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F. C. FIELD, JR
PROCESS FOR PREPARING A VARIABLE DENIER
COMPOSITE MULTIFILAMENT YARN

3,104,516

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2 Sheets-Sheet 1

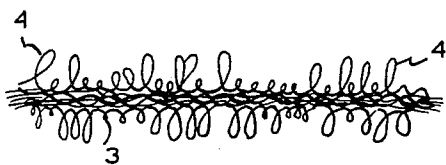


FIG. 1

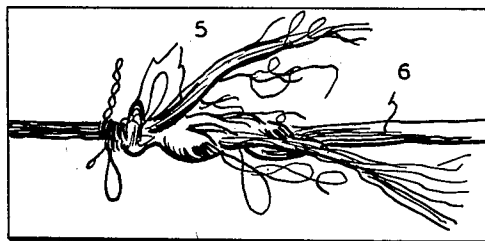


FIG. 3

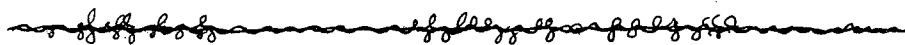


FIG. 2

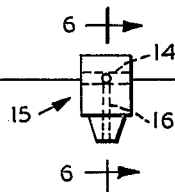
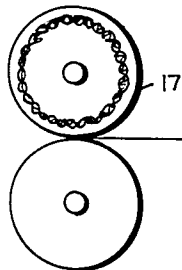


FIG. 5

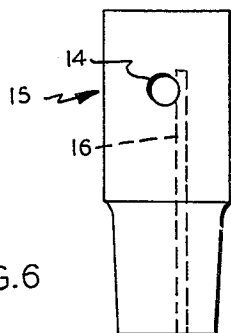


FIG. 6

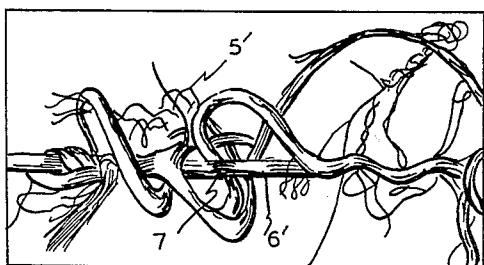
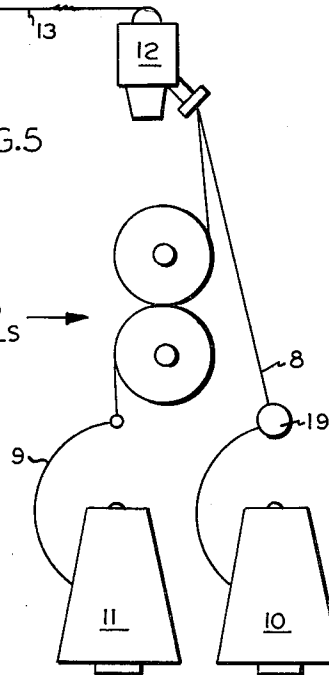


FIG. 4

FEED
ROLLS



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3,104,516

PROCESS FOR PREPARING A VARIABLE DENIER COMPOSITE MULTIFILAMENT YARN

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8 Claims. (Cl. 57—157)

The invention is concerned with textile yarns and more specifically with multiple-component textile yarns and processes for making them.

Textile yarns from both natural and synthetic fibers have been developed with a wide variety of physical structures. While there are many different purposes and goals which these different physical structures seek to achieve, a large number of these structures are designed to provide fabrics with attractive appearance and pleasing "hand." One yarn structure used in this way is known as slub or "thick-and-thin" yarn, a structure found in linen fabrics, particularly those of heavier texture. In silk fabrics the effect is called "Dupioni" and is found in men's and women's suit and dress fabrics.

In the manufacture of synthetic textiles, uneven denier effect has been produced in a number of ways. Some of these involve varying the rate at which filaments are formed or the rate at which filament-forming material is supplied during the process of filament formation, irregular quenching or coagulating treatments of the filaments during formation and, in the case of fibers and filaments which are drawn, variable drawing techniques. It is also possible to prepare variable denier yarns by specialized spinning or yarn forming processes from filaments which are in themselves uniform in denier. Such processes, however, generally require elaborate and expensive equipment from which variable denier yarn is produced only at a slow rate. In many cases, when special yarn spinning processes are involved, variations in denier are achieved by regular or irregular spacing of multiple wraps of one yarn component, called the effect yarn, upon a base of a second yarn component referred to as the core yarn. Such two-component yarn systems offer the possibility of very large variations in denier along the length of the yarn. These denier variations produce pleasing effects in fabrics of such yarns. However, because these yarns must be produced by an elaborate winding technique, the equipment necessary is very intricate and variation from one yarn type to another can be achieved only with time-consuming changes in the equipment. Furthermore, since components of these yarns are merely wrapped one about the other, the components tend to become separated with a resulting loss of the desired effect.

