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R. T. MOFFETT, JR., ET AL

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2 Sheets-Sheet 1

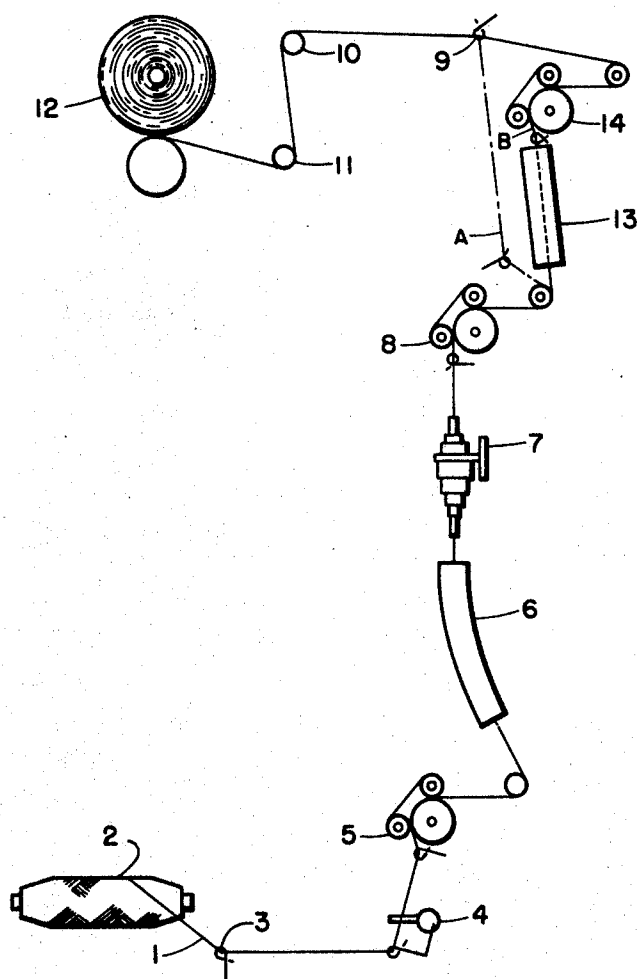


FIGURE 1

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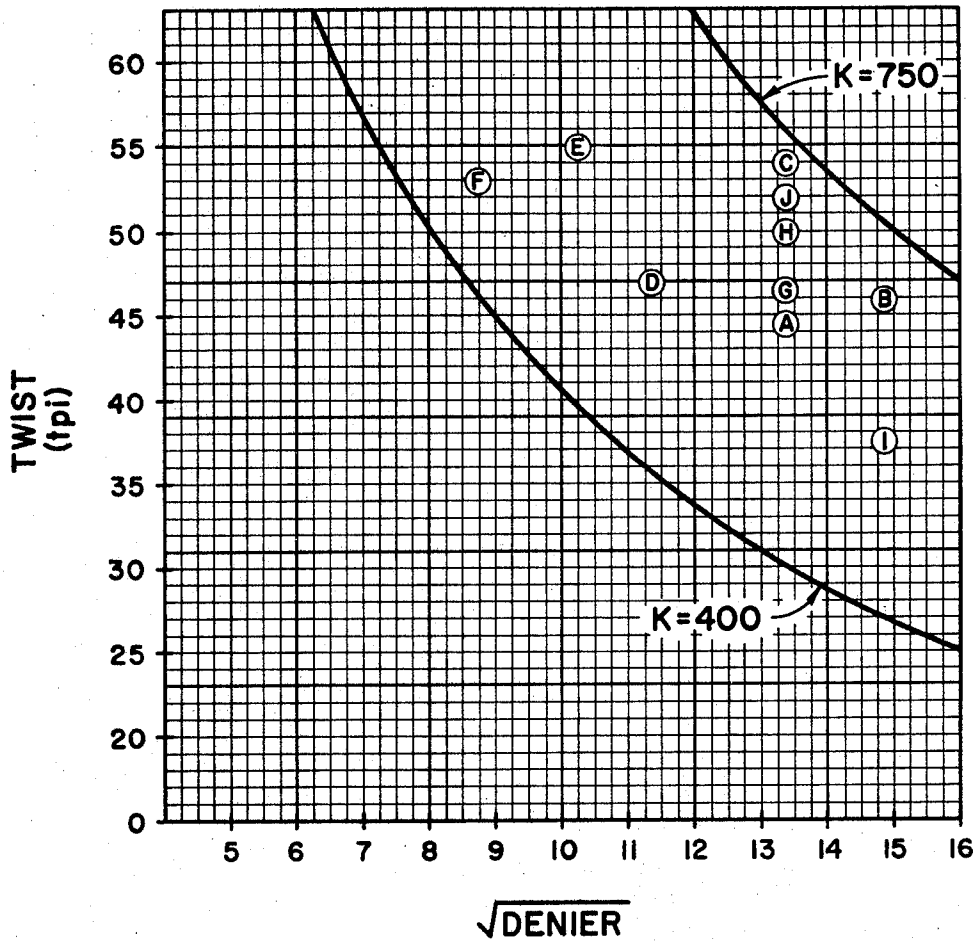


