

Nov. 11, 1969

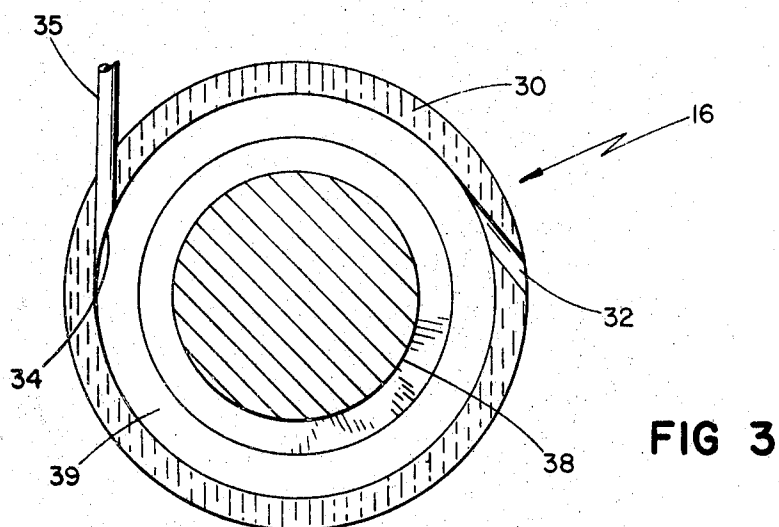
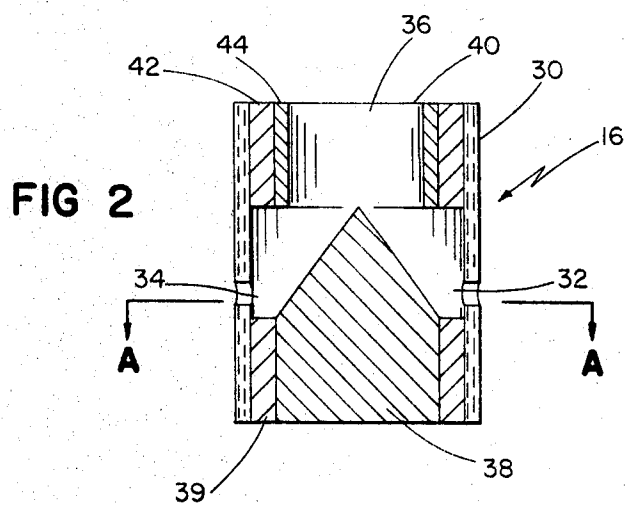
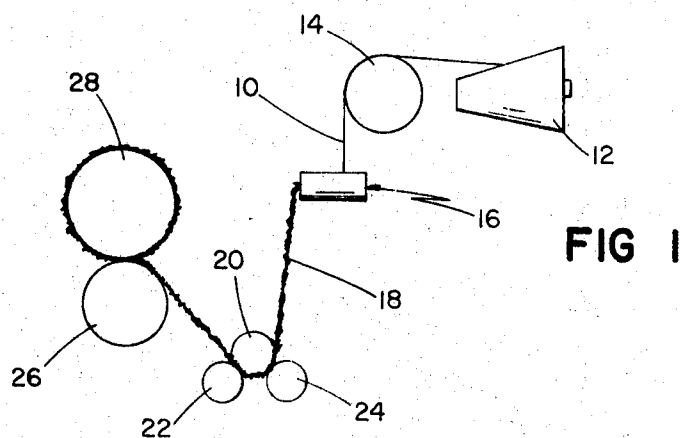
P. F. MARSHALL

