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## BULKY, HIGH-STRENGTH POLYETHYLENE TEREPHTHALATE YARNS

Adly Abdel-Moniem Gorrafa, Wilmington, Del., assignor to E. I. du Pont de Nemours and Company, Wilmington, Del., a corporation of Delaware  
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### ABSTRACT OF THE DISCLOSURE

A spun yarn of polyethylene terephthalate having a twist multiplier of from 1.4 to 2.0 and consisting of textile fibers of less than 2.0 denier per filament having measured staple lengths of from 2.25 to 3.0 inches. Blends of polyethylene terephthalate with minor portions of rayon and with minor portions of cotton are also disclosed. The yarn possesses high bulk and covering power with a good degree of strength.

This invention relates to textile yarns spun from staple, and more particularly to polyethylene terephthalate textile yarns which possess high strength and which impart to fabrics woven therefrom a high degree of covering power.

It is known that structural changes in yarn produce consequent effects on the quality of the yarn; for example, lowering the twist multiplier produces looser and bulkier yarn. It is also known, however, that such adjustment of yarn structure produces a consequent effect on other quality attributes; for example, lowering the twist multiplier produces lower yarn strength assuming, of course, that the initial twist of the yarn was at such a level as to produce optimum yarn strength. The practical employment of these known concepts which produce contradictory effects on yarn quality attributes has led to what was heretofore known as optimum structural combinations, the adjustment of which was dictated by the particular use contemplated for the yarn. Thus, if a high-bulk yarn was contemplated the twist would be lower and strength would be sacrificed and vice versa.

Attempts to obviate these contradictory effects produced by yarn structural adjustment so that bulk would not be sacrificed for strength would lead to consideration of staple length and fiber denier. However, the cotton system of staple processing is limited in its use to shorter staple lengths and the worsted system, although being able to process longer lengths, is not compatible with the lower deniers. Furthermore, the effect of pilling in fabrics, which is known to occur in fabrics composed of strong, fine-denier fibers, and lower twist yarns brought about a reluctance to experiment, and hence an acquiescence in the above-mentioned optimum combinations.

This invention provides a bulky, high-strength polyethylene terephthalate textile yarn, the quality attributes of which are obtained by a heretofore unknown combination of structural parameters. Another provision is polyethylene terephthalate textile yarn, the structural parameters of which are so designed that yarn strength is not sacrificed for bulk, and vice versa. A further provision is a textile yarn which may be spun from staple-length fibers on conventional processing equipment, and which imparts to fabrics woven therefrom an outstanding degree of cover, high-strength and pleasing aesthetic qualities.

These provisions are realized by polyethylene terephthalate textile yarn having a twist multiplier value of 1.4 to 2.0 and consisting of textile fibers of less than 2.0 denier per filament having a measured staple length of 2.25 to 3.0 inches (57.1 to 76 mm.). The term "polyeth-

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ylene terephthalate yarn" comprehends yarns consisting of polyethylene terephthalate fibers and yarns consisting of blends with other textile fibers wherein the polyethylene terephthalate fibers are the major component, e.g., including the common textile fiber blend of 65% by weight polyethylene terephthalate fibers with 35% rayon fibers. It has also been found that blends with cotton fibers, of the usual  $\frac{3}{4}$  inch to about  $1\frac{1}{2}$  inches staple length, may be used to attain the desirable attributes of this invention, e.g., blends of up to about 20% by weight of cotton fibers with about 80% or more of textile fibers of less than 2.0 denier per filament and having a measured staple length of 2.25 to 3.0 inches. The textile fibers are preferably about 1.5 denier per filament and not less than 0.6 denier per filament.

The term "twist multiplier" as used herein designates the numerical value of the turns-per-inch of the yarn divided by the square root of the cotton count of the yarn. It should be noted that twist multiplier as used herein is based on the English Cotton Count System.

