

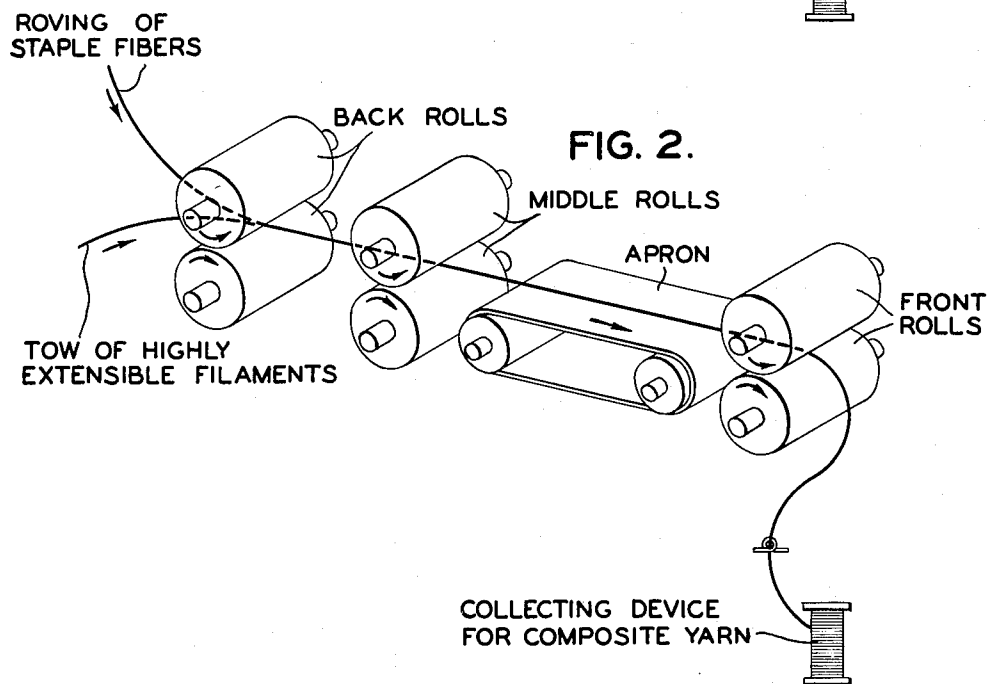
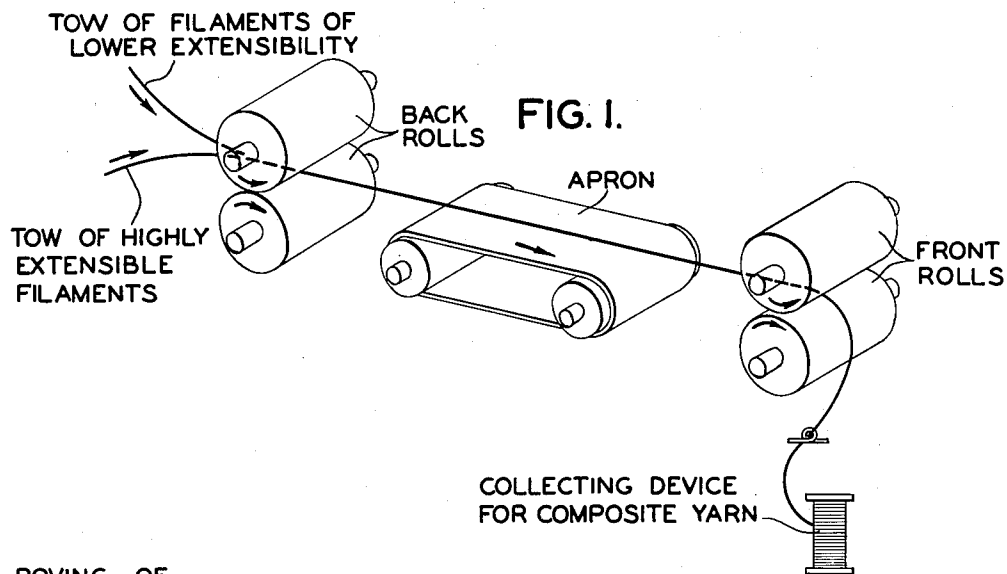
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COMPOSITE FILAMENT AND STAPLE YARN

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1

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COMPOSITE FILAMENT AND STAPLE YARN

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The present invention relates to novel composite yarns and to a method of producing them. More particularly, the invention relates to final yarn products containing both continuous filaments and staple fibers resulting, in a preferred form, from drawing filaments of different characteristics whereby some of the filament components are extended and become highly oriented and others become converted to staples. Filaments and rovings (staples) may also be used. In these new yarn products the staple fibers become firmly anchored to the filaments, giving a final stabilized yarn product having the appearance and feel of a spun staple yarn but with the superior properties of a filament yarn.

