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PROCESS FOR FORMING A SLUB YARN

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FIG. 1

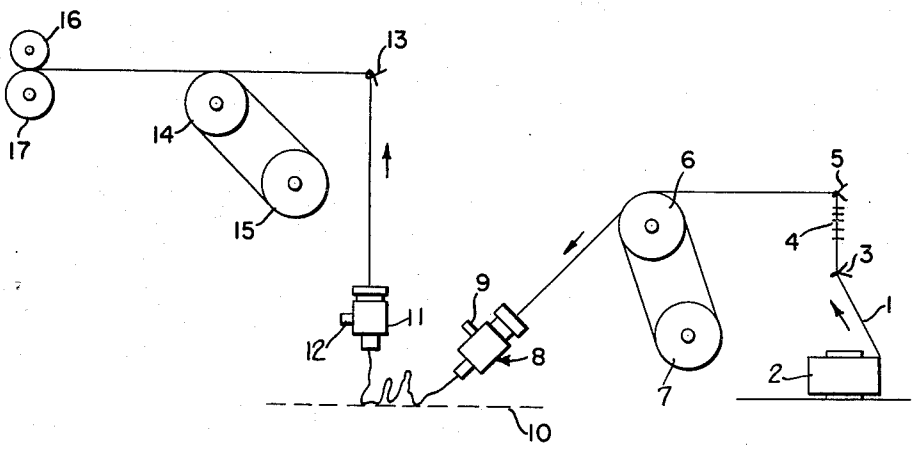
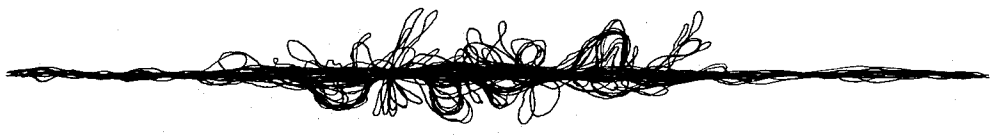


FIG. 2



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PROCESS FOR FORMING A SLUB YARN

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This invention relates to fluid treatment of yarn to introduce slubs or intermittent portions of greater denier than the remainder of the yarn.

Fluid treatment of yarn to impart bulkiness has become well known in the art. Fluid jets are used to introduce coils, loops and whorls randomly along the yarn filaments as described in Breen U.S. Patents No. 2,783,609, No. 2,852,906, and No. 2,869,967. Such treatments are particularly concerned with providing as uniformly bulked or textured yarn as possible, since uniform yarns are generally the most important article of commerce in the textile industry. However, the effectiveness of the texturizing treatment or bulking action can be made nonuniform along the yarn as described in U.S. Patents to Griset, No. 2,874,444, and to Field, No. 2,931,090. The novelty yarn produced in this way has a predominance of untextured portions which have been substantially unaffected by the treatment and intermittent bulked portions, which are either in the form of relatively short nubs or longer conventionally texturized portions, but are not of sufficient size to qualify as slubs.

It is sometimes desirable to produce yarns having much more decided variations in texture and denier in order to obtain novelty effects in fabrics for such purposes as casement fabrics, draperies, dress goods, upholstery fabrics and the like. Slub yarn for such purposes has been obtained in the form of silk threads from imperfect, freak or double cocoons, or from cocoons of wild or uncultivated silk worms. These "doupioni" silks are irregular in texture and carry slubs or thickened portions at irregular intervals. They are in limited supply. Methods for producing similar yarn synthetically have involved varying extrusion conditions so that the individual filaments vary considerably in denier or the filaments are caused to pile up and coalesce or stick together. The product has a harsh hand and less desirable appearance than "doupioni" silk, and is expensive to produce because of the low production rate and special process conditions required.

It is an object of the present invention to provide an improved method for producing a slub yarn. A further object is to provide a novel slub yarn in which the slubs are formed of entangled continuous filaments and are stable even though the filaments are not coalesced or otherwise stuck together. Other objects will become apparent from the disclosure and claims.

The process of this invention is suitable for forming stable slubs in any conventional organic textile yarn composed wholly or in part of continuous filaments. The yarn is continuously fed to a supply jet and forwarded by the jet in a high velocity stream of compressible fluid to impinge at an angle against a foraminous surface, preferably a screen. The essential function of this jet is to open up the yarn bundle and distribute the filaments in random fashion on the surface, and jets of the type disclosed in the above-mentioned patents are suitable for this purpose, but the jet may also be operated so as to bulk, crimp or otherwise texturize the yarn.

