United States Patent [19]

Buzano

[11] **3,823,541**

[45] **July 16, 1974**

[54] **EFFECT VOLUMINOUS YARN**

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[73] Assignee: **Societe Rhodiaceta**, Paris, France

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[21] Appl. No.: **191,115**

[30] **Foreign Application Priority Data**

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Oct. 22, 1970	France	70.38479
Dec. 9, 1970	France	70.44628

[52] **U.S. Cl.** ..... **57/144**, 57/140 J

[51] **Int. Cl.** **D02g 3/24**, D02g 3/34

[58] **Field of Search**..... 57/140 J, 144, 34 B, 157 F, 57/91

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Primary Examiner—John Petrakes

Attorney, Agent, or Firm—Cushman, Darby & Cushman

[57] **ABSTRACT**

A high bulk multifilament textured yarn is disclosed, and process and nozzle for manufacturing same. The yarn has alternating compact zones and open zones with the specific volume of the open zones being at least twice that of the compact zones, the open zones being substantially of oblong form with at least a portion of the filaments thereof being distributed in a random manner in the interior of said open zones and entangled therein. The yarn is produced by passing at least one effect yarn through a turbulence chamber under substantially no tension, with the yarn being fed substantially axially to said turbulence chamber by way of a cylindrical conduit having a smaller cross-sectional area than said turbulence chamber. The yarn of this invention may be used to make woven or knitted goods and is suitable for use in hosiery.

11 Claims, 15 Drawing Figures

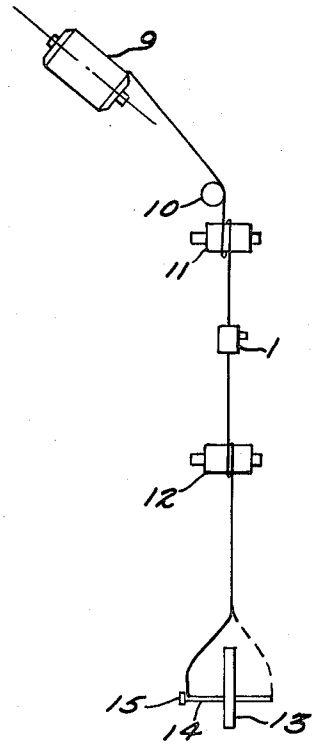

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Fig. 1.

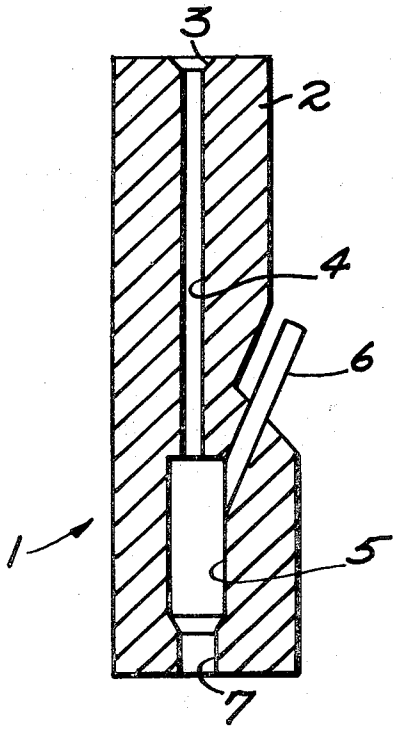

Fig. 2.

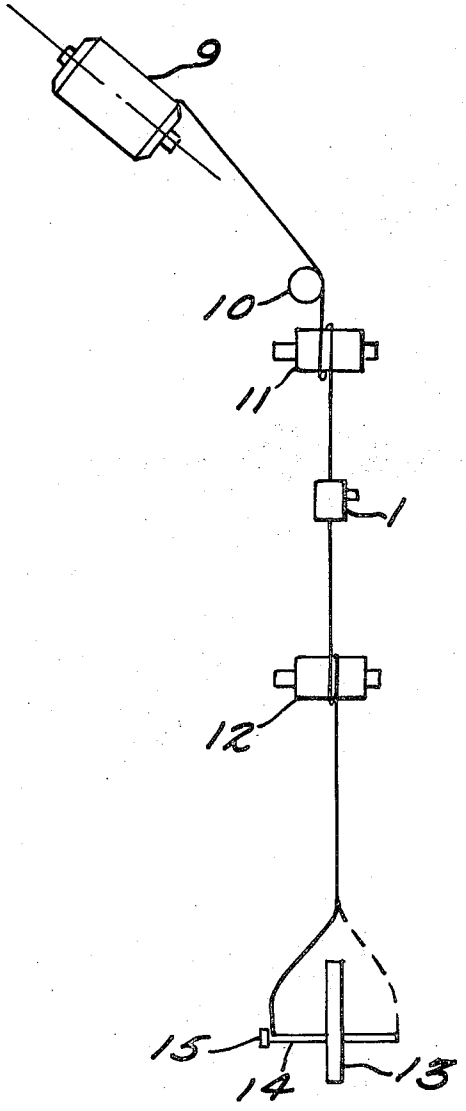

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Fig. 3.

