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METHOD AND APPARATUS FOR PRODUCING A NOVEL HIGH BULK CONTINUOUS FILAMENT LOW STRETCH YARN

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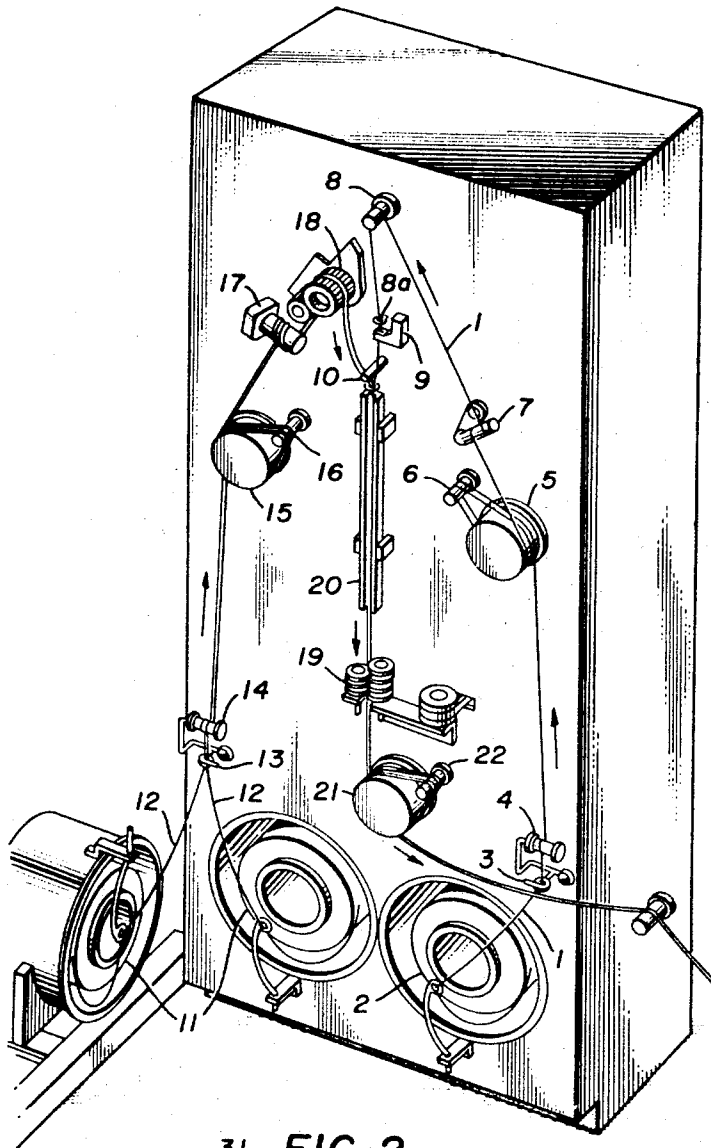


FIG. 1.

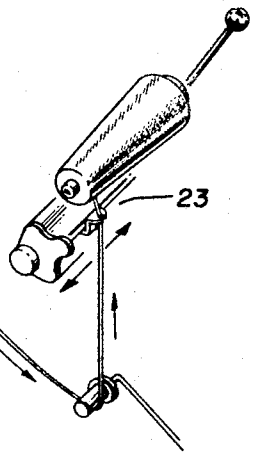




FIG. 2.



FIG. 3.

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METHOD AND APPARATUS FOR PRODUCING A NOVEL HIGH BULK CONTINUOUS FILAMENT LOW STRETCH YARN

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Original application May 31, 1966, Ser. No. 553,890, now Patent No. 3,401,516, dated Sept. 17, 1968. Divided and this application Jan. 2, 1968, Ser. No. 694,896
Int. Cl. D01h 13/26; D01d 5/22
U.S. Cl. 57—34
8 Claims

ABSTRACT OF THE DISCLOSURE

A process and apparatus for producing a synthetic filament composite singles yarn having a high degree of bulk and yet a low degree of stretch. A substantially untextured core yarn of at least one synthetic continuous filament is forwarded to a zone of contact with a sheath yarn composed of a plurality of textured synthetic continuous filaments. The core and the textured yarns are false-twisted together and bonded while so twisted. The false twist is released and the so produced singles yarn is taken up.

This application is a divisional application of application Ser. No. 553,890, filed May 31, 1966, now Patent No. 3,401,516.

The present invention relates to a novel continuous filament synthetic textile yarn, to the manner of producing such yarn and to the apparatus employed therein. It also relates to fabrics produced from such yarn. The yarns of the invention have a high degree of bulk and yet maintain a low degree of stretch. The invention provides a high integrated process for producing the textured yarn of the present invention as well as an apparatus employed therein and fabrics produced from the novel yarn.

Fabrics woven or knitted from conventional continuous filament yarns possess a characteristic slick or clammy hand. These fabrics do, however, have superior processability and wearing properties. Fabrics produced from natural fibers and staple synthetic fibers have a desirable soft hand and high covering power. Fabrics produced from yarns containing textured continuous synthetic filaments have a desirable soft hand but generally possess such a high degree of stretch as to yield unstable fabrics.