It is an object of this invention to provide new and improved processes for forming novel multicomponent variable-denier textile yarns in which the several yarn components of each yarn are intimately interentangled with one another. Another object is to provide improved processes for preparing a multicomponent intermediate textile yarn of substantially uniform long range denier, in which the various components are interentangled, but possess in the structure different elongation or strength characteristics so that they are suitable for subsequent preparation of variable-denier yarns of the preferred type described herein. It is a further object of this invention to provide such processes for the preparation of multicomponent variable denier textile yarns in which the relative quantities of core and effect yarns can be varied readily and simply. Other objects will become apparent from the description which follows.

FIGURE 1 is an enlarged view of a composite textured yarn of at least two yarn components passed

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through a yarn-bulking jet simultaneously and at different rates of overfeed;

FIGURE 2 is an enlarged view of a multifilament yarn after treatment by a yarn-bulking fluid jet;

FIGURES 3 and 4 are microscopic views of two composite yarns after treatment by the apparatus of FIGURE 5;

FIGURE 5 is a schematic drawing of suitable apparatus for carrying out the process according to the present invention;

FIGURE 6 is a cross-sectional view of the wrapping jet taken along line 6—6 of FIGURE 5; and

FIGURE 7 is a partial longitudinal cross-sectional view of a general type yarn-bulking fluid jet illustrating the preferred action and process of this invention, certain parts being broken away to simplify the showing.

According to the process of this invention there is provided a multifilament yarn containing at least two groups of filaments, one group comprising a plurality of filaments having a substantially higher "extensibility factor" or higher breaking strength characteristics than the remaining filaments, the filaments in one group being interentangled with the filaments of another group and being distributed in variable concentrations along the length of the other. At least one of these groups of filaments is a synthetic organic fiber. These yarns may be prepared by feeding through a yarn-bulking jet of fluid (such as those described in U.S. 2,783,609 to Breen and U.S. Patent 2,958,112 to Hall) simultaneously and at different rates of feed, two or more yarn components, whereby the individual filaments of the component yarns become interentangled to produce a product as shown in FIGURE 1 wherein filaments of yarn 3 are entangled with filaments of yarn 4. Normally, the yarn with the lowest rate of feed becomes a core yarn 3 and yarn components with higher rates of overfeed become effect yarns 4, giving a composite textured yarn of at least two components with the filaments of each interentangled with one another and with the components possessing substantially different "extensibility factors" or different breaking strength characteristics. By the term "extensibility factor" is meant to include the sum of the elongation-at-break of filaments in the yarn and the increase in length which the filaments undergo when straightened completely without stretching as well as either of these aspects separately.

While the textured yarns resulting from the process as described can be used in this state without further processing, it is desirable further to process these yarns to obtain the even more unusual and attractive variable denier yarns. In one embodiment, yarns, as described above, are treated to produce a multifilament yarn having a filamentary core component intimately interentangled with a plurality of distinct bundles of discontinuous filaments, the latter being distributed in variable quantities and lengths at random intervals along the yarn and completely surrounding the core component. The filamentary core component and bundles may be either spun or continuous filaments. It is preferred for increased strength and stability of the final product that the ultimate core component generally have a substantially linear configuration. The discontinuous filament bundles can be derived from a bulky type yarn. Greater interentanglement of the core component and discontinuous filament bundles is accomplished when the bundles are derived from spun staple fibers. Certain final yarns are prepared generally by passing at least two yarns through a fluid jet as described above followed by applying sufficient tension to the resulting composite structure thus produced to break the filaments of the component having the lowest extensibility factor or lowest breaking strength characteristics.

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The composite structure may be stretched, if desired, until the filaments with the highest extensibility factor or breaking strength characteristics are near their original length but not sufficiently stretched to break these filaments nor to separate the components completely one from another. The yarn-bulking fluid jet device referred to is preferably of the type described in U.S. Patents 2,783,609 and 2,852,906, to A. L. Breen, which is operated by passing a yarn into a turbulent fluid stream where by the individual filaments of the yarn are caused to be convoluted, bulked and interentangled. Yarns thus produced are bulky yarns characterized by having a plurality of substantially continuous filaments individually convoluted into coils, loops, whorls, and crunodal loops along the yarn surface, as shown in FIGURE 2.