FIGURE 2

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**METHOD OF TEXTURING YARN**

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U.S. Cl. 57-140

13 Claims

**ABSTRACT OF THE DISCLOSURE**

A process for texturing an entangled yarn comprising a cellulose ester yarn and a nylon yarn, said process comprising advancing the yarn at a first rate of speed through a temperature zone to a twisting zone, inserting a twist in the yarn computed from the formula

$$\text{Twist} = K / \sqrt{\text{denier}}$$

heating the twisted yarn to a temperature of from about 160 to 210 degrees centigrade for 0.25 to 2 seconds, advancing the yarn at a second rate of speed, which is about 95 to 110 percent that of the first rate, and taking up the untwisted yarn at a rate of from about 98 to 80 percent of the second rate of speed.

**Background of the invention**

This invention relates to an improved method for texturing or voluminizing yarn. More particularly, the invention relates to a method for the production of an improved continuous filament yarn of a combination of a yarn comprising cellulose ester, preferably cellulose triacetate, and nylon yarn, preferably nylon 6,6, which has been produced by an entangling operation, such as plying.

The texturing or voluminizing of yarns has been found useful for the purpose of increasing the bulk, and improving the hand, drapability, covering power and loft of fabrics manufactured from such textured yarns. Thus, using textured yarns, a fabric can be made having greater cover and bulk for a given weight of yarn than when untextured yarn is used, or less weight of yarn may be used to obtain the desired degree of cover and bulk.

In addition to the above advantages, fabrics made from textured yarns generally yield greater cover and improved moisture absorption, have excellent aesthetic appeal and dimensional stability as compared with fabrics made from untextured yarn, and have better resistance to fuzzing and pilling as compared with fabrics made from spun yarn.

Various difficulties are encountered in preparing or producing textured entangled yarns of a cellulose ester, such as cellulose triacetate, and nylon, such as nylon 6,6. It has been found that in some cases good yarn bulk is not obtained, voids or tight spots are found, and numerous broken filaments are produced. Poor processing efficiency often results during subsequent processing of the yarn. Moreover, the physical properties of the yarn, such as tenacity, have often been found to be too low as a result of the texturing.

The most significant problem encountered while texturing yarns of cellulose esters and nylon is the failure of the cellulose ester yarn to bloom after texturing. This problem has been traced to the relative behavior of the nylon and cellulose ester yarn during heating. The cellulose ester yarn, e.g., cellulose triacetate, elongates to conform to the helical filament path when twisted. Upon detwisting, the major portion of the axial stress is supported by the nylon; therefore, there is insufficient axial

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stress in the cellulose ester yarn to yield complete detwisting. The result is that short segments of the yarn retain the texturing S-twist and longer segments of yarn detwist through zero and a Z-twist level. This effect appears as a series of closely spaced tight spots.

It is therefore an object of this invention to provide an improved textured yarn comprising a cellulose ester yarn and a nylon yarn.

It is a further object of this invention to provide a method for the texturing of an entangled continuous filament yarn of a cellulose ester and nylon which yields a product having improved properties, thus avoiding low tenacity and subsequent processing difficulties.

Other objects will become apparent from the following detailed description and claims.

**Summary of the invention**

The process of this invention is applicable to yarn comprising a cellulose ester yarn and a nylon yarn containing from about 50 percent to about 95 percent cellulose ester yarn and from about 9 percent to about 30 percent nylon (said percentage based on denier and herein-after called denier percent) and having a total denier of from about 50 to about 300, preferably from about 100 to about 225. The yarn is twisted by a false twisting device such that it contains a false twist which is computed from the formula:

$$\text{Twist} = K / \sqrt{\text{denier}}$$

wherein K (the twist factor) ranges from about 400 to about 750, e.g., for most deniers of yarn, the twist may be in the range of from about 35 to 60 turns per inch. While the yarn is in such twisted condition, it is heated to a temperature of from about 160 to 210 degrees centigrade, preferably from about 175 to 190 degrees centigrade for a period of from about 0.25 to 2 seconds, preferably from about 0.5 to 1.5 seconds, most preferably from about 0.75 to 1.25 seconds. This is in contrast to the conditions for texturing nylon alone, e.g., nylon 6,6, which is heated to a temperature of at least 225 degrees centigrade.

