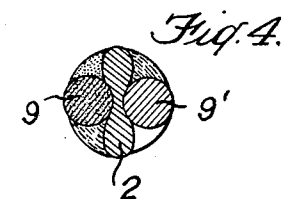
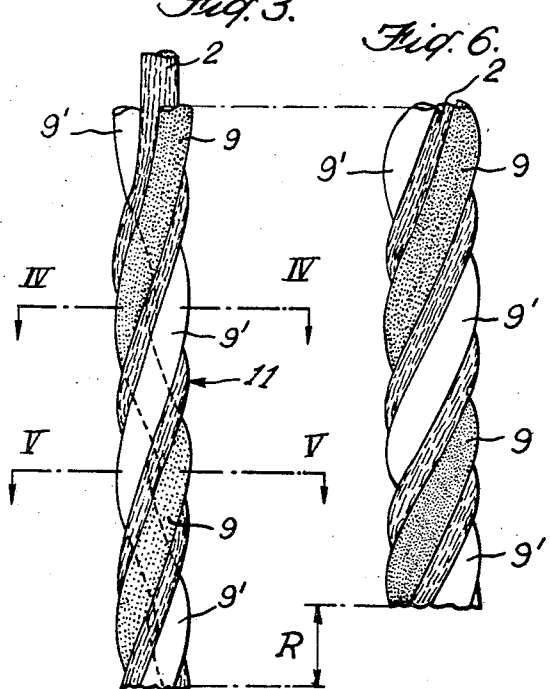
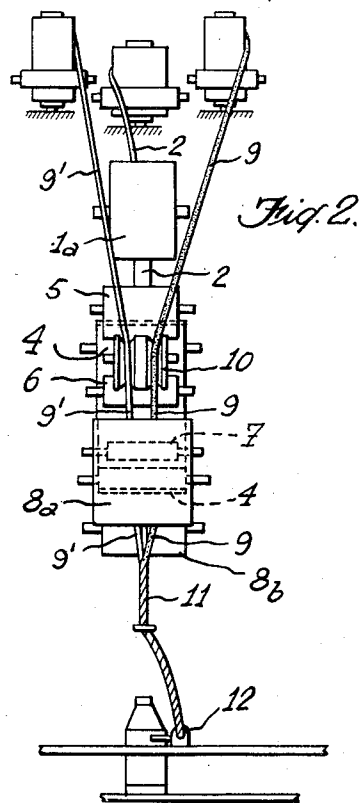
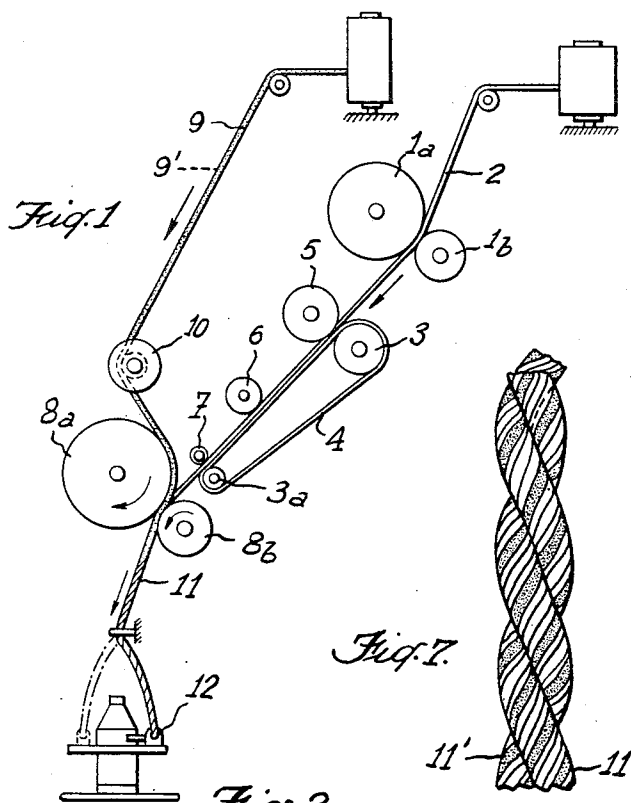


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M. MASUREL
COMPOSITE CORE YARN
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COMPOSITE CORE YARN

Michel Masurel, 25 Bis Rue de Triez,

Wasquehal, Nord, France

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3 Claims. (Cl. 57-140)

This invention relates to a composite yarn and to the process for making the yarn, this application for patent being a continuation-in-part of my pending application Serial No. 754,353, filed August 11, 1958, now abandoned.