Regardless of the type filamentary structure from which the bundles are derived, whether continuous or spun yarn, they eventually form distinct and separate groups of discontinuous filaments, completely surrounding the core yarn component and are sufficiently interentangled therewith to provide a stable slub yarn. These bundles, or slubs, are distinct in that they are each composed of a distinct body of discontinuous filaments, though there may possibly be, of course, some contact between individual bundles. The length of these bundles may vary along the length of the core component.

Although the multicomponent yarns of this invention may be, at least in part, bulky yarns, they are quite different from the bulky yarns of the above-mentioned Breen patent. Because of the difference in the rates of overfeed between the several components of the yarns of this invention and the nature of the stretch or breaking action, the filaments bunch together and are not distributed uniformly along the length of the ultimate yarn formed. This results in a slub effect, or significant variations in denier along the yarn, due to the fact that in some regions a greater quantity of material is present than in other regions. This resulting variation in over-all denier gives an effect similar to the Dupioni or linen type yarns and is most apparent and attractive when the yarn is woven or otherwise processed into a fabric.

In one embodiment of this invention, an intermediate composite yarn is made up of two components, the initial core yarn component (prior to breaking) having a substantially lower extensibility factor, or breaking strength characteristics (preferably less than about $\frac{1}{2}$ that of the other or initial effect yarn component with which it is combined). This result is brought about because the latter yarn component is overfed to the fluid jet at a substantially higher rate—preferably at least twice as fast (twice the unit length per unit time) as the feed rate of the initial core yarn component. When this intermediate composite yarn is stretched a sufficient amount, as already described, the initial core yarn component will break randomly and will form along the composite yarn a series of slubs giving the final composite yarn a variable denier structure. The initial effect yarn component which during the processing is fed into the bulking jet at a much higher rate than the initial core yarn component has a sufficiently high extensibility factor or breaking characteristic, to permit it to remain unbroken during both the interentangling and the stretching process which breaks the initial core yarn component. Thus, a reversal of relationship occurs between the two yarn components, the initial core component becoming the effect, or non-core, or slub component of the final composite yarn while the initial effect component becomes the ultimate core component of the final composite yarn product. During the stretching-breaking step broken sections of the final slub or effect yarn component contract while the unbroken members of the final core yarn component are elongated and the short bulked sections or lengths become knotted even more firmly into the composite structure. This bunching effect occurs at random

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intervals along the length of the composite yarn and the frequency of slub sections can be adjusted and controlled by variation of relative rates of overfeed and denier of components and conditions of breaking. In addition, bulking conditions such as total speed, air pressure, and jet adjustment as described in the above-mentioned Breen patent can be varied in a suitable manner to influence the bulkiness, the degree of entanglement, and the degree of loopiness and thus the eventual physical properties and appearance of the composite yarn.

A more preferred procedure embodying principles of this invention for providing the novel product of this invention comprises first passing at least two yarn components through a zone of fluid turbulence, such as that created in device 12 of the drawings and discussed herein-after, at least one of the yarn components having an extensibility factor or breaking strength characteristics significantly different from that of the remaining yarn components by a factor of at least 2. The yarn component having the higher extensibility factor or breaking strength characteristics is fed through the zone at a rate at least twice that of the other yarn component or components and at a rate approximately the same as that of the rate of removal of the final product from the zone of fluid turbulence.