The temperature zone is located on the yarn path before the point at which twist is inserted into the yarn, e.g., by a twisting device such as a false twist spindle. The twist is translated back along the length of the yarn in the direction of the incoming yarn until a point at which the twist is held in the yarn, e.g., by feed rollers or a snubbing device. As it leaves the temperature zone and twisting device, the yarn is advanced, e.g., by feed rollers, at a rate of about 95 percent to 110 percent, preferably from about 98 percent to 105 percent, of the rate at which the yarn is fed to the temperature zone, the latter preferred values being alternately identified as a feed of from about +2 percent to -5 percent to the advancing means, e.g., feed rollers, beyond the temperature zone and twisting device.

This yarn may be fed directly from the yarn advancing means to yarn take-up means, e.g., one or more yarn packages, which take up the yarn at a rate of about 98 to 80 percent, preferably about 95 to 84 percent of the rate at which the yarn is advanced by the yarn advancing means, i.e., a preferred overfeed of from about 5 percent to 16 percent, to the take-up package.

Textured yarn produced as described above may have a degree of yarn liveliness sufficient to cause some difficulty in subsequent yarn handling and processing. The textured yarn may advantageously be heat-treated or autoclaved to minimize torque caused by yarn liveliness. If it is desired to at least partially reduce the liveliness of the yarn, the yarn is subjected to heat-treatment after

take-up at a temperature of from about 75 degrees centigrade to 90 degrees centigrade, at approximately atmospheric pressure for a period of from about 50 to 100 minutes. The heat treatment may be a steam treatment followed by an exhaust and an additional dry heat cycle at from 75 degrees centigrade to 90 degrees centigrade for a period of time of from about 5 to 30 minutes. The latter treatment may be accomplished by using external heating means, e.g., electrical heating elements, while sucking the steam from the treating chamber which is not completely shut off from the atmosphere. Thus, hot air, in effect, replaces the withdrawn steam. Alternatively, just prior to take-up, the yarn may be heated to a temperature of from about 170 to 195 degrees centigrade, preferably dry heated, for from 0.5 to 2.5 seconds.

It has been found that in the ranges set out above, the temperature at which the yarn is heated while twisted, the rate at which the yarn is advanced by the yarn advancing means and the level of twist imparted are important parameters in obtaining a textured yarn of high or maximum bulk as indicated by crimp contraction. In addition, the range at which the yarn is advanced by the yarn advancing means beyond the first temperature zone and twisting device, the temperature to which the yarn is heated and the range set out above for the twist, in turns per inch, in the yarn which is heated, are important in obtaining a textured yarn of high or maximum tensile strength. Texturing outside the ranges of the process of this invention results in poor processability, especially in knitting.

The process may be used to treat untextured yarn comprising a cellulose ester yarn, preferably cellulose triacetate, and nylon, preferably nylon 6,6, having a total denier in the range of from about 50 to about 300, an initial twist in the range of from about 0 to 10 turns per inch, preferably from about 1.5 to 5 turns per inch, and preferably composed of from about 15 to 75 filaments.

The false twisting device referred to above may be any false twisting device, such as a friction false twister, but is preferably a high speed false twist spindle of any of the various types known in the art. The spindle rotates at a speed in the range of from about 30,000 to 350,000 r.p.m., preferably from about 85,000 to 280,000 r.p.m. For a yarn produced by plying, the twist accomplished by this spindle should preferably be in a direction opposite that of the ply twist of the supply yarn. Any residual twist present in the initial yarn should be taken into account when operating the twisting device in accordance with this invention so that the yarn contains the desired amount of twist in the temperature zone to yield a yarn having the desired degree of twist.

The process of this invention may be used to texture yarn at a rate based on the supply of yarn, in the range of from about 20 to 175 yards per minute, preferably from about 40 to 160 yards per minute, most preferably from about 50 to 150 yards per minute.

