United States Patent

[11] 3,593,513

[72] Inventor Cecil Everett Reese
Kinston, N.C.

[21] Appl. No. 665,623
[22] Filed Sept. 5, 1967
[45] Patented July 20, 1971
[73] Assignee E. I. du Pont de Nemours and Company
Wilmington, Del.

[54] **DYEING OF MIXED SYNTHETIC POLYMERIC YARNS**
4 Claims, 7 Drawing Figs.

[52] U.S. Cl. 57/140, 8/178, 8/179, 161/172
[51] Int. Cl. D02g 3/04
[50] Field of Search ..... 161/172; 57/140 B; 8/178, 179

[56] References Cited

UNITED STATES PATENTS

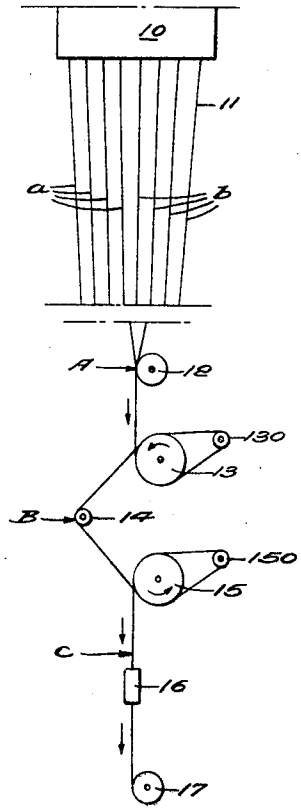
3,175,351	3/1965	Bloch	57/157
3,199,281	8/1965	Maerov et al.	161/172 X
3,200,576	8/1965	Maerov et al.	57/140 B
3,225,534	12/1965	Knospe	57/140

FOREIGN PATENTS

1,035,908	6/1966	Great Britain	
719,046	10/1965	Canada	57/140 B
869,993	6/1961	Great Britain	

Primary Examiner—Robert F. Burnett
Assistant Examiner—Raymond O. Linker, Jr.
Attorney—E. Leigh Hunt

ABSTRACT: A composite yarn of two discrete classes of filaments, each class having a different dye affinity or dissimilar inherent apparent coloration is characterized by a degree of filament intermingling of at least 65 percent, a break elongation from 5 percent to 100 percent, the difference in percent break elongation between the discrete classes of filaments being less than 15, and a tenacity from 1.0 to 10 g.p.d. The yarn is produced by separately spinning or cospinning two synthetic fiber-forming polymeric compositions into a multiplicity of discrete filaments, combining the filaments into a composite yarn during or prior to drawing the filaments as an integral yarn, and further processing the yarn to yield the desired properties.



PATENTED JUL 20 1971

3,593,513

SHEET 1 OF 2

Fig. 1.

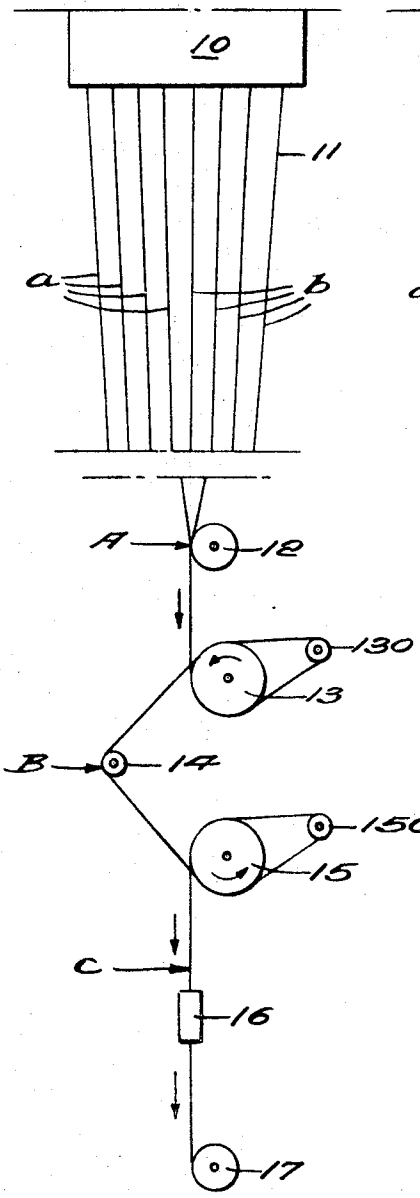
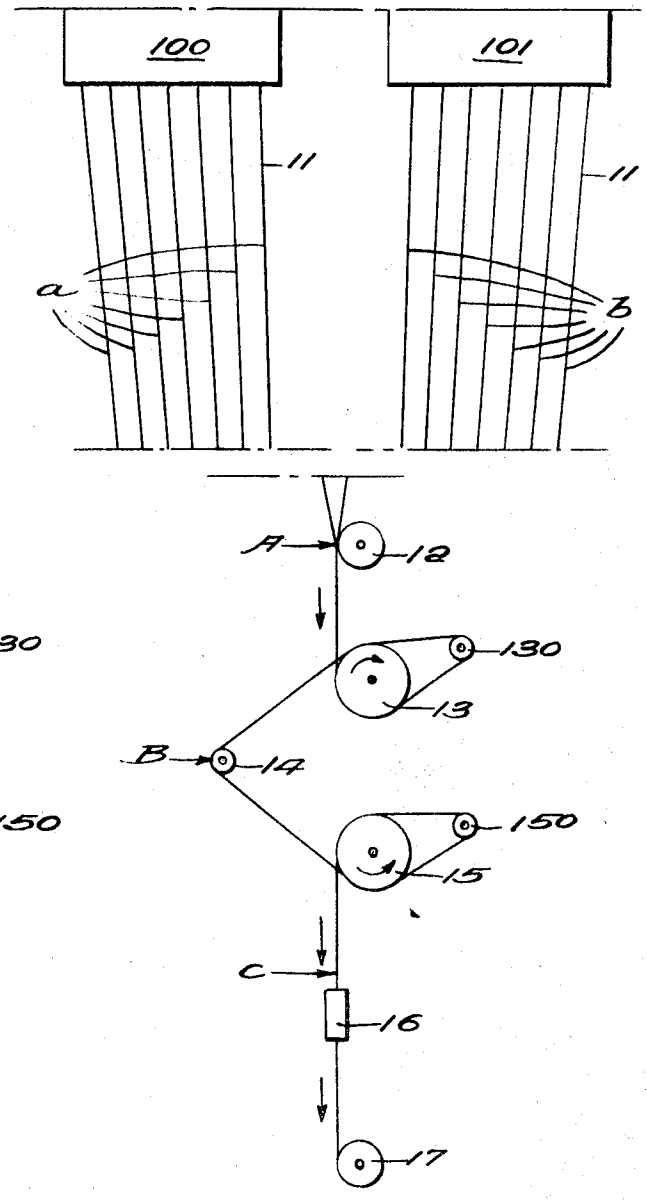


Fig. 2.



