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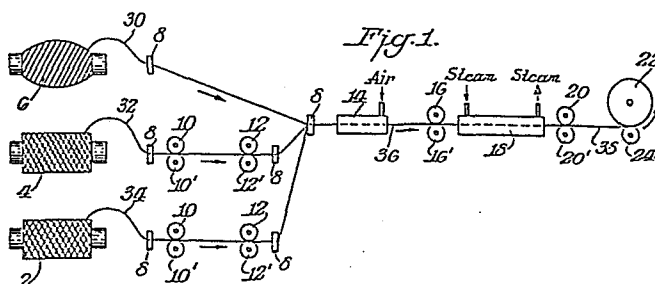
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54 **Air jet texturing system.**

57 A process is provided for producing highly resilient, textured, continuous multifilament polymeric yarns and combinations of such yarns with other continuous filament yarns and with spun yarns. The unstable or wild loops which form in conventional air jet textured yarns are substantially eliminated in the product yarns of this invention. The product yarns are formed by continuously drawing polymeric yarn under controlled temperature conditions, texturing the yarn in an air jet texturizer (14) and subjecting the textured yarn to saturated steam (18) while restraining the linear shrinkage of the yarn in the presence of the steam, followed by continuous take-up of the yarn on a package (22).



AIR JET TEXTURING SYSTEM

This invention relates to a process for the production of a continuous filament yarn of very high shrinkage potential.

Bulky or crimped yarns composed of continuous synthetic fibre-forming polymers such as polyester and polyamide can be produced by feeding yarn filaments with overfeed to an air jet texturizer to produce a large number of random loops or crimps in the yarn. The type and degree of texture in the product yarn produced by such techniques depends upon the amount of twist in the feed yarn and on the amount of overfeed in the texturing jet. The product yarn is generally spooled under tension but this product generally has poor linear stability and high boiling shrinkage values. The yarns are characterized by the presence of many ring-like or crunodal loops at irregular intervals along the surface of the yarn and internally in the yarn bundle.

When such prior air jet texturing techniques are employed, a certain number of unstable or "wild" loops is generated in a random fashion along the yarn. These

unstable loops can extend outwardly from the yarn bundle and adversely affect the yarn take off in subsequent textile mill operations. In fabrics made from such yarns, a hook-like or picky type characteristic may appear, and this is generally distasteful in apparel.

Processes are known for controlling these unstable loops to varying degrees. U.S. Patent specification 4,338,776 (Krenzer) describes a process and apparatus for producing a crimped continuous multifilament yarn by the sequential steps of air-jet texturizing to form multiple, random, filamentary loops, immediately pulling out metastable loops formed in the yarn without heating and without stretching or deforming the yarn filaments, next shrinking and heat setting the yarn at a temperature of about  $150^{\circ}$ - $245^{\circ}$ C., and then winding the yarn on to a spool at a predetermined yarn tension. The non-crimped, multifilament, feed yarn is conducted through an air jet texturizing nozzle at an overfeed rate said to be sufficient to form multiple random loops in the individual filaments, including some proportion of unstable loops. Following passage through the air jet, the yarn is conducted to feed and draw rolls in a heat-free

condition such that at least some of the unstable loops are pulled out of the yarn.

Prior methods of controlling the unstable or wild loops are generally expensive but only marginally effective. The present invention provides an effective and inexpensive method and apparatus for producing air jet textured yarns with substantially no unstable or wild loops. One product of this invention results from the high shrinkage inherent in cold-drawn, partially orientated, polyester, polyamide and similar yarns. The linear behaviour of these yarns produced by a process embodying the invention is controlled by tension at the entrance and exit ends of a steam chamber wherein a modest latent stretch is deliberately retained in order to improve the transverse fibre properties resulting in enhanced fabric resilience.

The following definitions apply to terms of the art as used in this specification. The term "fully-orientated yarn" denotes a polymeric yarn drawn to such an extent that its molecules are fully orientated and very little further extensibility is possible in a cold, i.e. unheated, condition without breaking. This is the

most stable yarn condition, total recovery or relaxation occurring on heating in an unrestrained state; however, there is a loss of transverse quality or resilience of the yarn.