Many attempts have been made heretofore to produce a composite or combination yarn made up of continuous filaments and staple or spun fibers. In spite of the advantages that should result from the combination of the high tensile strength properties of a yarn of continuous filaments and the hand, appearance and dyeing characteristics of a staple or spun yarn, no such yarns have met with commercial success. Up to the present time attempts to produce a so-called composite yarn have been unable to eliminate in the yarn the tendency of the staple components to be easily peeled off or be stripped from the continuous filament components. Another disadvantage has been an uncontrolled elongation with respect to each of the yarn components. As a result of an uncontrolled and unbalanced relationship between the yarn components, a yarn having a different breaking point for each of the components results. Such a condition is known as a double break. A yarn of this type is inherently a weak yarn.

It has now been found that it is possible to produce a new composite yarn that does not possess these known disadvantages. The new yarn has high tensile strength, uniform break, high resistance to stripping and good hand, appearance and dyeing characteristics.

The method of producing the new yarns consists essentially of doubling a tow of incompletely oriented, continuous and highly extensible filaments with an assemblage of potential yarn components, which term is intended herein to include a tow or yarn of filaments of substantially lower extensibility and a roving of staple fibers. The doubled material is then drafted to extend and highly orient but not break the filaments of the previously highly extensible incompletely oriented tow; the drafting, however, being sufficient to break into staple form the lower extensible filament; then twisting these doubled and drafted filaments and staples to form a composite yarn which combines and interlocks the continuous filaments and staple fibers.

The relatively unoriented, highly extensible filaments used in practicing the present invention may be any that have the property of being extensible to a high degree, i. e., of the order of more than about 100% preferably between 400–800% although the maximum extensibility may be as high as 2800%. Filaments which are suitable for my invention are nylon, a synthetic polymeric amide;

2

"Vinyon-N", a copolymer of vinyl chloride and acrylonitrile; polyethylene; "Orlon", a polymer of acrylonitrile; saran, available as "Permalon" and "Velon", polymers and copolymers of vinylidene chloride; and "Dacron", a polyester of terephthalic acid and ethylene glycol.

It is known that in a filament of this type, long chain molecules are distributed more or less at random relative to the axis of the filament. When the filament is first spun, the molecules are oriented to a minimum but nevertheless perceptible degree. As the filament is stretched, more and more of the long chain molecules become oriented with their axes parallel to the axis of the filament until a maximum degree of orientation is attained. Filaments in which the molecules are highly oriented, i. e., oriented to a maximum degree, possess high tensile strength. This is apparently due to the parallel alignment of the molecules and the consequently increased intermolecular friction. Filaments wherein the molecules are oriented a substantially less than maximum degree, a condition referred to herein as "relatively unoriented" or "incompletely oriented", are "highly extensible" in the sense in which this term is used in this description in that they may be extended in length at least 100% to 800% or even considerably higher without breaking. Unstretched "Vinyon-N" filaments, for example, may be stretched as much as 2500%, at elevated temperatures, without breaking.

In accordance with this invention, the tow of highly extensible filaments may be doubled and drafted with a tow or yarn of filaments of substantially lower extensibility, i. e., having an extensibility of no more than about 50% the extensibility of the highly extensible filaments. The filaments of high and low extensibility may be of the same or different material, the only requirement being that the filaments of low extensibility be no more than about half as extensible as the highly extensible filaments. The filaments of low extensibility may, for example, be partially or completely oriented nylon, "Vinyon-N", polyethylene, "Orlon", saran, "Permalon", "Velon", or "Dacron", or of viscose, cellulose acetate, "Fortisan", a particular regenerated cellulose, i. e., highly oriented cellulose acetate converted into cellulose by saponification, and the like.

The tow of highly extensible filaments may also be drafted and doubled with a roving of staple fibers, such as cotton, wool, and "Vicara", a regenerated protein fiber produced from zein by the Virginia Carolina Chemical Company, as well as with a roving of any of the previously mentioned materials in staplized form.

The drafting operation is conducted in such a manner as to orient more completely the highly extensible filaments without breaking them, while staplizing by drawing and breaking the less extensible continuous filaments or while drawing out the roving of staple fibers. The twisting operation may be carried out before, after or simultaneously with the drafting, prior or later twisting being preferred because it can be carried out more readily on existing textile processing machinery. The drafting can be done to constant tension, constant elongation or a combination of both. Most extensible filaments are best drawn at a constant rate of elongation and each type has an optimum rate of elongation dependent upon the ambient temperature and humidity conditions.