Various types of composite thread assemblies have been proposed in the past, comprising combinations of threads or yarn of different character assembled with the purpose of providing some specific advantage or appearance not attainable by the use of a single thread or yarn. Thus, one well-known example of a composite thread assembly is the combination of a rubber core with a textile thread covering wound therearound to provide an elastic thread assembly. Other examples include a worsted core with one or more silken threads coiled or braided therearound. Composite thread assemblies of the type just indicated are examples of a broad family characterized by having a core of one material and a covering made of one or more threads of other material coiled therearound, and the general purpose is to provide a thread assembly having tensile characteristics similar to those of the core and surface characteristics similar to those of the covering.

Similar assemblies have more recently been provided using both natural and synthetic fibre. For example, cores of polyamide have been provided with worsted or silken covering in order to provide a composite thread having the very high tensile strength of polyamides and the more attractive feel and aspect of the natural fibre used.

Concurrently with the development of composite threads of the natural and synthetic type just mentioned, there has recently been developed a so-called texturizing technique whereby continuous synthetic or artificial (man made and which will be termed "synthetic" in the following description) threads or yarns are modified by mechanical, physical and/or chemical treatments serving to impart a rough surface texture to the thread. The texturizing treatment may comprise opening up or spreading out the fibres by means of a blast of compressed air or the like, or crimping the fibres by a twisting-and-un-twisting process associated with a stabilising heat treatment, or further by a crimping treatment relying on mechanical and/or physical steps, e.g. heating steps.

In such "texturized" synthetic yarn products, the original physical and mechanical properties of the thread are considerably modified, due to the spreading and/or crimping or curling of the individual strands of the yarn filaments, tending to increase the thickness and volume while reducing the initial length of the yarn in relaxed condition.

Further attempts have been made in the past to produce synthetic thread products having properties bringing them into closer resemblance with natural fiber products, and thereby to provide simultaneously the high mechanical characteristics, i.e. tensile strength, of the former while imparting thereto some of the desirable features of the natural products, including inter alia high stretch and a high heat isolation power. Thus, composite threads of the general class mentioned above have been provided wherein natural fibers are associated as covering around a core of texturized synthetic thread. In one recently developed product of this type, instead of twisting a covering thread around a continuous core

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thread, the constituent thread elements of the composite thread product have been twisted simultaneously around one another, thus providing a distinctly different final composite assembly. These composite assemblies as heretofore produced, have generally comprised a roving or sliver of discontinuous fiber twisted together with a single continuous, texturized synthetic thread.

While the composite assembly thus produced had a number of outstanding advantages, it possessed certain disadvantages. The chief of these was that the loose fiber of the roving constituent of the composite assembly was not adequately held in position by the synthetic thread twisted therewith so that the strands of fibers of the roving tend to come loose and the resulting composite thread assembly lacks cohesion. This defect has been present regardless of the degree of twist and of pinching imparted during the twisting operation.

It is an object of this invention to provide a novel composite thread assembly of the general type described, which will have greatly improved characteristics, and specifically one that will possess substantially increased cohesion as compared to generally similar composite threads heretofore produced.

An object of this invention is to produce a yarn which will have the feel and coverage of yarns spun from natural fibers such as wool, and will have the tensile strength of yarns composed of synthetic continuous filaments.

According to the present invention at least two continuous synthetic filament yarns are used with the roving in the middle and the twisting is about the central longitudinal axis of the roving. The roving is drawn down to a size such that it intertwines or twists with the synthetic yarn strands and is effectively contained throughout as a narrow band between the helical turns of two synthetic yarns. At the same time, the twisted roving is exposed at its edges as a double helix around the surface of the composite yarn and gives the desired feel to the yarn. Preferably the size of the roving is such that its transversal section is no greater than that of the synthetic yarn components. Thus the roving is in effect squeezed between two synthetic yarns and is made to extend across the composite yarn and be exposed on both edges while being contained between the synthetic yarns on both sides of its axis.

The roving, or discontinuous thread constituent, may comprise natural fiber such as wool or other animal or vegetable fiber, or it may comprise synthetic fiber such as fiber spun "Viscose" or cellulose acetate, regenerated cellulose, protein, polypeptides, and the like, or such synthetic fiber as polyamide, polyesters, polyacrylonitrile, polyurethane, polyvinyl chloride, or polyolefines (such as polyethylene, polybutylene, polypropylene); inorganic fiber such as glass fiber, asbestos fiber, or the like, may also be used.

