Jan. 14, 1964 | D. TANNER | 3,117,906

COMPOSITE FILAMENT

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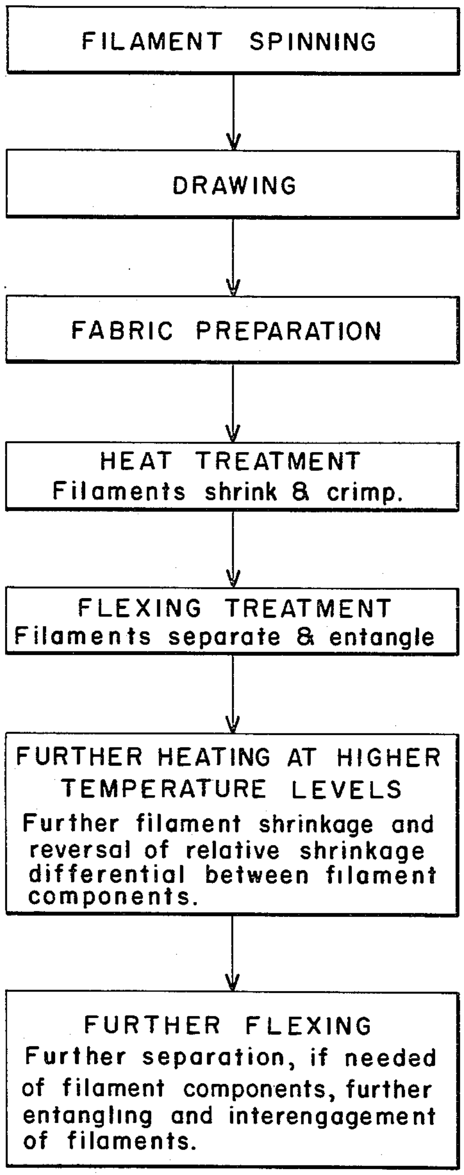
FIG. 1



INVENTOR
DAVID TANNER

BY

ATTORNEY

FIG. 2

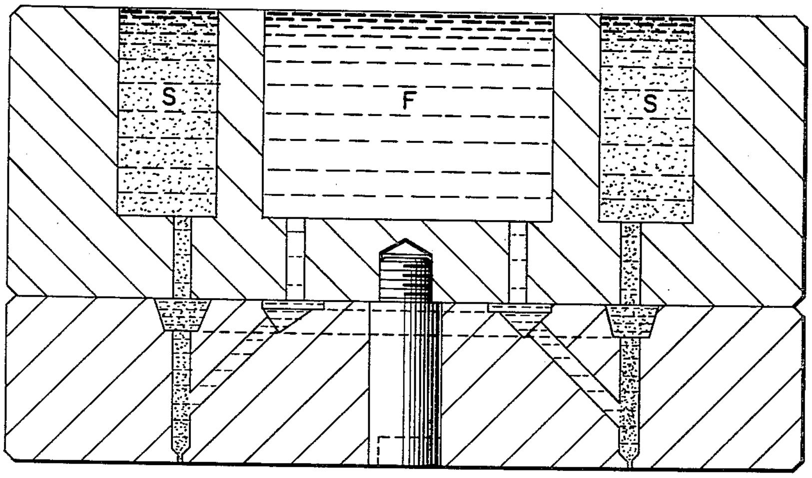
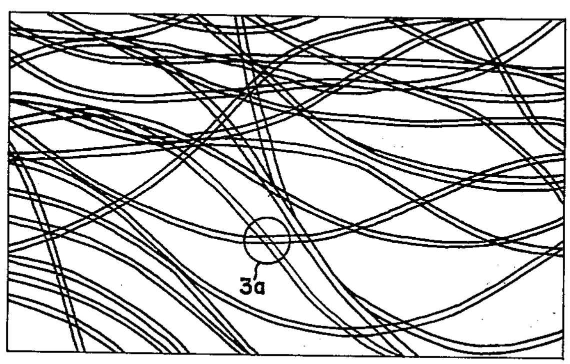


FIG. 3



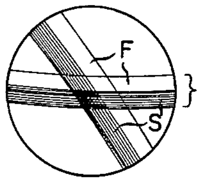


FIG. 3A

INVENTOR
DAVID TANNER

BY Harry C. Braddock
ATTORNEY

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COMPOSITE FILAMENT

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FIG. 4

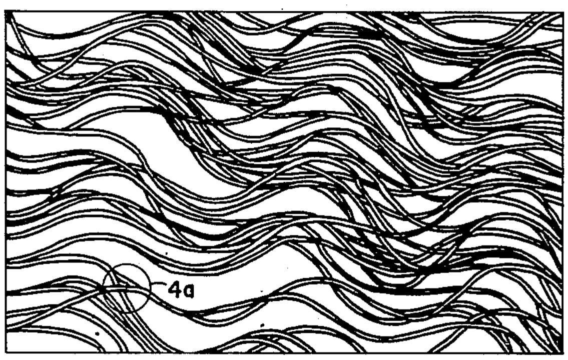
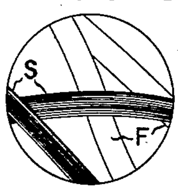