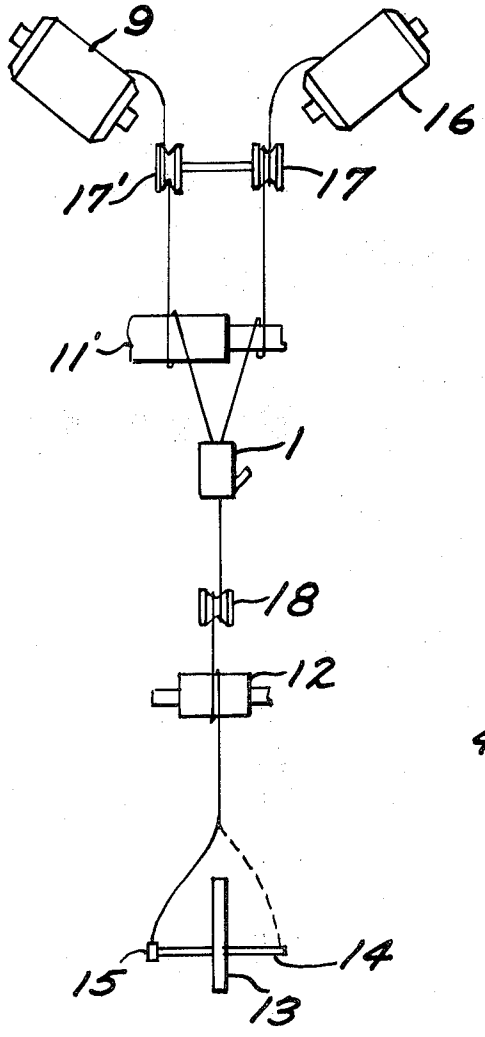

Fig. 4.

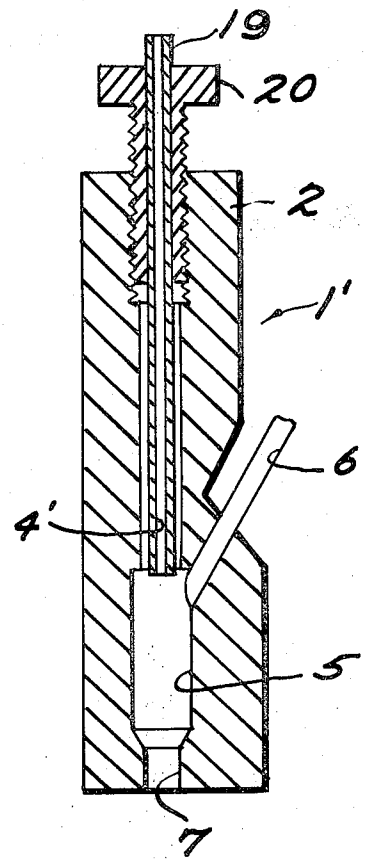

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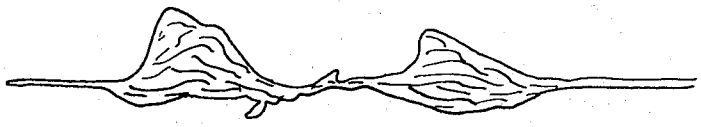
Fig. 5.

Fig. 6.



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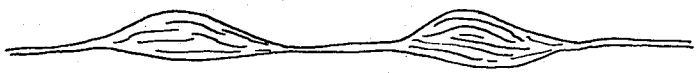

Fig. 11.

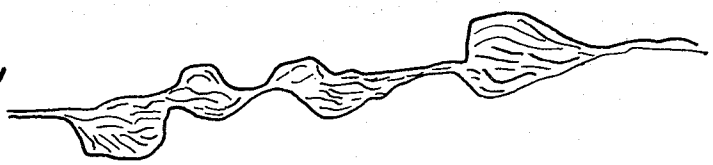

Fig. 12.

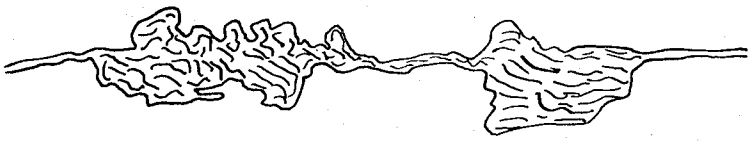

Fig. 15.

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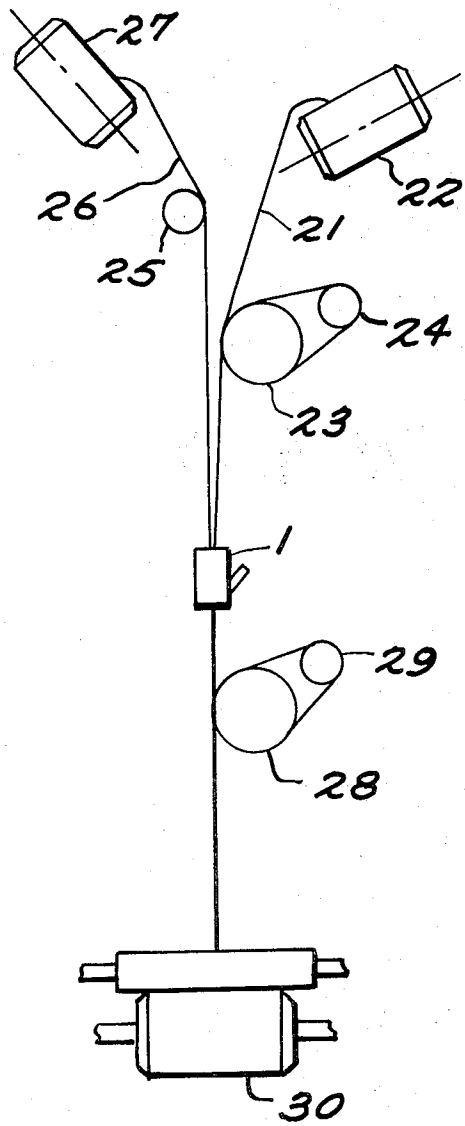
Fig. 8.