In the present specification two terms are used to describe the staple length of the fibers; "measured staple length" and "cut staple length." The "measured staple length" is measured in accordance with ASTM Procedure D-1440-55, for determination of the upper quartile value (U.Q.L.) for samples of fibers having a length distribution within the limits of good drafting ability in conventional cotton system processing. The term "cut staple length" refers to the staple cutting machine setting at which the continuous filaments, e.g., tow, are cut. Accordingly, in the present specification when it is said that the fibers are cut to a certain length the "cut staple length" is meant. Many staple cutting machines cut tow to staple while the tow is under tension, therefore, at a specific "cut staple length" setting the "measured staple length" of the resulting staple will vary inversely with the amount of tension which was applied to the tow during the cutting operation. For example, if staple is produced by introducing tow to a staple cutting machine, the machine having 2.5 inches "cut staple length" setting, the tow being under little tension, the "measured staple length" of the resulting staple will be approximately 2.45 inches, while if the tow is under a greater tension while being cut to staple by the same machine set at the same "cut staple length" setting, the "measured staple length" of the resulting staple will be approximately 2.35 inches.

It has long been known that to raise the twist multiplier of a yarn, all other parameters remaining constant, yarn strength is increased due to the increased special compactness and the fact that the fibers are induced to move closer to each other and thus the fiber-to-fiber frictional forces are increased. The closer spacial relationship of fibers to each other inevitably produces lower yarn bulk. Conversely, if the twist multiplier is lowered the fibers are not as close to each other and thus frictional forces are reduced and yarn is weaker, but bulkier. Of course, an excessive increase in the twist multiplier of cotton-system spun yarn above the twist multiplier which is normally used for textile purposes may also lower the yarn strength because of the increase in the helix angle of the fibers (obliquity) and the decreased fiber mobility which produces uneven yarn stress distribution.

It has now unexpectedly been found that if the "measured staple length" is from 2.25 to 3.0 inches (57.1 to 76 mm.) and the fiber denier is less than 2.0 (preferably about 1.5), the normal yarn twist multiplier of 3.5 to 4.0 can be drastically reduced to a value below 2.0 to produce bulky polyethylene terephthalate yarn which maintains a surprisingly high degree of strength. In fact, the strength of the yarn so produced is equivalent to, and may be greater than, the strength of yarn produced by cotton

system processing from the conventional 1.5 inch (38 mm.) staple with the conventional 3.5 to 4.0 twist multiplier. This discovery is unexpected from prior-art teaching that the strength is seriously decreased by lowering the twist multiplier to about 2.75 to 3.0 on the cotton system. Within the limitations herein set forth, the bulky yarn may be produced at the lower twist multiplier and no consequent decrease in yarn strength is produced thereby. The twist multiplier of the yarn of the present invention is 1.4 to 2.0, and preferably from 1.65 to 1.85.

The choice of staple length for the yarn of this invention is important in that if the length is too long, while the denier per filament is less than 2.0, the staple will not process well in carding and results in increased nepping. The operative range of the "measured staple length" for the yarn of this invention is 2.25 to 3.0 inches (57.1 to 76 mm.). Preferably, the "measured staple length" of the fibers or blend of fibers of the yarn of this invention is 2.25 to 2.5 inches (57.1 to 63.5 mm.) and the length variation of the individual fibers is within the limits of good drafting ability for conventional cotton system processing. It is to be understood that the yarns of the present invention may contain minor proportions of fibers of measured staple length less than 2.25 inches, providing that the measured staple length of the blend, as a whole, is within the above-established limitations.

Fibers which can be used for this invention are numerous. In general, any synthetic, man-made or natural textile fiber can be used provided its length and fineness characteristics conform to the specifications established herein. Polyethylene terephthalate fibers and blends thereof with other fibers are preferred.

Preferably, the cotton system or modified cotton system of staple processing is used in the practice of the present invention. In general, the carding operation should be

useful for shirting, sheeting, dress-wear, and home furnishings.

In finishing fabrics containing the yarns of this invention it will be found that calendering will transform the high bulk property into high covering-power in the fabric. Finishing operations used are those common in the art.

Surprisingly, the fabrics produced from this yarn can perform satisfactorily in actual use without risk of pill development in spite of the extremely low twist multiplier and fine denier ranges specified.