FIG. 4A



F,S, Separated

FIG. 5

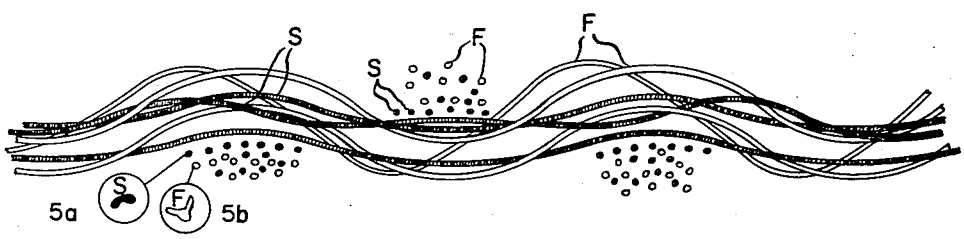
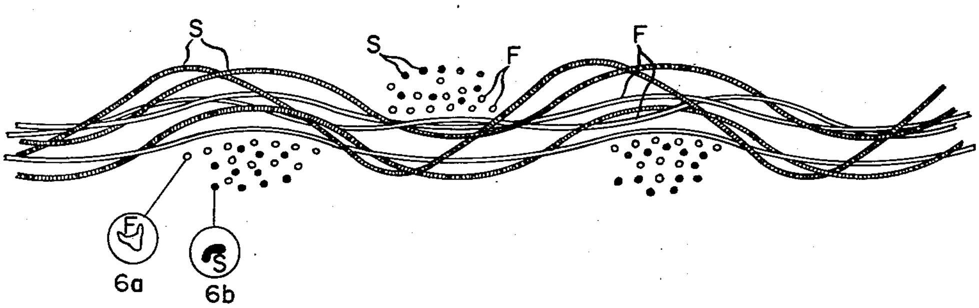


FIG. 6



INVENTOR
DAVID TANNER

BY Harry E. Braddock
ATTORNEY

FIG. 7

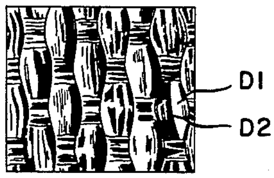


FIG. 8

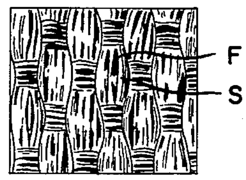


FIG. 9

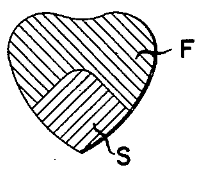


FIG. 10

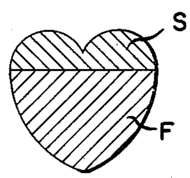


FIG. 11

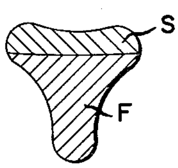


FIG. 12

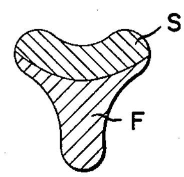


FIG. 13

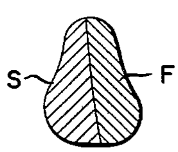
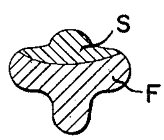


FIG. 14



INVENTOR
DAVID TANNER

BY Harry C. Braddock
ATTORNEY

United States Patent Office 3,117,906 Patented Jan. 14, 1964

3,117,906
COMPOSITE FILAMENT

David Tanner, Wilmington, Del., assignor to E. I. du Pont de Nemours and Company, Wilmington, Del., a corporation of Delaware

Filed June 20, 1961, Ser. No. 118,291
7 Claims. (Cl. 161—177)

This invention generally relates to improved synthetic fabrics and a novel process for their production. More particularly, the invention relates to novel and useful silk-like fabrics prepared from suitable continuous filament yarns comprising synthetic polymer filaments.

In recent years, the introduction of synthetic yarns, such as those made from polyamides and polyesters, has led to fabrics having high strength, improved durability and, most important, improved launderability and wrinkle resistance. However, fabrics made from these yarns, particularly, the continuous filament yarns, are imperfect and can be improved in a number of respects. For example, fabrics of filamentary polyamide yarns tend to have a slick, cold hand and are deficient in cover and luster in many end uses. Thus, in spite of certain superior functional properties, fabrics produced from these yarns do not have all the properties and the aesthetic qualities desired in an ideal fabric. Synthetic fabrics having the warm, dry hand, good luster, and other properties of silk, are particularly desirable.