This preferred process will be described in connection with FIGURE 7 of the drawings. As shown in this figure, the zone of turbulence is generally indicated as B and occurs in a jet device 12 of the type disclosed in U.S. Patent 2,958,112. This device comprises generally two main housing elements 61 and 62, the element 61 provided with a primary fluid flow passageway 64 extending therethrough and connected with a corresponding primary fluid flow passageway 63 extending through element 62. Another fluid flow passageway intersecting the passageway 64 is provided in the unit and formed by a tubular element 65 fitted in a bore intersecting passageway 64 as indicated in the drawing. Tubular element 65 extends across the passageway 64 and that portion of the element 65 which extends across the passageway is cut away on its downstream side as indicated in FIGURE 7. A stream of fluid is supplied under pressure into passageway 63 by a suitable means not shown. This fluid stream moves around tubular element 65 at relatively high velocity and develops a zone of high turbulence at B before passing out of passageway 64. A flow of air or other ambient fluid is induced created through tubular element 65 into the passageway 64 by the action of the primary flow of fluid through the device. The preferred procedure is carried out while maintaining the fluid flow conditions as discussed in the preceding sentences, and involves introducing a first yarn component 51 with a high extensibility or high breaking strength characteristics into the zone of turbulence at B via tubular element 65 and removing it from passageway 64 continuously by a suitable take-up device. This high extensibility or high breaking strength yarn component 51 is illustrated by dashed lines in FIGURE 7 and follows the path indicated. Component 51 is passed through the zone of turbulence B at a relatively high velocity, being fed into the device 12 at a velocity equal to or preferably only slightly greater than the velocity at which it is removed by the take-up device; this difference in velocity being desirable to more easily permit the bowing out, opening or spreading condition of the filaments of yarn component 51 in zone B as shown in FIGURE 7. While yarn component 51 is being passed through device 12 in the manner described, a second yarn component 52, of low extensibility or low breaking strength characteristics, shown in unbroken lines in FIGURE 7, is introduced into passageway 64 via tubular element 65 and fed into element 65 at a controlled velocity significantly lower than the velocity of yarn component 51. The two components move together through the tubular element 65 along the path indicated at A in the drawings,

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the component 51 moving at a high velocity relative to the velocity of component 52, the induced air flow in tubular element 65 assisting in the movement of yarn component 52 through the tubular element. When the slower moving lower extensibility or lower breaking strength yarn 52 reaches the zone of turbulence indicated at B, its filaments are opened up and are whipped about, tangling in and around the faster moving opened up filaments of yarn component 51. These filaments of component 52 which are in and around the faster moving filaments of component 51 are quickly broken off from the remainder of the incoming component 52 because of the tension applied to their tangled ends by the faster moving component 51 and because of their lowered tensile strength in their wrapped condition over and around the small radius filaments of the faster moving component 51. At any given instant some finite number of filaments of slower moving component 52 will be unbroken though engaged with faster moving component 51 and exerting force to continue feeding the following portion of component 52 into the turbulent zone, assisted, of course, by the induced air flow in tubular element 65. As filaments and groups of filaments of yarn component 52 are randomly entangled with filaments 51 of the other component and randomly broken off in a continuous operation it will be seen that in the area or zone indicated at C there is formed a composite yarn having a continuous core component 51 and a slub or effect component comprising a plurality of randomly spaced and entangled filaments 52 and groups of filaments 52 which have been broken off of yarn component 52 in the turbulent zone. Filaments 52 for the most part have been observed to form ultimately distinct bundles of discontinuous filaments distributed in variable quantities and lengths at random intervals along the higher extensibility factor or higher breaking strength characteristic yarn component 51 and sufficiently tangled therewith to consolidate the bundles with the component forming the core. It may be that an intermediate composite yarn may exist momentarily within the jet, having a brief transitory existence before filaments of the effect yarn are being broken to form the final composite yarn. The exact nature of the action within jet device 12 is not fully determined or understood.

The bundles, or slubs, may be further consolidated with the core member by any one of many twisting or treating procedures, such as by a downtwister, spinning frame, wrapping jets, such as disclosed in U.S. applications Serial Numbers 598,135, filed July 16, 1956, now Patent No. 3,009,309, and 752,451, filed August 1, 1958, now abandoned, chemical treatment, such as sizing, or plasticizing with either heat or solvent. The wrapper jet procedure is preferred in that the slub bundles are more tightly wrapped completely around the core member. Furthermore, the use of such wrapper jets is not a limiting factor on process speed and permits combining of the slubbing and wrapping operations as shown in FIGURE 5.

The ratio of windup speed to feed rate of the slub or effect yarn component whereby breaking of this component is effected depends primarily on the extensibility factor or breaking strength characteristics of the particular yarn. The ratio can be lower in cases where the effect yarn has a very low extensibility factor or low breaking strength. In general, a ratio of about 2:1 is satisfactory, while a ratio of up to about 50:1 and above may also be used.

A schematic drawing of suitable general apparatus for the process of this embodiment of the invention is shown in FIGURE 5. Core component 8 and slub component 9 are fed off bobbins 10 and 11, respectively into a fluid bulking jet 12 of the type described above. Feed of the slub component is controlled by the feed rolls as shown. The resulting composite yarn structure is then fed into the passageway 14 (see cross-sectional view of FIGURE 6, taken along line 6-6 of FIGURE 5)

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of wrapping jet 15 where it is subjected to a blast of fluid entering through orifice 16, which enters passageway 14 tangentially and then the yarn is wound up on roll 17. Alternatively, at high speed operation, a snubber bar 18 may be placed between the two jets, to prevent excessive backing-up of the twist imparted in the wrapping jet into the fluid bulking jet. Tensioner 19 may also be provided to control more definitely the tension on core component 8.

