United States Patent

Kashima et al.

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[54] **PROCESS FOR PRODUCING BULKY YARN FROM MULTIFILAMENT YARN**

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.**.....**28/72.12**
[51] **Int. Cl.**.....**D02q 1/16**
[58] **Field of Search**.....28/1.4, 72.12; 57/34, 140, 57/157

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Primary Examiner—Louis K. Rimrodt
Attorney—James E. Armstrong and Ronald S. Cornell

[57] **ABSTRACT**

Novel yarn having an improved bulk, a sufficient softness, strength and an appearance like spun yarn is prepared by using an improved process in which one or more kinds of multifilament yarn, including multifilament yarns of different strength, are supplied into a fluid jet zone, with different filaments in the same yarn or different yarns have different knot strength, one having a knot strength above 4.0 g/d and the other having a knot strength below 2.4 g/d. A fluid-jet-disturbing treatment, conditioned to have a disturbing strength sufficient to sever filaments of lower strength by increasing the fluid pressure over the fluid pressure used for the preparation of usual loop yarn, is applied to the multifilament yarn for severing the lower knot strength filament or yarn, thus causing the resulting short severed filaments entangle with the unsevered long filament group, forming naps having free ends which cover the surface of the long filament group.

5 Claims, 12 Drawing Figures

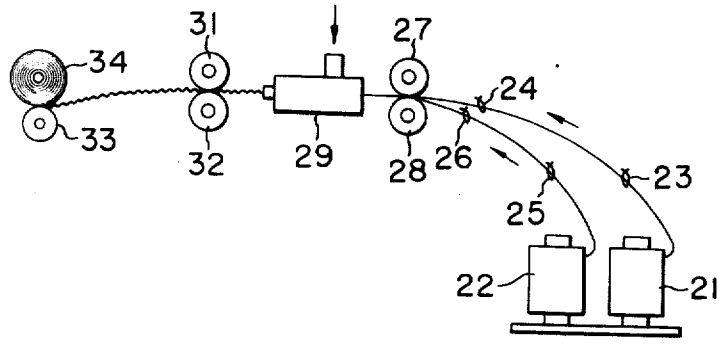


FIG. 1

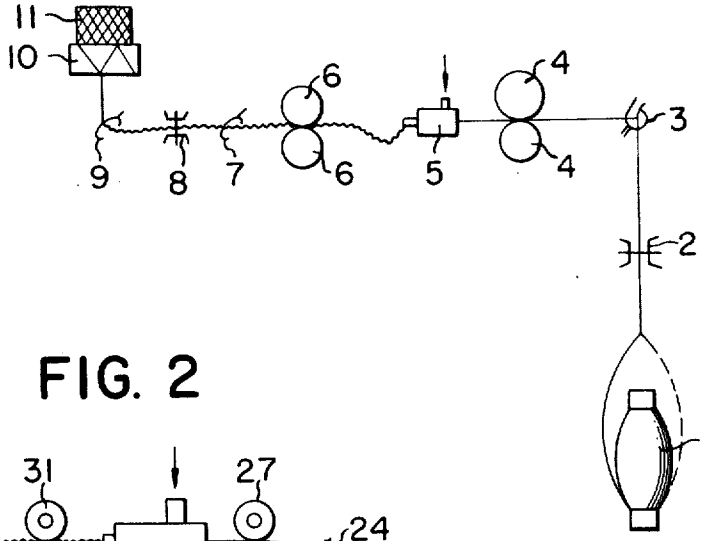


FIG. 2

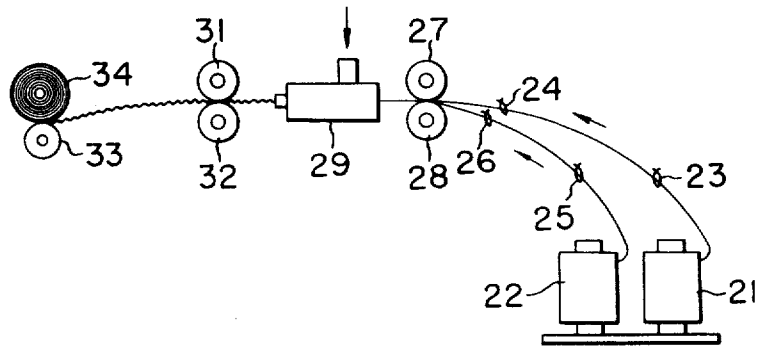


FIG. 3

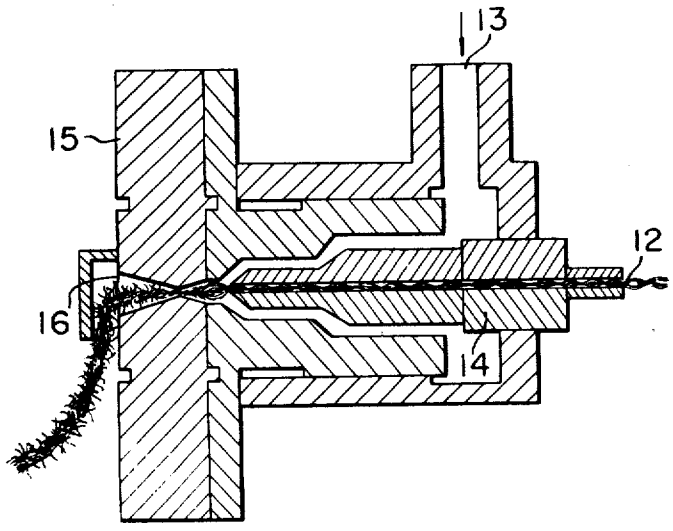


FIG. 4

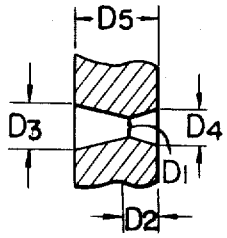


FIG. 5

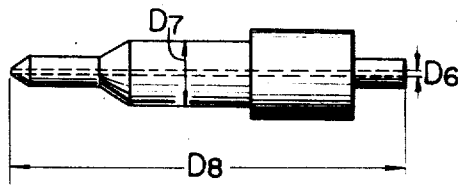


FIG. 6



FIG. 7

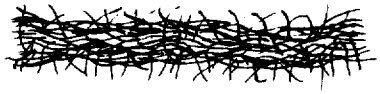


FIG. 8

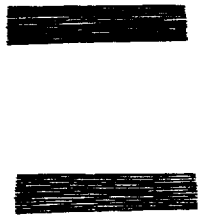


FIG. 9

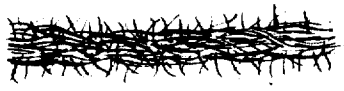


FIG. 10

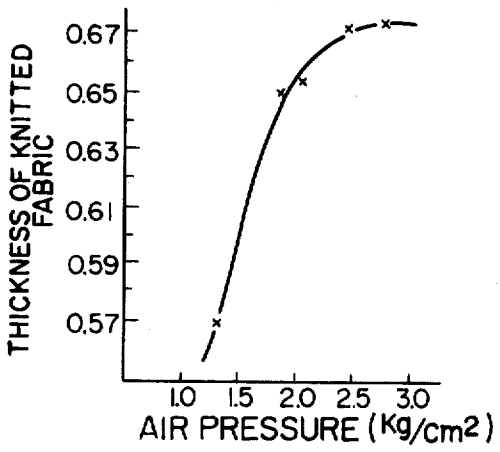


FIG. 11

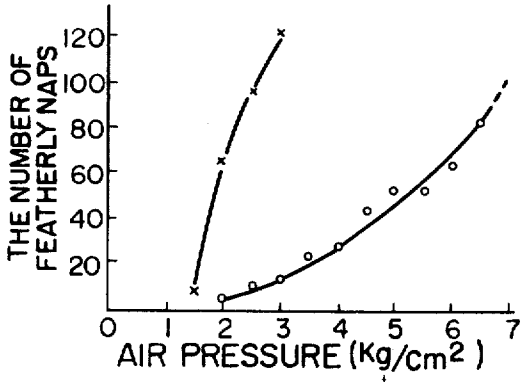
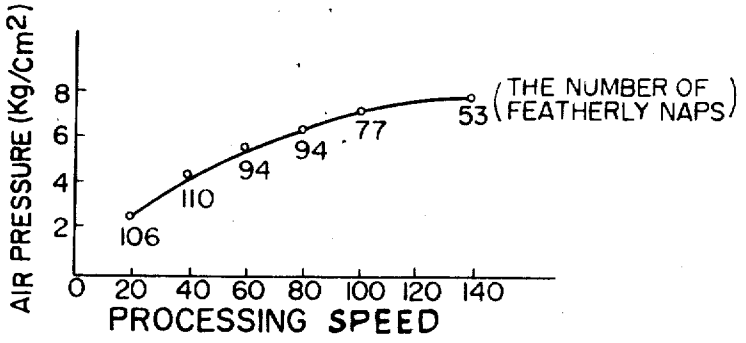


FIG. 12



PROCESS FOR PRODUCING BULKY YARN FROM MULTIFILAMENT YARN

BACKGROUND OF THE INVENTION

Textured yarn made according to prior methods is given bulkiness by treating continuous multifilament yarn. The filament in such textured yarn, however, has the form of twists and bends or curls and loops, and accordingly, the bulkiness is provided by the continuous filament as a whole. In contrast, the bulky yarn prepared according to the present invention is not a continuous filament as a whole, but a novel processed yarn in which bulkiness is provided by severing a part of constituent individual fibers to produce severed fragments which remain entangled with the unsevered continuous filament and form naps at the severed end portion of the said individual fibers, the naps covering the unsevered continuous filament group.