Improvements of a general nature in aesthetics have been attained with mixed shrinkage yarns. When the resulting fabric is scoured in hot or boiling water, the lower shrinkage filaments tend to crimp or loop, thus giving the fabric greater bulk and cover as well as an improved hand. However, when the mixed shrinkage yarns are unwound from the package for processing into fabric, the filaments retract slightly; and there is a difference in retraction between the high and low shrinkage filaments. As a result, the low shrinkage filaments form loops which cause great difficulties in yarn handling during the preparation of fabrics. In such mixed shrinkage yarns undesirable separation of the low and high shrinkage filaments into distinct bundles in the fabric occurs. This occurrence results in the fabrics exhibiting undesirable non-uniformities due to the clustering of like filaments as shown in FIGURE 7.

In the preparation of fabrics having improved aesthetics, it is desirable and necessary to incorporate filaments of very low denier. However, low denier filaments are extremely difficult to handle in the yarn processing and fabric preparation steps. Consequently, extremely fine filaments, such as those of about one denier per filament, are generally not produced commercially.

It is accordingly an object of this invention to provide improved fabrics having greatly improved properties and aesthetic qualities.

Another object is to provide an improved fabric which is closely similar and nearly identical to silk in properties and aesthetic qualities while having the usual excellent functional characteristics associated with the synthetic polymer fabrics.

A further object is to provide a process for preparing such fabrics.

A further object is to provide improved filaments particularly suitable for use in such fabrics and in the process.

Other objects and advantages will become apparent from the examples and disclosure to follow.

FIGURE 1 is a block diagram illustrating the general aspects of the process of the invention;

FIGURE 2 is an axial cross-sectional view of a spinneret assembly used in preparing filaments used in the practice of the present invention;

FIGURE 3 is an illustration based upon a photomicrograph showing a portion of a yarn of this invention before separation of the composite filaments into their component filaments;

FIGURE 3A is an enlargement of the portion of the fabric shown within circle *3a* of FIGURE 3;

FIGURE 4 is an illustration similar to FIGURE 3 showing a portion of a yarn bundle removed from the fabric after the composite filaments have been separated into their components and after the first heating and flexing treatment;

FIGURE 4A is an enlargement of the portion of the fabric shown within circle *4a* of FIGURE 4;

FIGURE 5 is an illustration based upon photomicrographs showing a warp cross section of a fabric embodying features of this invention after the first heating and flexing treatment. The preferred component filament cross sections are illustrated by the enlargements *5a* and *5b*.

FIGURE 6 is a similar illustration to that of FIGURE 5 in which the fabric is shown after first heating and flexing treatments and also after the second heating treatment to show the general relative reversal of the component filament positions; inserts *6a* and *6b* represent enlargements of cross sections of the components;

FIGURE 7 is an illustration based upon photomicrographs showing a plan view of a fabric with different filaments D1 and D2 each spun from a different orifice in the same spinneret assembly to form an initial evenly mixed yarn bundle and which later separates into bundles of like filaments in the fabric as shown;

FIGURE 8 is an illustration similar to FIGURE 7 showing a fabric of the present invention in which the different filaments, F and S, are spun as components of the same composite filaments, made into yarn and fabric and treated by the process of the invention to separate the filaments in a more evenly dispersed manner in the completed fabric. This fabric has received the first heating and flexing treatment only.

FIGURES 9–14 illustrate various cross-sectional forms of composite filaments suitable for use in the process and fabric of this invention, FIGURES 11 and 12 being the preferred forms.

The objects of the invention are accomplished by a process comprising generally preparing a grey fabric from yarn comprising composite filaments comprising at least two different synthetic polymeric components adhered together in side-by-side relation throughout substantially the entire length of the filament, said different components having different shrinkage characteristics when subjected to heat; subjecting the fabric to a treatment involving controlled conditions whereby the different components are separated to form separate filaments and heating the fabric to effect shrinkage of the filaments, the heating being of sufficient duration and intensity to cause the filaments from the different synthetic polymeric compositions to shrink to a substantially different degree. Preferably, the composite filaments are separated into separate component filaments by subjecting the fabric to certain levels of turbulence or agitation sufficient to cause considerable flexing of the filaments while contacting the fabric with a hot aqueous liquid. The liquid may optionally contain soaps, detergents or agents which swell one or more of the components to a moderate degree. An idea of the differences in covering power and distribution of the filaments can be obtained by referring to FIGURES 3 and 4.