Another important feature of this invention is the relationship between the components making up the composite yarn. Obviously, the differences in extensibility must be such that the highly extensible yarn does not break before the staplizing of the lowly extensible yarn. Also the difference in extensibility must be such that the highly extensible yarn becomes oriented when the drafting completes the staplizing of the tow or yarn of low extensibility. In certain cases it may be desirable to extend the highly

3

extensible filaments in some degree prior to the joint drafting in order to obtain the desired orientation of the highly extensible filaments and to avoid extended distribution of the staples. Another important factor is the component relationship whereby the drafting results not only in the desired orientation and staplizing and interweaving of filaments and staples but gives an end product in which the breaking points of the components are equivalent. This invention results in a composite yarn of great strength, of greater elongation at the break than an equivalent spun yarn, and one of improved stripping characteristics.

The degree of orientation of any given continuous filament at which it possesses its maximum tensile strength is known, or if not known, is readily determinable by those skilled in the art. It is likewise within the skill of the art to determine the breaking points of a yarn of any given continuous, oriented filaments and of a yarn of staple fibers if such breaking points are not already known. For optimum results in accordance with the principles of this invention, a tow of highly extensible filaments and a tow of less extensible filaments or roving of staple fibers are so selected for codrafting and twisting that the breaking point of the oriented filaments in the resulting composite yarn will be substantially equal to or greater than the breaking point of the staplized or staple fiber component and the tensile strength of the oriented filaments will be at a maximum. By proper selection of the codrafted assemblage of highly extensible filaments and lowly extensible filaments or staple fibers, a composite yarn having substantially a single break upon tensioning to the breaking point is obtained as a result of the codrafting.

Two typical arrangements for carrying out the method of this invention are illustrated, by way of example only, in the accompanying drawing wherein:

Figure 1 is a diagrammatic view of an arrangement of apparatus for codrawing two tows of continuous filaments, one tow containing filaments of substantially higher extensibility than the other; and

Figure 2 is a similar view of an arrangement of apparatus for codrawing a tow of continuous filaments with a roving of staple fibers.

One of the primary advantages of the product of this invention is that it combines the desirable high strength characteristics of oriented continuous filament yarns with the hand, appearance, dyeing characteristics and weaving properties of staple yarns. The composite yarn of this invention has a construction resisting the peeling back of the staple components from the continuous components.

The primary advantages of the method of the invention reside not only in the simplicity of the operation but also in the ability to use directly unoriented and undrafted filaments of polymeric materials. This is a considerable advantage inasmuch as it permits the textile manufacturer to carry out operations within his field utilizing products of lower cost than predrawn filaments. Also the capacity of the chemical manufacture is limited by the capacity for drafting and orienting the filaments which they produce. This invention therefore acts to increase the available supply of finished textile fibers.

These advantages, as well as the objects and utility of the invention, will become more apparent from the following examples which are intended to illustrate a number of typical embodiments of the invention.

Example 1

An untwisted tow of 34 non-elongated nylon filaments having a total denier of 1065 was supplied to a tow spinning frame and adjacent to it was placed a package of a 4400 denier viscose tow containing approximately 1470 filaments. The two tows were directed to a common back roll of the spinning frame, over the apron and through the front rolls, which were nine inches from the back rolls. Conventional methods of starting the tow spinner were followed, which may include taking the

4

doubled filaments to a common spindle. The front rolls were operated at approximately five times the peripheral speed of the back rolls so that the elongation of the tows was in the neighborhood of 400%. After the drawing operation, the yarns were given a twist of approximately $2\frac{1}{2}$ turns per inch.

It was found that the nylon filaments were substantially continuous and highly oriented and that the viscose fibers varied in length from a fraction of an inch up to about nine inches, i. e., the distance between the rolls. The viscose fibers were firmly anchored to the nylon filaments and resisted efforts to peel them back.

Example 2

An untwisted tow of 240 non-elongated "Vinyon-N" (Grade NOHI-125) having a total denier of 650 was supplied to a tow spinning frame and adjacent to it was placed a package of a 2200 denier viscose tow containing approximately 735 filaments. The two tows were directed to a common back roll of the spinning frame, over the apron and through the front rolls which were nine inches from the back rolls. The ambient temperature was maintained at between 70 and 90° F. Conventional methods of starting the tow spinner were followed, which may include taking the doubled filaments to a common spindle. The front rolls were operated at approximately 2.2 times the peripheral speed of the back rolls so that the elongation of the tows was in the neighborhood of 120%. After the drawing operation, the yarns were given a twist of approximately $2\frac{1}{2}$ turns per inch.