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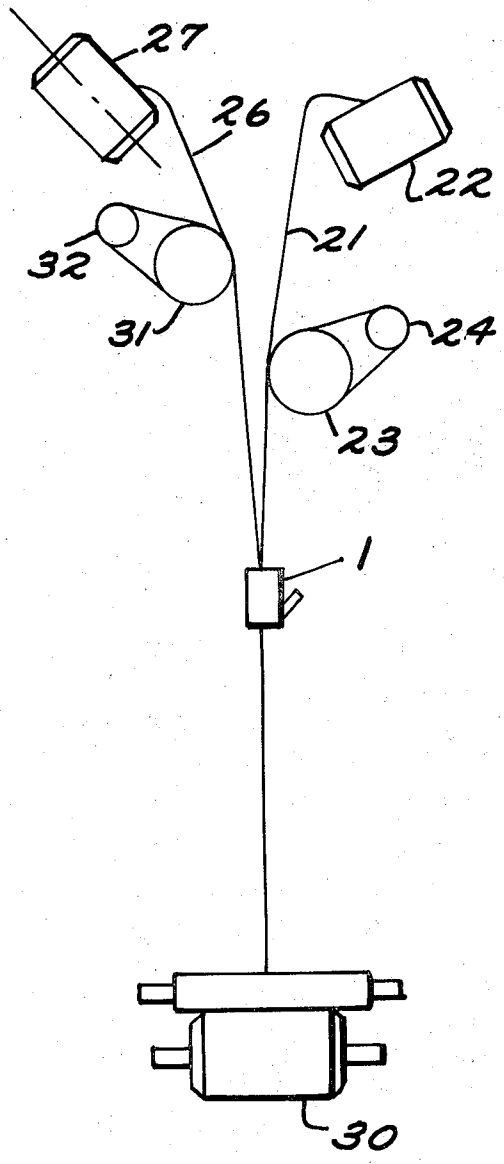

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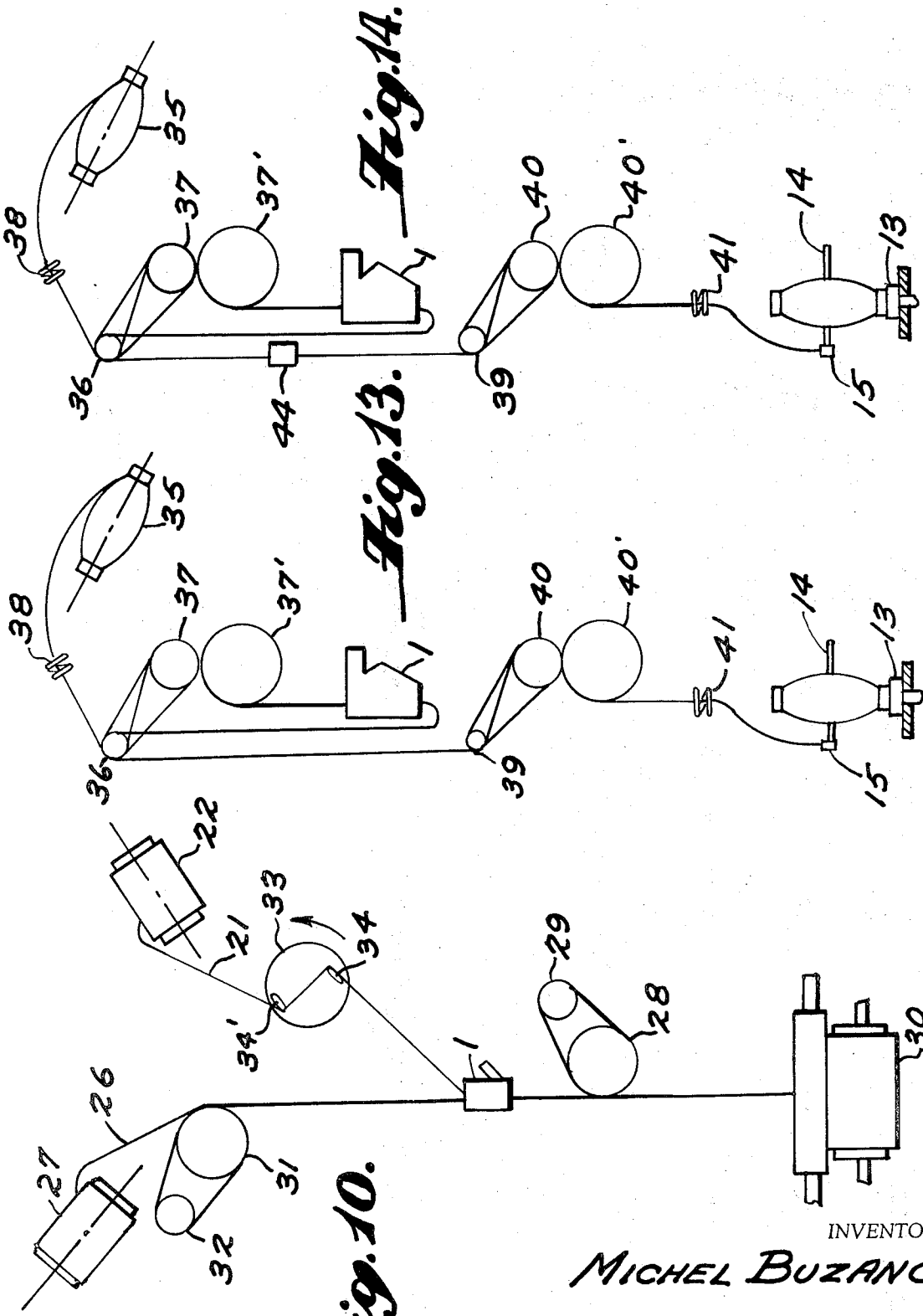

Fig. 14.

Fig. 13.

Fig. 10.

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EFFECT VOLUMINOUS YARN

BACKGROUND OF THE INVENTION

The prior art has long known how to produce a high bulk yarn by spreading apart or by rumpling the filaments forming the yarn. Some of the older processes utilized mechanical means but pneumatic means are now generally in use to open and separate the filaments, and even to give the filaments a certain number of convolutions, and to associate the filaments into a yarn. In such processes, a bundle of practically rectilinear continuous filaments is passed through a pneumatic zone of turbulence.