Preparation of bulky yarn by introducing a thread of the same quality into a fluid jet zone or by introducing two or more yarns into the fluid jet zone is well known in the art. The processed yarn obtained by the former method is usually given bulk because of the formation of irregular loops, curls, coils, tangles and knots along the length of the filament yarn. However, bulk thus achieved is substantially insufficient and the bulky yarn thus obtained has a hard hand-feeling because of the production of loops and curls, etc. Further, since the loops and curls are formed irregularly along the length of the thread, the resulting processed yarn itself shows insufficient bulk and an undesirable feeling because many loop mottles are produced. Moreover, when such yarn is knitted or weaved the resulting products usually have many mottles, making them of little commercial value. Further, the bulky yarn obtained according to prior methods has a variety of filament structures depending upon the processing conditions, such as the amount of fluid used, the fluid pressure, the yarn feeding velocity, the excess feeding ratio or yarns, and the structure of jet nozzle etc. In the preparation of such bulky yarn, it is necessary to make filaments entangle with each other without eliminating any loops because of the small applied tension, and to produce loops in succession. Therefore, a considerable problem is involved because the processing conditions of above mentioned variables must be exactly controlled to make a useable product. Further, when bulky yarn is made by introducing two or more yarns into the fluid jet zone, the same type of problems occur. Specifically, the processed yarn thus obtained preserves many filaments of the added yarns fed in excess, in the form of long and slender loops which serve to provide bulk. The bulky yarn made according to this method, however, is not generally used for making clothing, but rather it has special uses such as for fancy yarn. Many tangles occur in the manufacturing, and furthermore such yarn is not suitable for secondary processing because of filament separation, variation of tension and yarn cutting during processing operations such as knitting, weaving, etc.

The above-mentioned defects which are inevitably occur in prior art methods for the preparation of bulky yarn through the introduction of thread into the fluid jet zone are dramatically solved by using the present invention. In other words, the present invention provides a method of controlling the variable factors mentioned above, especially in controlling of fluid pressure in the fluid jet zone.

SUMMARY OF THE INVENTION

According to the present invention, bulky yarn is prepared by introducing multifilament yarn into the fluid jet producer and by increasing the disturbing strength of the fluid jet zone up to a strength required to sever the lower knot strength filaments by increasing the fluid pressure. The bulky yarn made according to the invention has extremely fine bulk due to the yarn structure, which comprise a central layer of the thread composed of comparatively long filament groups, the surface layer having severed filament ends densely protruding in a radial direction from the central layer, and the severed filaments being randomly entangled in the central and surface layers of the thread.

Continuous multifilament yarn is fed into the fluid jet zone wherein the scission of a part of the constituent filament yarn is caused by the fluid jet and its severed filaments are, simultaneously, caused to be tangled with the other constituent filament yarn. Continuous filament yarn of the same quality can be individually or, alternatively, two or more continuous filament yarns, which differ in strength from other, are supplied to the fluid jet zone. In the former case, a part of constituent multifilament is severed by the jet and the severed ends thus obtained are forced entangle with the unsevered constituent filament yarn. In the latter case, two or more kinds of continuous filament yarns having different strength are previously set together and then treated with the jet. The filament yarn of lower strength is severed by the jet and the severed fragments are forced to be entangle with the filament yarn of higher strength.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a schematic diagram of the apparatus used in the invention for the preparation of bulky yarn with one kind of continuous multifilament yarn;

FIG. 2 shows a schematic diagram of the apparatus employed for the preparation of bulky yarn with at least two kinds of multifilament yarns each having different strength;

FIG. 3 is a detailed sketch of the fluid jet producer shown in FIG. 1 and 2;

FIG. 4 is the enlarged view of nozzle shown in FIG. 3;

FIG. 5 is explanation drawing of needle in FIG. 3;

FIG. 6 is the side view of material yarn before treatment using the apparatus shown in FIG. 1;

FIG. 7 is the side view of the process yarn treated using the apparatus of FIG. 1;

FIG. 8 is the side view of the two kinds of material yarns before the treatment using the apparatus shown in FIG. 2;

FIG. 9 is the side view of the process yarn treated using the apparatus shown in FIG. 2;

FIG. 10 clearly shows the increasing tendency of the thickening of the knitted material with the increasing fluid pressure, wherein the knitted material was made under the same conditions using bulky yarns obtained at different fluid pressures.