INVENTOR
CECIL E. REESE,

BY
AGENT

Fig. 3.

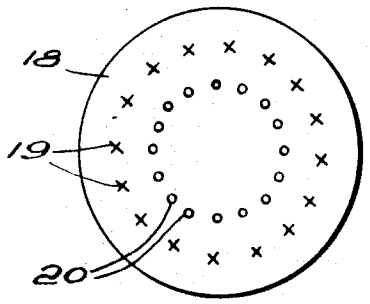


Fig. 4.

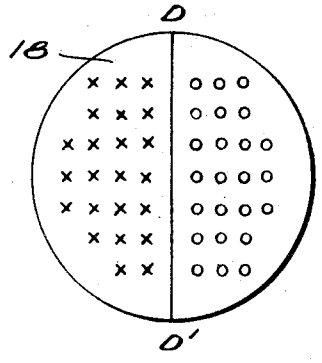


Fig. 5.

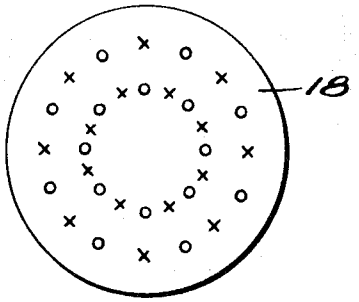


Fig. 6.

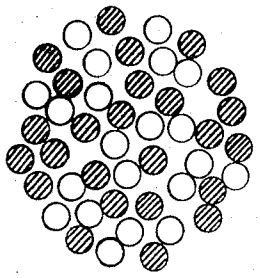
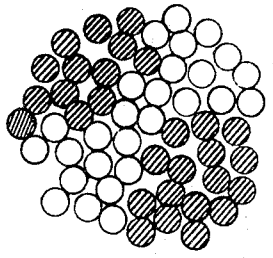


Fig. 7.



INVENTOR
CECIL E. REESE,

BY Lee E. Johnson
AGENT

DYEING OF MIXED SYNTHETIC POLYMERIC YARNS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to synthetic textile fibers, and more particularly to organic thermoplastic yarns of a mixed-color or mixed-luster appearance and to woven or knitted fabrics made therefrom.

2. Description of the Prior Art

It is known to ply differently colored groups of filaments to a composite yarn. It is also known to ply filamentary groups having different dye affinities to a composite yarn, prepare a fabric therefrom and subsequently expose the fabric to a dyestuff of a certain color which is compatible only with a portion of the filaments in the yarn giving that portion color. The fabric is subsequently exposed to another dyestuff of a different color which is compatible with the remaining filament portion giving it a different color. In these methods, fabrics are produced having a mixed-color appearance. Such fabrics have a mottled or blotchy appearance. Although the appearance of such fabrics makes them suitable, and in many cases desirable, for many uses, unfortunately, for suitings, blouses, dresses, sportshirts and the like, the size and distribution of the blotches which appear amplified to the eye by their color contrast make the fabrics harsh or loud and displeasing to the conservative or moderate taste. Similarly, if the plied yarns have markedly different luster or differ markedly in shrinkage, dyed or even white fabrics prepared from them have an undesirable moire appearance.

SUMMARY OF THE INVENTION

Accordingly, 2provides a thermoplastic textile yarn having dissimilar inherent apparent coloration. The yarn is produced by separately feeding at least two fiber-forming synthetic, organic, thermoplastic polymeric compositions to a spinning assembly, extruding the polymeric compositions to form groups of discrete filaments from each of the polymeric compositions, each group of filaments having dissimilar inherent apparent coloration, combining the filaments into a single composite yarn prior to completion of drawing, drawing the filaments as an integral yarn, and further treating the yarn to yield a finished yarn. The yarn after drawing must have a degree of filament intermingling of at least 65 percent and a difference in percent break elongation not exceeding 15. The filaments may be spun from different spinnerets or cospun from the same spinneret.

BRIEF DESCRIPTION OF THE DRAWINGS

Understanding of the invention will be aided by reference to the following description and the accompanying drawings wherein:

FIG. 1 is a schematic elevational view of a method for producing the yarns of the present invention;

FIG. 2 is a schematic elevational view of a second method for producing the new yarns;

FIGS. 3—5 are schematic plan views of spinnerets showing orifice patterns which may be used in the practice of this invention;

FIG. 6 is an enlarged cross-sectional view of a two-color yarn consisting of filaments having a degree of intermingling characteristic of the yarns of the present invention;

FIG. 7 is an enlarged cross-sectional view of a two-color yarn having a degree of filament intermingling characteristic of yarns of the prior art.

DEFINITIONS AND STANDARDS

"Inherent apparent coloration" is used to denote the characteristic appearance of a filament in a woven fabric after being exposed to a dye. The present invention requires that the filaments in the composite yarn have different inherent apparent coloration and thus in a fabric woven therefrom and

dyed in a certain manner will show different colorations. The different colorations may arise from a different dye-uptake potential of one group of filaments from the other or from the different affinity of one group of filaments to a certain class of dyestuffs or from different initial pigmentation or from different luster at equal dye-uptake potential, etc. Illustrative is a yarn comprising filaments of poly(ethylene terephthalate), hereafter referred to as 2G-T, and filaments of poly[ethylene terephthalate/(5-sodium sulfo)isophthalate], hereafter referred to as 2G-T/SSI. The 2G-T/SSI filaments are readily dyed by basic cationic dyestuffs while the 2G-T filaments are relatively unaffected. Also encompassed by the term are filaments with different amounts of delustering or coloring pigment, at least to the extent that, upon dyeing with certain dyestuffs, a different coloration would be apparent. In this connection it has now been found that, in accordance with the teachings herein, when the above-defined filament groups have different amounts of TiO_2, i.e., one group having more TiO_2 than the other, and the filaments are woven to a textile fabric, the fabric has a very desirable, uniformly lustrous appearance with, in certain cases, a desirable combination of silklike luster and excellent covering power. In this case the filament groups have different dyeabilities (i.e., different inherent coloration), but they need not be dyed to produce very desirable fabrics.