The continuous threads of the assembly may also be made from any of the types of fiber enumerated in the above list insofar they are continuous. Desirably, the said threads may comprise texturized synthetic yarn.

In accordance with an important feature of the invention, the initial relative arrangement of the constituent elements of the assembly prior to the twisting process is of considerable importance in order to achieve the desired clamping action on the loose roving fiber in the final assembly. Thus, as will later appear it is important that the roving be initially positioned between the two continuous threads and parallel thereto.

The composite twisted thread product resulting from the method thus described is basically different from any of the generally analogous composite assemblies heretofore provided, including that comprising a fiber roving twisted with a single continuous thread as referred to above. That is, the provision according to the invention

of the pair of continuous threads lying on opposite sides of, and twisted with, the roving results in a strong clamping and retaining action being applied to all the loose strands of the roving fiber, even when the degree of twist used is relatively low; at the same time however, the pinching action of the continuous threads on the strands of roving serves to dishevel the fibers of the roving and to straighten them out away from the longitudinal direction axis of the thread thereby imparting a shaggy, wooly or pile-like character to the product.

Thus it can be said that in composite threads heretofore known, either the core was entirely surrounded and concealed by the covering, as in covered thread, or else where a continuous thread was twisted with a roving constituent, the roving fibers were inadequately held down since they were not subjected to any clamping action and the assembly thus lacked cohesion. In the improved composite thread of the invention in contrast, the continuous yarn constituents can be looked at as being imbedded in a mass of discontinuous fibers, for which they provide a kind of flexible and resilient reinforcement, while the roving fibers, in which said continuous yarn is imbedded and concealed, impart a wooly or shaggy feel and aspect to the assembly.

From a careful investigation of the novel composite assemblies, especially carried out on large-scale samples comprising large constituent elements, it appears that, even though the composite thread cannot be said to include a core in the strict sense, still the discontinuous fibers or roving constituent, thereof, does in an important sense perform the function of a core, this core however being broken up by the pressure of the surrounding yarn wound therewith, into a number of radially, protruding fiber portions, all of which remain solidary with one another. More specifically, it can be said that the twist imparted to the three constituents of the composite thread, namely the discontinuous fibers element or roving and the two continuous texturized (e.g. nylon) threads in opposite sides thereof, results in providing a helically wound structure in which the three said constituent elements are alternately brought into juxtaposed relation, so that if one were to follow a longitudinal line or a generatrix of the composite thread, he would successively encounter a continuous yarn, a roving section, and a continuous yarn; and then again a continuous yarn, a roving section and a continuous yarn, and so on repeatedly. In this way, along each generatrix of the assembly there are found to occur pairs of continuous threads separated by roving sections of discontinuous fibers, with the latter being clamped between the continuous threads and being clamped thereby to stand out radially from the major portion of the surface of the composite thread assembly.

The main advantages of this condition are two-fold. First, the feel and aspect of the novel thread product are considerably enhanced; and at the same time the product possesses quite exceptional strength, both because of the high tensile strength of the continuous yarn (e.g. nylon) reinforcement, and because of the improved cohesion of the product as a whole and the firm bond of the roving fibers distributed in sections therebetween. In this connection it is important to observe that such a distributed condition of the roving fibers and consequent firm bond thereof would not be present if the discontinuous fibers roving were not initially disposed between the continuous threads.

As earlier indicated, it is preferred that the continuous threads used be texturized synthetic or artificial threads, since this will provide improved elasticity, and improved bonding action, and a softer and more "downy" character in the final product, together with high tensile strength and all of the remaining advantages specific to the invention noted above. However, it is not essential that the said continuous threads be texturized synthetic or artificial threads. Thus, any of various synthetic threads may be used preferably having some elasticity or stretch, e.g. due

to their inherent physico-chemical nature or to some treatment applied thereto, e.g. the use of non-oriented crystal structure or due to the shape of the spinning orifice used. It will be understood moreover that natural or synthetic yarns not necessarily possessing any special elastic properties may also be used.

The process and the product will now be described with reference to the accompanying drawings which illustrate one type of apparatus suitable for performing the process, and one embodiment of the product of the invention.

FIG. 1 is a diagrammatic side view of an apparatus for performing the process.

FIG. 2 is a diagrammatic front view of the same.

FIG. 3 is an enlarged elevation of a short length of composite yarn embodying the invention.

FIG. 4 is a slightly enlarged transverse section of the same on line 4-4 of FIG. 3.