In my copending U.S. patent application, Ser. No. 807,540, filed Mar. 17, 1969, now U.S. Pat. No. 3,678,549, entitled PROCESS FOR THE MANUFACTURE OF HIGH-BULK YARN, a process is disclosed wherein at least one yarn is introduced into a fluid turbulence zone of a nozzle, from which it is discharged in the same direction as the fluid, the yarn being fed in a non-axial manner through the nozzle so as to rub at least lightly against the walls of the nozzle prior to entering the fluid turbulence zone. In this process a high bulk yarn is obtained, generally having buttons of practically spherical shape. The process generally effects all of the filaments in the yarn. However, such a process is limited in its performance, especially as to the yarn speeds, e.g., generally involving yarn speeds of less than **100** meters/minute or so. It is highly desired that processes be developed which can be conducted at relative high speeds in order to be compatible with modern practices, which utilize a number of pieces of high speed equipment. It has also been desired to obtain a high bulk yarn with a fancy decorative or textured effect.

The Dahlstrom et al. U.S. Pat. No. 3,069,836 is directed to producing relaxed interlaced yarns in a single, continuous operation. The patent aims at producing yarns suitable for packaging on light cardboard cores having a good intra-package yarn properties. Polyamide or polyester filamentary structures are forwarded at a uniformly positive tension through a zone of fluid turbulence wherein a heated fluid is directed onto the filamentary structure with sufficient force to separate the filaments and interlace same into a compact unitary strand. At the same time, the filamentary structure is relaxed in a controlled amount. The final product has the handling properties of a true twist yarn, even at zero bundle twist, due to the interentanglement of filaments. As is apparent from FIG. **5** of this patent, the product produced thereby is uniformly interentangled and is not voluminous, behaves in a manner similar to that of twisted threads, and is not a textured or decorative yarn.

The Dahlstrom et al. U.S. Pat. No. 3,083,523 is similar in disclosure to the above-identified Dahlstrom et al. patent.

The Gemeinhardt et al. U.S. Pat. No. 3,417,415 is directed to producing bulk or texturized yarn having bindings or knots spaced along the yarn at predetermined points. The patent discloses passing continuous multifilament yarn at a 5 – 50 percent overfeed rate between two fixed points and laterally oscillating the yarn between two fixed points under the influence of a gas jet which is substantially perpendicular to the path of the yarn, with the yarn passing through the gas jet twice

in each complete period of oscillation. As is clear from FIGS. **4** – **7** of this patent, the bulk yarns produced thereby have the filaments in the interior of the more open zones of the yarn distributed in a substantially oriented manner.

The Breen et al. U.S. Pat. No. 3,043,087 is directed to a process for making alternating twist slub yarn from either staple or continuous filament yarn. The slub effect is achieved by passing a core filamentary strand through a fluid vortex, which twists the strand and causes it to balloon upstream of the vortex, while feeding a second filamentary material to wrap around the ballooning portion of the core strand to form a slub. The slub is carried by the core material through the fluid vortex where it is firmly wrapped around the core material with both the S and the Z twist.

The Breen U.S. Pat. No. 2,783,609 contains an early disclosure of a method of bulking a bundle of continuous filaments. The patent discloses the production of a yarn having numerous yarn loops held in place by twisting the yarn, or by encircling the nodes of loops by other loops (note column 4 of the patent). The yarns produced according to the patent are disclosed in FIGS. 4, 5 and 7 thereof and it will readily be appreciated that the resulting yarn does not have alternating compact and open zones.

The Benson U.S. Pat. No. 3,448,500 is directed to bulking continuous filament yarns, and is characterized by the absence of broken ends or fibers in the bulked yarn product. The yarn is uniformly bulked while presenting the formation of completed or closed loops, by separating a number of filaments into successive discrete undulatory arches or waves extending laterally from the core or bundle of yarn (note FIGS. 2 and 3 of the patent). A substantial majority of the yarn filaments remain in the core section **10**b.

The Breen U.S. Pat. No. 3,043,088 is directed to producing a yarn having enhanced bulk and a large number of protruding free fiber ends. A yarn which consists at least in part of stable length fibers held in place by a yarn twist is fed to a high velocity fluid jet which applies a false untwist to the yarn. The yarn is snubbed before and after the jet to prevent the untwist from backing up or carrying forward. The fibers obtained by the patentee are illustrated in FIGS. 4 – 9 and 15 – 18 of the patent.

SUMMARY OF THE INVENTION

A novel, high bulk, multifilament, textured yarn is obtained using a novel process.

The yarn has alternating compact zones and open zones, with the specific volume of the open zones being at least twice that of the compact zones. The open zones which are preferably at least as long as the compact zones, are of a general oblong shape. This textured yarn is produced by passing at least one effect yarn, under substantially no tension, through an axial conduit and then immediately into a turbulent chamber. The effect yarn is fed substantially axially to the axial conduit. In the turbulent chamber, the yarn is subjected to a multitude of multidirectional turbulences, which turbulences cause the yarn filaments to open up and interentangle in the open zones.

DESCRIPTION OF THE INVENTION

The present invention provides a high bulk yarn with fancy, decorative, textured effects which can be obtained at high production speeds.

The yarn of the present invention is a high bulk yarn based on multiple strand filaments, and exhibits a fancy or decorative effect. The yarn contains at least one end having alternating compact zones and open zones, with the filaments in the open zones opened up and separated to produce a higher specific volume for the open zones than the specific volume of the initial yarn. The envelope, or outer surface, of the open zones generally has a practically oblong shape, with at least part of the filaments of the at least one end being distributed in a haphazard manner in the interior of this envelope. Preferably, the envelope, or outer surface, of the open zone has essentially the shape of a spindle, which may or may not have the form of a revolution spindle about the major axis of the yarn. The spreading of the filaments, in relation to the major axis of the yarn, is variable from filament to filament.