The degree of filament intermingling (hereafter DFI) is measured in the following manner: The yarn to be analyzed is either wound about a flat metal holder about the size of a standard playing card or it is woven to a taffeta fabric, or both. It is then scoured and, in the case of the fabric, heat set. The sample is then dyed to produce a mixed-color appearance. An end is then cut to expose its transverse cross section, care being taken not to disturb the positions of the filaments in the yarn bundle. The cross section is photographed and the photograph enlarged. The enlargement will thus be similar to FIGS. 6 and 7 of the drawings; FIG. 6 showing the cross section of a 46 filament yarn and FIG. 7 showing the cross section of a 56 filament yarn. The number of filaments (n_1) of the first group, e.g., black filaments, which touch, or which would touch by mere straight line translation, filaments of the second group, e.g., white filaments, is counted. The number of filaments of the second group (n_2) which touch or which would touch by simple straight line translation, the filaments of the first group is then counted. The DFI is calculated by the formula:

$$\mathrm{DFI}(\%)=50\left(\frac{n_1}{n_{1t}}+\frac{n_2}{n_{2t}}\right)$$

wherein n_{1t} is the total number of filaments in the first group and n_{2t} is the total number of filaments in the second group. Thus the yarn of FIG. 6 has a DFI of about 95 percent while the yarn of FIG. 7 has a DFI of approximately 56 percent. Alternatively, if the two types of filaments can be distinguished without dyeing, then the dyeing step can be omitted. Thus yarns with variable luster, or with one group pigmented (colored) differently from the other, dyeing is not needed to distinguish the filaments and can be omitted. Similarly, yarns from polymer with differing melting points can be distinguished without dyeing by heating the cross sections until the lower melting filaments sinter sufficiently to distinguish from the other type of filaments.

The term relative viscosity (hereafter RV) as used in the following examples is the ratio of the viscosity of a 10 percent solution of 2G-T (or 2G-T/SSI as the case may be) 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. RV of nylon is the ratio of the viscosity of a solution of 8.4 percent (by weight) polymer in a solution of 90 percent formic acid and 10 percent water (by weight) at 25° C., to the viscosity of the formic acid/water solution, per se, measured in the same units at 25° C.

With reference to Table I, infra, the subjective appearance of a fabric is determined by visual examination. A rating of 5

represents a fabric with a uniform, attractive heather characteristic of fabrics from yarns of the present invention while a rating of 1 represents a very gross unappealing heather. A rating of 3 is considered to be just above borderline between acceptable and unacceptable.

Tenacity, the breaking strength of a fiber, is expressed in units of force per denier. Elongation at breaking is the linear deformation caused by a tensile force in the direction of a load. It is expressed in percent of the original fiber length. Elongation is measured in an Instron tester with the distance between the clamps set at 10 inches at a rate of elongation of 60 percent per minute. The yarn when measured for purposes of this disclosure has any yarn twist removed, and no twist is added prior to measurement. Boiloff shrinkage is a measurement of the relative amount of shrinkage of a yarn upon exposure to boiling water, for a period of 20 minutes and in the absence of tension. It is expressed as the percent change in length of the yarn immediately after the exposure relative to the preexposure length. Node length is measured by placing a length of yarn on a flat surface and securing both ends. A pin is inserted into the yarn and the pin is drawn along the lengthwise direction of the yarn until it stops due to the entanglement of the filaments. The average distance the pin moves between "stops" is the node length.

"Latyl" Carrier A is the trade name for a dye assistant for increasing the dyeability of polyester fibers, which is sold commercially by E. I. du Pont de Nemours and Co. It is a mixture of about 0.2 percent sodium lauryl sulfate, about 20 percent sodium sulfate, about 40 percent benzanilide and about 40 percent dimethylterephthalate. "Alsimag" is the registered trademark of American Lava Corp., Chattanooga, Tenn. for an alloy comprising aluminum, silicon and magnesium. The material is commonly used for thread guides.

All specific dyestuffs are referred to herein by their Color Index Number (C.I.) given in *color Index*, Second Edition, 1956, published by the American Association of Textile Chemists and Colorists and The Society of Dyers and Colorists.

EXAMPLES

The invention is further illustrated by the following examples of preferred embodiments which are not intended to be restrictive. Copolymer composition is shown as mole ratio and is expressed parenthetically just following the nomenclature of the copolymer.

EXAMPLE I

This example illustrates the preparation of a yarn in accordance with the present invention and the preparation of a dyed fabric therefrom having a pleasing heather appearance.

2G-T polymer of 30 RV containing 0.3 percent, by weight, TiO_2 and 2G-T/SSI (98/2) polymer of 22.9 RV containing 0.3 percent, by weight, TiO_2 are separately metered to two separate inlet ports of a melt-spinning assembly, substantially similar to FIG. 1, designed to accommodate the two streams and keep them separate. The polymers are discharged at a temperature of approximately 304° C. in conventional manner through 50 small orifices of a circular spinneret having an orifice pattern as shown in FIG. 4. Each orifice is Y-shaped and the filaments have a trilobal cross-sectional configuration as shown in Holland, U.S. Pat. No. 2,939,201. The 25 orifices forming one D of the pattern discharge the 2G-T of 29.8 RV; the remaining orifices discharge the 2G-T/SSI of 19.6 RV. The two groups of filaments merge just above point A shown in FIG. 1, by passing in sliding contact with a pin guide comprising two pins arranged crosswise and placed just upstream of the finish roll. The yarn is drawn in a 94° C. water bath to 2.67X. The draw roll is at a temperature to produce a boiloff shrinkage in the yarn of about 7—10 percent. The yarn is then wound onto a package at a speed in excess of 2,000 y.p.m. at a windup tension in the range of 25—35 g. The yarn has a denier of 70, a tenacity of 2.9 grams per denier (g.p.d.) and a break elongation of 24.3 percent. A representative cross section of the yarn shows a DFI of greater than 70. The difference in elongation of the filament groups does not exceed 15.