Microscopic views of two such composite yarns are shown in FIGURES 3 and 4, which show bundles 5 and 5' wrapped completely around core members 6 and 6'. The twisted areas generally obscure the entanglement produced but is clearly indicated at 7.

Additional suitable fluid jets include those described in U.S. applications Serial Numbers 604,564, filed August 16, 1956, now Patent No. 2,958,112, 698,103, filed November 22, 1957, and U.S. Patent 2,852,906. Those jets having a forwarding effect on the yarn are particularly desirable. Many of these fluid jets, with proper modification as to design and/or fluid used, are suitable as wrapper jets, it being essential only that the wrapper jet further consolidates the multi-component structure.

By the practice of this invention it is possible to achieve a wide range of variable denier composite yarns of the Dupioni type. Size and character of the individual slubs, frequency of occurrence of slubs, variation of maximum and minimum denier, and the amount of residual bulkiness can be easily controlled and regulated.

Various combinations of relative fluid pressures between the various jet elements may be used to produce variation in the size and length of the discontinuous filament bundles. Similar effects may be achieved by varying the rates of feed of the various components and the tension on the core component during the treating process.

Different rates of overfeed result in varying composite yarn structures and the different operating conditions of the bulking fluid jet and the wrapping jet provide different effects because of the varying extent of interentanglement and interpenetration of the yarn components of the structure. Jet air pressure may be fluctuated during the formation of the composite structure to produce variations in degree of entanglement or during the wrapping to produce variations in degree of wrapping. If intermittent periods of high air pressure are used in processing together a relatively brittle filament yarn component (e.g., glass filaments or some cellulose acetate filaments) and a relatively tough yarn component, the brittle component can be disintegrated and removed from the composite structure at intervals. This method of operation leads to a slub yarn containing discontinuous filaments, without employing a stretching-breaking process. Similar effects can be obtained by using, in place of the above-mentioned brittle filaments, a loosely-constructed staple yarn component of short fiber lengths, which can be broken under high air pressure operation of the jet.

Short range denier variations in the intermediate yarn product (prior to any breaking) of this invention are obtained simply by passing the yarns simultaneously through a fluid jet and then stretching without breaking. Concentrations of effect yarns along the composite yarn length can be accentuated by introducing a pinching or dragging device in the yarn path or by interrupting momentarily the flow of one or more of the yarn components with higher rates of overfeed. Thus, while over a long length, delivery of this component may be constant, there can be short range fluctuations of several hundred percent, and the composite yarn denier will vary correspondingly. Interruption of effect yarn flow can be controlled by such devices as cams, rocker-bar arms, and the like.

Any combination of two, three, or more different synthetic fibers may be used as the component members of the composite yarn. Also, a single type fiber in two

or more different yarn counts or pre-dyed and undyed yarns of the same or different polymers may be used in making up the composite structure. It is also possible, as discussed above, although less preferred, to employ as at least one component, either as a core or slub component, a synthetic staple yarn or naturally occurring fiber such as silk, linen, or even under certain circumstances cotton or woolen yarns. The desired effects are not so readily obtained with these latter combinations and continuous filament synthetic fibers with predetermined breaking elongation characteristics are preferred. Fibers which are already discontinuous respond less readily to the basic process already described, and there is available less flexibility in the range of products which result, but the fine hand of these products makes them highly desirable.

Preferably desirable combinations of components useful in this invention include nylon with rayon; nylon with acrylic fibers; polyethylene terephthalate fiber with rayon, acetate or acrylic fibers; acrylic fibers with rayon or acetate; nylon with silk or glass fibers and similar combinations, which on the basis of the foregoing descriptions, will be apparent to those skilled in the art.

This process may be coupled with other textile treating procedures, such as twisting, drawing or winding.

The following examples illustrate specific embodiments of the invention.