FIG. 11 shows the relation between the air pressure and the number of feathery naps;

FIG. 12 shows the relation between processing velocity and air pressure under the most suitable conditions.

DETAILED DESCRIPTION

The present invention will be understood in detail by referring to the drawings.

According to FIG. 1, material yarn 1 is fed to fluid jet producer 5 by feed rollers 4 and 4' at a constant velocity, passing through tensor 2 and guide 3, and, as clearly shown in FIG. 3, yarn 1 then passes through central hole 12 of needle 14 in fluid jet producer 5. At the same time, compressed air or steam, which is spurted forth through in-let passage 13, is passed around the circumference of needle 14 and further spurted forth to nozzle portion 15 and finally, jetted out from nozzle aperture 16 together with the passing material yarn 1. As shown in FIG. 3, it is preferable to use a kind of nozzle hole having a narrowed intermediate portion and a gradually enlarging opening. By using a nozzle hole design of this type, filaments are effectively forced to tangle with each other in the air or steam jet in the fluid jet producer and subsequently, a part of the constituent filament is successfully severed by the increasing pressure of the said fluid jet zone and the severed ends of filaments are simultaneously reformed in a direction radial from the center of the base thread or parallel with the said thread so as to provide an improved bulkiness in the processed yarn. The thread 1 thus obtained then passes through delivery rollers 6 and 6', guide 7, tensor 8, and finally is wound up by take-up package 11 adjacent to winding roller 10.

FIG. 6 shows the structure of the yarn before the treatment which is a non-twisted or weakly twisted yarn having filaments in approximately parallel to each other. FIG. 7 shows a typical side view of the yarn processed at a greater fluid jet pressure using an acrylonitrile long filament ya0042(strength, 44 g/D; percentage of elongation, 15.6 percent). As seen from these figures, the processed yarn of the invention has good bulk and less mottles, because of the nap-like severed filament ends having a length of less than 5 mm. In the case of the acrylonitrile filament yarn, the diameter of the treated yarn increased with the increasing fluid pressure. When an air pressure of 1.3 Kg/cm² was applied, there obtained a somewhat bulky yarn with loops of filament. This yarn had a diameter of 0.07 cm and was found to be insufficient in bulk. Further, the diameter of this yarn varied in the range 0.07 ± 0.05 cm., showing the existence of a great number of mottles. In contrast, when a pressure of 1.8 Kg/cm² was applied, the processed yarn thus obtained had a diameter of 0.10 cm, showing the occurrence of slight filament scission instead of the existence of a considerable number of loops. As mentioned above, the apparent diameter of the processed yarn markedly increases with increasing fluid pressure, as shown by the fact that a process yarn obtained at a fluid pressure of about 2.5 Kg/cm² was sufficiently covered with the severed filament ends without leaving any loops and was markedly improved in bulk.

The above-mentioned filament yarn was treated by varying the fluid pressure and the processed yarns thus obtained were fabricated into a knitted material at a constant density and subsequently, the thickness of resulting material was measured as shown in FIG. 10. When the yarn processed at a pressure of 1.3 Kg/cm² was used, the thickness of the knitted material was 0.57 cm., thus being of insufficient bulk. This material contained large mottles as shown by the variation in thickness in the range 0.57 ± 0.02 mm. When the yarn obtained at higher fluid pressure was used, the bulk of the material became improved with decreasing mottles as shown by the following data: 0.67 ± 0.005 cm. at 2.3 Kg/cm² and 0.67 ± 0.005 cm at 2.7 Kg/cm². As seen in FIG. 10, the bulky yarn having the severed filament's ends in a form of nap protruding from the base thread is extremely superior in bulk when compared with those having only loops. Furthermore, when made into knitted material, the product mottles was substantially free of and had more pleasant feeling than those made from yarn having only loops.

FIG. 2 shows a schematic diagram of an apparatus used for the preparation of bulky yarn from two or more kinds of multifilament yarns each having different knot strength. Two kinds of material yarns 21 and 22, each passing through guides 23 and 24 or 25 and 26, are set together, pressure-contacted, and pushed out at a constant speed to the fluid jet producer 29 (as clearly shown in FIG. 3) by a yarn feeder comprising a shaft 28 and roller 27, and finally pass through the yarn passage tube 12 of needle 14 shown in FIG. 3. At the same time, the compressed air or steam spurted forth through inlet passage 13 passes around the circumference of needle 14, jets out toward nozzle portion 15 and finally is emitted rapidly from the nozzle aperture 16 together with the passing yarn. The yarn which is thus emitted with the fluid from nozzle aperture 16 and has been processed into a desired bulky yarn, passes through rollers 31 and 32, and is finally taken up as product winder 34 by winder roller 33.