Additionally, since most continuous filament textured yarns obtain their bulkiness from kinks, crimps, curls or other deformation of the filaments which can be straightened out by tension on the yarn, the bulkiness of such yarns is inversely proportioned to the yarn tension. Fabrics of loose construction, such as most knitted fabrics, can usually be formed with the yarn under low tension allowing the crimps or curls to remain intact. Fabrics of tight construction, however, such as most woven fabrics, usually require that the yarn be under higher tension when the fabric is formed. This higher tension straightens out the crimps or curls and the close construction of the fabric prevents them from reforming to any appreciable degree, thereby producing a fabric with only marginally greater bulkiness than an untextured continuous filament yarn fabric. Staple fiber yarns, on the other hand, derive the majority of their bulkiness not from crimps or curls but from the discontinuous nature of the short fibers and from the ends of those short fibers which protrude out from the yarn bundle. It has long been a major goal in the synthetic fibers industry to provide a yarn composed entirely of continuous filaments possessing the desirable bulkiness retention of staple yarns when used in tightly constructed fabrics while eliminating the undersirable shedding and pilling associated with yarns made from

short fibers and eliminating the numerous manufacturing steps required to produce a yarn from staple fibers.

An object of the present invention is to provide a continuous filament yarn with the desirable soft hand and high cover of textured yarns while retaining the low stretch properties or longitudinal dimensional stability of conventional yarn.

It is further an object of the present invention to provide an apparatus for producing the yarn of the invention as well as a highly integrated process therefor.

It is further an object of the present invention to provide knitted or woven fabrics produced from the novel tension stable yarn.

Other and more specific objects of the invention will become apparent from a consideration of the present specification.

The yarn of the present invention is composed entirely of synthetic continuous filamentary materials. While the yarn is a composite yarn and is composed only of a plurality of continuous synthetic filaments and is formed from a plurality of yarn ends, the yarn itself is a singles yarn and is to be distinguished from a continuous filament plied yarn. In the instant specification and claims the term "singles yarn" is used to specify a composite yarn which is composed of a plurality of continuous filaments which are united into a compact bundle. The term as used distinguishes the instant yarn from ply yarn formed by twisting together two or more singles yarns.

The yarn herein is composed of an internal integral core which is itself made up of one or more substantially untextured, that is, straight, synthetic continuous filaments. This load-bearing core is surrounded by and has randomly bonded thereto a bulk-imparting sheath made up of a plurality of textured, that is, crinkled, synthetic continuous filaments. The bonding serves to eliminate movement of the sheath with respect to the core. It is thus seen that the yarn of the present invention, while it is a singles yarn, is a composite yarn in that it is made up of an integral core of continuous substantially untextured filamentary material surrounded by a sheath composed of a plurality of textured continuous filaments, the sheath being bonded to the core. The yarn is substantially free of twist but processes into fabric as one having 5 or more turns per inch. Preferably the yarn has less than 1 turn per inch but may have as high as 5.

It has been previously known in the synthetic textile art to produce continuous filament synthetic materials possessing a high degree of bulk by texturing a threadline composed of a plurality of continuous filaments, as for example by subjecting it to a deforming operation, e.g., stuffer box crimping or gear crimping. Such yarns, for many purposes, however, prove to be unsatisfactory in view of the fact that when they are subjected to a moderate degree of tension, the deformation of the individual filaments is removed; and, thus, the high degree of bulk and covering power of the yarn is eliminated. It is a feature of the present invention that a novel high bulk singles yarn is provided which is dimensionally stable while being made up completely of continuous filamentary material. When subjected to a tension which is less than the breaking strength of the core, the inventive yarn retains substantially all of the original bulkiness while other textured yarns lose substantially all of their bulk when subjected to only moderate amounts of tension.

In general, the process of the invention involves forwarding a substantially untextured core yarn which is composed of at least one synthetic continuous filament to a zone where it contacts a textured sheath yarn. The textured yarn is composed of a plurality of textured synthetic continuous fllaments of the same or different chemical composition as the core. The tension on the core in the zone of contact is greater than that on the textured

sheath by 0.1 to 5.0 g./d. In any event the tension on either is not sufficient to cause substantial breaking of the filaments. The core filament or filaments and textured sheath filaments are false twisted together by a false twist means in order to provide intimate contact between the core and sheath filaments. The textured sheath filaments are bonded to the core filaments. When the bonding is perfected the false twist is released. The bonding may be thermochemical using a solvent for the filaments or may result from the use of adhesives such as sizes, starch, polyacrylics, etc. The resulting product which is a substantially twistless singles yarn is then taken up in an orderly manner by means known in the art with or without additional twist.

The apparatus for producing the yarn of the invention comprises a highly integrated combination of elements. Means are provided for forwarding the core yarn to a zone of contact with a textured sheath yarn under a tension in excess of the tension on the sheath. Means for forwarding textured sheath filaments to the zone of contact with the core yarn are also provided. False twist means are present to impart a sufficient degree of twist to provide intimate contact between the core and sheath yarns. Bonding means are provided for bonding the sheath yarn to the core yarn as well as means to perfect the bond between the yarns. Finally, means are provided for forwarding the final product yarn to ta take-up means where it is taken up in an orderly fashion.

The nature of the present invention will be better understood from the following description taken in connection with the accompanying drawing in which certain specific embodiments of the instant invention have been set forth for purposes of illustration.

In the drawing:

FIGURE 1 is a perspective of an apparatus for carrying out the method of the present invention to produce the novel yarn.

FIGURE 2 is a schematic representation of the novel yarn of the present invention.

FIGURE 3 is a cross sectional view of the yarn of FIGURE 2 taken along the longitudinal axis.