Example I

Two continuous-filament textile yarns are fed simultaneously to a yarn-bulking jet of the type described in U.S. patent application S.N. 604,564, now Patent No. 2,958,112, using air as bulking fluid at sonic velocity. One yarn, a 200 denier, 64 filament blue-dyed cellulose acetate of zero twist, is fed to the jet at 29½ y.p.m. while the other, a 200 denier, 34 filament nylon yarn with ½ turn of Z twist per inch is fed at 57 y.p.m. The yarns are bulked in the jet and the composite structure wound up at 28 y.p.m. The composite structure is rewound on a downtwister with 7 turns of Z twist at 30 y.p.m. In the rewinding process, tension caused by the downtwister breaks the acetate filaments and elongates the nylon filaments, removing all crunodal loops from the nylon. The result is a slub-type yarn with a smooth nylon core, random lengths of discontinuous bulked acetate filaments being intimately interentangled with the nylon core filaments. This composite slub yarn is woven into a plain-weave fabric with a warp of 70-34 "Dacron" polyester fiber yarn to give a material with a pronounced slub effect in which only the slubs are blue.

Example II

The same jet device is used as in Example I. Three following yarn components are employed:

Yarn	Count	Feed Rate, y.p.m.
Pink acetate.....	100-32-0.....	41½.
Do.....	200-64-0.....	57.
White nylon.....	200-34-½ Z.....	100.

The composite bulked yarn is wound up at 30 y.p.m. and then broken as before on a downtwister. Both of the acetate yarns break, but with different frequency, giving a very random slub effect.

Example III

The general procedure of Example I is followed except that in place of acetate yarn an undyed zero-twist yarn of continuous filament polyethylene terephthalate is used. Feed rates to the jet are as described in Example I, except that the feed rate of the nylon component is varied at irregular intervals with a randomly operated rocker arm. The bulky composite yarn is rewound with low tension and the polyethylene terephthalate does not

break during the process. The resulting yarn product contains continuous strands of both nylon and polyethylene terephthalate with the nylon as an effect fiber forming slubs with random distribution during the winding operation because of the excess of the nylon yarn. This yarn is suitable for fabrics containing any type of variable denier bouclé or ratiné. The same procedure is followed using the intermittent tensioner described in U.S. application Serial Number 610,546, filed September 18, 1956, now Patent No. 2,931,090, instead of the rocker arm, and similar results are obtained.

Example IV

As in Example I, two textile yarns are employed as follows:

Yarn	Count	Feed Rate, y.p.m.
Red-dyed acetate.....	150-40-2 Z.....	80.
Undyed nylon.....	70-34-½ Z.....	40.

The product is wound up from the bulking jet at 39 y.p.m. During the bulking-combining process, the air pressure is caused to fluctuate at intervals from 35 p.s.i.g. to 55 p.s.i.g. At the higher pressure, the acetate component breaks up completely and is blown away from the yarn threadline. At lower pressure, the acetate is entangled with the nylon and remains as a slub-component.

Example V

The procedure of Example I is followed, except that in place of the acetate yarn, a rayon yarn, 100 denier, 34 filaments, 2½ Z twist, is used, and in place of the nylon yarn, a polyethylene terephthalate yarn of 70 denier, 34 filaments, ½ Z twist. After breakage, the rayon yarn becomes a slub component on the core of polyester filament.

Example VI

The procedure of Example I is followed, except that the nylon yarn is replaced with an acrylic continuous filament yarn, 200-80-0.3 Z.

Example VII

Two continuous-filament textile yarns are fed simultaneously into an air jet as described in Example I. One yarn, a 75 denier, 24 filament, zero twist navy blue acetate yarn is fed at a rate of 35.5 y.p.m. The other yarn, a 70 denier, 34 filament, ½ Z twist nylon yarn, is fed at a rate of about 425 y.p.m. and removed from the jet at 425 y.p.m. These yarns are treated in the air jet at an air pressure of 35 p.s.i.g. according to the process illustrated generally in FIGURE 7.

The resulting yarn in the jet is momentarily characterized in that the acetate yarn component is intimately entangled with the nylon yarn component, the nylon yarn component constituting a core element. However, as the resulting yarn is removed from the air jet at the wind-up speed of 425 y.p.m., the entangled acetate yarn is broken randomly along its length and is wrapped slightly around the nylon yarn, which has been elongated during its removal from the air jet, to form the final variable denier yarn.

The final yarn is then passed into the ⅛ inch passageway of a wrapping jet. Air is forced into this orifice through a ⅛ inch orifice at a rate of 40 p.s.i.g., tangentially of the 1st orifice. Upon close examination, this yarn shows a plurality of distinct bundles of discontinuous acetate filaments wrapped completely around the nylon yarn. Under a ten power microscope, the discontinuous acetate slubs are seen to be intimately entangled with the nylon yarn core. Some of the individual slubs encircle the nylon yarn core in both S and Z directions, one twist being superimposed over the other.