The invention is further illustrated by the following examples without being restricted thereto.

#### EXAMPLE I

This example illustrates that decreased twist multiplier according to the specification set forth hereinabove does not adversely affect yarn strength. It further shows that increase in staple length is not the only factor that leads to improved yarn strength.

Polyethylene terephthalate is spun to produce a semi-dull continuous filament yarn of 15.5 relative viscosity and 1.5 denier per filament. This yarn is divided into three portions. The first portion is cut to 1. inch (38 mm.) staple and second is cut to 2.5 inch (63.5 mm.) staple and the third is cut to 3 inch (76 mm.) staple by standard methods of staple manufacture. The "measured staple length" of these portions are 1.50, 2.34, 3.01 inches (38, 59.5, 76.4 mm.), respectively. Each portion is further divided into two subportions. The first subportion is spun to a yarn of 30/1 cc. (19.7 Tex) by conventional spinning methods and the second subportion is spun to a yarn of 50/1 cc. (11.8 Tex) by the same methods. Each of these yarns is given a certain twist multiplier as shown in the following table which also shows the physical properties of these yarns.

TABLE I

| 30/1 cc. (19.7 Tex) Yarns from 1.5 inch (38 mm.)<br>"Cut Staple Length" |             |              | 30/1 cc. (19.7 Tex) Yarns from 2.5 inch (63.5 mm.)<br>"Cut Staple Length" |             |              | 30/1 cc. (19.7 Tex) Yarns from 3.0 inch (76 mm.)<br>"Cut Staple Length" |             |              |
|-------------------------------------------------------------------------|-------------|--------------|---------------------------------------------------------------------------|-------------|--------------|-------------------------------------------------------------------------|-------------|--------------|
| Twist multiplier                                                        | Lea Product | C.V. percent | Twist multiplier                                                          | Lea Product | C.V. percent | Twist multiplier                                                        | Lea Product | C.V. percent |
| 3.50                                                                    | 2,880       | 14.8         | 3.52                                                                      | 3,480       | 17.0         | 3.54                                                                    | 3,270       | 15.1         |
|                                                                         |             |              | 2.50                                                                      | 3,700       | 15.4         | 2.52                                                                    | 3,960       | 15.1         |
|                                                                         |             |              | 2.00                                                                      | 3,750       | 14.5         | 2.00                                                                    | 3,770       | 14.8         |
|                                                                         |             |              | 1.70                                                                      | 3,680       | 14.4         | 1.70                                                                    | 3,730       | 14.8         |
|                                                                         |             |              | 1.28                                                                      | 3,180       | 15.7         | 1.28                                                                    | 3,420       | 15.9         |
| 50/1 cc. (11.8 Tex) Yarns from 1.5 inch (38 mm.)<br>"Cut Staple Length" |             |              | 50/1 cc. (11.8 Tex) Yarns from 2.5 inch (63.5 mm.)<br>"Cut Staple Length" |             |              | 50/1 cc. (11.8 Tex) Yarns from 3.0 inch (76 mm.)<br>"Cut Staple Length" |             |              |
| Twist multiplier                                                        | Lea Product | C.V. percent | Twist multiplier                                                          | Lea Product | C.V. percent | Twist multiplier                                                        | Lea Product | C.V. percent |
| 3.52                                                                    | 2,040       | 19.5         | 3.50                                                                      | 2,820       | 21.0         | 3.55                                                                    | 3,050       | 18.4         |
|                                                                         |             |              | 2.52                                                                      | 3,080       | 20.4         | 2.54                                                                    | 3,470       | 19.0         |

properly adjusted to avoid nep formation to an objectionable degree. Subsequent drafting operations are easily accomplished by conventional practices with the exception of obvious machine adjustments (e.g., roller setting) compatible with the staple length, and length distribution of the fiber stock being processed. In the roving step, if any, a twist multiplier significantly lower than usual will be found conducive to better drafting performance in the spinning operation. The spun yarn count can vary from a very coarse 4/1 cc. (147.6 Tex), to a very fine 100/1 cc. (5.9 Tex), bearing in mind that yarn uniformity at the fine counts should be within the conventionally acceptable limits.