Referring now to FIGURE 1 a yarn **1** composed of at least one end of continuous filament synthetic textile filaments is withdrawn from the supply paackage **2** and is fed through a guide **3** to snub point **4**. The synthetic textile material supplied from supply package **2** may be any of the well known synthetic continuous fiber forming materials useful in the formation of textile fabrics and formed by known techniques from synthetic fiber forming thermoplastic resins. Examples of such resins are polyethylene; polypropylene; polyurethanes; copolymers of vinyl acetate and vinyl chloride; the copolymers of vinylidene chloride and a minor proportion of monoolefinic compound copolymerized therewith, such as, for example, vinyl chloride; homopolymers of acrylonitrile, copolymers of acrylonitrile and a minor proportion of at least one mono-olefinic compound copolymerized therewith and polymer blends containing combined acrylonitrile and a major proportion; copolymers of vinyl chloride and acrylonitrile; linear polyesters of aromatic dicarboxylic acids and dihydric compounds, such as polyethylene terephthalate and copolymers derived from terephthalic acid and bis-1,4(hydroxymethyl) cyclohexane; modifications of such polyesters; linear polycarbonamides such as for example, polyhexamethylene adipamide; polyhexamethylene sebacamide, polymeric monoamino-monocarboxylic acids, such as polymeric 6-amino caproic acid; and other fiber-forming polymers. The invention is applicable particularly but not exclusively for treatment of yarns of polyamides having recurring intralinear carbonamide groups as an integral part of the main molecular chain, generally referred to as nylon yarns.

The yarn supplied from the supply package **2** can be yarn, the filaments of which have a circular or noncircular cross section. Of particular note in regard to a non-circular cross sectional filament is one having a triskelion cross section along its length. This type of filament has 3 branches, each of which is preferably equally spaced about the center thereof. The distal ends of the branches are substantially uniformly curved or bent in one direction. The filament is particularly characterized by having three-fold axial symmetry and presenting no planar symmetry. Additionally, other non-circular cross section yarns can also be employed.

The yarn supplied from package **2** will form the internal core of the product. FIGURE 1 illustrates an embodiment of the present invention wherein a single yarn end composed of a plurality of continuous filaments is supplied which will form the load-bearing core. It is, however, to be understood that the present invention is not limited to a yarn in which the core is formed from only a single yarn end. One can utilize two or more yarn ends to form the core of the novel yarn. In view of the fact that the core will serve to provide the longitudinal dimensional stability to the ultimate yarn and will affect the hand as well as the flexibility of the yarn produce, it is necessary that the materials forming the core, the number of yarn ends making up the core, and the total denier of the core be selected with the desired attributes of the ultimately produced product, i.e., the necessary stability of the yarn itself, in mind. The number of filaments in the core strand and the denier per filament can vary over a rather wide range, depending upon the desired properties of the final product yarn. It is preferable that the core make up approximately 33% of the total denier of the final yarn product since a more balanced product will result between dimensional stability and bulk. This percentage will vary, however, with the desired characteristics of the final product from about 10–50%. In this regard it may generally be said that where the percentage of the core is greater, there will be less bulk in the ultimately produced composite yarn.

The core yarn is forwarded through guide **3** and around the tensioning snub pin **4** to the core yarn feed roll **5** with its associated separator roll **6**. In the embodiment of FIG. 1, the core yarn normally will be drawn to provide desired molecular orientation during the process; and, therefore, it is necessary to provide a sufficient number of wraps about the feed roll **5** and its associated separator roll **6** in order to prevent or minimize slippage during this drawing of the core. FIG. 1 illustrates a single stage drawing of the core yarn at draw pin **7**. It is to be understood that the drawing can be accomplished in a plurality of stages in a manner known in the art or in the alternative all the drawing can be accomplished prior to the yarns employed in the present procedure.

From the feed roll **5** the core yarn is forward to a zone of contact with a textured yarn. In the presently illustrated embodiment this zone of contact is in the yarn path just below guide **8**, **8***a* and splitter pin **10**. The textured and core yarns are false twisted together and the textured yarn will be randomly bonded to the core. It is necessary, therefore, to provide means for accomplishing this bonding.

In FIG. 1 the bonding means illustrated is a solvent applicator **9** in which the yarn is passed in contact with a wick saturated with a solvent for the yarn material. From feed roll **5** the yarn is passed to a draw pin **7** to a guide pin **8** and eye guide **8***a* and to the solvent applicator **9**. It is not necessary that a solvent be applied to the yarn by the applicator. An adhesive composition can be employed which will serve to bond the textured sheath yarn to the core. It should be noticed that when selecting an adhesive to serve as the bonding agent, consideration must be given to the appearance of the yarn product as well as the dyeing characteristics, that is, the bonding agent for most purposes should not impart an unsightly appearance or adversely affect the even dyeing of the product. Also the agent ought not render the product too

rigid. These considerations are of course in addition to the basic considerations of obtaining a strong bond between the sheath and core yarns and of employing a bonding agent which will not be unduly tacky when the product yarn is taken up.

The bonding of the substantially straight cores filamentary yarn to the crinkly sheath filamentary yarn is preferably a thermochemical one. The chemical solvents employed in the thermochemical bonding are active so as to soften the yarn and to render the same stickable at the elevated temperatures employed. The solvents can be composed of an active substance normally solid at room temperature but readily dissolvable in a relatively inert volatile diluent to form a single phase liquid. When the yarn carrying the solvent is heated, the diluent flashes therefrom and the action of the active substance is dissipated. Specific solvents will be selected with regard to the type of yarns being processed.