To substantially maintain the bulk resulting from the above-described process, the tension on the textured yarn during coning is preferably maintained at a low and uniform rate. It is advantageous to maintain the tension on the yarn during coning within the range of from about 0 to 15 grams, preferably from about 7 to 10 grams, and to maintain the bail roll pressure as low as possible, preferably at about 2 to 3 pounds pressure at the start. During coning the spindle speed is preferably maintained at a speed of from about 1000 to 2000 r.p.m. Care must be taken to avoid excessive or concentrated tension as this can cause stripbacks of the cellulose ester yarn on the nylon yarn.

The textured yarn of this invention is particularly suitable for use in knitted fabrics which may be produced on any of a variety of single, double or links and links needle circular or flat knit knitting machines. The textured yarn is sometimes advantageously knit as a singles to minimize knot size and maintain good bulk. Yarn tension

during knitting is preferably maintained at from about 1 to 5 grams, preferably from about 2 to 4 grams, and is as uniform as possible. The yarn is preferably fed to the knitting needles by positive feed rolls to maintain uniform tension. Woven fabrics may also be made from the textured yarn of this invention.

The texturing process described above may be suitably carried out on uncolored yarn or a yarn which has already been colored. The coloring may be accomplished using procedures well known in the dyeing art, e.g., using disperse dyes for the cellulose triacetate component and acid dyes for the nylon 6,6 component.

The typical dyeing formulations listed below suggest the versatility possible in dyeing combined yarns of cellulose triacetate/nylon 6,6. Dye percentages are based on the weight of the yarn.

	Percent
Turquoise (Union Shade)	
Disperse Blue 87 -----	0.30
Disperse Blue 60 -----	0.87
Disperse Yellow 42 -----	0.06
Black (Union Shade)	
Disperse Black 9 -----	1.0
Acid Black 107 -----	1.2
Black and Yellow (Nylon-Black/Triacetate-yellow)	
Acid Black 107 -----	1.2
Disperse Yellow 42 -----	0.66
Red and White (Nylon-Dyed/Triacetate-Reserved)	
Acid Red 252 -----	1.6

The resultant fabric may be dyed, but the yarn is preferably packaged dyed after texturing and may be colored before being subjected to the texturing process. The dyeing of the yarn package, or alternately the fabric, is preferably carried out using an aqueous solution of any suitable disperse dye and suitable acid dye in a one-bath procedure. When dyeing the textured yarn, a thorough after-scour is preferable, particularly for medium and heavy shades, to remove unfixed dyes and to insure good lightfastness. The dyebath contains from about 0.1 to about 12 percent by weight of dye, and the dyeing may be carried out at a temperature of from about 50 to 120 degrees centigrade.

In the drawings:

FIGURE 1 is a schematic representation of a false-twist crimping process; and

FIGURE 2 is a graph of twist vs. denier.

The invention may be further illustrated with reference to FIGURE 1 wherein untextured yarn 1 is taken from the yarn supply package 2, passed through pigtail guide 3, passed around the pigtail guide 3 and broken end device 4 and advanced by rollers 5. The yarn is then passed through a first temperature zone 6 and is twisted by false twist spindle 7 from where the twist is translated back to rollers 5. From false twist spindle 7, the yarn is advanced by rollers 8 from which the yarn may take one of two paths. If there is no need to reduce the liveliness of the yarn or if it is desired to reduce liveliness in a subsequent treatment rather than as part of the texturing process, the yarn may take path A, and is passed directly from rollers 8 to pigtail guide 9 and guide bars 10 and 11 and is taken up by yarn take-up package 12.

If a yarn having a reduced degree of liveliness is desired directly from the texturing process, the yarn follows path B, and is passed through second temperature zone 13 to rollers 14 and then to guide 9, guide bars 10 and 11 and yarn package 12. Whether the yarn follows path A or path B, the actual twist accomplished by false twist spindle 7 is substantially removed by the time the yarn reaches rollers 8.

Table I below shows the twist, the value of K (the twist factor), the denier and square root of the denier for all the yarns which were false twist textured according to the procedures outlined in Examples I-X, herein-after shown.