A portion of the yarn (portion 1) is twisted 3 "Z" turns/inch on a downtwister and subsequently uptwisted an additional 4.5 "Z" turns/inch and twist-set at 57.2° C. (dry bulb)/51.7° C. (wet bulb) (2 hours/1.75 hours, respectively). Another portion (portion 2) is downtwisted 3 "Z" turns/inch.

A plain weave fabric is prepared using the yarn of portion 1 as the warp and the yarn of portion 2 as the filling. The loom construction is 104 ends/inch by 80 picks/inch. The fabric is scoured at the boil using known size removal assistants. The scoured fabric is heat set at 170° C. at scoured dimensions. Three swatches of the fabric are prepared. Each swatch is dyed with one of the following well-known cationic dyestuffs using "Latyl" Carrier A as a dye assist:

a. C.I. Basic Red 14
b. C.I. 51004
c. "Cationic Black"

Cationic Black is a mixture of 2.8 percent C.I. 48055; 0.8 percent C.I. 42040; 0.5 percent C.I. 42510; and 0.25 percent C.I. 51004, percentages being based on fabric weight.

The fabrics show a pleasant heather coloration, the filaments of the copolymer having absorbed the dye; the filaments of the homopolymer being undyed by these cationic dye formulations.

The example is repeated using a spinning assembly having an orifice arrangement substantially similar to that shown in FIG. 3. The filaments of the copolymer are discharged from orifices of the outer circle of the spinneret and the filaments of the homopolymer are discharged from orifices of the inner circle of the spinneret. Results are substantially the same.

The example is repeated again using a spinneret having an orifice arrangement substantially similar to that shown in FIG. 5. Results are substantially the same.

The example is repeated again using a spinneret having an orifice arrangement substantially similar to that shown in FIG. 3. The copolymer extrudes from the outer circle and the homopolymer extrudes from the inner circle. Four swatches of fabric are cut. In this case two dyes, a disperse dye and a cationic dye, are applied to each swatch instead of just the cationic dye. Thus, the homopolymer receives only the disperse dye and the copolymer receives the cationic dye and the dispersed dye. Each swatch is dyed with one of the following combinations:

a. 2 percent C.I. disperse red 59 + Cationic Black;
b. 2 percent C.I. disperse blue 60 + Cationic Black;
c. 2 percent C.I. disperse yellow 42+2 percent C.I. basic red 14;

2 percent C.I. disperse yellow 42+2 percent C.I. 51004.

In this listing the disperse dye precedes the plus sign and the cationic dye follows it. Dyeings are performed using both dyes in a single bath and using one dye in one bath and the other dye of the combination in another bath. In all cases the fabric shows the same pleasing heather effect which is characteristic of dyed fabrics made in accordance with the present invention.

The example is again repeated using, for one group of filaments, 2G-T of 31.6 RV containing 0.3 percent by weight TiO_2 and poly[ethylene(terephthalate/hexahydroterephthalate)] (90/10) copolymer of 39.5 RV and containing 0.3 percent TiO_2 for the other group of filaments. The freshly spun filaments are drawn 2.8 X in a draw bath at 95° C. Boiloff shrinkage is from 7—10 percent. The yarn has a denier of 70 and a tenacity of 3.7 grams per denier and a break elongation of about 30 percent. The difference in percent elongation of the filamentary groups does not exceed 15 percent. The yarn has a DFI of about 69 percent, measured by the sintering technique described above. The yarn is woven into a fabric as described in the reference example and dyed with C.I. disperse blue 60. The copolymer filaments absorb the dye at a faster rate than the other filaments and the fabric is taken from the dyebath before reaching equilibrium dye uptake. The

pleasant heather effect characteristic of the new yarns is apparent.

EXAMPLE II

This example illustrates the preparation of a fabric from the same polymers used in Example I, but the yarn used for the fabric is prepared by separately spinning and drawing the two polymers and then the two yarns are plied together, a procedure old in the art.

One end of 35-denier/25-filament 2G-T yarn consisting of filaments of trilobal cross sections is made using spinning conditions essentially equivalent to those of Example I. The prepared yarn has a RV of about 28, a break elongation of about 30 percent, and a boiloff shrinkage of about 8 percent.

One end of 2G-T/SSI (98/2) of the same denier, number of filaments and cross sections is made in essentially the same manner. The copolymer yarn has an RV of about 18, an elongation of about 31 percent, and a boiloff shrinkage of about 6—10 percent.

The ends are plied on a downtwister being twisted 3 "Z" turns/inch. Part of the 3 "Z" yarn is twisted an additional 4.5 "Z" turns per inch to yield a 7.5 "Z" yarn. Fabrics identical to those prepared in Example I are made. The finished fabric after dyeing with any of the dye combinations of Example I gives a gross unpleasant heather typical of mixed-color fabrics of the prior art. DFI of the yarn in these fabrics is 40 percent.

EXAMPLE III

This example shows the combination of 2G-T filaments with nylon filaments in the practice of the present invention.

Two polymers, 2G-T and 6, 6-nylon are spun to filaments under conditions similar to those of Example I. The RV of the nylon filaments is about 36 and the RV of the polyester filaments is about 28. Break elongation for the nylon is about 26.6 percent and about 27.8 percent for the polyester. The mixed-filament yarns all have a DFI of about 70 percent. The yarns are twisted 3 "Z" turns/inch for the fill and 7.5 turns/inch for the warp and converted into a fabric of 104 ends/inch by 86 picks/inch loom count. The fabric is scoured at boil using known size removal assists, and subsequently heat-set at 170° C. at scoured dimensions. Four swatches are cut and each swatch is dyed with one of the following dye formulations:

a. C.I. disperse red 59 (disperse dye);
b. C.I. disperse red 59 + C.I. 62055;
c. C.I. disperse yellow 42 + C.I. 62055;
d. C.I. 62055 (acid dye).