The yarn of the present invention, having a marked decorative or textured effect, is obtained at high speed using the process of the present invention. The process generally involves yarn speeds greater than 100 meters/minute, preferably greater than 200 meters/minute. The decorative or textural effect yarn may comprise more than one yarn end.

According to one embodiment of the present invention, the yarn is produced from one or more yarn ends, and the length of each open zone is greater than the length of each compact zone. In order to get a marked texture effect, the apparent volume of an open zone is greater than twice the apparent volume of a compact zone. Preferably, the open zones and the compact zones are distributed over the yarn according to a regular pattern.

The present invention is applicable to yarns, filaments, and similar strands whether spun or continuous. Continuous multifilament yarn will be employed hereinafter as exemplary of all such strands, since in this form the present invention has its greatest utility. The yarns used in the present invention may be of a wide variety of fibrous material, either natural or synthetic, such as, e.g. polyester, polyamide, polyolefin, cellulose acetate, and the like. Preferably the yarns are at least partly of continuous filaments, and more preferably the yarns are substantially wholly of continuous filaments.

In one embodiment, the yarn of the present invention comprises at least two ends, at least one of which is a core yarn which is in the rectilinear state, and at least another of which is an effect yarn which forms open zones around the core yarn.

In a preferred form of one embodiment of the present invention, the fancy effect yarn, when using one or more ends, has less than 40 percent of the filaments thereof entangled in the open zones of the final product. In one preferred embodiment, the textured effect has a marked random character and the specific volume of the open zones is greater than 2.5 times the specific volume of the compact zones. The compact and the open zones, especially the open zones, can contain blocked broken strands at least in part in such zones, which broken strands impart the yarn an appearance comparable to that of spun fibers.

In some cases wherein at least two ends are utilized, with at least one of the ends serving as a core yarn which is surrounded by one or more effect yarns, the core yarn can be markedly compact over substantially its entire length.

The high bulk multifilament textured yarn of the present invention has alternating open zones and compact zones, with the specific volume of the open zones being at least twice, preferably at least 2.5 times, the specific volume of the compact zones. Preferably, at least about 20 percent of the filaments of said open zones are distributed in a random manner in the interior of said open zone. More preferably, at least 50 percent of the filaments are so randomly distributed.

The length of the open zones and the compact zones will vary depending upon the particular operating conditions, e.g. the open zones may be only a few millimeters long, even as short as 3 – 5 millimeters, or they may be as long as 20 or 30 or even more centimeters. In one preferred embodiment of the present invention, the length of the compact zones is less than the length of the open zones, preferably being at least 50 percent less than the length of the open zones.

The yarn of the present invention is obtained by a process in which at least one yarn end is introduced, under substantially no tension, into turbulence chamber of a nozzle after having first passed through a nozzle upstream portion of reduced cross-section. The yarn is fed to the nozzle in a substantially axial manner. In the turbulence chamber, the yarn is subjected to the action of a multitude of multi-directional turbulences, which have the effect of disorganizing the yarn and rearranging same in a manner such as to produce a textured yarn having open zones and compact zones.

In one embodiment of the process wherein at least two ends are introduced into the turbulence chamber of the nozzle, at least one end can be fed at a sufficient tension to maintain it in a rectilinear state, in which case the various ends preferably form an angle of at least 10° therebetween upstream of the nozzle. The use of such an angle between the ends substantially avoids accidental and intermittent binding upstream of the turbulence chamber.

According to another embodiment of the process of this invention, at least one yarn end is fed to the nozzle in a controlled manner. Such controlled feeding may or may not be periodical or at regular intervals.

In another embodiment of the present invention, the yarn filament or strand strengths and the amount of turbulence are chosen such that a substantial number of yarn strands are broken under the effect of the turbulence. Once the yarn filaments are separated, suitable jet turbulence will whip the various filaments about with such rapidity that the flex life of the material is rapidly exceeded and some or even most of the filaments are broken. Preferably, at least 30 percent of the filaments of the effect yarns are broken. Preferably, the yarn is then interlaced in a known manner to produce a product having improved physical properties. Low density effect yarns are preferably used, such as collulose acetate, acrylic or polyester fibers.

The yarn can often be advantageously subjected to a sudden change of direction when passing out of the nozzle.

Bundles or ends of filaments having different characteristics may be used, such as filaments formed of different polymers or else filaments of the same polymer

but of different types. In either event, the toughest filaments will generally be disposed in the central part of the yarn forming the core thereof while the weaker yarns will be disposed around such core. It is most convenient to use ambient air, e.g., at a temperature of about 20° –25°C., as the gas jet or gas stream. However, it is also feasible to use any other gas which does not exert a deleterious effect upon the filaments, and, if desired, the air or other gas may be heated to an elevated temperature to shrink the yarn filaments or to fix the yarn by partially softening or melting the filaments during the treatment in the nozzle. It is possible to apply various coatings or finishes to the yarn during the jet treatment. Heated air or other gas may also be used to simultaneously dry a yarn which has been wetted in a previous step with, e.g. water or an organic solvent. The temperature of the gas or air should not be so high as to be deleterious to the yarn, e.g. cause substantial fusion or degradation of the filaments.

A particularly advantageous device for the practice of the process of the present invention is formed by the nozzle described in my co-pending application Ser. No. 807,540, filed Mar. 17, 1969, the disclosure of which is hereby incorporated for the additional teaching of the nozzle therein. This nozzle comprises a cylindrical conduit for yarn passage, with the conduit having an upstream part of reduced section and a downstream part having greater cross-sectional area, with no joining zone therein-between. The fluid jet feed conduit opens into the downstream, or wider, part of the cylindrical conduit, making an acute angle with the longitudinal axis of the cylindrical conduit. Preferably, the fluid jet feed conduit opens into the greater cross-sectional area portion of the axial conduit in the upstream part thereof.