More specifically, the preferred process comprises preparing a grey fabric from yarn comprising uncrimped continuous composite filaments of intermediate denier consisting of a first synthetic polymeric component and a second synthetic polymeric component adhered together in side-by-side relation throughout substantially the entire length of the filament, said first component having the characteristic that it shrinks to a substantially greater degree than the second component when subjected to boiling water but to a substantially lesser degree than the second component when heated to a higher temperature but below the softening point of the polymer; treating the grey fabric with a hot aqueous liquid, the temperature being sufficient to cause said first component to shrink to a greater degree than said second component whereby the filaments crimp with a resultant bulking effect on the fabric; flexing the fabric and filaments to a sufficient degree whereby the filament components split apart to form separate low denier filaments comprising said first and second synthetic polymeric components, the filaments F from the second component having a greater extended length than the filaments S from the first component and accordingly forced into position in or near the surfaces of the fabric as shown in FIGURE 5; drying the fabric and heating to a temperature above 100° C., the temperature being sufficiently high to cause the filaments F comprising said second polymeric component to shrink to a substantially greater degree than the filaments S from said first polymeric component whereby a significant number of the filaments from the first polymeric component are brought to or near the surface of the fabric and a significant number of filaments from the second component are moved into the interior of the fabric; a general reversal of relative positions of the filaments as is illustrated in FIGURES 5 and 6. Preferably the filaments become interentangled and interengaged by this action. Also, in order to achieve the preferred silk-like properties in the yarn the filaments of at least one component should be provided with at least one longitudinally extending sharp edge.

Fabrics of this invention comprises generally filaments of two different synthetic polymeric compositions, the different filaments being well intermingled, the filaments from one of the polymeric compositions having a substantially greater extended length than the other filaments whereby these filaments are crimped and looped in the fabric and a greater number of these filaments occur in the surface of the yarn and fabric than is the case with the other filaments. The yarn history, such as the initial polymers used, spinning and drawing conditions, determine the relative amounts of shrinkage between the filament components. These conditions may be varied in a suitable manner to achieve the desired fabric properties which are determined to some extent by the relative positions of the component filaments. The undesirable clustering of like filaments is also substantially eliminated as shown in FIGURE 8. Preferably, the filaments having the greater extended length are of lower denier than the other filaments and the different filaments may have different cross-sectional shapes as will be discussed hereinafter.

A preferred group of filaments of the present invention are those in which the first component has its external surface comprised generally of, for any short longitudinal portion, a deep, convexly curved, cylindrical surface and a shallow, concavely curved, cylindrical surface generally positioned to intersect the convexly curved surface or extensions thereof along two parallel lines such that two longitudinally extending sharp edges are formed on and along the first component. Illustrative

of this component are the portions F shown in FIGURES 11, 12 and 14. The second component is adherent to and extends along the first component, with the components being closely fitted together along at least one contacting surface to form a composite filament having a substantially smoothly rounded transverse cross-sectional contour (see FIGURES 11, 12 and 14). The components are readily separable under predetermined conditions along the contacting surfaces into separate, independent component filaments.

The following examples are given by way of specifically illustrating the invention and are not intended to be construed as limiting in any sense.

EXAMPLE I

Side-by-side composite filaments were produced from poly(hexamethylene adipamide) having a relative viscosity of 40 in m-cresol and poly(ethylene terephthalate) having a relative viscosity of 29 in a solution of trichlorophenol (7 parts) and phenol (10 parts). The polymers were melted separately and the melts were led separately to the holes of a spinneret of the type shown in FIGURE 1 and which is described in detail in copending application Serial No. 118,470, filed June 20, 1961, in the name of Alvin L. Breen. The two polymers were fed to the spinneret holes in a ratio by weight of 37% polyamide and 63% polyester. The composite filaments had a trilobal cross section of the type disclosed and claimed in U.S. 2,939,201, the cross sections being characterized by a modification ratio of about 2.0. The polyamide part of the cross section was ribbon shaped and the polyester portion bell shaped. The filaments were attenuated by winding them up at about 500 times the speed at which they leave the spinneret. The filaments were then air quenched, drawn to a ratio of 3.7 over a 90° C. pin and wound into a package in the conventional manner. The final drawn yarn consisted of 26 filaments of 2.7 denier each, the polyamide component being 1.0 denier and the polyester component 1.7 denier.

The drawn yarn was woven to a conventional taffeta fabric having a loom count of 86×64, the warp yarn having a twist of 5Z and the filling ½Z. The fabric was crab scoured using a scouring solution containing 10 grams per liter of Varsol (a petroleum distillate), 0.5 gram per liter of Triton X100 (an alkyl-aryl polyester alcohol emulsifying agent) and 0.5 gram per liter of trisodium phosphate. The fabric was given 8 passes through the apparatus, the first pass being at 120° F., the second pass at 150° F., the third pass at 180° F. and the last 5 passes at the boil. Examination of the fabric at various stages in the scouring process showed that the composite yarn first crimped resulting in a considerable bulking of the fabric, then on further scouring the flexing of the fabric caused the different components in the filaments to split apart with the nylon component having the higher shrinkage so that the polyester component was looped and brought to the surface of the fabric as shown in FIGURE 5. Identification of the components was achieved by dyeing the fabric with anthraquinone green which dyes the polyamide but not the polyester. After scouring the fabric was dried relaxed and heat set 2% under width at 400° F. for 30 seconds. The heat setting treatment resulted in the polyester filaments shrinking more than the polyamide filaments with the result that the extended length of the polyamide filaments is greater by about 3% than that of the polyester filaments and the polyamide filaments were looped and crimped and tended to predominate in the surface of the fabric, a general reversal of relative positions of the component filaments as shown in FIGURES 5 and 6. After heat setting the fabric was becked bleached and beck dyed in the conventional manner.