The yarn produced possessed a tensile strength considerably higher than the tensile strength of a similar size yarn prepared from tow spun viscose alone and the properties of the yarn with respect to dyeing, handle, appearance, etc., were found to be substantially those of viscose.

Other types of "Vinyon" yarns can be drawn and oriented to a high degree at temperatures of about 130° C. However, if such temperatures are not used the yarns may be used as those of low extensibility having a range of 20-30%. Cellulose acetate yarns are of an even lower order of extensibility.

Example 3

An untwisted tow of 34 non-elongated nylon filaments having a total denier of 452 was supplied to a tow spinning frame and adjacent to it was placed an untwisted tow of 34 nylon filaments prestretched 480% and having a total denier of 1065. The two tows were directed to a common back roll of the spinning frame, over the apron and through the front rolls, which were nine inches from the back rolls. Conventional methods of starting the tow spinner were followed, which may include taking the doubled filaments to a common spindle. The front rolls were operated at approximately five times the peripheral speed of the back rolls so that the elongation of the tows was in the neighborhood of 400%.

The prestretched nylon filaments were broken into staples up to about nine inches in length and were uniformly distributed along the length of the yarn produced. The yarn had the general characteristics of tow spun nylon as far as physical appearance, handle, etc., are concerned but possessed a strength higher than the strength exhibited by tow spun nylon yarn of the same denier. Furthermore, the yarn was made with a twist multiplier lower than is possible with spun nylon alone. This is a distinct advantage in that lowered twist contributes to higher loft and consequently better covering power when such yarns are woven into fabrics. It also simplifies the manufacture of napped or brushed fabrics.

Example 4

A 20 filament tow of non-elongated polyethylene having a denier of 700 was supplied to a conventional cotton spinning frame co-incidentally with a nylon roving

of 1.5 denier, 1.5" staple and the two were carried together to the middle roll of the frame, over the apron and through the front roll. The peripheral speed of the front rolls was approximately 480% of the speed of the middle rolls and the composite yarn was collected on a single spindle after being twisted approximately $3\frac{1}{2}$ turns per inch.

The yarn thus produced showed remarkable elasticity, low twist and normal textile processing properties. A yarn of 4.87 number (cotton system) was obtained which showed a tensile strength of 1422 grams and an elongation of 65% at break. The yarn thus produced was woven into construction typified by soft filled sheetings of a count 42 W x 40 F. This soft filled sheeting was napped completely in only two passes through a napper whereas several more passes would normally be expected to be required to produce a nap of equal quality and produced a soft open textured flannel with surface fibers almost wholly composed of nylon. When placed in boiling water, this fabric shrank almost instantaneously to provide to produce a fabric of 62 W x 42 F count.

Example 5

A 20 filament tow of non-elongated polyethylene having a denier of 700 was supplied to a conventional cotton spinning frame co-incidentally with a five hank roving of $1\frac{1}{8}$ " staple cotton and the two were carried together to the middle roll of the frame, over the apron and through the front roll. The peripheral speed of the front rolls was approximately 480% of the speed of the middle rolls and the composite yarn was collected on a single spindle after being twisted approximately $3\frac{1}{2}$ turns per inch.

Yarns thus produced showed remarkable elasticity, low twist and normal textile processing properties. Yarns of 5.7 number (cotton system) were obtained which showed uniformly a tensile strength of 850 grams and an elongation of 22.2% at break. The dyeing properties were distinctly those of cotton.

Example 6

A 5 filament tow of non-elongated polyethylene having a total denier of 365 was supplied to a conventional cotton spinning frame co-incidentally with a seven hank roving of $1\frac{1}{16}$ " staple cotton and the two were carried together to the middle roll of the frame, over the apron and through the front roll. The peripheral speed of the front rolls was approximately five times the speed of the middle roll and the composite yarn was collected on a single spindle after being given a twist multiplier of 4.00 to produce a yarn of 24s single (calculated). The yarn thus produced had considerable elasticity, low twist and normal textile processing properties. However, due to some residual contraction in the polyethylene the yarn number was actually 21 singles. The singles yarn was plied to produce a 3-ply yarn.