In one embodiment of this nozzle, the cylindrical conduit downstream part of greater cross-sectional area ends downstream in a short discharge section of somewhat smaller diameter. In a particularly advantageous embodiment, the cylindrical conduit upstream part of reduced section is formed by an adjustable tube, which is adjustable in position relative to the downstream part of greater cross-sectional area. The upstream tube is conveniently associated with a polished screw to permit variation of position of this tube.

The apparatus used in the process of this invention to produce the yarn of this invention also comprises means for releasing, guiding and pulling the yarn which is known to the art. In some embodiments, it is advantageous to use periodically or non-periodically controlled releasing means, such as the effect generators of the type described in French Patent No. 1,546,531.

DESCRIPTION OF THE DRAWINGS

The invention will be more clearly understood with reference to the accompanying drawings wherein:

FIG. **1** is a schematic view of the nozzle used in the process of this invention;

FIG. **2** is a schematic diagram of the apparatus for the treatment of only one yarn end;

FIG. **3** is a schematic diagram of the apparatus used when two yarn ends are treated;

FIG. **4** is one embodiment of a nozzle which can be used in the practice of the present process, wherein the upstream portion of the nozzle, having a conduit of reduced cross section for yarn passage, is adjustable;

FIGS. **5, 6** and **7** illustrate the yarn produced according to working Examples 1 – 5;

FIG. **8** is a schematic diagram of another embodiment for treating two yarn ends, one of which is controlled, to produce yarns having a highly decorative effect;

FIG. **9** is a schematic diagram of another variation of the apparatus for treating two yarn ends but with the feed of both yarn ends controlled;

FIG. **10** is a schematic diagram of yet another embodiment for treating two yarn ends, with one yarn end fed in a nonperiodic manner;

FIGS. **11** and **12** illustrate the appearance of yarns produced by working examples **6** and **7**;

FIGS. **13** and **14** are schematic diagrams of further embodiments of apparatus used to treat one yarn end and represent the apparatus used in working examples **8 – 11.**

FIG. **15** represents the appearance of the yarn produced by working Examples 8 – 11.

In FIG. **1,** nozzle **1** comprises a body **2** having therein an axial conduit **4** for the yarn or yarns. Axial conduit **4** has an opening **3** which is slightly flared, with the opposite end of axial conduit **4** opening into an enlarged area **5** into which fluid flows via conduit **6.** The enlarged area **5** terminates in a short discharge section **7** of somewhat smaller diameter.

The apparatus of FIG. **2** is used wherein one yarn end is to be treated. The apparatus includes bobbin **9,** guide **10,** feed or delivery roller **11,** nozle **1,** discharge or release roller **12** and conventional wind-up means, in this instance illustrated as a system comprising a spindle **13,** ring **14** and traveler **15.**

The apparatus schematically represented by FIG. **3** is suitable for treating two yarn ends. The apparatus comprises bobbins **9** and **16,** grooved guides **17, 17'** and **18,** step delivery roller **11'**, which permits one yarn to be overfed in relation to the other, nozzle **1,** and discharge or release roller **12,** together with a conventional wind-up system.

FIG. **4** represents an embodiment of nozzle **1,** wherein the nozzle **1'** is adjustable. The axial conduit **4'** is formed by an adjustable tube **19** which is maintained in position by polished screw **20.**

FIG. **8** represents apparatus for the production of highly decorative yarns from two yarn ends. An effect yarn **21** passes from bobbin **22** over controlled roller **23,** which is associated with roller **24,** and then enters nozzle **1** wherein it is associated with core yarn **26** pulled freely from bobbin **27** over guide **25.** The yarn discharged from nozzle **1** is pulled by controlled roller **28,** associated with roller **29,** before being wound up, using conventional wind-up apparatus, on bobbin **30.**

FIG. **9** represents an embodiment of the apparatus of FIG. **8,** wherein the controlled yarn is also released in a controlled manner. In FIG. **9,** the effect yarn **21** is handled on the same apparatus as in FIG. **8.** The core yarn **26** is pulled from bobbin **27** by controlled roller **31** associated with roller **32,** located upstream of nozzle **1.** The discharge rollers **28, 29** may then be omitted, and the yarn passed directly to wind-up apparatus and bobbin **30.** This particular apparatus arrangement permits the production of a decorative yarn having a very regular distribution of the open zones in the yarn.

With the apparatus of both FIG. **8** and FIG. **9,** relatively long and pronounced open zones are obtained on the yarn.

The apparatus of FIG. **10** allows the production of a decorative yarn having intermittent open zone areas. The apparatus is somewhat similar to that of FIGS. **8** and **9** except an effect generator **33,** carrying **2** eccentric cleats **34, 34'**, is located between bobbin **22,** carrying effect yarn **21,** and nozzle **1.** Core yarn **26** is fed in a controlled manner, and the yarn discharged from nozzle **1** passes over controlled roller **28,** associated with roller **29.** Alternatively, effect generator **33** may be replaced by conventional entangling apparatus, either mechanical or electronic.

FIG. **13** represents a schematic diagram of another embodiment of apparatus which can be used to treat one yarn end. The yarn passes from bobbin **35** through guide **38** over guide **36,** delivery roller **37,** back to guide **36,** back to delivery roller **37,** then over associated delivery roller **37'**, through nozzle **1,** over guide **36** to guide **39,** around release roller **40,** back to guide **39,** again around release roller **40** and then to associated release roller **40'** and to a conventional wind-up system having spindle **13,** ring **14** and traveler **15,** after passing through guide **41.**

The apparatus of FIG. **14** is the same as the apparatus of FIG. **13** except an interknit nozzle **44** is used between guide **36** and guide **39.** The interknit nozzle **44** is known, and is illustrated, for instance, in French Patent No. 1,556,272, the disclosure of which is hereby incorporated by reference for the disclosure of such nozzle therein.