The process yarn of our present invention is obtained by overfeeding, at least 5 percent, preferably, 10 to 25 percent, a long yarn into the fluid jet device. A yarn is fed into the fluid jet zone at the tip of yarn passage tube, and causes filaments to be disturbed and severed. Immediately after this operation is carried out, the resulting filaments are entangled to each other to form a yarn. Filaments put into the inlet of needle are led to the tip of it, with some twist caused, and finally into the fluid jet zone.

FIG. 2 shows the step in which multifilament yarns are processed. As shown in FIG. 3, it is desirable that type of nozzle having a narrowed intermediate passage and a gradually enlarging opening, is used for the preparation of the process yarn of our present invention. When filaments were passed through the fluid passage of this type nozzle design, most magnificent results were brought about. In short, as shown in FIG. 4, jet nozzle aperture is narrowed at the intermediate parts between inlet and outlet of fluid passage, just like this type; ⋈ ; that is, a passage with an intermediate portion narrower than its inlet or outlet. More specifically, this type nozzle has the following structure:

nozzle's inlet (D_4)	3mm
narrowed part of nozzle aperture (D_1)	1.5mm
nozzle's outlet (D_2)	4mm
width of nozzle (D_3)	10mm
interval between inlet and outlet (D_5)	3mm.

Next, the structure of needle is, as shown in FIG. 5, as follows:

length of needle 14 (D_a)	56mm
width of yarn passage tube (D_e)	1.0mm
diameter of the central part of needle (D_f)	7mm.

The most important structure in this apparatus is that the interval between nozzle 15 and needle !14 should be 0.4 to 0.6 mm.

It is impossible to define the processing conditions of this invention as a whole because they become different according to the size of filaments and the structure of the fluid jet zone. However, when multifilament yarns of total deneir between 100 and 800 are processed, there obtained a process yarn suitable for clothing. In this case, the processing conditions are restricted as follows:

air pressure	1.5 to 10 Kg/cm²
amount of air	40l/NTP/min. to 150l/NTP/min.
processing speed	20 to 100 m/min.

These conditions may be decided in accordance with the kinds of multifilament yarns. The relation among air pressure, air amount, and the number of feathery naps will be clearly understood by refering to FIG. 11 and 12. The most suitable conditions are given by using the apparatus of FIG. 3 are shown in Table I. Table II represents the physical properties of multifilament yarns. In addition, —*x*— stands for the pocessing velocity of 20 m/min and —*o*— does that of 60 m/min. The numerals in parentheses in FIG. 12 mean the number of featherly naps.

When material yarns having filaments of higher strength such as nylon, polyester, etc., are introduced into fluid jet producer 29 as material yarns 1 and 2, very large amounts of jet fluid must be applied in order to sever the filaments in the material yarns. On the other hand, when a material yarn having filaments of comparatively lower strength, such as rayon, acetate, polyacrylonitrile, etc., is individually processed, the amount of jet fluid required is much less. Thus, when two or more different yarns of varying strength are fed to the fluid jet zone, the amount of jet fluid required for nylon, polyester, etc., is sufficient to cause the filaments in material yarn such as rayon, acetate fiber, polyacrylonitrilic fiber, etc., to be disturbed, separated and entangled and further, severed at nozzle aperture 16. FIG. 8 shows side view of two kinds of untreated material yarns to be used in the above-mentioned process and FIG. 9 shows the side view of the processed yarn after treatment.

The processed yarn of this invention is the bulky yarn which shows an apparance similar to spun yarn and has the severed filaments of randam length whose one end radially protrudes while the other end entangles with the base filaments inside the yarn. This bulky yarn is composed of the densely entangled filaments and substantialy has uniform thickness along the length of yarn.

This processed yarn does not twist toward one direction unless twisting is processed and the average length of the feathery naps of the severed filaments having free ends at the outer surface layer of yarn is about 5 mm. It is impossible to measure the actual length of severed filament as a whole because of firmly entangled portion. The base filament at the core of the processed yarn is considerably long or not severed at all.

When the processed yarn is made of filaments, acetate rayon, acrylic filaments, viscose rayon, and cupro rayon are suitable. Polyamide filaments and polyester filaments can't be severed so easily as these filaments mentioned above even if they are introduced into the fluid jet zone. The former group of filaments characteristically shows smaller strength (g/denier) or smaller knot strength. Smaller the percentage of elongation, more easily the filaments are severed.