"Undrawn yarn" denotes continuous filament yarn in a totally undrawn state or as-spun condition.

The term "partially orientated yarn" denotes a polymeric yarn drawn to an extent such that its molecules are somewhat or "partially" orientated, but the extent of draw is less than that for fully drawn yarn. The resilience of partially drawn yarn is improved compared to fully drawn yarn, resulting in improved wrinkle resistance in fabrics made from such yarn.

The term "spun yarn" as used herein denotes any yarn made from relatively short discontinuous yarn ends that are reconstituted by twist or other means to form continuous lengths of yarn of commercial usefulness. These yarns can be made of synthetics or of nature fibres such as cotton or wool.

According to the present invention there is provided

the steps of feeding a continuous filament, partially-orientated, synthetic, polymeric, feed yarn to and through a feed roll system and thence to and through a draw roll system and guiding the drawn yarn to a take-up system.

The invention will now be described, by way of example only, with reference to the accompanying diagrammatic drawings, in which:

Fig. 1 is a diagram illustrating the preferred yarn drawing, texturing and steam treating process embodying the invention;

Fig. 2 is a highly enlarged diagram of a conventional textured multifilament yarn having stable and unstable loops;

Fig. 3 is a highly enlarged diagram of a textured multifilament yarn produced by a process according to the invention having no unstable loops;

Fig. 4 is a schematic side elevation of apparatus for carrying out the process in accordance with the invention for making a core and effect yarn; and

Fig. 5 is an end elevation of the apparatus of Fig. 4.

The process hereinafter described serves to produce highly-resilient, textured, continuous, multifilament, polymeric yarns and combinations of such yarns with other continuous filament yarns and with spun yarns. The unstable or wild loops which form in conventional air jet textured yarns are substantially eliminated in the product yarns of the novel process. The product yarns are preferably formed by continuously drawing polymeric yarn under controlled temperature conditions, texturing the yarn in an air jet texturizer and subjecting the textured yarn to saturated steam while restraining the linear shrinkage of the yarn in the presence of the steam, followed by continuous take-up of the yarn on a package.

A fundamental physical concept relevant to the process is the recognition of the substantial shrinkage which takes place when partially orientated or fully orientated polyester yarn is exposed to a hot wet medium. Initial experiments indicated that cold drawn polyester yarn samples drawn to approximately a 1.45 or as much as 1.6 draw ratio and exposed to boiling water at open atmospheric conditions (approximately

99°C) shrank virtually instantaneously and wild loops present in the yarn prior to immersion disappeared completely.

In a continuous process, which is preferred, it was determined that partially orientated polyester yarn could be cold drawn, i.e. in the absence of heat, bulked with an air jet texturizer and then passed through a steam chamber using steam at (25 to 30 pounds per square inch), there being restraining rolls at the entrance and exit ends of the steam chamber to restrain and control the shrinkage of the yarn while in the steam chamber. Preferably, the linear speed of the yarn through the exit rolls is in the range of about 0.8 to 2.0 times the linear speed of the yarn through the entrance rolls, the linear shrinkage of the yarn being in the range of about 20 to about 100 per cent.

The highly resilient yarns produced by processes according to this invention are characterized by having less than complete fibre orientation as manifested, for example, by exhibiting less than fully drawn fibre birefringence. This characteristic is defined as the difference between the principal



refractive index in the stretch direction and the principal refractive index perpendicular to the stretch direction.

The yarn produced by processes according to this invention may be combined with virtually any other yarn including, without limitation, continuous filament polyester, polyamide, polyolefin, cellulose acetate, and other similar yarns, as well as spun yarns including synthetics and natural fibres such as cotton. While not fully understood, it is believed that upon restrained linear shrinkage in the steam chamber, the wild loops in the drawn yarn gather in the companion yarn such as cotton and hold the latter in intimate contact.