The fabric was judged to be more silk-like in aesthetics than any synthetic fabric available, including fabrics with trilobal filament cross sections and mixed shrinkage filaments. The fabric had a combination of a warm, soft hand, good resilience and a non-synthetic, subdued luster. In addition, the fabric had high bulk and cover and excellent fabric uniformity as well as uniformity of dyeing in spite of the fact that it was made up of polymers which dye differently.

The fabric was subjected to 15 wash cycles along with nylon and Du Pont "Dacron" polyester fiber controls and evaluated after each fifth wash. The fabric of this invention was found to be superior to nylon in launderability and about equivalent to 100% "Dacron" fabrics which are well known for their excellent performance.

EXAMPLE II

Following the general procedure outlined in Example I of U.S. Patent 2,512,606 di(p-aminocyclohexyl) methane was prepared, reacted with azelaic acid to form a salt and the salt polymerized to give a polymer having an inherent viscosity of 0.89. This polymer and poly(ethylene terephthalate) were melted separately and extruded to form side-by-side composite filaments as described in Example I. Equal weights of the polymers were supplied to the spinneret to produce filaments which were 50% polyamide and 50% polyester. The filaments were drawn to a ratio of 2.51 as described in Example I. The final drawn yarn contained 29 filaments of 2.55 denier each. The filaments had a trilobal cross section as described in Example I. When the drawn yarn was placed in hot water in a relaxed state it developed about 25 crimps per inch. The yarn was woven into a fabric and the fabric finished as described in Example I. Examination of the fabric showed that the filaments had split to only a minor degree. Filament splitting was induced by placing the fabric in an aqueous solution containing 0.25 grams per liter of Alkanol ACS (a non-ionic surfactant) and a 0.5 gram per liter of Avitone T (an anionic hydrocarbon sodium sulfonate softener) and heating to 50° C. followed by the addition of 5 grams per liter of sodium O-phenylphenate and an hour of vigorous boiling and flexing of the fabric. The final fabric was found to be similar to that of Example I with regard to aesthetics and launderability.

EXAMPLE III

A mixture of p-xylylene diamine and b-xylylene diamine containing 10% of the latter diamine was combined with azelaic acid and polymerized to give a polymer having an inherent viscosity of 0.91. This copolyamide and poly (ethylene terephthalate) were extruded to form a composite filament containing 50% of each component, following the general procedure of Example I. The filaments were drawn to a ratio of 3.66 as described in Example I. The drawn yarn consisted of 34 filaments each having a denier of 1.74. The yarn was woven into a fabric and the fabric finished as described in Example I. After scouring and heat setting it was observed that the filaments had split to only a minor degree. Filaments splitting was then induced as described in Example II. After the filaments had been split, the fabric had a hand similar to that of a fine cotton fabric due to the initial high crimp development and bulking of the yarn prior to splitting. The launderability of the fabric was similar to that described in Example I.

EXAMPLE IV

Linear polypropylene having a melt index of 9 and poly(hexamethylene adipamide) having a relative viscosity of 39 were extruded in equal proportions by weight following the general procedure of Example I. The filaments were drawn to a ratio of 2.7, the drawn yarn consisting of 34 filaments having a denier of 2.53 each. The yarn was woven into a fabric and finished as described in Example I, except that the heat setting step was omitted. The filaments which were round in cross section split into elliptical polyamide filaments and crescent shaped linear

polypropylene filaments. The fabric had excellent bulk and cover and was similar to a fine cotton fabric in hand.

EXAMPLE V

Example IV was repeated except that linear polyethylene having a melt index of 6 was substituted for the linear polypropylene. The yarn was used to prepare knitted tubing which was finished as described in Example IV. The tubing had high bulk and softness due to splitting of the filaments and high differential shrinkage between the components.

EXAMPLE VI

Example I was repeated except that the composite filaments were of 4 denier each, the poly(ethylene terephthalate) and poly(hexamethylene adipamide) components each being 2 denier. The fabric from this yarn had good bulk and cover but was less desirable with respect to warmth, softness, and luxurious handle than the fabric of Example I.