When two kinds of filaments differing in knot strength is used for material yarns to be processed, the

TABLE I

(1) The most suitable conditions

Material multifilament yarns, denier/number of filaments	Feeding speed, m./min.	Feeding ratio, percent	Air pressure, kg./cm.²	Air amount, Nl/min.	Properties of the processed yarn: Apparent denier	Strength, g./d.	Tension, percent
Acrylic, 150/60 Acetate, 150/40	20	15	2.0	50	168	1.6	9.0
Nylon, 70/24 Acrylic, 150/60	20	12.5	2.7	85	245	1.3	10.0
Nylon, 70/24 Acetate, 150/40	20	20	2.5	80	235	0.9	17.4
Ester, 75/36 Acrylic 150/40	20	15	2.5	80	249	1.5	10
Ester, 75/36 Acetate, 150/40	20	20	2.5	80	237	1.0	14.7
Ester, 75/36 Acetate, 150/40×4	20	10	3.7	93	700	1.1	14.7
High velocity: Nylon, 50/17 Acetate, 150/40	100	15	6.5	110	209–220	0.7–0.8	15.7–22.4

Table II

Properties of Material Yarn

material multifilament yarns	dry strength g/d	dry elongation %	knot strength g/d
nylon	4.5	25	4.0
ester (polyester filaments yarn)	4.1	16.5	4.4
(acrylic filaments yarn)	4.9	15.7	2–2.3
acetate	1.3	23.8	1.0
rayon	1.7–2.3	18–24	1.4–2.0
Benbelge	1.8–2.7	10–17	1.5–2.4

severed filaments of long filament yarn of lower knot strength protrude in thick on the outer surface layer of yarn, and at the same time, that of higher knot strength is not severed or otherwise exist as comparatively long filament. And as a result, both of them entangle each other to form a processed yarn rich in bulk. The structure of the processed yarn in accordance with this invention is clearly shown in FIG. 6 and FIG. 8.

As described above, thread made according to the present invention is composed of a comparatively long filament group, the surface layer of which has severed filament ends protruding densely in a radial direction from the central layer, the severed filaments entangled in the central and surface layers of the thread. Since the severed filaments ends have high density, there are substantially no mottles on any part of a thread and accordingly, a pleasant hand feeling is provided. In addition, any synthetic fiber material can be utilized as the multifilament yarn in the present invention.

In the case in which more than two continuous filament yarns of different knot strength are used in the present invention, the knot strength of yarns is defined in relative sense; that is, the filament of lower knot strength which is severed and preserved by the unsevered filaments through entanglement is defined to be lower in strength than the filament preserving the severed filament ends. When two or more continuous filament yarns are used as material yarns, the combination of continuous multifilament yarn should contain monofilaments of different strength. The difference in strength is usually provided by the difference in fiber material. For example, it is preferable to employ combinations of continuous long fibers such as rayon and polyester, acetate and nylon, polyester and cupra, etc. However, the difference in strength can also be attained by using fibers of same kind. In other words, the difference can be realized by varying the size of monofilaments comprising the yarn. In this case, it is desirable that the elongation of filaments of lower strength in the yarn is less than those of higher strength.

A twisted yarn may be employed as the continuous long fibers in the present invention, but non-twisted yarn is preferably. In the case in which the material yarns differing in kind or size from each other are employed in combination, the disturbing strength in the fluid jet zone should be adjusted to a condition sufficient for the scission of filaments in the continuous multifilament yarn of lower elongation. Such adjustment can be made from a experimental determination of a critical value for respective combination. By predetermining the minimum amount of fluid jet per unit time required to sever the filaments of each fiber in the fluid jet zone, a fluid jet amount suitable for the processing of combined fibers is successfully determined to have the maximum or minimum, each corresponding to the minimum amount of fluid jet for preferable. each combined fiber. The minimum fluid jet amount is approximately in proportion to the strength of the fiber, that is, energy needed to sever filaments.

The yarns employed in combination should be set together and supplied into the fluid jet zone. Further, the speed used to feed the yarn composed of filaments of lower knot strength to the zone should be as high as, or higher than that used to feed the yarn composed of filaments of higher knot strength. If the yarn composed of filaments of lower knot strength is fed to the said zone at a speed lower than that of the filament of higher knot strength, there is insufficient scission of the filament of lower knot strength and also the formation of loops of the filament yarn of higher knot strength, which results in a thread having structure of so-called fancy yarn.