Cold drawn, untextured but steam-treated yarns produced by processes according to this invention are believed to be useful in otherwise conventional core effect yarn systems to produce economically synthetic yarns which are silk-like both in tactile and in visual character. In general, the yarns produced by processes according to this invention include conventional fine denier applications of single or multiple ends of continuous filaments for use in

apparel and other applications including sewing thread and fenestration yarns. Spun yarns can be combined with continuous filament yarns by employing the shrinkage of the filament loops to trap filament ends in the spun yarn and establish an integrated product. Processes in accordance with the invention can also be applied to destabilized fully drawn yarns by drawing with a subsequent reduction of the wild loops by steam treating resulting in improved yarns for sewing thread, upholstery and fenestration yarns. Means are further provided by which short, but random, non-uniformities can be introduced to overcome the plastics-like appearance of conventional continuous filament products.

Referring now to the drawings, Fig. 1 shows continuous filament polymeric yarns 32 and 34 being fed from supply yarn packages 4 and 2 respectively to feed rolls 10 and 10' and thence to and through draw rolls 12 and 12' which run at a higher speed than the feed rolls and thereby impart draw to the yarn. Preferred draw ratios range from about 1.45 to about 1.6 when partially orientated yarn is used as the feed yarn. If fully orientated yarn is fed as filaments 32 and 34, this yarn is preferably drawn about 20 to about 35% at

an elevated temperature in the range of about  $101^{\circ}\text{C}$  to about  $138^{\circ}\text{C}$  for polyester yarns. The heating can be accomplished by using heated feed rolls 10 and 10' and draw rolls 12 and 12' (or a heating device intermediate the sets of rolls) and wrapping the filaments about these rolls several times to provide residence time under temperature. Following drawing, the drawn yarn is guided to an air jet texturizer 14 by guides 8 where it may be combined with another yarn 30 fed from package 6 which may be a spun yarn, not drawn, for example. The textured multifilament yarn 36 exiting the air jet texturizer is guided to and through second feed rolls 16 and 16' and into and through the steam chamber 18 where it is subjected to saturated steam at about  $104^{\circ}\text{C}$  to about  $148^{\circ}\text{C}$ . The steam treated yarn passes through rolls 20 and 20' which, as aforesaid, control the speed, tension and thus the linear shrinkage of the yarn bundle at desired degrees. The highly resilient drawn, textured and steam-treated yarn 38 is then wound upon yarn package 22, with the aid of stabilizer roll 24, thus providing the product yarn according to this invention.

Fig. 2 illustrates schematically the stable crunodal

loops 39 in multifilament yarn 36 produced by conventional texturing means and random unstable loops 37. Following steam treatment the unstable loops are substantially eliminated as depicted in Fig. 3.

In another embodiment of a process in accordance with this invention, a core and effect yarn is produced as depicted in Figs. 4 and 5. Therein, feed yarns 44 and 46 fed from yarn supplies 40 and 42, respectively, proceed through otherwise conventional core and effect yarn apparatus. At least one of the feed yarns is made as described in connection with Fig. 1 but eliminating the air jet texturing. That is, at least one of the feed yarns in Fig. 4 has been drawn but not steam treated or textured as shown in Fig. 1. The core yarn 44 in Fig. 4 is fed at a constant rate through the roll system and to and through the air jet texturizer 66. The effect yarn 46 is caused to create thick sections by overfeeding this yarn at desired time intervals by means of roll 60 and roll 58 causing yarn 46 to overfeed to jet 66. When thin sections are desired, rocker arm 56 is caused to disengage roll 58 from roll 60 and roll 54 in cooperation with roll 52 slows the speed of filament 46, thereby producing a thin section. The engagement or disengagement of rolls

54 and 58 can be controlled as desired using known fluidics techniques, not shown except for air signal tube 55. Upon removal of the air signal, spring mechanism 57 causes rolls 52 and 54 to disengage and rolls 58 and 60 to engage to overfeed yarn 46. The textured yarn 68 exiting the air jet is guided to and through feed rolls 16 and 16' and into and through the steam chamber 18 where it is subjected to saturated steam. The steam treated yarn passes through rolls 20 and 20' which control the speed, tension and linear shrinkage of the yarn at desired degrees. The thick and thin core and effect yarn 68 produced according to this method is collected on take-up roll 70 with the aid of stabilizer roll 72. This yarn so produced should have a broad range of more exotic end uses, with a broad range of appearance and slub density tailored for style, having tactile and visual characteristics of silk.