In this listing, the disperse dye which is absorbed by the 2G-T filaments and nylon filaments precedes the plus sign and the acid dye which is compatible only with the nylon follows the plus sign.

The example is repeated using, as the two polymers 2G-T/SSI (98/2) and 6,6-nylon. The RV of the 2G-T/SSI is about 21 and the RV of the 6,6-nylon is about 36 and the RV of the 2G-T/SSI filaments is about 19.8. Swatches of fabric are dyed with each of the following dye formulations:

e. C.I. basic red 14 (compatible with 2G-T/SSI only);
f. C.I. 62055 (compatible with nylon only);
g. C.I. basic red 14 + C.I. 62055;
h. C.I. disperse red 59 (compatible with both groups of filaments) + C.I. 62055;
i. C.I. disperse red 59 + C.I. 51004.

The unique pleasing heather effect characteristic of fabrics made from yarns of the present invention obtains in each of the fabrics.

EXAMPLE IV

This example illustrates the importance of combining the two groups of filaments prior to or during drawing in order to achieve the critical degree of filament intermingling necessary to the practice of this invention, and compares the appearance of dyed fabrics woven therefrom with the appearance of fabrics prepared from yarns comprising two groups of filaments which are not made according to this invention.

A series of fabrics from yarns comprising melt-spun 70-denier/50-filament 2G-T and 70-denier/50filament 2G-T/SSI (98/2) filaments is made in accordance with the following procedure:

Yarn A.

The two polymers are cospun from a single spinneret as in FIG. 1 using an arrangement of spinning orifices as in FIG. 3 with the copolymer extruding from the outer ring and the homopolymer extruding from the inner ring. Preparation conditions are essentially the same as in Example I. RV of the 2G-T is 30.9; RV of the 2G-T/SSI is 21. The filament groups are combined at or just prior to point A. Two ends of the yarn are downtwisted 3 "Z" turns per inch to yield a 140-denier/100-filament yarn. The yarn is used for the filling over a standard 70-denier/34-filament 2G-T warp.

Yarn B.

The two polymers are cospun from a single spinneret such as shown in FIG. 3 and combined at or just prior to point A of FIG. 1. The spinning temperature is 297° C. Yarn of the homopolymer is 28 RV and 32 percent elongation, and yarn of the copolymer is 19.6 RV and 19.5 percent elongation. The yarn is drawn in a steam jet a t160° C. and thereafter annealed on hot rolls to produce a shrinkage at boil of about 6 percent. Two ends of this yarn are downtwisted to give 140-denier/100-filament yarn of 3 turns per inch which is used as the fill over a stock 70-denier/34-filament 2G-T warp.

Yarn C.

This yarn is made by spinning two ends of Yarn B above, as in FIG. 2, at the same conditions. The two ends are combined just before point A of FIG. 2 by superimposing one threadline over the other on an Alsimag pin which is used as a yarn guide. The yarn count is 140 denier/100 filaments. This yarn is twisted 3 "Z" turns/inch and used as a filling over the same type of warp as the warp used with Yarn B above.

Yarn D.

The copolymer and homopolymer are spun in a manner illustrated by FIG. 2. One spinneret is used for the 2G-T and a second one for the 2G-T/SSI. The 2G-T spinning temperature is 293—295° C. The yarn RV is about 25 with the resulting yarn after drawing having an elongation of about 21—26 percent. The 2G-T/SSI copolymer is also spun at a block temperature of about 293—295° C. The yarn RV is about 15.5 and has an elongation after drawing of about 21—26 percent. The two threadlines are combined just before point A. The convergence guide is arranged in an effort to spread the first threadline into a layer of filaments. The second threadline is then superimposed over the first on this guide causing intermingling of the two-filament types. The final yarn is 140 denier/100 filament and is used as the filling over the same type warp as used for Yarn B.

Yarn E.

This is prepared by combining one end of 70-denier/50-filament 2G-T/SSI and one end of 2G-T of the same count. Each yarn is prepared separately. The 2G-T/SSI is spun using all of the orifices of the orifice pattern of FIG. 3. The spinning temperature is about 300° C., and the yarn has an RV of 15.6 and an elongation of about 28 percent. The 2G-T is spun on identical equipment, at the same spinning temperature, and the yarn has an RV of about 28 and an elongation of about 29 percent. The two yarns, after drawing, are fed over guides to combine them into one threadline, around a feed roll, and through an interlace jet. The degree of interlacing produces a node length of about 5 inches. Final yarn count is 140 denier/100 filaments. The yarn is downtwisted to 3 "Z" turns/inch and is used as a filling over the same type warp yarn as used for Yarn B.

Yarn F.

One end of 70-denier/50- filament 2G-T/SSi yarn and one end of 70-denier/34-filament 2G-T yarn are downtwisted to 3 "Z" turns/inch. The final yarn count is 140 denier/84 filaments. The yarn is used as the filling in the same type of warp as was used for Yarn B.

Yarn G.

Identical to Yarn F except that the twist is 8 "Z" turns/inch.

Yarn H.

This yarn is spun using the spinneret pattern shown in FIG. 4, the 2G-T extruded from the orifices on one side of the line and the 2G-T/SSI from the orifices on the other side of the line of the spinneret. The filaments are converged at or just before point A by means of a V-shaped guide (two Alsimag pins arranged into a V) just above the finish roll. The V-guide converges the filaments and also urges the threadline against the finish roll. The finish roll axis of rotation is perpendicular to the line DD' in the spinneret of FIG. 4. Without the guide the filaments fall free on their path to the feed roll, bypassing the finish roll, and the degree of intermingling is poor. Only the yarn made with the guide is considered in the remainder of this example. The 2G-T yarn has an RV of about 26, and the 2G-T/SSI has an RV of about 21. The difference in percent break elongation of the two groups does not exceed 15. Yarn count is 70 denier/50 filaments. Part of the yarn is twisted 7.5 "Z" turns/inch and used for the filling in a 104 ends/inch by 76 picks/inch plain weave fabric. Part of the yarn is twisted to 3 "Z" turns/inch and used as the filling over a stock 70-denier/34-filament 2G-T warp in a plain weave construction.