As the fluid employed for the jet in the present invention, air at the ordinary temperature is desirable but fluids such as hot air or steam are also effective.

Our invention is further illustrated by the following examples.

EXAMPLE 1

A polyacrylonitrile filament yarn, 150 denier per 60 filaments, having a tear strength of 3 g/d and a percentage of maximum elongation of 15 percent, was treated by using an apparatus arranged as shown in FIG. 1 under the following conditions:

yarn feeding velocity	20 m/min.
winding velocity	17.5 m/min.
excess feeding ratio	12.5%
air pressure	2.7 Kg/cm²
consumption of air	58 ℓ/min.

Material yarns introduced into the yarn passage tube 12 of needle 14 spurted forth toward nozzle 15 and were treated by jet when they passed through narrowed part D_4.

The yarn thus obtained had a yarn-diameter of 0.21 cm. and few mottles, and was found to be a process yarn of sufficient bulkiness. The yarn, when knitted, gave a knitted material of a thickness of 0.67 mm. having an improved feeling and a sufficient bulkiness. The yarn, when knitted, gave a knitted material of a thickness of 0.67 mm. having an improved feeling and a sufficient bulkiness.

EXAMPLE 2

An acrylic filament yarn, 150 denier per 60 filaments, was treated by using the apparatus of Example 1 under the following conditions:

yarn feeding velocity	20 m/min.
winding velocity	18 m/min.
excess feeding ratio	10 %
air pressure	1.3 Kg/cm²
consumption of air	40 ℓ/min.

The yarn thus obtained had a yarn-diameter of 0.07 cm. and great number of mottles, and was found to be a process yarn of insufficient bulkiness. Further, the process yarn comprised only loops, there being no scission of loops because of the low air pressure. The process yarn, when knitted, gave a knitted material having a thickness within the range of 0.57 ± 0.07 mm., which was found to have many mottles in thickness and to be of insufficient bulkiness. The feeling of the process yarn was inferior to that obtained in Example 1.

EXAMPLE 3

An acetate filament yarn, 150 denier per 40 filaments, was processed by using the same jet-processing

apparatus as shown in FIG. 1, under the following conditions:

yarn feeding velocity	20 m/min.
winding velocity	17 m/min.
excess feeding ratio	15 %
air pressure	2.2 Kg/cm²
consumption of air	50 l/min.

The resulting yarn had substantially no loops and was a bulky yarn, having an appearance similar to the usual spun yarn, being covered with naps of severed filaments at the surface. The process yarn showed a strength of 0.48 g/d and a percentage of elongation of 7.8 percent. In contrast, when the air pressure and the air-consumption were set to 1.5 Kg/cm² and 45l/min., respectively, there was obtained a process yarn having many filament loops appearing at the surface thereof. The process yarn thus obtained had an appearance nearly identical to that of filament yarn and is analogous to the material yarn of acetate filament yarn, and consequently, was of insufficient bulkiness.

In the examples that follow at least two kinds of continuous filament yarns of different strength are employed.

EXAMPLE 4

A yarn of nylon 6, 70 deniers per 24 filaments, having a strength of 4.7 g/d and a percentage of elongation of 24.8 percent and a long fiber yarn of poly acrylonitrile, 150 deniers per 60 filaments, having a strength of 3.5 g/d and a percentage of elongation of 15.6 percent were simultaneously introduced into the air jet zone at a same yarn feeding velocity.

The processing was carried out under the following conditions:

air pressure	2.7 Kg/cm²
yarn feeding velocity	20 m/min.
winding velocity	15.5 m/min.
consumption of air	85 l/min.

The process yarn thus obtained appeared as a base thread of nylon filament yarn surrounded by a feathery filament yarn of polyacrylonitrile radially protruding from the base thread. The length of the feathery filaments of polyacrylonitrile did not exceed 4 mm. The yarn thus obtained was a bulky yarn of improved feeling having a base thread diameter of 1.6 mm., a dry strength of 1.4 g/d and a dry percentage of elongation of 10.3 percent.

When an air pressure of 1.8 Kg/cm² was used, acrylic fiber filaments appeared on the surface of the central filament group of nylon 6. However, substantially no naps were observed.

EXAMPLE 5

A polyester yarn, 75 denier per 36 filaments having a strength of 5 g/d and a percentage of elongation of 22 percent, and four acetate yarns and 150 denier per 40 filaments, having a strength of 1.2 g/d and a percentage of elongation of 21.9 percent were simultaneously introduced into the air jet zone at the same yarn feeding velocity.

The processing was carried out under the following conditions:

air pressure	2.5 Kg/cm²
yarn feeding velocity	20 m/min.
winding velocity	16 m/min.
consumption of air	80 /min.