FIG. 5 is a slightly enlarged transverse section of the same on line 5-5 of FIG. 3.

FIG. 6 is a view similar to FIG. 3 showing the said length of composite yarn when bulked, and,

FIG. 7 is an enlarged elevation of a short length of a commercial product comprising two composite yarns of FIG. 3 plied together.

Feed rolls 1a and 1b draw a roving 2 of parallel staple fibers, such as wool fibers, from its package and deliver it to a drafting section comprising cylinders 3 and 3a, belt 4 mounted thereon, and cylinders 5, 6 and 7 cooperatively engaging the belt to advance a roving passing between them and the belt. From there the roving is fed into the bite of feed rollers 8a and 8b which are caused to rotate at a controlled, slightly greater peripheral rate than that of the rollers 1a and 1b for the purpose of drawing the roving to the size desired.

As best shown in FIG. 2, two continuous filament yarns 9 and 9' are simultaneously fed with the roving to the delivery rolls 8a and 8b, being directed by a guide pulley 10. This pulley has two peripheral grooves which are positioned to receive and direct the yarns 9 and 9' respectively, into the bite of feed rollers 8a and 8b immediately adjacent and on opposite sides of the roving 2.

The nature and composition of the continuous filament yarns 9 and 9' will vary with the desired characteristics of the finished product. As started, it is for many purposes desirable that these yarns be texturized, as by crimping in apparatus disclosed in United States Patents Nos. 2,758,357 and 2,758,358 of August 14, 1956, nylon yarn so texturized being the commercial "Ban-Lon" and "Textralized" yarn referred to above.

From rollers 8a and 8b the three component strands comprising the roving 2 and the two texturized nylon yarns 9 and 9' are fed into a ring twister of spinning device and are twisted together into the composite yarn 11 and then wound on to a receiving spool or bobbin as shown in the drawings. The strands are, of course, under tension in this operation of withdrawing from their packages and during the drawing of the roving and the twisting and rewinding operation of the traveler 12. This tension extends the nylon yarns 9 and 9' into straight yarns free of apparent crimp, but this yarn retains the inherent tendency to contract and resume its crimped configuration which it will do when it is relaxed and is subjected to the proper treatment, such as being heated or soaked in warm water and then dried while free of restraint.

The composite yarn 11 is shown in enlarged detail in FIGS. 3, 4 and 5. The staple fibers of the roving enter between the feed rolls 8a and 8b free of twist and as the three strands emerge from the bite of the feed rolls they are twisted together in the same direction by the rotation of the traveler around the bobbin. The loose nature of the staple fibers allows the roving to be flattened out or spread as it is squeezed between the yarns 9 and 9', as shown particularly in FIGS. 4 and 5. The con-

tinuous filament yarns 9 and 9' become partially impressed into the roving at its transverse center and to force the fibers of the roving in substantially equal volume on opposite sides of the diameter intersecting the centers of the continuous filament yarns. The roving is thus exposed on its two helical edges but is substantially contained between the yarns 9 and 9'. Hence the composite yarn has a high degree of cohesion while the roving is sufficiently exposed at its two edges to give the desired soft and wooly feel to the yarn.

The continuous filament component yarns 9 and 9' may be and preferably are of the same composition and appearance but in the drawings one of them, namely, yarn 9, is shown stippled, while the roving 2 is surface marked to indicate its composition of short fibers. It will be understood that this is for more clearly distinguishing the component strands throughout their helical twistings. FIGS. 4 and 5 represent sectional views in which the component strands have 180° difference in twist.

The commercial yarn may be formed by plying together two or more composite yarns such as shown in FIG. 3. Thus, composite yarn 11 may be plied with the composite yarn 11' delivered by another spinning frame, as shown in FIG. 7. The component strands of the two plied yarns will preferably have the same twist both in number per unit of length and in direction. The ply twist will be opposite to that of the individual composite yarns.

The bulking of the yarn may be done before or after knitting or weaving, and is effected by causing a shrinkage of the yarn as indicated in FIG. 6. It may be obtained, for example, by passing the yarn in an oven at 100° C. for five minutes, or by soaking the yarn or fabric in lukewarm water and allowing it to shrink as it dries. Yarn within the usual denier range in which the nylon components are texturized will have a shrinking capacity of from 8 to 15%.