Yarn produced in accordance with the present invention can be used to make fabrics of plain, twill, satin, sateen, oxford, basket and like weaves. Such fabrics are

Lea Product, as used herein, is the numerical value obtained by multiplying the cotton count of the yarn by the Skein Breaking Strength in pounds. The Skein Breaking Strength is measured on a skein prepared by winding 120 yards (109.7 meters) of yarn around a reel of 1.5-yard (1.37 meter) circumference, placing the skein on a hook, and applying a load to the bottom of the skein. The load is increased until the skein breaks and the value of the load in pounds is recorded as the Skein Breaking Strength.

C.V. percent (coefficient of variation), as used herein, is a measure of the variation of thick and thin segments in a yarn integrated over a specific length of the yarn. Commercially available uniformity testers may be used.

Relative viscosity (R.V.) pertains to the ratio of the viscosity of a 10% solution of the polymer in a mixture

of 10 parts of phenol and 7 parts of 2,4,6-trichlorophenol (by weight) to the viscosity of the phenol/trichlorophenol mixture, per se, measured in the same units at 25° C.

#### EXAMPLE II

This example shows that the strength of yarns composed of blends of different staple fibers is not adversely affected by lowering the twist multiplier and increasing the staple length according to the specification set forth above.

Polyethylene terephthalate 1.5 denier per filament yarn is produced according to the procedure of Example I and divided into two portions. One portion is cut to 1.5 inch (38 mm.) staple and the other to 2.5 inch (63.5 mm.) staple. The "measured staple length" of these por-

semidull polyethylene terephthalate of 15.5 R.V., 1.5 denier per filament and 2.5 inches (63.5 mm.) "cut staple length" and 35% viscose rayon of 1.5 denier per filament and 2.5 inches (63.5 mm.) "cut staple length."

This blend is divided into two portions. The first portion is spun to 50/1 cc. (11.8 Tex) and given a twist multiplier of 1.65 in the "Z" direction; the second is spun to 30/1 cc. (17.7 Tex) and given a twist multiplier of 1.45 "Z." The yarns are woven into fabrics of the description shown in Table III and each fabric is finished by the sequence of padding, desizing, crabbing six passes in the crab, scouring and bleaching, drying, singeing, calendaring, heat setting, light scouring with the addition of a softener, drying and semidecating. The construction and characteristics of these finished fabrics are shown in Table III.

TABLE III

| Item | Fabric  | Yarn Count          |                     | "Cut Staple Length" (inches) | Twist Multiplier, warp filling | Loom construction (warp and fill) | Finished Construction | Fabric Weight, oz./sq. yard | Filling Strength, lb./elong. Percent | Air Permeability | I <sub>r</sub> | I <sub>t</sub> |
|------|---------|---------------------|---------------------|------------------------------|--------------------------------|-----------------------------------|-----------------------|-----------------------------|--------------------------------------|------------------|----------------|----------------|
|      |         | Warp                | Filling             |                              |                                |                                   |                       |                             |                                      |                  |                |                |
| "A"  | Control | 50/1 cc. (11.8 Tex) | 50/1 cc. (11.8 Tex) | 1.5                          | 3.50/3.50                      | 100 x 2                           | 114 x 75              | 2.91                        | 37.7/27                              | 101              | 74.1           | 4.0            |
| "B"  | Test    | 50/1 cc. (11.8 Tex) | 50/1 cc. (11.8 Tex) | 2.5                          | 1.65/1.65                      | 90 x 72                           | 107 x 77              | 2.70                        | 32.9/29                              | 27               | 77.1           | 1.80           |
| "C"  | Control | 50/1 cc. (11.8 Tex) | 30/1 cc. (19.7 Tex) | 1.5                          | 3.50/3.50                      | 100 x 60                          | 111 x 64              | 3.40                        | 57/27                                | 97               | 77.1           | 3.5            |
| "D"  | Test    | 50/1 cc. (11.8 Tex) | 30/1 cc. (19.7 Tex) | 2.5                          | 1.65/1.45                      | 90 x 60                           | 107 x 66              | 3.16                        | 55/31                                | 21               | 80.5           | 1.43           |