For treating nylon yarns, solutions of multi-hydroxybenzenes have been found to be effective evanescent solvents. Dihydroxybenzene compounds which can be employed as the active substance in the solvents include resorcinol, hydroquinone, and pyrocatechol. A trihydroxybenzene, for example, is pyrogallol. The multi-hydroxybenzenes are not limited to the foregoing specific compounds since derivatives thereof can also be used to effect cohesion and the stabilization of the yarn. The preferred procedure is to dissolve the compounds in a suitable inert diluent. Dihydroxybenzenes and trihydroxybenzenes are readily soluble in water, common alcohols (methanol, ethanol, etc.) and common ethers (dimethyl ether, diethyl ether, etc.). It has been found that a preferred procedure involves dissolving a predetermined amount of the benzene compound in water or methanol. An aqueous or methanolic solution containing about 5–80 percent dihydroxybenzene or trihydroxybenzene on a weight basis gives good results. The preferred concentration is 30–40 weight percent. The concentration of the active substance in the evanescent solvent will depend on many factors, such as the characteristics of the particular substance employed, the amount of liquid placed on the nylon yarn, the polymeric structure of the yarns, etc.

Another effective evanescent solvent for use in treating nylon yarns is molten chloral hydrate or a solution thereof. Chloral hydrate is also readily soluble in water, common alcohols (methanol, ethanol, etc.) and common ethers (dimethyl ether, diethyl ethers, etc.). A preferred procedure involves dissolving a predetermined amount of chloral hydrate in water or methanol. An aqueous or methanolic solution containing about 25–90 weight percent chloral hydrate gives good results. The preferred concentration of chloral hydrate in solution is 40–85 weight percent.

For treating acrylic filament yarns (yarns made from acrylonitrile polymers) solutions of aliphatic cyclic carbonates are effective evanescent solvents. These carbonates can be selected from the group of the cyclic carbonates of 1,2-, 2,3- and 1,3-dihydric aliphatic alcohols. Such aliphatic cyclic carbonates include ethylene carbonate, propylene carbonate, trimethylene carbonate, 1,2-butylene carbonate, 1,3-butylene carbonate, 2,3-butylene carbonate, isobutylene carbonate and mixtures thereof. Especially useful of the foregoing group is ethylene carbonate. An aqueous solution containing about 5–80 percent aliphatic cyclic carbonate on a weight basis gives good results. The preferred concentration of aliphatic cyclic carbonate is 40–60 weight percent.

Other bonding techniques can be employed. For example, there may be mentioned a process of gas activated bonding of polyamides as described in U.S. patent application Ser. No. 528,699 filed Feb. 16, 1966 having common ownership herewith. Such procedure involves bonding two or more ployamide structures crossed and under tension at their intersections by exposure to an activator such as a gaseous hydrogen halide or boron trifluoride followed by removal of the activating gas.

In the embodiment of FIG. 1 the solvent is applied from the applicator prior to the contact with the textured yarn. The core yarn with the solvent applied then passes to the splitter pin **10** below which it is combined with the textured yarn in a manner disclosed below. If desired, the solvent can be applied to the yarns below the zone of contact and while they are false twisted together.

From the supply packages **11** yarn ends **12** which are composed of a plurality of continuous filaments and which are to serve as the textured sheath are withdrawn. FIG. 1 illustrates an embodiment of the present invention utilizing two ends of yarn serving as the textured or crinkled yarn sheath. It is, however, to be understood that only one yarn end may be employed or several ends may be utilized. The desired characteristics of the final product yarn will govern the choice of the number of ends of yarn employed as the textured yarn, as well as the denier of the yarn employed. It is to be noted here that the material employed as the textured yarn supply may be the same or different from the yarn employed in the core and it may be the same or different denier and/or denier per filament as the yarn employed as the core material. It is also within the present concept to employ a mixture of materials within the textured sheath and the core. For example, when employing two ends of yarn for the textured yarn supply, they need not be the same material, or the same total denier, or the same denier per filament. The properties of the final product yarn can be controlled by altering these variables. A factor governing the choice of the material, denier and denier per filament will be the dyeing characteristics desired in the ultimately produced fabric product. The desired hand of the product fabric is also a factor.

It is preferred that the amount of textured yarn employed be sufficient to make up about 50–70% of the total denier of the ultimately produced product. It is also preferred that in order to obtain the optimum operating conditions in processing the core yarn and the textured yarn possess about the same denier per filament. This results in a more balanced yarn product and more favorable operating conditions during the processing to produce the ultimately desired novel yarn. As indicated, the desired hand of the final product will govern to a great extent the amounts and the denier per filament of the textured yarn source. Generally, as one increases the percent of the textured yarn in the product, the hand of the final product will be softer. Also the finer the individual filaments of the textured yarn the softer will be the hand. By varying the denier per filament of the textured yarn source, it is possible to control the appearance of the ultimately produced yarn and the nature of the fabrics produced therefrom. These fabrics can be varied from cotton-like to woolen-like materials.

The yarns **12** are forwarded through a guide **13** to snub pin **14**. After one or more wraps is taken about snub pin **14**, the yarns are forwarded to feed roll **15** and its associated separator roll **16** where a sufficient number of wraps are made in order to minimize slippage.

The yarns **12** are then forwarded to a texturing zone. The texturing operation employed can be any of those texturing means commonly employed with thermoplastic synthetic fiber materials. There may be mentioned in this regard a stuffer box, a knife edge, etc., as well as a false twist texturing means.