After inspection, the composite slub yarn is woven

into a plain weave fabric with a warp of 70-34 count polyethylene terephthalate fiber yarn to give a decorative material with a pronounced effect produced by the blue acetate slubs.

Example VIII

The procedure of Example VII is repeated except that a 55 denier, 18 filament, zero twist bright acetate yarn is substituted for the navy blue acetate yarn and a 40 denier and 13 filament, $\frac{1}{2}$ Z twist nylon yarn is substituted for the nylon yarn. The feed rate of the acetate yarn component is 27 y.p.m., the rate of the nylon yarn component and wind-up speed being about 425 y.p.m. The air jet pressure is 55 p.s.i.g., the wrapping jet pressure being the same. Both visual and microscopic examination indicate a similar slub yarn is obtained. When woven into a plain weave fabric with the same polyester yarn, a decorative fabric with a pronounced slub effect is obtained.

Example IX

The procedure of Example VII is repeated except that 40 denier, 20 filament, 2.5 X twist dull rayon yarn is substituted for the acetate yarn and 70 denier, 34 filament, $\frac{1}{2}$ Z twist nylon is used. The feed rate of the rayon component is 52.5 y.p.m., the feed rate of the nylon component being 840 y.p.m. The yarn is removed from the air jet (operating at a pressure of 15 p.s.i.g.) at a wind-up speed of 840 y.p.m. and fed into a wrapping jet operating at an air pressure of 30 p.s.i.g. Again it is noted that the slubs are distinct bundles of discontinuous filaments wrapped completely around the nylon yarn core. Microscopic examination as before shows an intimate interentanglement between the slubs and the core. The right and left twist phenomenon is again noticed.

A plain-weave fabric is prepared as before to provide a decorative material showing the slub effect.

Example X

The general procedure of Example VII is repeated, except that a 60/1 blend of polyethylene terephthalate-acrylic fiber spun yarn (18 Z twist) is substituted for the acetate yarn and 70 denier, 54 filament zero twist polyethylene terephthalate yarn is substituted for the nylon yarn. The feed rate of the spun yarn component is 8 y.p.m., the feed rate of the continuous yarn being 425 y.p.m. The air jet and wrapping jet pressures are 40 p.s.i. and 35 p.s.i., respectively. The wind-up rate of the bulky yarn from the air jet is 56 y.p.m. Visual observation indicates the spun yarn component broken into several distinct filament bundles wrapped completely around the polyester continuous filament core. Free ends are particularly noticeable in this embodiment. Microscopic examination shows very clearly the entanglement of the slub and core components, as well as the free ends. A fabric is woven as before to provide a decorative material of particularly good hand.

Example XI

The general procedure of Example VII is repeated except that 110 denier, 36 filament, zero twist bright acetate is substituted for the navy blue acetate and 210 denier, 34 filament, $\frac{3}{4}$ Z twist nylon is used. The feed rates of the acetate component and nylon component are 27 and 425 y.p.m., respectively. The wind-up speed is 425 y.p.m., the air jet and wrapping jet air pressures being 54 and 44 p.s.i., respectively. Both visual and microscopic examination indicate a similar slub yarn is obtained, although the slubs are just slightly shorter in length than those produced in Example VII. A similar woven fabric is obtained.

Example XII

The general procedure of Example VII is repeated except that 40 denier, 20 filament, 2.5 Z twist dull rayon

yarn is substituted for the acetate yarn and 70 denier, 34 filament, zero twist polyethylene terephthalate yarn is substituted for the nylon yarn. The feed rates of the rayon and polyester yarns are 27 and 425 y.p.m., respectively. The wind-up speed is 425 y.p.m., the air jet and wrapping jet air pressures being 15 and 30 p.s.i., respectively. Both visual and microscopic examination indicate a similar slub yarn is obtained, except that the slubs are slightly shorter as in Example XI. A similar woven fabric is obtained.

Additional suitable fluids for the jet treatments include hot air, steam and inert gases.

This application is a continuous-in-part of my co-pending application Serial No. 799,128, filed March 13, 1959, now abandoned.

While certain embodiments of my invention have been disclosed in detail as required by the patent law, other modifications within the spirit of the invention will occur to those skilled in the art. All such modifications are intended to fall within the scope of the following claims.