tions are 1.50 and 2.34 inches (38 and 59.5 mm.) respectively. Viscose rayon fiber of 1.5 denier per filament is produced and divided into two portions. The first is cut to 1.5 inch (38 mm.) staple and the second to 2.5 inch (63.5 mm.) staple. The "measured staple length" of these portions are 1.50 and 2.56 inches (38 and 65.0 mm.) respectively. A staple blend is then prepared consisting of 65% polyethylene terephthalate 1.5 inch (38 mm.) staple and 35% 1.5 inch (38 mm.) rayon. The 2.5 inch (63.5 mm.) polyethylene terephthalate staple is then blended with the 2.5 inch (63.5 mm.) rayon staple to a proportion of 65% polyethylene terephthalate to 35% rayon. Yarn is then spun from these two staple blends by spinning at different twist multipliers as shown in the following table which also shows the properties of the yarns obtained thereby.

TABLE II

| Cotton Count        | "Cut Staple Length"   | Twist Multiplier | Lea Product | C.V. Percent |
|---------------------|-----------------------|------------------|-------------|--------------|
| 30/1 cc. (19.7 Tex) | 1.5 inches (38 mm.)   | 3.50             | 2,850       | 15.4         |
| 30/1 cc. (19.7 Tex) | 2.5 inches (63.5 mm.) | 1.45             | 3,040       | 13.0         |
| 30/1 cc. (19.7 Tex) | do.                   | 1.49             | 3,550       | 15.3         |
| 30/1 cc. (19.7 Tex) | do.                   | 1.80             | 3,280       | 13.0         |
| 40/1 cc. (14.8 Tex) | 1.5 inches (38 mm.)   | 3.50             | 2,550       | 15.7         |
| 40/1 cc. (14.8 Tex) | 2.5 inches (63.5 mm.) | 1.70             | 2,740       | 16.1         |
| 50/1 cc. (11.8 Tex) | 1.5 inches (38 mm.)   | 3.50             | 2,260       | 19.0         |
| 50/1 cc. (11.8 Tex) | 2.5 inches (63.5 mm.) | 1.47             | 2,350       | 18.5         |
| 50/1 cc. (11.8 Tex) | do.                   | 1.65             | 2,770       | 17.6         |
| 50/1 cc. (11.8 Tex) | do.                   | 1.83             | 2,770       | -----        |

#### EXAMPLE III

This example shows the improved fabric covering power obtained in fabric woven from the yarns of the present invention as compared to fabric woven from yarns of the prior art.

Four fabrics are prepared from yarns of the following description:

To control yarns are prepared from a blend of 65% semidull polyethylene terephthalate of 15.5 R.V., 1.5 denier per filament and 1.5 inch (38 mm.) "cut staple length" and 35% viscose rayon of 1.5 denier per filament and 1.5 inch (38 mm.) "cut staple length." This blend is divided into two portions; the first portion is spun to 50/1 cc. (11.8 Tex) and given a twist multiplier of 3.5 and the second portion is spun to 30/1 cc. (19.7 Tex) and given a twist multiplier of 3.5.

Two test yarns are prepared from a blend of 65%

Filling Strength is measured by the ravel strip procedures of ASTM D-1682-59 Method 1R-E.

Air Permeability is measured in accordance with ASTM D-737-46.

Covering Power is the degree which a fabric hides a background. Two measurements are applied to quantitatively describe such efforts; viz, I<sub>r</sub> and I<sub>t</sub>.