A particularly suitable texturing operation is the gear crimping operation illustrated in FIGURE 1. In this operation the yarns **12** are forwarded to a positively heated draw pin **17** where they are passed a sufficient number of wraps in order to heat the yarns. The yarns are then forwarded between the cooled gears **18** traveling at a speed in excess of the speed of the forwarding roll **15**. The yarns are thus drawn between the pin **17** and the gears. In the passage through the gears the filaments

are deformed and the deformation is set in order to provide the necessary texturing. The gears **18** may be positively cooled, but such positive cooling is not necessary to obtain a desired texturing at low speeds. In addition, multiple passes through the gears **18** may be made in order to increase the degree of texturing achieved. Such texturing operation per se is known in the art, and in this respect attention is directed to U.S. Patent 3,027,516.

While substantial economic advantages are achieved by having an integrated process wherein the texturing of the supply yarns **12** is conducted as an integral step of the process, it will be apparent that it is possible to perform the texturing operation as a separate operation and simply supply previously textured yarn from a supply package directly into the zone of contact with the core yarn. This permits omitting the texturing operation per se as a part of the process and apparatus.

The textured yarn is fed from the texturing zone to a point below the splitter pin **10** where it is combined with the core yarn **1**. The core yarn has been treated in a manner to admit bonding to the textured yarn by the bonding applicator **9**. As previously indicated the bonding treatment can be effected subsequent to the combining of the core and textured yarns if desired.

The textured yarn is fed to the zone of contact with the core yarn under a tension which is less than the tension on the core yarn. In the aspect of the invention where the core yarn is drawn during formation of the product the tension on the core will of course be that required for the drawing of the particular material of the core.

The textured yarn is overfed to the zone of contact with the core yarn. By "overfeeding" the textured yarn it is meant that the length of the textured yarn (when considered in a straightened condition) which is fed into contact with the core yarn in a given amount of time is greater than the length of core yarn fed to the contact in the same amount of time. The amount of overfeed is controlled by adjusting the speed of the textured yarn feeding means with respect to the speed of the yarn forwarding means below the zone of contact between the textured and core yarns.

The amount of overfeed of the textured yarn may conveniently be determined by relating the total denier of the final product singles yarn to deniers of the core and textured yarns, respectively, which make up that product. In this respect, a given product yarn will have a specific total denier T_d. A portion of this total denier will be due to the denier of the core. Since the core is untextured and the nature of the starting materials and draw ratios will be known, the portion of the total denier which the core makes up will be a known value C_d. The denier of the textured sheath yarn contained in the final product may then be calculated:

$$S_d = T_d - C_d$$

The difference between the total denier of the textured sheath yarn, S_d, and the denier of the drawn but untextured sheath yarn, U_d, may then be determined, i.e., $S_d - U_d$. This difference between the actual total denier of the sheath in the final product and the denier of the drawn but untextured sheath yarn when divided by the value of the denier for the drawn but untextured yarn and multiplied by 100 will give the value for the percent overfeed. Thus:

$$\text{Percent overfeed} = \frac{S_d - U_d}{U_d} \times 100$$

This overfeed varies in the range of generally from about 8 to about 100% and will be dependent upon the type of textured yarn employed as the textured sheath yarn. The amount of overfeed of the textured yarn will produce a significant effect upon the properties of the final product and thus will vary with these desired properties. The more overfeed conducted for example, the loftier will be the final product. When employing the gear textured yarn, the overfeed will vary from about 8 to about 40%. A preferred range of overfeed with this type of texturing is about 25 to about 30% overfeed. When the overfeed is below about 8%, insufficient loftiness of the final product is obtained. At an overfeed of above about 40% with the gear crimped yarn, processing difficulties are encountered; and taking up the overfeed in order to form a satisfactory coherent final product becomes difficult. When employing a false twist textured yarn as the sheath an overfeed of as much as up to about 100% can be processed to yield an acceptable product.

The core and textured yarns are false twisted by false twist imparting means **19**. Any false twist mechanism capable of imparting a false twist of from about 5 to about 75 turns per inch in the yarn is satisfactory. In this regard there may be mentioned in the friction type false twister, as well as the positive spindle type. A preferred false twist device is disclosed in U.S. application Ser. No. 399,742 filed Sept. 28, 1964, now abandoned, and comprises interleaved spaced discs rotated in the same direction. The yarn is twisted with such device by engaging the peripheral edges of the interleaved discs.

The false twist imparted to the yarn backs up beyond the heated block **20** to the splitter pin **10**. As a result of the false twisting intimate contact is provided between the textured yarn and the straight core. While in intimate contact, the bonding between the sheath and core yarns is perfected. In the illustrated embodiment a bonding composition is employed which is a solvent for the core yarn. As the yarns progress through the heater block **20**, the solvent flashes off; and the bond between textured yarn and the core yarn is completed. The amount of twist, as previously indicated, will vary in an amount of from about 5 to about 75 turns per inch. The degree of imparted twist will affect the loftiness of the yarn product. With more twist one obtains a tighter bond between the textured yarn and the untextured core and the less loft will exist in the final product. However, the twist must be a sufficient amount to obtain a unitary final product. That is to say, the final product must be one in which the core and the textured yarn form a singles yarn which does not separate when processed into fabrics.

The amount of twist imparted by the false twist means will control the amount of the overfeed of the textured yarn. In the event, however, that the overfeed of the textured yarn to the core is excessive for the particular type of textured yarn employed, it is necessary in order to take up this degree of overfeed, to apply such a great amount of twist than a substantial risk is taken that the core will be broken. In practice, therefore, it is necessary to determine the optimum conditions depending upon the particular types of yarn employed and the particular type of product desired.