TABLE I

Denier	$\sqrt{\text{Denier}}$	Twist	K (twist factor)	Reference Example No.	Figure 2 Reference
75	8.7	53.0	460	6	F
105	10.3	55.1	566	5	E
130	11.4	46.7	525	4	D
180	13.4	44.5	600	1	A
180	13.4	46.8	630	7	G
180	13.4	50.0	670	8	H
180	13.4	52.0	700	10	J
180	13.4	54.0	725	3	C
220	14.8	37.6	560	9	I
220	14.8	46.0	680	2	B

FIGURE 2 is a graph of twist vs. the square root of the denier, for the yarns of Examples I-X. This graph shows the values of the twist factor, K, of Examples I-X and also shows that the twist factor, K, may range from about 400 to about 750, as required in applicants' process. Reference points A, B, C, D, E, F, G, H, I and J represent the value of the twist factor in Examples I-X, respectively.

Knitted fabrics produced by the process of this invention are suitable for a wide variety of end uses and exhibit high bulk and excellent hand, cover and loft. They are particularly useful for the production of garments such as dresses, sweaters, skirts and blouses.

The term "cellulose triacetate" as employed herein has reference to cellulose acetate having fewer than about 0.29, and preferably fewer than about 0.12, free hydroxyl groups per anhydroglucose unit of the cellulose molecule, i.e., an acetyl value, calculated as combined acetic acid by weight, of at least 50 percent, and preferably at least about 61 percent.

As employed herein, the term "nylon" has reference to nylon 6,6 which describes polyhexamethylene adipamide and derivatives thereof, such as copolymers with a minor amount of nylon 6; or nylon 6 which refers to polycaprolactam and derivatives thereof, such as copolymers with a minor amount of nylon 6,6. The term "LTDZ" employed in the examples is used to designate yarn having a metier twist of from about 0.15 to 0.25 turns per inch in the Z direction.

The invention is further illustrated by the following examples:

#### Example I

Referring to FIGURE 1, a continuous multi-filament plied yarn consisting of 83 denier percent 150/LTDZ/22 cellulose triacetate and 17 denier percent 30/1/2Z/10 nylon 6,6, containing 32 filaments, having a total denier of 180 and a twist of 2 turns of Z-twist per inch, is fed by rollers 5 to the first temperature zone, i.e., heater 6 and false twist spindle 7, at a speed of 72 yards per minute. False twist spindle 7 is operated at a speed of 115,000 r.p.m., which causes the yarn to contain a twist in the S direction between spindle 7 and rollers 5 of 44.5 turns per inch. Yarn containing such twist is heated to a temperature of 185 degrees centigrade for a period of 1.0 second.

The yarn from false twist spindle 7 loses most of its twist and is advanced by rollers 8 (First Feed) at a speed of 73.5 yards per minute, which is 102 percent of that at which it is fed by rollers 5. This is equivalent to a 2 percent underfeed to rollers 8. The yarn from rollers 8 travels along path A to pigtail guide 9 and guide bars 10 and 11 to yarn take-up package 12, where it is taken up (Package Feed) at a speed of about 68 yards per minute, which is 92 percent of the speed at which it is advanced by rollers 8. This corresponds to a 8 percent overfeed to take-up package 12.

The textured yarn wound on package 12 is prescoured at 71 degrees centigrade for 15 minutes. Using a suitable disperse and acid dye, here Disperse Yellow 42 and Acid Black 107, in a one-bath procedure, the yarn is packaged dyed at 120 degrees centigrade for 1.5 hours.

The nylon 6,6 is dyed black and the cellulose triacetate is dyed yellow. The yarn is then scoured for 20 minutes at 70 degrees centigrade. A yarn lubricant is applied in the final rinse of the dyebath and the yarn then dried at 100 degrees centigrade.

The dyed yarn is then prepared for knitting by winding overend from the dye packages onto cones. The textured yarn is coned at a speed of 1500 r.p.m. using a start-up of 10 grams tension and continuous tension relief to compensate for the increasing yarn speed. The tension is relieved to 8 grams for a 1 1/2 to 2-pound package. During winding, a suitable lubricant is applied to the yarn to assist in knitting.

A Swiss piqué doubleknit is prepared from the textured yarn using a knitting machine wherein the yarn tension is maintained at a constant tension from 2 to 4 grams and is as uniform as possible. The yarn is fed to the knitting machines by positive feed rolls to assist in maintaining uniform tensions.

To develop the bulk and relax the stitching of the fabric, it is tumbled in a hot-air tumbler for 30 minutes at 105 degrees centigrade in a machine with a drum which alternately rotates clockwise and counterclockwise for 18 seconds each way. The fabric is cooled to 60 degrees centigrade with continued tumbling prior to removal from the machine.

The fabric is slit and undergoes frame heat-setting at 195 degrees centigrade for 20 seconds.