The twists, that is, the turns per unit of length, will depend upon the desired characteristics and will vary with the denier. In general, it may be said that the twists per meter are proportional to the square root of the metric number of the yarn, that is, the square root of the ratio of the denier of the yarn to an arbitrary quantity, e.g., 9000. Thus for a 200 denier yarn the metric number is 45. The square root of this quantity multiplied by a proportionality constant which is the coefficient of twist determines the twists per meter. For example, with a 200 denier yarn and a coefficient of twist of 65, the twists per meter will be about 440 or a little more than 10 per inch. This will obviously vary with the denier.

The proportion of the continuous yarns and of the roving is determined by the desired characteristics of the composite yarns and by the use to which it is to be put, that is, whether weaving or knitting or other mode of use. The variations from approximate equality will depend on the metric number and bulking capacity desired as well as the desired feel. As a rule a range of proportions of 30/70 to 70/30 of both types of constituents (in volume during the operation of the process but before shrinking) has been found appropriate.

It is found that the strength of the composite yarn is substantially higher than that of the identical twist yarn in the absence of the roving constituent. The yarn is characterized by absolute evenness and a good loft, these properties making possible the employment of the yarn to make light articles of clothing which are nevertheless warm and comfortable. The yarns are soft, strong and resistant to pilling and articles of wear made from fabric woven or otherwise fabricated from this yarn have excellent stability with no tendency to lose their shape when worn or washed.

As mentioned, preferably the continuous threads used are substantially stretchable or elastic, e.g. by the use of texturized nylon yarn, and as a result the composite thread as a whole will possess substantial elasticity, at the same

time as having the high tensile strength of the continuous yarn used.

It is emphasized that the use according to the invention of two (or more) continuous yarn elements one on each side of the roving element, results in a final assembly having entirely different characteristics from those of the conventional assembly comprising a roving and single thread twisted together. In particular, in this conventional assembly owing to the absence of any clamping forces acting on opposite sides of the roving for the assembly of the invention, there is a high tendency for the strands of fibers of the roving to be rapidly loosened and shredded out in response to normal service friction, resulting in rapid disintegration. This defect is completely absent in the improved three-element assembly of the invention for the reasons already explained.

The two (or more) continuous yarn constituents in the assembly of the invention are not necessarily similar, but may differ as to their nature and/or treatment, e.g. texturization; further the two threads may each be twisted preliminarily to assembly, e.g. in opposite directions.

In addition to the previously described advantageous features, the novel composite threads of the invention may have a high degree of shrinking and swelling capacity, owing to the manner in which they are formed. This shrinking capacity depends on the tendency of the continuous threads to retract or sink into the roving, due to the clamping forces present in the assembly as above explained, in order for this feature of the composite thread to be manifest, it is usually necessary to apply some external agent, such as a heat treatment in a dry or wet medium, to cause a strong retraction of the continuous threads into the rove. The rove fibers may in some cases have per se a tendency to retract.

According to a modification of the invention, the roving may comprise a mixture of different fibers having different shrinkage characteristics in response to heat or other retracting agent.

As regards the mechanical strength characteristics of the composite thread these are found consistently to exceed the sum of the strengths of the constituent elements thereof. This is because the roving or other constituent made up of discontinuous fibers, while having poor or very poor mechanical strength when tested per se, acquires a very substantial strength owing to the compressed condition in which it is retained in the assembly and thus participates to a marked degree in the combined tensile strength of the whole, as will be apparent from the ensuing examples.

EXAMPLE 1

A composite thread is produced by the method of the invention from the following constituents:

One worsted roving titling 62,000 meters/kilogram after drawing and produced from roving of 6200 meters/kg. drawn at a rate of ten in the spinning frame.

Two texturized nylon threads produced by a method of the type disclosed in U.S. Patents 2,758,357 and 2,758,358, each of about 40 deniers, or 225,000 meters per kg.

The size of the final resulting thread is about 40,000 meters/kg. and its twist is about 475 turns, which corresponds to a twist coefficient of about 75 as given by the equations:

$$\text{Twist} = 75\sqrt{\text{size}}$$

$$\text{and}$$

$$\frac{1}{\text{Size of final thread}} = \frac{1}{\text{Size of drawn roving}} + \frac{1}{\text{combined size of continuous threads}}$$

The tensile characteristics of the composite thread are indicated in Table 1 below, together with the degree of shrinkage obtained on passing the thread in an oven at 100° C. for 5 minutes. It is found by these tests that the

thread has a high shrinking capacity of about 8.32%, and that the shrinkage is due primarily to a crimping of the fibers, thereby increasing the covering or spreading capacity of the thread, rather than being in the nature of a true shrinkage in which the density and compacity of the material is increased. The table further indicates the corresponding characteristics of the individual constituent nylon threads, considered single and also twisted in two strands with equal twist.