In the embodiment of FIGURE 1, with respect to the zone in which the false twist occurs, it is to be noted that the core yarn is drawn for orientation between snubbing pin **7** and draw and take-off rolls **21** with its associated separator roll **22**. The draw ratio employed for the core yarn will vary with the material employed. The degree of draw will affect the stability provided the product by the core yarn. In general with nylon material the draw ratio may be said to be from about 2 to about 4. This draw ratio will likewise be determined in those cases where the drawing is accomplished as a separate step prior to combining the core and sheath yarns.

In one aspect of the instant invention it is possible to reduce the amount of drawing of the core yarn accomplished due to the difference in forwarding speed of the yarn between feed roll **5** and draw and take-off roll **21** to a value lower than that indicated above. The false twisting operation is then permitted to accomplish a portion of the drawing. The false twisting of the core will produce a shortening of the yarn length between the false twist spindle and the snubbing pin **7** thus accomplishing a portion of the drawing of the core yarn. This has a disadvantage in that it is difficult to control the specific

amount of drawing accomplished by the false twist mechanism and a tendency is encountered to impart uneven dyeing properties to the core as a result of an uneven drawing. Also there is a tendency where this degree of false twist is employed to impart a texturing to the core which reduces the longitudinal stability of the ultimately produced yarn product.

Below the false twist means **19** the false twist imparted to the yarn is released so that the product emitted from the false twist spindle is a zero twist singles yarn. The product is forwarded from the false twister to the draw and take-off roll **21** with its associated separator roll **22** where a sufficient number of wraps are provided in order to prevent slippage. The draw and take-off roll is operated at a speed in excess of the speed of the feed roll **5** to produce the previously referred to drawing of the core yarn in the desired amount. In those embodiments where the drawing of the core yarn is accomplished as a separate step, it will be apparent that roll **21** will serve as a forwarding roll and will provide the proper tension and yarn speeds during processing. From the draw and take-off roll the final yarn product is forwarded to the take-up means **23**. In FIGURE 1, a cone type take-up is illustrated; however, any type of take-up may be employed, preferably a cheese or cone type without imparting twist to the strand since the take-up of the yarn can be accomplished faster and thus more economically.

The final product yarn is sufficiently lofty in order to prevent any problem of crushing the cheese or cone core even if a shrinkage of the yarn occurs. In one aspect of the present invention a relaxation stage is inserted in the processing procedure between the point at which the yarn leaves draw roll **21** and the point at which it is taken up on a take-up means **23**. Any type of relaxation step known in the art may be employed. As for example, a plural stage heating and relaxing procedure such as is employed in the relaxation of nylon–66 yarns can be used.

The yarn produced as the final product in the described process is thus composed entirely of continuous filaments. It is a singles yarn of little or no twist and one which possesses a high degree of bulk and yet retains the longitudinal stability necessary in producing stable fabrics. The yarn is characterized by having an internal integral core of substantially untextured filamentary material which is surrounded by and has bonded thereto a sheath of textured filamentary materials. By "substantially untextured" is meant that the core is not sufficiently deformed so that it fails to provide longitudinal stability to the product thus permitting the application of relatively low tensions to pull out a large amount of the bulkiness of the product yarn.

A section of the yarn of the present invention is represented by FIGURE 2. The textured yarn **31** forms a sheath which is bonded to and surrounds the core **32**. FIGURE 3 is a cross-sectional view of the yarn of FIGURE 2 taken along the longitudinal axis. This view illustrates the internal integral core **32** surrounded by the textured yarn sheath **31** which is bonded to the core.

The following examples are presented as being illustrative of the present invention. These are not to be taken as being limitative of the invention. Changes can, of course, be made therein without departing from the spirit of the invention.

EXAMPLE I

Employing an apparatus substantially as shown in FIGURE 1, and in the manner described in the instant specification composite, a core and textured singles yarn product was produced. The yarn serving as the core was one end of nylon–66 yarn having an undrawn denier of 700 and 68 filaments. The textured yarn was made up of two ends of nylon–66 yarn also having an undrawn denier of 700 and 68 filaments. During processing the draw ratio for the core yarn was estimated to be 3.2 and the draw ratio for the textured yarn was estimated to be 3.5 with some drawing occurring during false twisting. The solvent applicator was supplied with chloral hydrate dissolved in methanol. The weight percent of chloral hydrate in solution was 80. The yarn picked up about 2 weight percent of the solution. A hot draw pin was used for the making of the textured yarn and was maintained at a temperature of 210° C. The textured yarn made from the two ends was fed from the texturing gears to the zone of contact with the untextured core yarn at an overfeed of 18.8% with respect to the speed of the core yarn. A false twister as disclosed in S.N. 399,742 mentioned supra was employed and run at a speed of 5100 revolutions per minute (r.p.m.), imparting a twist in the composite strand of 40 t.p.i. The temperature of the heater block was maintained at 245° C.

The product yarn was taken up at a speed of 300 yards per minute at a wind-up tension of 45 to 50 grams as a cheese package.

The product yarn was composite singles yarn of substantially no twist having an internal integral core surrounded by and having bonded to it a sheath of textured yarn. The yarn demonstrated good longitudinal stability and retains its bulkiness when subjected to high longitudinally applied tension. The final product denier was 650. The yarn had a boiling water shrinkage of 7.3% and an elongation at break of 20.7%.

