1 further comprising means for positively cooling the peripheral surface of said draw roll.

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3. Apparatus for drawing and texturing undrawn thermoplastic yarn comprising,
driven feed roll means for forwarding undrawn yarn at one speed,

a draw roll assembly comprising,

a cooled draw roll driven in one direction for forwarding the yarn delivered thereto from said feed roll means at a faster speed than said one speed,

a separator roll near said draw roll,

a heater roll having peripheral contact with said cooled draw roll and driven by the latter in an opposite direction therefrom, said heater roll provided with a circumferential peripheral groove defining a clearance between said heater and draw rolls of a size approximating the dimension of a yarn normally traveling there-through to prevent a nip being exerted on the yarn,

said separator roll being positioned in relation to said heater roll such that a yarn, traveling from said separator roll into contact with said draw roll via said clearance, contacts at one side thereof the periphery of said heater roll substantially immediately prior to contact of the opposite side thereof with said draw roll.

4. A continuous process for drawing and texturing thermoplastic undrawn yarn comprising,
delivering undrawn thermoplastic yarn to a forwarding zone and forwarding the undrawn yarn at one rate of speed to a second forwarding zone for forwarding the yarn therefrom at a faster rate of speed

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than said one rate, to effect molecular orientation of the yarn by attenuation thereof at least three times its original length,

in the second forwarding zone passing opposite sides of the yarn in sequence and uninterruptedly over a heated surface for heating one side of the yarn to a temperature not exceeding the melting point thereof and over a chilled surface for cooling the opposite side thereof with the heated yarn leaving the heated surface and immediately contacting the chilled surface without any nip being exerted on the yarn so as not to flatten the latter,
whereby the yarn is cooperatively molecularly oriented and textured.

5. A continuous process for drawing and texturing thermoplastic undrawn yarn as in claim 4 wherein said yarn is passed over rotating heated and cooled surfaces.

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