Example 7

A 20 filament tow of non-elongated polyethylene having a denier of 700 was supplied to a conventional cotton spinning frame co-incidentally with a "Vinyon-N" roving of 3 denier, 1.5" staple and the two were carried together to the middle roll of the frame, over the apron and through the front roll. The peripheral speed of the front rolls was approximately 480% of the speed of the middle rolls and the composite yarn was collected on a single spindle after being twisted approximately $3\frac{1}{2}$ turns per inch.

The composite yarn thus prepared possessed, in addition to the desirable properties of high strength, good hand, appearance and the like, the property of being non-inflammable.

The composite yarn thus produced was woven into a fabric, napped and then shrunken in boiling water. The

highly napped fabric thus produced would not burn and did not suffer from flash fire hazards.

It is to be understood the foregoing examples are merely illustrative and that many variations and changes will occur to those skilled in the art upon reading this description. All such changes and variations are intended to come within the scope of the invention as defined in the appended claims.

I claim:

1. A method of producing a composite yarn having the appearance of a staple yarn, which comprises doubling and codrafting a tow of incompletely oriented, continuous and highly extensible filaments with an assemblage of potential yarn components; said drafting operation being sufficient to elongate permanently by at least about 100% and highly orient but not break the filaments in the previously incompletely oriented filaments; and twisting the yarn thus produced.

2. A method of producing a composite yarn having the appearance of a staple yarn, which comprises doubling a first tow of incompletely oriented, continuous and highly extensible filaments with a second tow of continuous filaments of substantially lower extensibility, drafting the doubled tows to elongate permanently by at least about 100% and highly orient but not break the filaments in the first tow and to break the filaments in the second tow, and twisting the yarn so produced.

3. A method of producing a composite yarn having the appearance of a staple yarn, which comprises doubling a first tow of incompletely oriented, continuous and highly extensible filaments with a second tow of continuous filaments having an extensibility substantially no greater than about half the extensibility of the highly extensible filaments, drafting the doubled tows to elongate permanently by at least about 100% and highly orient but not break the filaments in the first tow and to break the filaments in the second tow, and twisting the yarn so produced.

4. A method of producing a composite yarn having the appearance of a staple yarn, which comprises predrawing a tow of highly extensible, unoriented filaments an amount insufficient to orient them completely, doubling said predrawn tow with a tow of continuous filaments having an extensibility substantially less than the extensibility of the incompletely oriented filaments, drafting the doubled tows to elongate permanently by at least about 100% and highly orient but not break the filaments in the first tow and to break the filaments in the second tow, and twisting the yarn so produced.

5. A method of producing a composite yarn having the appearance of a staple yarn, which comprises doubling a first tow of incompletely oriented, continuous and highly extensible filaments having a given breaking point after elongation by a given amount with a second tow of continuous filaments of substantially lower extensibility having a breaking point substantially equal to said given breaking point after staplization and elongation by said given amount, drafting the doubled tows to elongate them said given amount to highly orient but not break the filaments in the first tow and to break the filaments in the second tow, and twisting the yarn so produced.

6. A method of producing a composite yarn having the appearance of a staple yarn, which comprises doubling a first tow of incompletely oriented, continuous and highly extensible filaments with a second tow of continuous filaments of substantially lower extensibility, drafting the doubled tows an amount sufficient to elongate permanently by at least about 100% and orient and impart maximum tensile strength to the filaments in the first tow without breaking them and to break the filaments in the second tow, and twisting the yarn so produced.

7. A method of producing a composite yarn having the appearance of a staple yarn, which comprises doubling a tow of incompletely oriented, continuous and highly ex-

tensible filaments with a roving of staple fibers, drafting the doubled tow and roving to highly orient but not break the filaments in the tow, and twisting the yarn so produced.

8. A method of producing a composite yarn having the appearance of a staple yarn, which comprises predrawing a tow of highly extensible, unoriented filaments an amount insufficient to orient them completely, doubling said predrawn tow with a roving of staple fibers, drafting the doubled tow and roving to highly orient but not break the filaments in the tow, and twisting the yarn so produced.

9. A method of producing a composite yarn having the appearance of a staple yarn, which comprises doubling a tow of incompletely oriented, continuous and highly extensible filaments with a roving of staple fibers, drafting the doubled tow and roving an amount sufficient to orient and impart maximum tensile strength to the continuous filaments without breaking them, and twisting the yarn so produced.

10. A low twist, composite yarn combining the high strength characteristics of oriented continuous filament

yarns with the hand, appearance, dyeing characteristics and weaving properties of staple yarns, said composite yarn comprising a number of highly oriented, continuous filaments and a plurality of staple fibers firmly anchored thereto and resistant to peeling, the continuous filaments and staple fibers having substantially a single break, upon tensioning to the breaking point.

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