EXAMPLE VII

Example I was repeated except that the composite filaments were generally pear-shaped in cross section as shown in FIGURE 13. During the scouring of the fabric the filaments split into separate filaments having cross sections with at least one sharp point. The fabric was similar in aesthetics and launderability to that of Example I.

EXAMPLE VIII

Example I was repeated except that the cross section of the composite filament was generally heart-shaped as shown in FIGURES 9 and 10 and the filaments split into polyester filaments having a shield shaped cross section and polyamide filaments of elliptical cross section. The fabric was similar to that of Example I.

EXAMPLE IX

Example I was repeated except that the composite filaments were of tetralobal cross section as shown in FIGURE 14 and the filaments split into filaments having bell shaped cross section. The fabric was similar to that of Example I.

EXAMPLE X

Example I was repeated except that the polymers were extruded at a ratio of 18% polyamide and 82% polyester to produce, after splitting, polyamide filaments of 0.4 per denier each and polyester filaments of 1.8 denier each. The finished fabric was similar to that of Example I except that the hand was somewhat softer.

The foregoing examples illustrate various processes by which outstanding fabrics may be produced according to this invention. The nature of the fabrics is also illustrated. Continuous filament fabrics of improved aesthetics varying from those similar in hand to fine cottons to the silk-like fabrics may be produced depending on the polymers used, the difference in shrinkage between the different filaments, the denier of the final filaments, and their cross-sectional shapes.

Of primary importance in the process is the controlled separation of the filament components to produce extremely fine filaments in the fabric while retaining the advantages of the higher denier composite filaments prior to splitting, and during the yarn processing and fabric preparation steps. In order to achieve this, the filaments chosen for preparation of the fabrics of this invention must comprise a plurality of components adhered together in substantially side-by-side relation. While three or more components may be employed if desired, for practical purposes two-component systems are preferred. The components may be present in various ratios relative to one another. Two-component systems may, for instance, contain 20% of one component and 80% of the other, or various ratios, such as 50:50, 40:60, or 30:70 may be employed. In the production of silk-like fabrics it is generally desirable, however, that the component having the higher shrinkage on heat setting have the higher denier so that the finer filaments will predominate in the surface of the fabric to give a soft hand while the heavier filaments on the interior contribute to resilience.

The splitting apart of the components to form separate filaments may be achieved in any desired manner, provided that the filaments are not excessively damaged in the process. Suitable treatments involve flexing or mechanical working of the filaments in the dry state or in the presence of liquids. The preferred process, however, is to treat the filaments with a hot aqueous solution while subjecting the fabric to vigorous agitation to flex the filaments. The level of adhesion between the filament components is controlled so that the filaments remain adherent during yarn treatment and fabric preparation and separate upon being subjected to the desired conditions after the fabric is formed.

The aqueous solution may, optionally, contain various detergent soaps, emulsified solvents, etc., that may be desired to remove sizing or for other purposes. In cases where the components may be somewhat difficult to split apart, suitable swelling agents for one or both of the components may be employed to aid in component separation. Suitable swelling agent for the particular polymeric system employed will be readily apparent to those skilled in the art. With a polyamide-polyester system, for instance, an aqueous solution of sodium O-phenylophenate is suitable. Also in such a system the average level of adhesion forces between the dry filament components of the same component filament is preferably at least about 13 g./cm.

The cohesion between the components in the filaments can conveniently be determined by cutting about 8 cm. lengths of the filaments, splitting the components apart at one end by flexing the end, or if necessary by immersing the end in a swelling agent for one of the components, e.g., a 5% aqueous formic acid solution, attaching one of the split apart components to a sensitive strain gage and the other component end to a rod which is drawn away from the strain gage at a constant rate of 2.4 cm./min. The force required to pull the components apart is recorded by an electronic recorder attached to the strain gage. The strain gage employed was a Statham Instrument Company gage having a range of 0 to +0.15 oz. The signal from the gage was fed to a preamplifier, then to an amplifier and finally to a conventional Sanborn recorder. The rod to which one of the component ends was attached was floated in a horizontal position in a container of water by means of two corks. A filament or strand of yarn was attached to one end of the rod and the other end of the yarn passed around a small motor driven roller to draw the rod away from the strain gage at a slow, constant rate of 2.4 cm./min. To compensate for differences in denier and cross sectional shape, the length L of the interface between the adhered components of the composite filament is determined and the measured force, F, divided by this value. This length L is measured on a photomicrograph taken at high magnification of a transverse cross section of the composite filament by rolling a map reader along the clearly visible line at the interface of the different components.

Since the measured force varies as the composite filament is split apart, the percentages of the filament length which split within given ranges of forces are multiplied by the mean force for each range and the sum of these values divided by 10 to obtain the average force required to split the filament. In carrying out this operation the ranges shown in the following table were employed. The values shown in the first column in the following table for percent splitting are averages of values obtained on 17 filaments. Likewise, the interface length L used in the calculation was the average for the same 17 filaments. The values of tables I and II correspond to filaments of a highly satisfactory nature and performance according to

this invention, whereas the values of table III correspond to filaments approaching unsatisfactory nature and performance.