Use of this procedure results in the production of a knitted fabric of high bulk and excellent hand, cover and loft.

#### Example II

A continuous multi-filament plied yarn, consisting of 91 denier percent 200/LTDZ/34 cellulose triacetate and 9 denier percent 20/1/2Z/7 nylon 6,6, containing 41 filaments, having a total denier of 220, and a twist of 2 turns of Z-twist per inch, is fed by rollers 5 to the first temperature zone, i.e., heater 6 and false twist spindle 7, at a speed of 81 yards per minute. False twist spindle 7 is operated at a speed of 135,000 r.p.m., which causes the yarn to contain a twist in the S direction between spindle 7 and rollers 5 of 46 turns per inch. Yarn containing such twist is heated at a temperature of 185 degrees centigrade for a period of .58 second.

The yarn from false twist spindle 7 loses most of its twist and is advanced by rollers 8 (First Feed) at a speed of 82 yards per minute, which is 101 percent of that at which it is fed by rollers 5. This is equivalent to a 1 percent underfeed to rollers 8.

The yarn from rollers 8 travels along path A to pigtail guide 9 and guide bars 10 and 11. The yarn is then taken up by take-up package 12 at 92 percent (Package Feed), the rate at which it is advanced by rollers 8.

The textured yarn is steamed for 75 minutes at 85 degrees centigrade and then coned at a speed of 1150 r.p.m. using a start-up at 10 grams tension and continuous tension relief to compensate for increasing yarn speed. The tension is relieved to 8 grams for a 1 1/2 to 2-pound package. While coning, a yarn lubricant is applied to assist in knitting.

A full-fashioned knit fabric is prepared by feeding two single ends of the textured yarn to the 21 gauge full-fashion knitting machine. The full-fashioned knit panels produced are assembled into garments which are then steamed to remove wrinkles. The garments are then autoclaved at 27 pounds per square inch for 10 minutes.

The garments are then scoured loose in a paddle dyeing machine for 25 minutes at 80 degrees centigrade. The scoured garments are dyed loose at 100 degrees centigrade for 1 1/2 hours using the single-bath procedure of Example I. The garments are after-scoured for 20 minutes at 65 degrees centigrade with the excess moisture extracted by centrifuge. The garments are tumble-dried at 101 degrees centigrade and steamed to remove wrinkles.

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## Example III

The yarn of Example I is false twist textured at a spindle speed of 135,000 r.p.m. to cause a twist in the S direction of 54 turns per inch. The yarn containing such twist is heated to a temperature of 185 degrees centigrade for a period of .67 second. The yarn is advanced at a first feed of -2 percent and is taken up at a package feed of 70 yards or +8 percent.

The textured yarn is then prescoured, dyed, coned and knitted into fabric according to the procedures of Example I.

## Example IV

A continuous multi-filament plied yarn consisting of 77 denier percent 100/LTDZ/26 cellulose triacetate and 23 denier percent 30/1/2Z/10 nylon 6,6, containing 36 filaments, having a total denier of 130 and a twist of 2 turns of Z-twist per inch, is fed by rollers 5 to the first temperature zone, i.e., heater 6 and false twist spindle 7, at a speed of 51 yards per minute. False twist spindle 7 is operated at a speed of 86,000 r.p.m., which causes the yarn to contain a twist in the S direction between spindle 7 and rollers 5 of 46.7 turns per inch. Yarn containing such twist is heated to a temperature of 185 degrees centigrade for a period of 1.35 seconds.

The yarn is advanced by rollers 8 at a speed of 51 yards per minute, which is 100 percent of that at which it is fed by rollers 5. The yarn travels from rollers 8 along path A to pigtail guide 9 and guide bars 10 and 11 to yarn take-up package 12, where it is taken up at a speed of 47 yards per minute, which is 92 percent of the speed at which it is advanced by roller 8.

The textured yarn is prescoured, dyed, coned and knitted into fabric according to the procedure of Example I.

## Example V

A continuous multi-filament entangled yarn consisting of 71.5 denier percent 75/LTDZ/20 cellulose triacetate and 28.5 denier percent 30/1/2Z/10 nylon 6,6, containing 30 filaments, having a total denier of 105 and a twist of 2 turns of Z-twist per inch, is fed by rollers 5 to the first temperature zone, heater 6 and false twist spindle 7, at a speed of 58 yards per minute. False twist spindle 7 is operated at a speed of 115,000 r.p.m., which causes the yarn to contain a twist in the S direction between spindle 7 and rollers 5 of 55.1 turns per inch. Yarn containing such twist is heated to a temperature of about 185 degrees centigrade for a period of 1.2 seconds.