CLAIMS

1. A process for the production of a continuous filament yarn of very high shrinkage potential characterized by the steps of feeding a continuous filament, partially-orientated, synthetic, polymeric, feed yarn to and through a feed roll system (10,10') and thence to and through a draw roll system (12,12') and guiding the drawn yarn to a take-up system (22,24).

2. A process according to claim 1, characterized by the steps of conducting said drawn yarn to and through a second feed roll system (16,16') which feeds said yarn at a controlled rate into and through a steam chamber (18) containing saturated steam, the yarn exiting the steam chamber being conducted to and through a fourth roll system (20,20') in cooperation with said second feed roll system (16,16') to restrain and control the linear shrinkage of said yarn within the steam chamber and thence guiding the drawn and steam treated yarn to a take-up system, thereby producing a highly resilient filament yarn exhibiting less than fully orientated fibre birefringence, the drawing being effected under unheated conditions.

3. A process according to claim 1 or claim 2 wherein said feed yarn is a polyester, a polyamide, a polyolefin, a vinyl or an acrylic polymer.

4. A process according to claim 2 characterized by the further steps of conducting said cold drawn yarn to a texturing air jet system (14), conducting said yarn end through said jet thereby forming multiple random loops in the yarn end including a proportion of random unstable loops, and thence conducting the yarn leaving said air jet to and through the second feed roll system (16,16').

5. A process according to claim 4 for the production of highly resilient textured continuous multifilament yarn characterized by the further steps of feeding at least one end of a further continuous filament synthetic polymeric feed yarn to and through a secondary feed roll system (10,10') and thence to and through a secondary draw roll system (12,12') whereby the feed yarn is drawn, conducting said drawn yarn to the said texturing air jet system (14) and combining said drawn further yarn at the entrance end of said jet system with at least one other said yarn, conducting the combined yarn ends through said

jet, thereby forming multiple random loops in the individual filaments including a proportion of random unstable loops, and conducting the multifilament yarn leaving said air jet to and through the said second feed roll system (16,16').

6. A process according to claim 4 or claim 5 characterized in that said feed yarn is partially orientated yarn.

7. A process according to claim 1 characterized in that said feed yarn is fully orientated yarn and is drawn by about 20 to about 35 per cent at elevated temperature.

8. A process according to claim 5 characterized in that said other yarn is continuous filament polyester, polyamide, polyolefin, cellulose acetate or a spun yarn.

9. A process according to claim 5 characterized in that said other yarn is cotton.

10. A process according to claim 1 for the production of a highly resilient, textured, continuous,



multifilament, core and effect yarn characterized by the further steps of conducting said feed yarn and at least one other yarn in combination to a core and effect yarn system having means for overfeeding either core or effect yarn, thence conducting the combined yarn ends to and through a texturing air jet, conducting the yarn (36) leaving said air jet to and through a second feed roll system (16,16') which feeds said yarn at a controlled rate into and through a steam chamber (18) containing saturated steam, the yarn exiting the steam chamber being conducted to and through a fourth roll system (20,20') cooperating with said second feed roll system (16,16') to restrain and control the linear shrinkage of said yarn within the steam chamber, wherein said core and effect is produced by overfeeding either the core yarn or the effect yarn at desired and controlled time intervals, and guiding the textured core and effect yarn to a take-up system (70,72), thereby producing a highly resilient textured core and effect yarn, said feed yarn exhibiting less than fully orientated fibre birefringence.