The yarn was employed in the production of various types of fabrics requiring a textured yarn of good dimensional stability in the manner described in subsequent examples herein.

EXAMPLE II

The procedure of the above was repeated except an aqueous solution containing 50 weight percent resorcinol was used instead of chloral hydrate. The nylon–66 untextured yarn picks up about 1 weight percent of the solution. The textured continuous filament sheath cohered satisfactorily to the core of the continuous filament yarn so that it could be used as filling in the weaving of taffeta yarn without being twisted. The load bearing core and the bulk-imparting sheath of the composite product caused it to be similar to cotton yarn both in appearance and tactile qualities, as well as in process handling.

Similarly excellent results are obtained when a methanolic solution of 65.5 weight percent resorcinol; an ethanolic solution of 29.9 weight percent hydroquinone; a methanolic solution of 26.4 weight percent hydroquinone; saturated aqueous solution of resorcinol; saturated methanolic solution of pyrogallol; and the like are employed in the production of the untwisted dimensionally stable bulky yarn herein. In each case the yarn is composed of a straight load-bearing continuous filament core and a crimpy bulk-imparting sheath of continuous filaments. Other nylons such as nylon–6 can be treated with like results. In addition, acrylic filament yarn can be processed with the application of an aqueous solution of ethylene carbonate or the like.

EXAMPLE III

The procedure of Example I was repeated except the twist imparted by the false twist device to the yarn was increased to 60 turns per inch. The yarn exhibited less bulk but had increased longitudinal dimensional stability.

EXAMPLE IV

The procedure of Example I was repeated except that only one end of textured yarn was employed. The yarn showed less bulk. However, the yarn could be converted into woven fabric having a cotton-like appearance and hand.

EXAMPLE V

The procedure of Example I was repeated except that the core yarn was made from polyethylene terephthalate polymer. The yarn could be converted into woven fabric having a cotton-like appearance and hand.

Various deniers of nylon–66 continuous filament yarns were made and processed in accordance with Example I to produce the yarns used in making the fabrics in the nine following examples (Examples VI through XIV). In each case two ends were textured and one end was untextured.

EXAMPLE VI

Low-stretch high-bulk yarn of the invention having a total denier of 115 and 62 nylon–66 filaments was used as filling with a warp of standard 70–34 nylon–66 yarn. These yarns were woven into a plain-weave fabric on a 50-inch Draper Model XD loom, there being 78 picks/inch in the filling and 96 ends/inch in the warp. The finished fabric had an appearance and handle similar to cotton percale fabric, and was judged well suited to bed sheeting, shirting, blouses, and dresses.

EXAMPLE VII

A high-sley faille taffeta fabric was woven on a Draper loom using 96 ends/inch of standard 70–34 nylon–66 in the warp with 50 picks/inch of filling comprised of 290 denier-102 filaments nylon–66 yarn of the invention. The finished fabric had a smooth soft hand and a flat sheen that made it particularly suitable for outerwear garments such as jackets and raincoats.

EXAMPLE VIII

Three ends of 290 denier-102 nylon–66 filament high-bulk low-stretch yarn of the invention were plied to form a single end of 870 denier yarn. This yarn was skein-dyed conventionally and was used to produce a single-knit, bulky knit sweater fabric on a Universal V-bed flat knitting machine. Knitting efficiency of this yarn proven to be significantly superior to that of standard spun staple yarns. The fabric had a very bulky texture and soft, warm hand similar to wool. Sweaters made of this fabric had a luxurious appearance and were reported to be very comfortable to the wearer.

EXAMPLE IX

A birdseye weave crepe fabric was woven on a Draper loom with 100 end/inch warp and 66 picks/inch of filling. Both the warp and filling yarn were comprised of 115 denier-62 filament nylon–66 yarn of the invention that was made by combining two ends of textured 30–26 nylon with one end of untextured 30–10 nylon yarn. The fabric had a characteristic bulkiness and soft hand that made it suitable for diapers and other skin-contacting applications, as well as for outerwear apparel.

EXAMPLE X

Yarn similar to that referred to in Example IX was used with a Draper X–3 loom to weave another crepe fabric having 68 ends/inch in the warp and 70 picks/inch in the filling. Dyed pale blue the finished fabric had a very soft but dry hand and, when made into dresses and blouses, was observed to show excellent drape about the figure of the wearer.

EXAMPLE XI

Fabric of plain basket weave construction was woven on a Crompton & Knowles S–6 loom. The acrylic warp was comprised of 12 one's, single ply, of a 50:50 mixture of 5 denier and 8 denier Acrilan acrylic fibers of 2½ staple length, and 13 t.p.i., of Z twist. Filling was 290 denier-102 nylon-66 filament high-bulk low-stretch yarn of the invention. There were 56 ends/inch in the warp and 56 picks/inch in the filling. Dyed charcoal grey, the finished fabric had excellent body and soft handle making it highly attractive for use in trousers and men's and women's suitings, as well as in winter sport shirts.

EXAMPLE XII

The same yarns and loom referred to in Example XI were again used with 56 ends and 56 picks but in a 2/2 twill fabric construction. This finished fabric had a more dense bulkiness and a mildly harsh handle or "hard finish," making it especially suitable for trousers and women's skirts.