EXAMPLES OF THE INVENTION

In the following examples a nozzle **1** was used which had a height of 54 mm, a conduit **4** length of 34 mm and diameter of 2 mm, and an enlarged area **5** length of 19 mm and a diameter of 5 mm. The discharge section **7** had a height of 5.5 mm and an internal diameter of 3.8 mm. Conduit **6** had a diameter of 2 mm, a length of 12 mm and made an angle of 25° with the longitudinal axis of the nozzle (i.e. with the axis of conduit **4**).

Example 1

A polyethylene terephthalate yarn, 50 dtex/22 filaments, having an initial twist of 12 turns/meter and a multilobed cross section, was treated on apparatus illustrated in FIG. **2** under the following conditions:

Delivery speed of the yarn by the roller (**11**):	474 m/min
Pulling speed by the roller (**12**):	443 m/min
Spindle (**13**) speed:	7100 turns/min
Air pressure to the nozzle (**1**):	4.5 kg/cm²
Yarn tension: downstream of roller (**12**)	4 g
Specific volume of the yarn (measured by the Koningh test):	3.58 cm3/g
Length extension at the rupture point:	11%
Frequency of effects about	12 to 13 mm.

The resulting yarn had the appearance of FIG. **5.**

Example 2

This example illustrates the influence of the process parameters overfeed rate, air pressure and yarn speed. The polyethylene terephthalate yarn used in Example 1 was treated with the apparatus of FIG. **2,** but using the nozzle **1'** of FIG. **4.** The position of tube **19** was empirically regulated. Except as indicated, the process conditions were the same on each of the runs of this experiment. The following tables indicate the variance in operating conditions and the results obtained:

a) Influence of pressure:				
— feeding speed:			475 m/min	
— rate of overfeeding:			7%	
air pressure in kg/cm²		3.5	4.5	5.5
specific volume in cm3/g		1.7	2.03	2.4
b) Influence of overfeeding rate:				
— feeding speed:			475 m/min	
— air pressure:			4.5 kg/cm²	
overfeeding rate		4.5	7	11
specific volume in cm3/g		2.2	2.03	2.2
c) Influence of yarn speed:				
— rate of overfeeding:			7%	
— pressure in kg/cm²:			4.5	
yarn speed in m/min	475	400	350	215
specific volume in cm3/g	2.03	2.04	2.34	2.50

Example 3

A cellulose acetate effect yarn, 167 dtex/36 filaments, 0 turns/meter, and a polyhexamethylene adipimide core yarn, 44 dtex/13 strands, 12 turns/meter were treated on apparatus corresponding to FIG. **3,** using the following operating conditions:

Feeding speed of the polyamide yarn:	206 m/min
Feeding speed of the cellulose acetate yarn:	236 m/min
Pulling speed of the yarn by roller (**12**)	176 m/min
Spindle (**13**) speed:	5100 turns/min
Air pressure to nozzle (**1**)	2.5 kg/cm²

The yarn obtained in this example had the appearance of the yarn of FIG. **6,** and the following characteristics:

— Average yarn gauge:	241 dtex
— Yarn gauge of open zones:	253 dtex
— Yarn gauge of compact zones:	211 dtex
— Frequency of effects about	12–15 mm
— Specific volume:	3.4 cm3/g

Example 4

A cellulose acetate effect yarn, 84 dtex/24 filaments, 0 turns/meter, and a polyhexamethylene adipimide core yarn, 44 dtex/13 filament, 12 turns/meter, were treated on the apparatus of FIG. **3** using the following conditions:

Feeding speed of the polyamide yarn:	262 m/min
Feeding speed of the cellulose acetate yarn:	268 m/min
Pulling speed of the yarn by roller (**12**)	256 m/min
Spindle (**13**) speed:	5100 turns/min
Air pressure to nozzle (**1**)	3.5 kg/cm².

The resulting yarn had the appearance of the yarn of FIG. **7,** and the following characteristics:

— Average yarn gauge:	134 dtex
— Yarn gauge of open zones:	171 dtex
— Yarn gauge of compact zones:	128 dtex
— Frequency of effects:	12–15 mm
— Specific volume:	2.2 cm3/g.

Example 5

A polyethylene terephthalate yarn, 50 dtex/22 filaments, 12 turns/meter, and a cellulose acetate effect yarn, 167 dtex/36 filaments, 0 turns/meter, were treated on the apparatus of FIG. **3,** using the following operating conditions:

—Feeding speed of the polyamide yarn:	257 m/min
—Feeding speed of the triacetate yarn:	263 m/min
—Pulling speed of the yarn by rollers (**12**):	236 m/min

—Rotation speed of the wind-up spindle:	5100 turns/min
—Air pressure to nozzle (1):	1.5 kg/cm².

The yarn had the appearance of the yarn of FIG. 7 and the following characteristics:

—Average yarn gauge:	228 dtex
—Yarn gauge of open zones:	290 dtex
—Yarn gauge of compact zones:	217 dtex
—Frequency of effects:	about 7 mm

Example 6

A decorative slub yarn was manufactured on apparatus corresponding to FIG. 9 using two ends of multilobed iridescent polyethylene terephthalate yarn, 50 dtex/22 filaments, 12 turns/meter, as the core yarn and as the effect yarn, using the following operating conditions:

-Speed of the core yarn:	560 m/min
-Speed of the effect yarn:	585 m/min
-Speed of winding on bobbin (30):	556 m/min
-Air pressure to nozzle (21):	4 kg/cm².