The yarn is advanced by rollers 8 at a first speed of 58 yards per minute, which is 100 percent of that at which it is fed by rollers 5. The yarn from rollers 8 travels along path A to pigtail guide 9 and guide bars 10 and 11 to yarn take-up package 12, where it is taken up at a speed of 53 yards per minute, which is 92 percent of the speed at which it is advanced by rollers 8. This corresponds to a 8 percent overfeed to take-up package 12.

The textured yarn is then prescoured, dyed, coned and knitted into fabric according to the procedures of Example I.

## Example VI

A continuous multi-filament entangled yarn consisting of 73.2 denier percent 55/LTDZ/15 cellulose triacetate and 26.8 denier percent 20/1/2Z/7 nylon 6,6, containing 22 filaments, having a total denier of 75 and a twist of about 2 turns of Z-twist per inch, is fed by rollers 5 to the first temperature zone, heater 6 and false twist spindle 7, at a speed of 60 yards per minute. False twist spindle 7 is operated at a speed of 115,000 r.p.m., which causes the yarn to contain a twist in the S direction between spindle 7 and rollers 5 of 53.0 turns per inch. Yarn containing such twist is heated to 185 degrees centigrade for a period of 1.16 seconds.

The yarn is advanced from false twist spindle 7 by rollers 8 at a speed of 60 yards per minute, which is 100

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percent of that at which it is fed by rollers 5. The yarn from rollers 8 travels along path A to pigtail guide 9 and guide bars 10 and 11 to yarn take-up package 12, where it is taken up at a speed of 54 yards per minute, which is 94 percent of the speed at which it is advanced by rollers 8. This corresponds to a 6 percent overfeed to take-up package 12.

The textured yarn is prescoured, dyed, coned and knitted into fabric according to the procedures of Example I.

## Example VII

The yarn of Example I is false twist textured at a spindle speed of 44,000 r.p.m., which causes the yarn to contain a twist in the S direction between spindle 7 and rollers 5 of 46.8 turns per inch. Yarn containing such twist is heated at a temperature of 185 degrees centigrade for a period of .70 second.

The yarn is advanced from false twist spindle 7 by rollers 8 at a speed which is 102 percent of that at which it is fed by rollers 5. This is equivalent to a 2 percent underfeed to rollers 8.

The yarn from rollers 8 travels along path B and the yarn is dry-heat set for 1.40 seconds at 185 degrees centigrade. After dry-heat setting, the yarn is advanced by rollers 14 at a rate of 80 percent of that at which it is advanced by rollers 8. The yarn is then taken up by take-up package 12 at a speed of 26 yards per minute which is 84.9 percent (4.9 percent underfeed) of the rate at which it is advanced by rollers 8. The yarn is then coned, knitted into fabric and dyed according to the procedures of Example I.

## Example VIII

The yarn of Example I is fed to the first temperature zone at a speed of about 70 yards per minute and false twist textured at a spindle speed of 210,000 r.p.m. to cause a twist in the S direction of 50 turns per inch. The yarn containing such twist is heated to a temperature of 185 degrees centigrade for a period of 0.58 second. The yarn is advanced at a first feed of -2 percent and is taken up at a package feed of 116 yards per minute or +8 percent.

The textured yarn is then prescoured, dyed, coned and knitted into fabric according to the procedures of Example I.

## Example IX

The untextured yarn of Example II is fed by rollers 5 to the first temperature zone, i.e., heater 6 and false twist spindle 7, at a speed of 26 yards per minute. False twist spindle 7 is operated at a speed of 115,000 r.p.m., which causes the yarn to contain a twist in the S direction between spindle 7 and rollers 5 of 37.6 turns per inch. Yarn containing such twist is heated at a temperature of 180 degrees centigrade for a period of 0.72 second.

The yarn from false twist spindle 7 loses most of its twist and is advanced by rollers 8 (First Feed) at a speed of 27 yards per minute, which is 104 percent of that at which it is fed by rollers 5. This is equivalent to a 4 percent underfeed to rollers 8.

The yarn from rollers 8 travels along path A to pigtail guide 9 and guide bars 10 and 11. The yarn is taken up by take-up package 12 at 93 percent of the rate at which it is advanced by rollers 8. The yarn is steam-heated for 75 minutes at 80 degrees centigrade. The steam is then exhausted and the yarn subjected to dry heat at 80 degrees centigrade for about 15 minutes. After heating, the yarn is prescoured, dyed, coned and knitted according to the procedures of Example II.