EXAMPLE XIII

A 199 denier-51 filament yarn was made according to the invention by combining two ends of textured 50–17 nylon-66 with one end of untextured 50–17 nylon-66 yarn. This bulky dimensional-stable yarn was used to produce a lightweight, double-knit fabric on a Bentley, 18 cut, double-knit, circular knitting machine. The finished fabric was highly opaque and had a mildly dry hand. It was judged to be well suited to such diverse applications as dresses, bathing suits, slacks, and women's coat-suits.

EXAMPLE XIV

A warp yarn was formed by plying two ends of regular 70–13 "Superloft" false twist textured nylon yarn; 132 ends/inch of this yarn was used with 64 picks/inch of a filling yarn comprised of 290 denier-102 filament nylon-66 yarn of the invention. These yarns were used in a Tricotine construction woven on a Crompton & Knowles W–3 broad loom. Dyed dark brown, this fabric had a pleasant dry hand, high opacity, bulky body, practically no stretch in the filling direction but excellent stretch and recovery in the warp direction. Made up in stretch pants this fabric was observed to show excellent drape and "hugging" to the contours of the wearer (but without the uncomfortable clinging sometimes noted with stretch fabrics).

EXAMPLE XV

Drawn nylon-66 continuous filament yarn having a total denier of 70 and 34 individual filaments was textured by passing it through a conventional commercial stuffer box crimper. This yarn was fed across the heater to the false twist device of the apparatus herein described. Just prior to contacting the textured yarn, a drawn 70/34 nylon-66 untextured yarn was coated with the chloral hydrate solution of Example I. The contacting ends were false-twisted 35 t.p.i. The yarn was taken up on a coner. The yarn could be converted into woven fabric having a cotton-like appearance and hand.

Yarns of the invention are highly versatile in end usage and can be woven on any of the conventional textile looms or be knitted on any type of conventional knitting machine for use in sweaters, skirts, dresses, blouses, rainwear, and other outerwear garments, sheets, etc. In combination with other fibers, yarns of the invention are useful for ski pants and sportswear, suitings, etc. In general, the yarns may be applied to most end uses in which the more desirable inherent properties of regular nylon are required but without the harsh hand characteristic of regular nylon. Fabrics made from yarns herein are more resistant to mussing, that is, garments therefrom worn by a consumer after being in a sitting position for an extended time will show less crumple or ruffle. Moreover, any mussing will disappear more rapidly upon the wearer rising.

Since many different embodiments of the invention can be made without departing from the spirit and scope thereof the invention is not limited by the specific illustrations except to the extent defined in the following claims.

We claim:

1. The process of producing a synthetic continuous filament singles yarn which comprises forwarding substantially untextured core yarn composed of at least one synthetic continuous filament to a zone of contact with a sheath yarn composed of a plurality of textured synthetic continuous filaments, the tension on the core yarn being greater than that on the textured sheath yarn in the zone of contact false twisting the core and textured yarns together, bonding the textured yarn to the core yarn, when so-twisted together, releasing the false twist and taking up the singles yarn product.

2. The process of producing a synthetic continuous filament singles yarn which comprises:

(a) forwarding a core yarn composed of at least one synthetic substantially untextured continuous filament to a zone where it is drawn for orientation;

(b) overfeeding a textured yarn composed of a plurality of synthetic continuous filaments in an amount of from about 8 to about 100% with respect to the core yarn, into contact with said core yarn in the core yarn drawing zone;

(c) applying a bonding composition to the core yarn in the drawing zone prior to contact with the textured yarn;

(d) false twisting the core yarn and textured yarn together in the drawing zone;

(e) heating the yarns while false twisted to induce the bonding of the textured yarn to the core yarn;

(f) releasing the false twist; and

(g) taking up the composite singles yarn without imparting twist therein.

3. A process as in claim **1**, wherein the textured sheath yarn is overfed into contact with the core yarn directly from being textured.

4. A process as in claim **2**, wherein the texturing operation is a gear crimping process and the amount of overfeed is from about 8 to about 40%.

5. A process as in claim **1**, wherein the bonding composition is a chloral hydrate.

6. A process as in claim **1**, wherein the final product yarn is subjected to a relaxing operation immediately prior to the take-up.

7. An apparatus for the production of a composite singles yarn comprising:

(a) means for forwarding a substantially untextured corn yarn to a zone of contact with a textured yarn under a tension in excess of the tension on the textured yarn;

(b) means for forwarding a textured sheath yarn to a zone of contact with the core yarn;

(c) means for imparting to the core and textured yarns a sufficient degree of false twist to provide intimate contact between the yarns;

(d) means for bonding the textured yarn to the core yarn;

(e) means for forwarding the composite yarn to a take-up zone; and

(f) means for taking up the yarn in an orderly manner.

8. An apparatus for the production of a composite singles yarn comprising:

(a) a first source of undrawn synthetic continuous filament yarn;

(b) means for forwarding the undrawn yarn from the first source;

(c) means for imparting a molecular stretch to said yarn and for forwarding the yarn across a heater block;

(d) means located in the yarn path between the heater block and the means for forwarding the yarn from the first source for applying a bonding agent to the yarn;

(e) a second source of undrawn synthetic continuous filament yarn;

(f) means for forwarding the undrawn yarn from the second source;

(g) a pair of intermeshing gears for drawing the yarn forwarded from the second source across a heated member while crimping and cooling the resulting heated drawn yarn and for forwarding the yarn to element (c);

(h) a false twist device located in the yarn path between the heater block and element (c) for false twisting the two yarns together across the block; and

(i) means in the yarn path beyond element (c) for taking up the yarn in an orderly manner.

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