I claim:

1. An improved process for preparing a variable denier composite multifilament yarn, said improved process comprising the steps of moving at least two yarn components through a turbulent medium zone, the filaments of one of said yarn components having a relatively low extensibility factor with respect to the other yarn components, said low extensibility yarn component fed at a lower rate of movement than said other yarn components so that a first variable denier composite yarn is formed with said low extensibility yarn as a continuous core component and said other yarn components as a continuous slub component, and then applying sufficient tension to said resultant first variable denier composite yarn to break said low extensibility yarn component and form a second variable denier composite yarn with said other yarn components as a continuous core component and said broken low extensibility yarn as a series of intermittently spaced bundles of discontinuous length filaments interengaged in and along the length of said continuous other yarn core component.

2. The improved process of claim 1 in which the second composite yarn is subsequently subjected to sufficient torque to consolidate the bundles into tight engagement with said continuous other yarn.

3. An improved process for preparing a variable denier composite multifilament yarn, said improved process comprising the steps of moving at least two yarn components through a turbulent medium zone, the filaments of one of said yarn components having a relatively low extensibility factor with respect to the other yarn components, said low extensibility yarn component fed at a lower rate of movement than said other yarn components so that a first composite yarn is formed with said low extensibility yarn as a continuous core component and said other yarn components as a continuous bulked component, and applying sufficient tension to said resultant first composite yarn to break said low extensibility yarn component and form a second composite yarn of variable denier with said other yarn components as a continuous core component and said broken low extensibility yarn as a series of intermittently spaced bundles of discontinuous length filaments interengaged in and along the length of said continuous other yarn core component.

4. The improved process of claim 3 in which the second composite yarn is subsequently subjected to sufficient torque to consolidate the bundles into tight engagement with said continuous other yarn.

5. An improved process for preparing a variable denier composite multifilament yarn, said improved process comprising the steps of moving at least two yarn components through a turbulent medium zone, the filaments of one of said yarn components having relatively low breaking

strength characteristics with respect to the other yarn components, said low breaking strength yarn component fed at a lower rate of movement than said other yarn components so that a first composite yarn is formed with said low breaking strength yarn as a continuous core component and said other yarn components as a continuous bulked component, and applying sufficient tension to said resultant first composite yarn to break said low breaking strength yarn component and form a second composite yarn of variable denier with said other yarn components as a continuous core component and said broken low breaking strength yarn as a series of intermittently spaced bundles of discontinuous length filaments interengaged in and along the length of said continuous other yarn core component.

6. An improved process for preparing a variable denier composite multifilament yarn, said improved process comprising the steps of moving at least two yarn components continuously through a turbulent medium zone, the filaments of one of said yarn components having a lower level of tensile properties with respect to the filaments of the other yarn components, said one yarn component fed continuously into said zone at a lower rate of movement than said other yarn components so that a plurality of lengths of a first composite yarn are temporarily successively formed, with the filaments of said one yarn entangled with and around said filaments of said other yarn components, and substantially immediately after the formation of each successive length of said first composite yarn, applying sufficient tension to said length, by action of the faster moving component, to break the filaments of said one yarn component and convert each said length successively to a final composite yarn of variable denier with said other yarn components as a continuous core component and said broken one yarn component as a series of intermittently spaced bundles of discontinuous length filaments interengaged in and along the continuous other yarn core component.

7. An improved process for preparing a variable denier

composite multifilament yarn, said process comprising the steps of directing a moving high velocity stream of a fluid medium into an enclosed zone to create therein a high degree of turbulence, passing a first yarn component through said zone, feeding said first yarn component into said zone at a rate sufficiently greater than the rate at which said first yarn is removed from said zone to permit the filaments of said first component to open up a limited amount in the turbulence of said zone, concurrently maintaining a sufficient level of turbulence and feeding a second yarn component into said zone, at a rate significantly less than the rate of removal of said first yarn component from said zone, into engagement with said opened up filaments of said first moving component so that said incoming filaments of said second yarn component continuously become entangled with and around said opened up moving filaments of said first component and then become randomly continuously broken off from the incoming second yarn component due to the difference in rates of yarn component movement to form a single composite variable denier yarn with said first yarn component as a continuous core element and said broken lengths of said filaments of said second component as intermittently spaced groups of discontinuous lengths interengaged in and along said continuous core element.

8. The improved process of claim 7 in which the final composite yarn is subsequently subjected to sufficient torque to consolidate the bundles into tight engagement with the continuous core element.

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