3,477,220

DRAFTABLE NOVELTY YARNS AND PROCESS THEREFOR

Filed Oct. 4, 1967

2 Sheets-Sheet 1



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DRAFTABLE NOVELTY YARNS AND PROCESS THEREFOR

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2 Sheets-Sheet 2

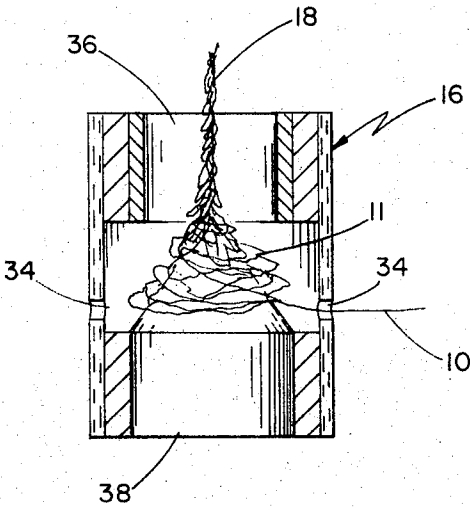


FIG 4

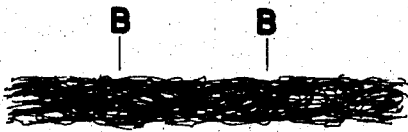


FIG 5



FIG 6

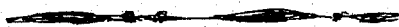


FIG 7

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DRAFTABLE NOVELTY YARNS AND PROCESS THEREFOR

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9 Claims

ABSTRACT OF THE DISCLOSURE

A multifilament continuous strand is fed into a whirling body of fluid contained in a vortex cell in such a manner as to cause the strand to pleat back and forth axially upon itself, forming a heavy denier compacted and extensible yarn held in self-sustaining form by the entanglement of individual filaments in one pleat with individual filaments in a contiguous pleat. The yarn thus formed may be used as is, may be plied or twisted with another yarn, or may be drafted to yield a novelty yarn with a series of randomly-spaced slubs or nubs.

This invention relates to a self-compacted multifilament yarn. More particularly, it relates to a method for pleating or folding a multifilament strand longitudinally upon itself by means of a fluid vortex, with the formation of a relatively heavy denier self-sustaining yarn which may subsequently be drafted or drawn out while being plied or twisted with another strand, may be so plied or twisted in its original undrawn condition, or may be used in unplied form where a bulky yarn is desired.

Basically, the process of this invention involves the continuous folding of randomly spaced portions of a multifilament feed strand in a fluid vortex, said folding causing the strand to form a series of pleats. Simultaneously the force of the fluid vortex perturbs the individual filaments in the multifilament strand and blows them apart, so that individual filaments in a fold or pleat of the strand are entangled with individual filaments in the previously-formed and pleats of the multifilament feed strand. Since the yarn product is being withdrawn from the vortex at a fraction of the rate at which the feed strand is being admitted to the vortex, the result is a yarn composed of a series of pleats of multifilament strand, longitudinally arranged in entangled and overlapping relationship.

It is therefore a primary object of this invention to provide a relatively bulky extensible yarn, with a surface resembling a spun yarn, from a strand of continuous multifilament textile material.

It is an additional object of the invention to provide processes for combining the primary extensible yarn of the invention with other textile strands to provide novelty yarns suitable for fashioning into fabrics.

Other objects of the invention will appear more fully from the following description and drawings, in which: FIGURE 1 is a schematic flow sheet of the process of the invention.

FIGURE 2 is an idealized cross-sectional view of a vortex cell suitable for producing the yarns of this invention.

FIGURE 3 is an enlarged cross-sectional view looking down through the cell of FIGURE 2 along the line A—A.

FIGURE 4 is a representation of the yarn formation in the vortex cell.

FIGURE 5 represents a typical yarn of the process of this invention.

FIGURE 6 represents a segment of the yarn of FIGURE 5 after moderate drafting.

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FIGURE 7 represents a segment of the yarn of FIGURE 6 after further drafting.

Referring to FIGURE 1, a multifilament strand 10 from a convenient supply source 12 is fed at a controlled rate to a vortex cell 16, the construction and operation of which are set forth hereinbelow. Controlled feed of the multifilament strand is effected by wrapping the strand for several turns around the driven grooved feed wheel 14.

The multifilament strand 10 is drawn into the vortex cell 16, and is pleated upon itself longitudinally, the successive pleats being interengaged by entanglement of the individual filaments of the strand. The compacted yarn thus formed, 18, is withdrawn from the vortex cell at a fraction of the rate at which the strand 10 is fed to the cell, withdrawal being effected by means of the weighted rubber-covered roll-off roll 20 which is surface-driven by the drive rolls 22 and 24. From the roll-off roll 20 the yarn passes to the driven grooved take-up cylinder 26 and thence to the finished package 28.

FIGURE 2 is an idealized enlarged cross-section of the vortex cell 16 of FIGURE 1, shown in vertical elevation rather than in the horizontal position which it occupies in the flow sheet. By idealized is meant that the cell wall openings 32 and 34 are shown as oppositely disposed, whereas a more convenient placement is to have the openings opposed at an angle other than 180°, as shown in FIGURE 3. The cell 16 comprises a chamber, conveniently of cylindrical shape, having a side wall 30 and end walls 38 and 40. The lower end wall 38 is a solid plug, preferably conical in shape, inserted into the cell, and conveniently held in place by a circular rubber gasket 39; the upper wall 40 comprises a short length of tubing 44 set in a tubular rubber gasket 42, leaving the opening 36 for the exit of the pleated yarn.

The vortex cell is typically compact, being formed for example from a piece of $\frac{1}{16}$ inch Pyrex tubing $\frac{3}{4}$ inch in height. The upper opening 36 is formed by a piece of thin-walled copper tubing 44 of $\frac{1}{4}$ inch inside diameter, set in a piece of rubber tubing serving as the gasket 42.