A very tight yarn having a marked textured effect and the appearance of the yarn of FIG. 11 was obtained, having the following characteristics:

—Average yarn gauge:	106 dtex
—Compact zone yarn gauge:	98 dtex
—Average length of the open zone:	12.6 cm
—Maximum length of the open zone:	52 cm
—Minimum length of the open zone:	3 cm
—Distance between two consecutive effects - average:	10 cm
—Distance between two consecutive effects - maximum:	23 cm
—Distance between two consecutive effects - minimum:	4 cm
—Specific volume:	4.5 cm3/g.

Example 7

The same yarn used in Example 6 above was used as the effect and as the core yarn in the production of a textured yarn from two yarn ends in the apparatus represented by FIG. 10. The effect generator 33 had two cleats 34, 34′ thereon, and the following operating conditions were observed:

Speed of the core yarn:	306 m/min
Pulling speed of roller (28):	300 m/min
Rotation speed of the disc (33):	60 turns/min
Air pressure to nozzle (1):	5.5 kg/cm².

The yarn had the appearance of the yarn of FIG. 12, and the following characteristics:

—Specific volume:	4.5 cm3/g
—Distance between two consecutive open zones:	2.5 m
—Yarn gauge of the open zones:	140 dtex
—Yarn gauge of the compact zones:	98 dtex
—Average length of the flames.	12.5 cm
—Maximum length of the flames.	23.5 cm
—Minimum length of the flames.	1 cm

Example 8

An acrylic yarn, 90 dtex/44 filaments, 0 turns/meter, was converted into a textured yarn on apparatus corresponding to FIG. 2 using the following operating conditions:

— Feeding speed of the yarn:	300 m/min
— Overfeed rate:	2%
— Air pressure to nozzle: (1)	2.5 kg/cm²
— Speed of the spindle (13) :	5500 turns/min
— Tension of the yarn:downstream of roller (12)	7 to 9 g.

The resulting yarn had the appearance of the yarn of FIG. 16 with an extension at rupture of 5.7% and a tensile strength of 0.99 g/dtex.

The properties of the yarn of this example can be increased by imparting a certain torsion to the yarn after passage through nozzle 1, as summarized by the following table:

	Extension at rupture,%	Tensile strength in g/ dtex
Post twisted yarn at 30 turns/m	6.2	1.01
Post twisted yarn at 100 turns/m	9.7	1.44

Example 9

This example is identical to Example 8, except that the acrylic yarn initially (that is, as taken off bobbin 35 had a twist of 150 turns/meter. The resulting textured yarn had a more compact appearance than that produced by Example 8 with an extension at rupture of 10.2 percent and a tensile strength of 1.51 g/dtex.

Example 10

If a greater specific volume is desired as well as a shorter and more flexible yarn, it has been found advantageous to use a yarn with a great number of weak filaments, which weak filaments are broken, as the specific volume (or pile density) depends, in part, upon the number of broken strands in the yarn.

An acrylic yarn, 90 dtex/90 filaments, 0 turns/meter was processed on the apparatus of FIG. 13, using the following conditions:

—Feeding speed of the yarn:	300 m/min
—Overfeed rate:	1 %
—Air pressure to nozzle (1):	2.5 kg/cm²
—Speed of the spindle (13):	5500 turns/min
—Balloon tension at wind-up system (13,14,15)	7 to 9 g

A yarn with a rather high specific volume was thus obtained, consisting mainly of short flexible filaments, having a tensile strength of 1.7 g/dtex.

Example 11

This example was identical to Example 10 above, except that the apparatus of FIG. 14 was used. As mentioned before, the only difference between the apparatus in FIG. 13 and that of FIG. 14 is the interknit nozzle 44. The particular nozzle used was described in French Patent No. 1,556,272, using air pressure in the interknit nozzle of 2.5 kg/cm². The cohesiveness of the filaments was increased, as well as the tensile strength, which was 2 g/dtex. The yarn had essentially the same appearance as that produced by Example 10. The interknitting treatment has the advantage that it is distinctly more economical than mechanically imparting a torsion or twist to the yarn.

What is claimed is:

1. High bulk textured multifilament yarn comprising at least one end, said yarn having alternating compact and open zones forming effects, the frequency of effect being between about 5 and about 50 mm, the specific volume of said open zones being at least twice the specific volume of said compact zones, the shape of the outer surface of said open zones being oblong, at least 20 percent of the filaments of said at least one end being distributed in a random manner in the interior of said open zones, with the distance of said filaments in relation to the major axis of the yarn varying from filament to filament, less than 40 percent of the filaments being entangled in the open zones, the average length

of the compact zones being at least 50 percent less than the length of the open zones.

2. The yarn claimed in claim **1** wherein said open zones have a specific volume at least 2.5 times greater than the specific volume of said compact zones.

3. The yarn as claimed in claim **1** wherein said yarn contains at least two ends, at least the major portion of the filaments of at least one of said ends being opened to form said open zones.

4. The yarn as claimed in claim **3** wherein at least one end is an effect yarn, which forms said open zones by the opening of at least most of the filaments thereof, and at least one other end is a core yarn in a rectilinear state which has a specific volume in said open zones which is substantially the same as the specific volume in said compact zones.

5. The yarn as claimed in claim **4,** wherein said at least one core yarn is of filaments having greater tensile strengths than the filaments of said effect yarn.

6. The yarn as claimed in claim **5,** wherein at least 30 percent of the filaments of said yarn are broken.

7. The yarn as claimed in claim **1,** wherein the said open zones and said compact zones contain broken filaments, blocked at least in part in said zones.

8. The yarn as claimed in claim **1,** wherein the shape of the outer surface of said open zones is in the form of a spindle.

9. The yarn as claimed in claim **8,** wherein the form of said spindle is a revolution spindle.

10. The yarn as claimed in claim **1,** wherein said open zones and said compact zones occur in regular effect periods.

11. The yarn as claimed in claim **1,** wherein said yarn has a distinct random textured effect.

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