Table I

Percent Split	Range, g./cm.	Mean, g./cm.	Percent Split × Means	Avg., g./cm.
21.7	0– 3	1.5	33	
16.1	3– 6	4.5	73	
24.2	6– 12	9.0	218	
10.2	12– 18	15.0	152	
10.6	18– 24	21.0	222	
6.4	24– 36	30.0	192	
3.3	36– 48	42.0	138	
2.2	48– 72	60.0	132	
2.7	72–144	108.0	292	
2.6	144–170	141.0	353	
100.0			1,805	18

Table II

Percent Split	Range, g./cm.	Mean, g./cm.	Percent Split × Means	Avg., g./cm.
16.2	0–3	1.5	24	
15.3	3–6	4.5	69	
20.5	6–12	9.0	185	
11.6	12–18	15.0	174	
5.0	18–24	21.0	105	
6.5	24–36	30.0	195	
3.5	36–48	42.0	147	
2.4	48–72	60.0	144	
7.6	72–144	108.0	820	
5.6	144–200	172.0	962	
5.8	200–250	225.0	1,310	
100.0			4,137	41.4

Table III

Percent Split	Range, g./cm.	Mean, g./cm.	Percent Split × Means	Avg., g./cm.
46.0	0–3	1.5	69	
15.9	3–6	4.5	72	
15.1	6–12	9.0	136	
7.5	12–18	15.0	112	
3.3	18–24	21.0	69	
4.4	24–36	30.0	132	
1.9	36–48	42.0	80	
2.7	48–72	60.0	162	
3.2	72–95	84.0	268	
100.0			1,000	10.0

An average cohesion value of at least about 13 g./cm. was determined to characterize satisfactory samples of preferred yarns tested. These values were determined in a manner described above.

In the preferred process for making silk-like fabrics, the composite filaments have the characteristic that they crimp when subjected to boiling water but subsequently split when subjected to sufficient levels of mechanical working or flexing. The filaments which shrink to the lesser extent under these conditions having the characteristics that they shrink to a greater extent than the other filaments when heated to a temperature within about 20° to 30° C. of the softening point of the particular polymer. In the production of the fabric the initial crimping in the hot solution results in a desirable bulking of the fabrics. When the filaments subsequently split apart the filaments from one component are forced to the surface of the fabric (FIGURE 5) while in the subsequent heat setting operation the other filaments have the higher shrinkage so that the filaments which were originally at the surface tend to be forced into the fabric interior to some extent while the other filaments are brought to the surface in a general reversal of relative positions in the yarn and fabric as shown in FIGURES 5 and 6. This reversal in shrinking characteristics results in desirable intermeshing and intermingling of the filaments to produce good fabric uniformity and dyeing uniformity plus good cover and bulk in the fabrics. For producing fabrics for this type, the polyester-polyamide combination has been found most suitable.

In the production of silk-like fabrics and in other uses where a soft hand is desired, the filaments in the fabric which have the lower shrinkage on heat setting should have the lower denier, the denier per filament of the lower denier filaments preferably being no greater than about 1.6. For other effects, higher deniers may be used.

In addition to the silk-like fabrics, various other desirable aesthetic effects may be achieved depending on the starting fibers and the methods employed in fabric preparation. Thus, by employing yarns which have been appropriately heat relaxed, filaments which have the same shrinkage in boiling water but different shrinkages in the higher temperature heat setting step may be obtained in the fabric. On the other hand, a considerable difference in shrinkage at the boil may be obtained and the higher temperature shrinkage eliminated by omitting the heat setting step, as is usually the practice with knitted goods, or by the selection of polymer compositions which have substantially the same shrinkage at the higher temperature. It is essential, however, that the different components exhibit a difference in shrinkage of at least 1% at some temperature below the softening point of that polymer in the fabric which has the lower softening temperature.

Another advantage of considerable interest of the fabrics of this invention is that they exhibit a subdued non-synthetic luster and good cover without the use of a delustering agent in the fiber, although delustered fibers may be used to enhance this effect if desired.