I<sub>r</sub> is calculated by the formula

$$\frac{(R_w - R_b) - (RC_w - RC_b)}{(R_w - R_b)} \times 100 = I_r$$

where RC<sub>w</sub> is reflectance of a white plate covered with fabric; RC<sub>b</sub> is reflectance of a black plate covered with fabric; R<sub>w</sub> is reflectance of an uncovered white plate; R<sub>b</sub> is reflectance of an uncovered black plate. Reflectance is

measured by using a photoelectric reflection meter Model No. 610 manufactured by Photovolt Corp., of New York. White and black plates used are Photovolt Catalog No. 6162 and No. 6163. A green tri-stimulus filter is used, and the light intensity reflected from the fabric and/or the plate at a 45° angle from the plane of the plate is measured.

It is a measurement of light transmission through a fabric. A Durst No. 609 Projector manufactured by Durst S.A., Italy, is used as the light source and diffusing element. Light from the projector is cast upon a fabric sample and the amount of light transmitted through the fabric is measured by a Photo Multiplier Microphotometer, Cat. No. 10-211, manufactured by American Instrument Co., Inc. of Maryland. The reading of the microphotometer with the fabric sample in the apparatus is recorded as percentage points of the original amount of

light with no fabric sample in the apparatus. This percentage light transmission is recorded as  $I_t$ .

EXAMPLE IV

This example shows that, contrary to what would be predicted by prior art teachings, fabrics of the present invention do not pill severely and perform as well in this respect as control fabrics of the prior art.

A control yarn is prepared by normally processing a fiber blend consisting of 65% polyethylene terephthalate staple, of 1.5 inch (38 mm.) "cut staple length" and 1.5 denier per filament, and 35% viscose rayon of 1.5 (38 mm.) "cut staple length" and 1.5 denier per filament. A 50/1 cc. (11.8 Tex) yarn is spun from this blend at a 3.5 twist multiplier. A control fabric is woven from this yarn at 100 x 72 (39 ends/cm. x 78 picks/cm.) loom construction.

A test yarn is prepared identical to the control yarn of this example except that the "cut staple length" is 2.5 inch (63.5 mm.) and the twist multiplier is 1.84. This test yarn is used for the filling of a test fabric, the warp yarn of which is the control yarn described above in the present example. The loom construction for this fabric is 100 x 72 (39 ends/cm. x 28 picks/cm.).

The control and the test fabrics are finished according to the finishing procedure described in Example III above.

Dress shirts are tailored from the control fabric and from the test fabric and each is wear-tested. The shirts made from the test fabric have a pilling rating after wear-testing of 4.7 to 5.0 while the shirts made from the control fabric have a pilling rating after wear-testing of 5.0.

Wear-testing as used herein refers to a test of the following procedure: The shirt made from the test fabric

hours and machine-washed 15 times. The pilling rating of the shirts of the test fabric averages 4.75.

Dress shirts are tailored from the test fabric of Example III, the structure of which is designated as Item B of Table III with the exception that the loom construction is 90 x 60 (about 35 ends/cm. x 24 picks/cm.). The shirts are wear-tested and evaluated in the same manner as the shirts of the first test fabric of this example. The pilling rating of the shirts after wear-testing averages 4.9.

EXAMPLE VI

This example illustrates that yarns produced in accordance with the present specification, which contain a minority of short staple-fibers, possess all the desirable attributes herein described.

Polyethylene terephthalate 1.5 denier per filament yarn is produced according to the procedure of Example 1 and divided into two portions. The first portion is cut to 1.5 inch (38 mm.) staple and the second to 2.5 inch (63.5 mm.) staple. These portions are then separately processed to produce carded sliver from each lot. Combed cotton slivers are prepared from Texas cotton of about 1 1/4 inch (28.6 mm.) length by methods common in the art. A control yarn consisting of 80% of the polyethylene terephthalate 1.5 inch (38 mm.) staple and 20% of the cotton is prepared by draw-frame blending of slivers, followed by normal processing steps. The control yarn is spun to 30/1 cc. (19.7 Tex) and 3.50 twist multiplier.

A test yarn consisting of 80% of the polyethylene terephthalate 2.5 inch (63.5 mm.) staple and 20% of the cotton is similarly spun to 30/1 cc. (19.7 Tex) and 1.72 twist multiplier. Strength and uniformity of the yarns of this example are shown in Table IV.