The process yarn thus obtained was bulky yarn in which the base thread of the ester filament yarn was surrounded by the feathery acetate filaments protruding radially from the base thread. The feathery acetate filaments did not exceed a length of 3 mm. The process yarn was a bulky yarn having a base thread diameter of 2.4 mm., a dry strength of 1.0 g/d, a dry percentage of elongation of 14.4 percent, and an improved bulkiness.

After setting the material yarn together in a uniform direction, the processing was repeated with the exception that an air pressure of 1.5 Kg/cm² was used. Although acetate filaments were found on the surface of the thread, no naps were produced.

EXAMPLE 6

A yarn of nylon 6, 70 denier per 24 filaments, having a strength of 4.7 g/d and a percentage of elongation of 24.8 percent and two viscose rayons, 120 denier per 50 filaments, each having a strength of 2.1 g/d and a percentage of elongation of 15 percent were simultaneously introduced into the fluid jet device as shown in FIG. 3.

The processing was carried out at the condition as follows:

exceed feeding ratio	15 %
air pressure	2.5 Kg/cm²
yarn feeding velocity	20 m/min.
consumption of air	50 Normal l/min.

The bulky yarn thus obtained has an appearance similar to usual spun yarn whose surface is being covered with rayon naps. This bulky yarn has 314 apparant denier.

EXAMPLE 7

A long fiber yarn of polyethylene terephthalate 75 denier per 36 filaments, having a strength of 4.1 g/d and a percentage of elongation of 16.5 percent and a non-twisted yarn of Cuproammonium rayon, 150 denier per 108 filaments, having a strength of 2.3 g/d and a percentage of elongation of 16 percent are simultaneously introduced into the fluid jet device as shown in FIG. 3.

The processing was carried out under the following conditions:

exceed feeding ratio	12.5 %
yarn feeding velocity	20 m/min.

The bulky yarn thus obtained has an appearance similar to spun yarn and composed of feathery cuprorayon ends protruded from the surface of the base yarn. This bulky yarn has 232 apparant denier and light feeling.

As mentioned above, the bulky yarn according to the present invention is composed of feathery filament ends of added yarns radially protruding at an irregular displacement around the base thread of higher strength and has an improved softness in feeling as well as sufficient bulkiness. Further, the bulky yarn according to the present invention is endowed with properties

similar to the usual spun yarns. The bulky yarn is vastly superior in its knitting properties when compared with the usual jet-process yarn and accordingly, is of substantially greater economic value.

We claim:

1. A process for producing a bulky yarn from multifilament yarn, the improvement comprising the combination of steps:
   1. providing a multifilament yarn composed of filaments having a knot strength above 4.0 g/d and filaments having a knot strength below 2.4 g/d, previously set together,
   2. introducing, at an overfeed ratio of 10–25 percent, and a yarn feeding speed of 20–100 m/min., the yarn composed of filaments of differing strength into a venturi-type passage where turbulent gaseous fluid is formed at a gauge pressure of 2.0–10 kg/cm² and an air consumption of 40–150 NTP/min,
   3. severing the filaments of lower knot strength,
   4. entangling the severed filaments with the filaments of higher strength such that the severed ends having various lengths, protrude irregularly from the filaments of higher strength, and wherein the resulting bulky yarn is substantially free of loops,
   5. removing the resulting bulky yarn from said venturi-type passage.

2. A process for producing a bulky yarn from multifilament yarn, the improvement comprising the combination of steps:
   1. setting together a multifilament yarn having knot strength above 4.0 g/d and a multifilament yarn having knot strength below 2.4 g/d,
   2. introducing, at an overfeed radio of 10–25 percent, and a yarn feeding speed of 20–100 m/min., these multifilaments of different knot strength into a venturi-type passage where turbulent gaseous fluid is formed at a guage pressure of 2.0–10 kg/cm² and an air consumption of 40–150 NTP/min,
   3. severing the said multifilament of lower knot strength,
   4. entangling thus severed filament with the multifilament of greater knot strength, and wherein the resulting bulky yarn is substantially free of loops,
   5. removing the resulting bulky yarn from said venturi-type passage.

3. The process according to claim 2, in which said multifilament yarns are pushed out into the portion that is 0.4–0.6 mm off from the outlet of the said passage.

4. The process according to claim 2, in which said multifilament yarn having knot strength above 4.0 g/d is nylon and polyester fiber filament.

5. The process according to claim 2, in which the multifilament yarn having knot strength below 2.4 g/d is selected from the group comprising acetate rayon, acrylic fiber, viscose rayon and cupra rayon.

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