The relationship of the air and strand inlets 34 and 32 are shown more clearly in FIGURE 3, which represents an enlarged cross-sectional view of FIGURE 2, looking downward along the line A—A. It is important that the direction of the fluid jet delivered through the opening 34 be substantially tangential to the inner cell wall, and that the jet enter the cell through a convergent opening in which the ratio of length to diameter is at least 6 to 1. By this means the fluid jet is always operating at about sonic velocity, a smooth jet stream is caused to flow around the cell wall, and turbulence is minimized. A convenient method of delivering such a jet stream is to seal into the fluid inlet 34 a No. 18 hypodermic needle, with an exit mouth curved to fit the inside curvature of the cell wall 30, as shown partly broken away at 35 in FIGURE 3. The strand inlet 32 need be no larger than 0.03 inch, and a convenient placement of the inlets is to have the fluid inlet 34 leading the strand inlet 32 by 140°.

The above dimensions are illustrative only, and are not to be regarded as restrictions on the cell structure. A detailed analysis of the mechanics of the formation of these yarns can be based only on examination of the behavior and appearance of the end product and on a consideration of the parameters of the process. A complicating factor is that at least four phenomena are occurring simultaneously, three of which are illustrated in FIGURE 4.

As the feed strand 10 enters the cell 16, it is presumably thrown temporarily into the form of a loop or loops by the whirling body of fluid.

These loops, represented schematically at 11 of FIGURE 4, impinge upon or are intercepted by the dependent trailing end of the portion of the yarn 18, which is rotat-

ing around the periphery of the cell. Whether this yarn overtakes a loop or whether a loop will impinge upon the yarn will depend on the relative velocities of loop and yarn, which vary from point to point depending on momentary considerations such as frictional encounters with the cell wall. In either case, the existence of the feed strand 10 in loop form in the interior of the cell is a transient state of affairs, since the collision with the rotating yarn end throws the loops into a series of folds or pleats, which are blown upwardly along the axis of the yarn 18 by the fluid force which is exhausting through the exit opening 36. In this way, folds or pleats are laid down axially along the finished yarn 18, which may contain, for example, between 5 yards and 50 yards of feed strand in each yard of finished yarn.

Finally, the individual filaments of the multi-filament strand 10 are blown apart and fanned out, so that when successive pleats are formed along the axis of the yarn 18, these pleats are entangled and temporarily interlocked with each other by interfilamentary engagement.

It is to this axially-pleated configuration that the yarn of this invention owes its ability to undergo extensive drafting, as illustrated in FIGURES 2, 5, 6, and 7. FIGURE 5 represents a typical yarn of the process of this invention. If the section between the points B—B in FIGURE 5 is drafted to four times its original length, as by drafting rolls or the like, the configuration of FIGURE 6 is reached, where relatively long slub-like sections of the filamentary yarn are joined by segments of thinner yarn wherein the yarn denier may approach the denier of the original feed strand. If, in turn, the section C—C of FIGURE 6 is again drafted to four times its length, there is a further attenuation to a configuration such as is represented by FIGURE 7, where both slubs and nubs may appear along the axis of the yarn.

In general, the distribution of slubs and nubs along the axis of a drafted yarn of this type is irregular. The feed strand from which the yarn is formed is of a low degree of twist, low enough to allow the blowing apart and fanning out of the individual filaments constituting the feed strand. It is primarily this engagement of individual filaments in contiguous pleats that is responsible for the fact that the final yarn is self-sustaining and that an appreciable force must be applied to cause it to become drafted. In a drawing operation which drafts the yarn to any substantial extent, it will be found that there is usually a set of filament-to-filament entanglements that are so snarled that the filaments are broken in the drafting process, thus adding to the fuzzy appearance of the drafted yarn. As might be predicted, the degree of filament breakage is related to the tensile strength of the filaments, viscose rayon and acetate showing maximum breakage, nylon and polyester being much less.

The yarn of this invention has numerous and varied commercial applications.

(1) It may be used per se as in knitting operations with a positive feed or roll-off, or when doubled with a stress-bearing yarn.

(2) It may be drafted and twisted to yield a yarn marked by slubs and nubs along its length.

(3) It may be drafted and plied or twisted with another yarn serving as a carrier.

(4) It may be combined, either in undrafted or drafted form, with a carrier yarn and wrapped according to the process set forth in my U.S. Patent 3,041,812, to form a bulky wrapped hand-knitting yarn in the former case, a wrapped slub-and-nub yarn in the latter.