Another advantage of the present invention is that fabrics containing sharp edged filaments are obtained. This contributes significantly to the silk-like character of the yarn and fabric. Various cross-sectional shapes in the original composite filament as shown in FIGURES 9–14 may be employed to give, on separation into its component, sharp edged filament. The sharp edge, in order to contribute to the silk-like properties is defined by two longitudinally extending filament surfaces intersecting in an acute angle significantly less than 90°. Such filaments cannot be obtained directly by extrusion since the polymer or polymer solution employed tends to assume a circular cross section and, even though the shape may be varied considerably, sharp edged filaments cannot be produced by this means. In the present process filaments with round cross sections may be split into semi-circular cross sections having sharp edges or a round cross section may be split into an ellipse and a crescent depending on the configuration of the orifices used in the extrusion. Filaments having substantially rectangular shape may be split into two generally triangular shapes having the desired sharp edges or other shapes as desired. Various other shapes may be used in the original composite filaments to obtain filaments of various cross-sectional shapes in the final fabric. One of the preferred shapes in the composite filament is the trilobal shape disclosed and claimed in U.S. Patent 2,939,201. The trilobal shaped filament may be split into ribbons and bells as illustrated in FIGURES 11 and 12, Example I or various other shapes depending on the position and relative amounts of the components.

Suitable pairs of components for use in this invention can be found in all groups of synthetic fiber-forming materials. Because of their commercial availability, ease of processing and excellent properties, the condensation polymers and copolymers, e.g., polyamides, polysulfonamides and polyesters and particularly those that can be readily melt spun are preferred for application in this method. Suitable polymers can be found for instance, among the fiber-forming polyamides and the polyesters which are described in such patents as U.S. Patents 2,071,250; 2,071,253; 2,130,523; 2,130,948; 2,190,770; and 2,465,319. The preferred group of polyamides comprises poly(hexamethyleneadipamide), poly(hexamethylene sebacamide), poly(epsiloncaproamide) and the copolymers thereof. Suitable polyesters, besides poly(ethylene terephthalate), are the corresponding copolymers containing sebacic acid, adipic acid, isophthalic acid as well as the polyesters containing recurring units derived from glycols with more than two carbons in the chain, e.g., diethylene glycol, butylene glycol, decamethylene glycol and trans-bis-1,4-(hydroxy methyl)-cyclohexane.

Other groups of polymers useful as components in filaments of the present invention can be found among the polyurethanes, the polyureas, cellulose esters and cellulose ethers as well as among the polyvinyl compounds including such polymers as polyethylene, polyacrylonitrile, polyvinyl chloride, polyvinylidene chloride, polyvinyl alcohol, and copolymers containing the monomers of these polymers and similar polymers as disclosed in U.S. Patents 2,601,256; 2,527,300; 2,456,360; and 2,436,926.

Summarizing, this invention provides suitable filaments and yarns in conjunction with a process which makes possible easy efficient fabric preparation due to the larger denier and smoothly rounded filament transverse cross section while also making it possible to achieve greatly improved and desirable fabrics by converting the initially formed fabric into the improved desirable fabric by the treatment and timing of the treatment for separating the lower denier component filaments and manipulating the separated components in the manner indicated. This advance is believed to be especially significant as to the fabric aspects as well as the process aspects.

The improved fabrics of this invention are useful for many purposes. The woven fabrics are particularly desirable and useful as superior substitutes for silks and fine cottons in various apparel end uses, while the knitted constructions may be employed to advantage in such articles as socks, sweaters, and undergarments.

A number of applications, embodiments and modifications of the invention have been specifically described. However, it is intended that the spirit and scope of the invention be determined and defined only by the following claims.

I claim:

1. An improved unitary spun composite filament especially adapted for use in yarns from which fabrics are to be prepared and which fabrics are later treated under predetermined conditions to crimp and separate the filament into its lower denier component filaments to change the fabric properties to closely resemble natural silk, said filament comprising a first continuous longitudinally extending component of substantially constant transverse cross section, said first component having its external surface comprised generally of, for any short longitudinal portion, a deep convexly curved cylindrical surface and a shallow concavely curved cylindrical surface generally positioned to intersect the convexly curved surface or extensions thereof along two parallel lines such that two longitudinally extending sharp edges are formed on and along said first component, said first component formed of one synthetic polymeric composition, said filament further comprising a second distinct continuous longitudinally extending component adherent to and along said first component, said second component of substantially constant transverse cross section of another synthetic polymeric composition, said components closely fitted together along at least one contacting surface to form the composite filament having a substantially smoothly rounded transverse cross-sectional contour for ease of processing, said components readily separable under said predetermined conditions along said contacting surface into separate independent component filaments.

2. The improved filament of claim 1 in which the denier of said second component lies in the range of about 0.1 to about 1.8.

3. The improved filament of claim 2 in which the aver-

age level of adhesive forces between the dry components lies in the range of at least 13 g./cm.

4. The improved filament of claim 3 in which said first component is a polyamide and said second coponent is a polyester.

5. The improved filament of claim 4 in which said polyamide is poly(hexamethylene adipamide) and said polyester is poly(ethylene terepthalate).

6. The improved filament of claim 4 in which said polyamide is poly(epsilon caproamide).

7. The improved filament of claim 5 in which the composite filament transverse cross section in trilobal, that of the first component is substantially bell-shaped and that of the second component is substantially ribbon-like.

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