Yarn I.

Identical to Yarn H except that it is interlaced just after drawing to a node length of about 5 to 10 inches. The yarn is converted into a fabric in a manner similar to that used for Yarn H.

Yarn J.

Identical to Yarn H except the two threadlines (one 2G-T and one 2G-T/SSI) are maintained separate until the yarn reaches the draw pin in the hot water bath in the drawing process (point B of FIGS. 1 and 2). No convergence guide is used, but a straight Alsimag pin is used to push the two separate groups of filaments against the finish roll. The yarn is interlaced to a pin count of 5 to 10 inches. This yarn is also converted into fabric in the same manner as used for Yarn H.

Yarn K.

Identical to Yarn H except the two threadlines are maintained separate until the yarn reaches the draw/annealing rolls (numbered 15 in FIGS. 1 and 2) of the spinning machine. Yarn is interlaced to a pin count of about 5—10 inches. This yarn is also converted into fabrics in a manner similar to that of Yarn H.

Yarn L.

Identical to Yarn H, except yarn threadlines are kept separate until after the draw rolls. The yarn is interlaced to a pin count of about 5—10 inches. This yarn is also converted into fabrics in a manner similar to that used for Yarn H.

Fabrics from each of the above yarns are finished by scouring at the boil and heat setting at 170° C. at scoured dimensions. Finished fabrics are dyed with 1 percent C.I. disperse red 59, 4 percent disperse yellow 54 and 2 percent C.I. basic blue 35 with 5 g/l "Latyl" Carrier A. A 4 percent disperse yellow 54 and 2 percent C.I. 51004 mixture is used with the above mixture and by itself.

The yarns are also wound upon flat holders as described above for measuring DFI. These yarns are dyed with 4 percent disperse yellow 54 and 2 percent C.I. basic blue 35 using 5 g/l of "Latyl" Carrier A. The DFI is determined from the wound yarn or from the above-described fabrics made from the yarn, or both. Parenthetical values shown in Table I are for yarns from fabrics while values just preceding these are for yarns from holders. The subjective appearance of the fabrics is also shown in Table I.

TABLE I

Yarn	Subjective Appearance of Fabric	DFI (%)
A	5	89(95)
B	4	93(92)
C	4	90
D	4	84
E	2	40
F	1	44(49)
G	1	47(44)
H	5	83(76)
I	5	90(80)
J	3	70(70)
K	3	76(66)
L	1	47(54)

It is apparent from this example that fabrics prepared from yarns of DFI of about 70 and above are acceptable in appearance while fabrics prepared from yarns of DFI less than about 60 percent are unacceptable. The higher values are achieved when the filamentary groups are mixed and brought together to an integral yarn at the correct place in the process. After the threadlines are integral, mixing is not achieved. Interlacing causes little, if any, additional intermingling or improved fabric appearance.

EXAMPLE V

This example shows the advantages of a yarn with well-intermingled filaments of two types each with different amounts of delusterant compared to a yarn containing the same two filament types where intermingling is poor.

Yarn A.

2G-T polymer of about 30 RV containing about 0.3 percent TiO_2 is spun into yarn using conditions similar to those of Example I with the exception of the number of spinneret orifices. The yarn has a count of 35-denier/25-filaments and an RV of about 26.5. The yarn has an elongation of about 26.5 percent and a boiloff shrinkage of about 18 percent.

Yarn B.

2G-T polymer of about 29 RV containing no delustering pigment is spun into a 35-denier/25-filament yarn under conditions similar to those used to produce Yarn A. This yarn has an RV of about 26.5, an elongation of about 29 percent, and a boiloff shrinkage of about 10 percent.

Yarn C.

This yarn is prepared by cospinning polymers of Yarn A and Yarn B using substantially the conditions of Example I, and combining all filaments into a 70-denier/50-filament yarn just before point A of FIG. 1. The spinneret used is similar to that shown as FIG. 4. The cospun yarn has an RV of about 27, a TiO_2 content of about 0.15, an elongation of about 28 percent, and a boiloff shrinkage of about 8 percent.

Yarn D.

2G-T of about 30 RV containing 2 percent TiO_2 is spun under substantially similar conditions as used for Yarn A to give a 35-denier/25-filament yarn of about 26 RV containing about 2 percent TiO_2. The yarn has a break elongation of about 33 percent, and a boiloff shrinkage of about 10 percent.

Yarn E.

Polymer of about 32 RV containing 0.1 percent TiO_2 is spun using substantially conditions as used for Yarn A to give a 35-denier/25-filament yarn of about 26 RV containing about 0.1 percent TiO_2. The yarn has a break elongation of about 26 percent, and a boiloff shrinkage of about 10 percent.

Yarn F.

This yarn is cospun from polymers used to prepare Yarn D and Yarn E. Conditions are essentially those of Example I. This 70-denier/50-filament yarn has an RV of about 26, a TiO_2 content of about 1.0 percent, a break elongation of about 26 percent, and a boiloff shrinkage of about 10 percent.

Yarns A and B are plied together during downtwisting to 3 "Z" turns/inch. Each yarn has a count after twisting of 70-denier/50-filaments Yarns D and E are plied in the same manner. Yarn C and Yarn F are each downtwisted to 3 "Z" turns/inch.

These four yarns [(1) Yarn A plied with Yarn B; (2) Yarn C; (3) Yarn D plied with Yarn E; (4) Yarn F]are woven as filling over a stock 70-denier/34-filament 2G-T warp in a plain weave construction. The woven fabric is scoured at the boil and subsequently heat set at 170°C. at scoured dimensions.

Portions of each of these four yarns are wound on a card and their DFI is determined as stated above. For these measurements, the dyeing step is unnecessary and is omitted.

Subjective rating of the degree of moire (corresponding to the degree of heather in the dyed fabrics) in the fabrics and the DFI values are given in Table II.