TABLE IV

| Yarn       | Fiber Blend<br>(Percent by weight)                    | Twist<br>Multiplier | Lea<br>Product | C.V.<br>(Percent) |
|------------|-------------------------------------------------------|---------------------|----------------|-------------------|
| Control... | 80—1.5-inch polyethylene terephthalate.<br>20—cotton. | 3.50                | 2,850          | 16.3              |
| Test.....  | 80—2.5-inch polyethylene terephthalate.<br>20—cotton. | 1.72                | 2,940          | 16.5              |

of the present example is worn by a human being during normal daily activity for 10 hours in one day; on the following day the shirt made from the control fabric of the present example is worn by the same person during an essentially identical course of daily activity for 10 hours. Each shirt is machine-washed on the day it is not worn; this procedure continues, the shirt of the test fabric and the shirt of the control fabric being worn by the same person on alternate days and washed on the day it is not worn until each shirt is worn for 200 hours and machine-washed 20 times. Pilling performance is evaluated by visually examining the collar and cuff areas of the test and control shirts which have been wear-tested. The collar and the cuff areas are visually rated with reference to a scale of numerical values of 1.0 to 5.0, 1.0 being the numerical value of a severely pilled fabric and 5.0 being the numerical value of a fabric with essentially no pills.

EXAMPLE V

This example further illustrates the performance-in-wear of fabrics the warp and filling yarns of which are prepared in accordance with the present invention.

Dress shirts are tailored from the test fabric of Example III the structure of which is designated as Item D of Table III. The shirts are wear-tested and evaluated according to the procedure described in Example IV above with the exception that the shirts are worn a total of 150

The yarns of the present invention have the advantage of retaining their strength and imparting to fabrics woven therefrom a considerably high degree of covering power by a unique and special combination of certain structural specifications which are in direct contradiction to the prior art teachings.

A further economic advantage of the yarns of the present invention lies in the fact that conventional equipment may be used throughout the manufacture. Thus, no new equipment and capital expenditure is necessitated to produce these yarns. A saving is further realized due to the fact that extremely low twist is sufficient.

Fabrics may be woven from these yarns to be used for garments or other purposes. These fabrics are produced with considerable degree of covering power and have a pleasing hand, drape and other aesthetical qualities.

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

I claim:

1. A bulky polyethylene terephthalate textile yarn which possesses high strength and imparts a high degree of covering power to fabric woven therefrom, the yarn having a twist multiplier value of 1.4 to 2.0 and con-

sisting of textile fibers of less than 2.0 denier per filament having a measured staple length of 2.25 to 3.0 inches.

2. Yarn as defined in claim 1 wherein the twist multiplier value is 1.65 to 1.85, the fibers are about 1.5 denier per filament and the measured staple length is 2.25 to 2.5 inches.

3. Yarn as defined in claim 1 wherein the textile fibers are a blend of 65% polyethylene terephthalate fibers with 35% rayon fibers.

4. A bulky textile yarn which possesses high strength and imparts a high degree of covering power to fabric woven therefrom, the yarn having a twist multiplier value of 1.4 to 2.0, consisting of a blend of up to about 20% by weight of cotton fibers, of  $\frac{3}{4}$  inch to about  $1\frac{1}{2}$  inch staple length, with at least about 80% by weight of polyethylene terephthalate textile fibers of less than 2.0 denier

per filament and having a measured staple length of 2.25 to 3.0 inches.

References Cited

UNITED STATES PATENTS

|           |        |         |          |
|-----------|--------|---------|----------|
| 2,897,042 | 7/1959 | Heiks   | 57—140 X |
| 3,044,250 | 7/1962 | Hebeler | 57—140   |

FOREIGN PATENTS

|         |         |                |
|---------|---------|----------------|
| 212,352 | 1/1958  | Australia.     |
| 229,710 | 8/1960  | Australia.     |
| 609,794 | 10/1948 | Great Britain. |
| 610,096 | 10/1948 | Great Britain. |
| 870,017 | 6/1961  | Great Britain. |

JOHN PETRAKES, *Primary Examiner.*