(5) In general, it may be combined with another draftable strand in any type of fiber-drafting operation, such as a fly frame, draw frame, slubber, slub-injection device, and the like. In such processes it may be drafted, as with one or more ends of roving, beyond the point to which it was originally contracted or compacted, as illustrated by the following example.

Example I

A typical extensible yarn of this invention was prepared by compacting into pleated configuration a 300 denier 76 filament continuous filament acetate strand, using the process of FIGURE 1 and the vortex cell of FIGURE 3 operating at 80 p.s.i.g. air pressure. The input speed to the cell was 1742 feet per minute, and the contraction factor was 15.2, giving an output of 115 feet per minute of compacted yarn.

A Whitin spinning frame Model FS-3 was creeled with two bobbins of 1.7 hank cotton roving and one bobbin of the above compacted acetate yarn, with one cotton strand on each side of the acetate. The spinning frame draft was 18, front roll speed 356 feet per minute, spindle speed of 4,700 r.p.m., traveler size 13, twist 13.6 turns per inch.

The resulting novelty yarn was 8.3 cotton count and was marked by the appearance at random intervals of acetate slubs of varying sizes. An interesting feature of slubs made by this process is that the ends trail for a considerable distance into the body of the yarn, and that a multiplicity of slubs may be connected to each other by continuous filaments common to several slubs. The slubs are thereby anchored securely into the novelty yarn and resist distortion or displacement.

The following table will illustrate some yarns produced by the process of this invention, employing various continuous-filament strands as starting material. All examples were made at a contraction factor of 15.2: that is, the denier of the finished yarn is 15.2 times that of the feed strand.

TABLE I

Filament strand	Yield in yards per pound	Denier	Cotton Count
Bright acetate 300/76.....	980	4,560	1.16
Dull acetate 300/76.....	980	4,560	1.16
Two ends 150/42 bright viscose.....	980	4,560	1.16
Bright viscose 200/44.....	1,460	3,040	1.74
Bright viscose 150/42.....	1,960	2,280	2.3
Dacron 56 150/68.....	1,960	2,280	2.3
Antron 140/34.....	2,100	2,128	2.5
Nylon 140/68.....	2,100	2,128	2.5
One end bright viscose 150/42-one end bright acetate 150/38.....	980	4,560	1.16

Having thus described my invention, I claim:

1. A continuous multifilament compacted extensible yarn which comprises

at least one substantially continuous multifilamentary strand longitudinally pleated in irregularly overlapping relationship along the principal axis of said yarn,

the pleats of said multifilamentary strand being held together to form a self-sustaining compacted yarn by the intermingling and intertangling of individual filaments on pleats which lie in contact with each other.

2. The product according to claim 1 in which each yard of compacted extensible yarn is composed of from 5 to 50 yards of pleated filamentary strand.

3. A method for producing a compacted extensible yarn which comprises

continuously feeding at a controlled rate at least one continuous multifilamentary strand into a fluid vortex,

continuously forming a series of longitudinally-directed pleats in irregularly overlapping relationship along the principal axis of said yarn while continuously dispersing the individual filaments comprising said strand,

continuously rendering said yarn self-sustained by intermingling and intertangling individual filaments of sections of said strand with individual filaments of contiguous other sections of said strand, and withdrawing the compacted yarn from the fluid vortex

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at a rate substantially less than the feed rate of said multifilamentary strand.

4. A method for transforming a continuous multifilamentary strand into a novelty yarn characterized by slubs and nubs disposed randomly along its length, which comprises

5 preparing an extensible compacted yarn according to the process of claim 3,
drafting the extensible compacted yarn,
and imparting true twist to said drafted yarn to impart tensile strength and resistance to further extension.

5. The method according to claim 4 in which sufficient drafting force is applied to break a portion of the entangled continuous filaments.

6. A method for transforming a continuous multifilamentary strand into a novelty yarn characterized by slubs and nubs disposed randomly along its length, which comprises

15 preparing an extensible compacted yarn according to the process of claim 3, drafting the extensible compacted yarn, and plying the drafted yarn with at least stress-bearing carrier yarn.

7. A method for producing a novel bulky wrapped yarn which comprises

20 forming a novelty yarn according to the process of claim 6,
and wrapping said yarn with at least one wrapping strand in the form of double-back loops disposed around said yarn for a plurality of turns.

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8. A method for producing a novelty yarn characterized by slubs and nubs disposed randomly along its length, which comprises

5 preparing an extensible compacted yarn according to the process of claim 3,
combining said compacted yarn with at least one end of staple-fiber roving, and processing said yarn and said roving through a spinning frame.

9. A method according to claim 8 in which the spinning frame draft factor is greater than the contraction factor originally applied to the compacted yarn.

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25 DONALD E. WATKINS, Primary Examiner

U.S. Cl. X.R.

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