TABLE II

Identification	Subjective rating of moiré*		DFI
	Filling fabrics	Mirror cards	
1. Yarn A plus Yarn B (plied)	1–2	1–2	49
2. Yarn C	5	5	93
3. Yarn D plus Yarn E (plied)	1	1	32
4. Yarn F	5–4	5–4	96

*Rating scale of from 1 to 5 in which 5 is best (least moiré) and 1 is the poorest (most moiré).

Subjective comparisons of the white finished fabrics and wound cards show that the plied yarns [items (1) and (3) above] give a gross moire, nonuniform, unattractive appearance in both the fabric and the card. In contrast, white finished fabrics and cards from the well-intermingled yarns [items (2) and (4) above] give a uniform, pleasing appearance. In the well-intermingled yarns, fabrics from Yarn C are somewhat more uniform and more pleasing in appearance than Yarn F. Relatively large differences in the delusterant content of the two components appears to give fabric with a more apparent moire.

EXAMPLE VI

This example shows the importance of proper break elongation adjustment in the practice of the present invention.

A 50-filament cospun yarn is prepared by cospinning 2G-T and 2G-T/SSI with a spinneret of the pattern shown in FIG. 3. The copolymer has an RV of about 25; the homopolymer has an RV of about 24. The difference in percent break elongation of the two groups is 17; the 2G-T having a break elongation of 32 percent and the 2G-T/SSI having a break elongation of 15 percent. Spinning conditions are identical to Example I. The yarns contain approximately 0.3 percent TiO_2 and are extruded at about 300° C. The yarn is drawn 219X in a liquid bath and has a denier of 73, a tenacity of 2.0 g.p.d., and an elongation of 21 percent. It is wound at a speed in excess of 2,000 yards per minute. The yarn is downtwisted and woven as filling into a stock 70-denier/34-filament 2G-T warp. The loom construction is 90 ends/inch × 80 picks/inch. The fabric is dyed as in Example I. A sample of the twisted yarn is wound on a card, dyed, and the DFI is measured. The heather rating of the fabric is 2, and the DFI of the yarn is 62, both ratings indicative of unacceptable yarn performance.

The example is repeated with the exception that instead of using a liquid bath, the yarn is drawn in a steam jet according to well-known procedures, and the spinning temperature is about 305° C. The yarn is wound at a speed greater than 2,000 yards/min. The heather rating is 1, and the DFI of the yarn is 40, the rating showing the adverse effect of the jet on yarns with a significant difference in break elongation of their constituent filamentary groups.

EXAMPLE VII

This example illustrates the preparation of yarns in accordance with the present invention, comprising one group of filaments which has carbon black added prior to spinning.

A 140-denier/100-filament yarn is prepared by cospinning 2G-T and 2G-T/SSI (98/2) with a spinneret of the pattern illustrated in FIG. 3. The homopolymer has an RV of about 30 and contains approximately 2.3 percent, by weight, carbon black pigment. The copolymer has an RV of about 20 and contains approximately 0.3 percent by weight of TiO_2. The homopolymer is spun through the outer ring of the spinneret. The copolymer is spun through the inner ring of the spinneret. Spinning temperature is approximately 297° C. The homopolymer filaments have an RV of about 26.5 and, after drawing, an elongation of about 30 percent. The copolymer filaments have an RV of about 19. The filaments are combined just before point A of FIG. 1 and are drawn 2.2X. The resulting yarn has an elongation of about 30 percent and the elongation difference between the two groups of filaments is less than 15 percent. The DFI of the yarn is 84 percent. The yarn is twisted to 3 turns/inch and woven as a filling over a stock 70-denier/34-filament 2G-T warp at a griege fabric count of 90 ends/inch by 80 picks/inch. After finishing, the fabric shows a pleasant desirable heather pattern characteristic of the yarns of the present invention.

DESCRIPTION OF PREFERRED EMBODIMENTS

With reference to the drawings in which like numbers of reference are used to designate like parts, FIG. 1 shows two groups of filaments 11 spinning from spinning pack assembly 10; group *a* having different apparent coloration than group *b*. The groups merge at point A adjacent or just before finish roll 12 and subsequently pass to feed roll 13 and associated separator roll 130, partly around draw pin 14, around draw roll 15 and associated separator roll 150 which is heated to produce the desired shrinkage in the final yarn, and then through interlace jet 16 and finally to package 17. Draw pin 14 may be heated or may be partly immersed in a liquid bath. Pin 14 and the liquid bath may be replaced by a jet which impinges fluid onto the threadline. These drawing methods are well known in the art.

FIG. 2 illustrates filaments *a* and filaments *b* spinning from two adjacent spinnerets 100 and 101, respectively. The groups merge at point A adjacent or just before finish roll 12.

FIG. 3 illustrates a face of a spinneret 18 having a plurality of small orifices 19 and 20; orifices 19 discharge a polymer having different apparent dyeability from the polymer discharged through orifices 20. The X's and O's designate orifices 19 and orifices 20 respectively, and are meant to show that orifices 19 spin a certain polymer and orifices 20 spin another; the letters indicate positions but not the actual configuration of the orifices themselves. FIG. 4 shows an orifice arrangement wherein all orifices for a given polymer type are grouped together on one side of the line DD' which bisects the spinneret. FIG. 5 shows an orifice arrangement wherein orifices X and O alternate in two concentric circles. FIG. 6 shows an enlarged representative cross section of a yarn comprising two groups of filaments of different colors and having a degree of filament intermingling characteristic of the yarns of the present invention. FIG. 7 shows a yarn cross section displaying a degree of filament intermingling, characteristic of the yarns of the prior art.

The instant invention includes a process for producing a synthetic organic textile yarn comprising at least two groups of continuous filaments which have different inherent apparent coloration, comprising separately feeding at least two polymeric compositions which may be structurally identical or different to a spinning assembly and extruding them in the form of discrete filaments, the filaments of the first polymeric composition having a different inherent apparent coloration than the filaments of the second polymeric composition, combining the groups of filaments to a single yarn either during or prior to drawing the yarn as a unit to produce a degree of filament intermingling of greater than 65 percent and preferably greater than 80 percent, drawing the filaments as an integral yarn to a high degree of orientation so that the difference in percent break elongation of the groups does not exceed 15. The polymers may be spun from a single spinneret as in FIG. 1 and combined preferably upstream of point A or at point A or preferably at point B but not at point C. The polymers may be spun concurrently from adjacent spinnerets as in FIG. 2 and combined preferably upstream of point A, at point A or less preferably at point B but not at point C. The yarns may be interlaced by procedures well known in the art by use of interlace gas jet 16 of the Figures. However, interlacing has little or no effect on the degree of fiber intermingling for the purpose of this invention.