## Example X

The yarn of Example I is false twist textured at a spindle speed of 280,000 r.p.m. to cause a twist in the S direction of 52 turns per inch. The yarn containing such twist is heated to a temperature of 185 degrees centigrade for a period of 0.70 second. The yarn is advanced at a first

feed of -5 percent and is taken up at a package feed of 150 yards per minute or +8 percent.

The yarn is then prescoured, dyed, coned and knitted into fabric according to the procedures of Example I.

Example XI

The yarn of Example I is false twist textured according to the procedure of Example I. The yarn is then autoclaved by: (1) prevacuuming for 5 minutes at a pressure of 26 inches of mercury; (2) steaming at 27 pounds per square inch at 132 degrees centigrade for 10 minutes; (3) lowering the pressure to 0 to 3 pounds per square inch; (4) steaming at 27 pounds per square inch at 132 degrees centigrade for 10 minutes; (5) lowering the pressure to 0 to 3 pounds per square inch; (6) steaming at 27 pounds per square inch at 132 degrees centigrade for 10 minutes; and (7) vacuuming for 5 minutes at a pressure of 26 inches of mercury.

The yarn is then coned and knitted according to the procedures of Example I. The fabric is then prescoured at 70 degrees centigrade for 15 minutes. Using a suitable disperse dye and acid dye, here Disperse Black 9 and Acid Black 107, the fabric is dyed at 120 degrees centigrade for 1.5 hours. The fabric is dyed to a Union Shade of black and is scoured for 20 minutes at 70 degrees centigrade.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. Process of texturing an entangled yarn comprising a cellulose ester yarn and a nylon yarn, said process comprising:

- (a) advancing said yarn from a source thereof at a first rate of speed through a temperature zone to a twisting zone;
- (b) inserting a twist in the yarn, in turns per inch, computed from the formula:

$$\text{Twist} = K / \sqrt{\text{denier}}$$

wherein K ranges from about 400 to 750, said twist being translated back along the yarn in said temperature zone;

- (c) heating the said twisted yarn in said temperature zone to a temperature of from about 160 to 210 degrees centigrade for a period of from about 0.25 to 2 seconds;
- (d) substantially untwisting the yarn and advancing said yarn beyond the twisting zone at a second rate of speed which is about 95 to 110 percent that of said first rate; and
- (e) taking up said untwisted yarn at a rate of from

about 98 to 80 percent of said second rate of speed.

2. The process of claim 1 wherein said entangled yarn comprises cellulose triacetate yarn and nylon 6,6 yarn.

3. The process of claim 1 wherein the yarn is twisted on a spindle which rotates at a constant rate between about 30,000 and about 350,000 revolutions per minute.

4. The process of claim 3 wherein a twist of from about 35 to 60 turns per inch is inserted in the yarn; the twisted yarn is heated to a temperature of from about 175 to 190 degrees centigrade for a period of from about 0.5 to 1.5 second; the yarn is advanced at a second rate of speed which is about 98 to 105 percent that of said first rate, and the yarn is taken up at a rate of speed which is about 95 to 84 percent that of the second rate of speed.

5. The process of claim 3 wherein said yarn has a denier of from about 50 to 300, a twist before texturing of from about 0 to 10 turns per inch and is composed of a total of from about 15 to 75 filaments.

6. A textured yarn produced by the process of claim 5.

7. The process of claim 3 wherein the yarn is textured at a rate of from about 20 to 175 yards per minute, based on the supply of yarn.

8. The process of claim 3 comprising the further step of heat treating the yarn just prior to take up at a temperature of from about 170 to 195 degrees centigrade for a period of from about 0.5 to 2.5 seconds.

9. The process of claim 3 comprising the further step of heat treating the yarn after take-up at a temperature of from about 75 to 90 degrees centigrade for a period of from about 50 to 100 minutes.

10. The process of claim 3 comprising the further step of autoclaving the textured yarn after take-up.

11. The process of claim 3 comprising the further step of coning the textured yarn at a speed of from about 1000 to 2000 revolutions per minute and a tension of from about 0 to 15 grams.

12. The process of claim 11 comprising the further step of knitting the yarn into fabric at a yarn tension of from about 1 to 5 grams.

13. A fabric produced by the process of claim 12.

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