Table I

Nature of material	Size (km./kg.)	Twist (turns/m.)	Strength, g.	Elongation, percent	Tested length		Shrinkage, percent
					Before shrinkage	After shrinkage	
Composite yarn.....	40.....	475	470	28.1	46.9	43.0	8.32
Texturized crimped nylon plied yarn.....	2/225, 2 x 40 deniers	475	400	28.7	46.85	41.0	12.49
Texturized crimped nylon yarn.....	1/225, 1 x 40 deniers.	20	168	25.2	47.75	39.35	16.67

EXAMPLE 2

The same procedure and tests are applied as in Example 1 with the only difference that the two nylon yarns are texturized by a different process and designated by the registered trade name of "Agilon." The test results are given in the following Table II:

Table II

Nature of material	Size (km./kg.)	Twist (turns/m.)	Strength, g.	Elongation, percent	Tested length		Shrinkage, percent
					Before shrinkage	After shrinkage	
Composite yarn.....	40	475	400	21.7	47.5	44.0	7.37
Texturized yarn plied "Agilon".....	2/225	475	367	25.1	46.15	40.6	12.03
Texturized "Agilon".....	1/225	20	201.6	31.63	47.5	42.8	9.89

EXAMPLE 3

The same procedure and tests are performed as in the foregoing examples except that the two nylon yarns are

A composite yarn is produced according to the invention from:

Worsted roving titling 53 km./kg. after drawing.

Two pure polyvinyl chloride "Rhovyl" yarns, non-texturized, each of 120 km./kg. (75 deniers).

The final size of the composite yarn is about 28 km./kg. and its twist is about 400 turns (as given the equations

indicated in Example 1). The tensile and other characteristics are those given in Table IV below the shrinkage characteristics being measured after passing the material in an oven at 80° C. for 5 minutes. The table further indicates the corresponding characteristics for pure "Rhovyl" yarn alone and plied in two ends with the same

degree of twist as in the composite yarn. In this case the shrinkage of the constituent yarns does not apparently result in a substantial shrinkage of the composite yarn.

Table IV

Nature of material	Size (km./kg.)	Twist (turns/m.)	Strength, g.	Elongation, percent	Tested length		Shrinkage, percent
					Before shrinkage	After shrinkage	
Composite yarn.....	28	400	496	19.05	46.8	45.7	2.35
"Rhovyl" plied yarn.....	2/120	400	386	20.7	48	35.7	25.63
Continuous "Rhovyl" yarn.....	1/120	400	197	21.3	49.9	36.2	27.45

not texturized. The test results are given in Table III. It is seen that the shrinkage obtained with the composite yarn is considerably less than in the preceding examples, this being due to the fact that the continuous yarns have a substantially lower shrinking capacity. This proves that the shrinkage is primarily due to the texturized yarn rather than the wool fiber.

Table III

Nature of material	Size (km./kg.)	Twist (turns/m.)	Strength, g.	Elongation, percent	Tested length		Shrinkage, percent
					Before shrinkage	After shrinkage	
Composite yarn.....	40	475	510	23.3	48.15	46.3	3.84
Continuous nylon plied yarn.....	2/225	475	423	22.2	48.95	46.7	4.60
Continuous nylon yarn.....	1/225	20	200.3	20.82	49.45	46.8	5.36

In all four examples it is found that the strength of the composite yarn is substantially higher than that of identical plied yarn in the absence of the worsted roving constituent.

What I claim is:

1. A composite yarn comprising two continuous filament yarn components and a drawn roving component of

staple fibers, the roving component being between the yarn components, said roving component defining a longitudinal axis extending therealong, the three said components being twisted about the axis of the roving component, the roving component being disposed substantially equally on opposite sides of its said axis, the roving component on each side of its axis being helically twisted with the yarn components and being contained therebetween.

2. A composite yarn comprising two continuous filament yarn components having inherent stretchability and a drawn roving component of staple fibers with the roving component being between the yarn components, said roving component defining a longitudinal axis extending therealong, the yarns and the roving being twistably plied about the axis of the roving component with the yarn

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components under tension and the roving component being disposed substantially equally on opposite sides of its said axis, the roving component on each side of its axis being helically twisted with the yarns and contained therebetween.

3. A composite yarn as defined in claim 2 in which the continuous filament yarn components are relaxed and contracted to a normal state.

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