When the filaments are spun from separate spinnerets as shown in FIG. 2, any conventional spinneret may be used.

When the filaments are spun from a single spinneret as schematically illustrated in FIGS. 3, 4 and 5, a special spinneret known in the art to allow the cospinning of two different polymers is used. A suitable apparatus which is acceptable for cospinning the yarns of the present invention is illustrated and described in U.S. Pat. No. 2,398,729.

As previously mentioned, in known processes where filaments of different dyestuff receptivity are combined to make a mixed-dye yarn using mixed-dyeing procedures, the filaments having a certain apparent dyeability are plied with the filaments having a different apparent dyeability. Such procedures, dealing with polyester filaments plied with polyamide filaments, are described in British Pat. No. 869,993. It has now been discovered that if, instead of plying such filament groups subsequent to drawing, as is the process of the prior art, the unoriented filaments are mingled and drawn as an integral yarn as herein set forth to produce a high degree of orientation, wound in conventional manner and woven to a fabric and the fabric dyed with a mixture of dyestuffs, the appearance of this fabric is remarkably different from a similar fabric woven from plied yarns. Moreover, in the above-described case of yarn comprising groups having different amounts of delustering pigment, the fabrics produced by the present teachings are markedly different in appearance from fabrics produced from yarns of plied groups of filaments having the same differences in amount of delustering pigment.

When it is stated that a yarn or fabric is exposed to a mixture of dyestuffs, it is to be understood that the fabric or yarn may be inserted into a single vessel containing a mixture of different dyestuffs, or that the fabric or yarn may be inserted stepwise into a number of vessels each containing one or more dyestuffs. Many process variations may be utilized; for instance, the yarn or fabric may be exposed to a dyestuff compatible with both components and subsequently overdyed by exposure to a dyestuff compatible exclusively with one component; the yarn may be exposed to a dyestuff which is compatible exclusively with one component, and subsequently exposed to a dyestuff compatible with both components, and so on.

In the practice of the present invention, the general classifications of dyestuffs which may be used are consistent with the particular species of filaments dealt with. Thus, a homopolyester such as 2G-T, is compatible with disperse dyes and certain copolyesters such as 2G-T/SSI (as shown in Griffing & Remington U.S. Pat. No. 3,018,272) have functionalities which make them compatible not only with disperse dyes but also with cationic (also called basic) dyes. Polyhexamethylene adipamide has functionalities making it compatible with acid dyes. Suitable dyestuffs of the said classes for each of the known synthetic fibers are known to those skilled in the art.

In order to achieve the benefits of the present invention by means of an economically feasible process, the polymers of each class must be extruded and intermingled by being brought together before they are drawn. They must remain intermingled throughout the draw zone. In the process of the present invention the filaments are drawn to produce a break elongation of from about 5—100 percent and preferably from about 20—40 percent and a tenacity of from about 1.0—10 and preferably about 1.5 to 6.0 grams per denier. Surprisingly, the difference in percent break elongation of the groups must not exceed 15. The break elongation is measured as described above. When elongation is measured on the composite yarn on an Instron, two break elongations may be recorded. The first break level (in percent) must be at most 15 percent units higher or lower than the second break level in order to practice this invention. It is well known that break elongation may be controlled by proper selection of relative viscosity (RV) for each polymer class. Thus if two polymers such as 2G-T and 2G-T/SSI in the proportions shown in Example I, are used, the RV of each should normally not be the same, but the RV of the 2G-T should be about 6.0 points higher than the 2G-T/SSI RV. Such adjustment will assure the proper break elongation of each individual group in the yarn bundle with a maximum difference of no more than 15 percent.

The yarns of the present invention must have a DFI of greater than 65 percent and preferably greater than 80percent.

The results of this invention can be attained by cospinning the yarns in any of the following ways: basic dyeable filaments spun solely through the outside annular orifices of a spinneret and disperse dyeable filaments through the inside annular orifices of the spinneret or vice versa (shown in FIG. 3); basic dyeable filaments spun through the orifices on one side of the spinneret and dispersed dyeable filaments spun through the orifices on the other side of the spinneret (shown in FIG. 4); basic dyeable filaments and disperse dyeable filaments spun through alternating orifices of the spinneret (shown in FIG. 5). Other combinations and orifice patterns will become apparent to those skilled in the art.

The proportion of one group of filaments to the remaining portion of filaments in the yarns may be from 10:90 to 90:10 and is preferably 50:50. The new yarns may be twisted to conventional twist levels and may be of any conventional denier and number of constituent filaments. The new yarns comprise filaments which may have any cross section, e.g., round, dog bone, trilobal, etc. The new yarns may be textured by methods well known in the art such as by twist/heat-set/untwist methods known in the art.

STATEMENT OF UTILITY

The yarns of the present invention can be woven or knitted into suiting, dress materials, upholstery fabrics and, in general, any textile for use where the evenly mottled, heather appearance is desired.

What I claim is:

1. In a composite drawn textile yarn of two types of continuous, oriented, synthetic polyester filaments, the improvement for providing a uniform, attractive heather in fabric made from the yarn and having the two types of filaments differently colored; wherein the improved yarn consists essentially of 10 percent to 90 percent by weight of basic dyeable filaments of poly [ethylene terephthalate/(5-sodium sulfo)isophthalate] and 90 percent to 10 percent of polyethylene terephthalate filaments which are relatively unaffected by basic dyestuffs, the two types of filaments have a difference in percent break elongation of less than 15, and the degree of filament intermingling in the yarn is greater than 80 percent.

2. Yarn as defined in claim 1 having a tenacity of 1.5 to 6.0 grams per denier and a break elongation of 20 percent to 40 percent.

3. Yarn as defined in claim 1 wherein the filaments of each type comprise about 50 percent by weight of the yarn.

4. A fabric prepared from the yarn defined in claim 1.