Slubs are formed in the yarn by means of a second jet. This slubbing jet directs a high velocity stream of compressible fluid against the foraminous surface adjacent to and at a converging angle to the stream from the supply jet. This creates a zone of turbulence between the streams

which causes filaments of the open yarn bundle to fold back on themselves, initiating the formation of slubs. The yarn is then withdrawn from the surface at a rate of at least 5% less than the feed rate to retain the folds in the yarn. The folds or filament loops are consolidated in the yarn as slubs by withdrawing the yarn through the slub jet stream in a direction which is counter-current to the flowing stream. The turbulent flow causes the filaments to intermingle and entagle the folds or loops to form stable slubs which are random in length and distribution.

The jets disclosed in the above-mentioned patents are also suitable for use as slubbing jets. However, it may be preferable to use interlacing jets of the type disclosed in Bunting and Nelson U.S. Patent No. 2,985,995, arranged so as to provide a stream of fluid counter-current to the direction of yarn travel to the jet from the screen for the required slubbing action. Then, as the yarn passes through the jet, the filaments are separated and interlaced to hold the slubs firmly in place.

The slubs can be further consolidated in the yarn by adding a third jet, after the slubbing jet, to twist protruding loops or ends about the yarn. Torque jets of the type disclosed in Breen and Sussman U.S. Patent No. 2,997,837 and also No. 3,009,309 are suitable for this purpose. A torque jet can be used as the slubbing jet to combine these operations, thereby providing economy in fluid consumption. This has the unexpected result of improving the operability of the slubbing process. When poor weavability results from weak spots in the yarn within slubbed regions, it is particularly advantageous to use the torque jet to ply the slubbed yarn with an unslubbed carrier yarn.

In the drawing, which illustrates the invention discussed hereinafter,

FIGURE 1 is a diagrammatic representation of one embodiment of the process and the apparatus used therein, and

FIGURE 2 is an enlarged view of one form of slub yarn product of the invention.

Referring to the drawing, substantially zero twist multifilament yarn **1** is withdrawn from supply package **2** through pigtail guide **3**, tension gate **4** and guide **5** by feed rolls **6** and **7**, the yarn passing a sufficient number of times around the pair of rolls to provide positive control of the feed rate. The yarn then passes through supply jet **8** and is forwarded to screen **10** by air introduced into the jet through fitting **9** to form a high velocity stream. The yarn is struck against the screen at an oblique angle of about 45° by air passing through the screen. A slub jet **11**, similar to the supply jet, is supplied with air under pressure through fitting **12** to form a high velocity stream which is directed perpendicularly against the screen to impinge on the screen adjacent to the other stream from the supply jet. The turbulence created between the two streams causes the yarn to twist, loop and entangle on itself. The yarn is withdrawn from the screen through the slub jet and over pigtail guide **13** by take-up rolls **14** and **15** similar to feed rolls **6** and **7**, but operated at a slower speed. As the yarn is pulled through the slub jet, the slubs are firmly consolidated in the yarn by intermingling of the folds, loops and filaments of the slubs and base yarn bundle. The slub yarn passes from the take-up roll **14** to a conventional windup, such as a package **16** surface driven by a roll **17**.

Suitable process conditions are illustrated in the examples of Table I. The general procedure described above is followed with the specific operating details indicated for each example. Under the heading, Yarn Treated, 70/50/0 indicates a 70 denier yarn of 50 filaments and zero twist. The angles given in the last column refer to the angle at which the supply jet fluid is

directed against the screen. This angle may be from substantially 0° to 90° and in Example 19 is varied over the entire range. The process is likewise operable with slub jet angles over this broad range although the examples illustrate operation with the slub jet arranged to direct fluid perpendicular to the screen as shown in the drawing. Example 20 illustrates the use of a torque jet to ply slubbed yarn with an unslubbed carrier yarn for greater strength.

The characteristics of novel slub yarn products obtained are shown in Table II for typical examples of Table I. The products are entirely random in appearance with slubs in a wide range of lengths, thicknesses and frequencies. The corresponding random location of slubs in fabric woven from the yarn is a distinct advantage. However, the special procedure of Example 19 can give sufficient regularity to provide a novel stripe effect in fabric woven from this particular type of slub yarn.

umn 20 of U.S. Patent No. 2,985,995. The base yarn of these new slub yarns has a coherency factor of at least 20 and the slub portion has a coherency factor of at least 20% greater than the base yarn. Thus the ratio of the coherency factor of slub portions to that of the base yarn is at least 1.2:1. Base yarn coherency factors are frequently greater than the 60 to 90 shown in Table II and can run as high as 200–400. The slub coherency factor will usually be 100–300 and can run as high as 400–900. With the process conditions of Example 11 a slub yarn is obtained which has a base yarn coherency factor of about 240 and a slub coherency factor of about 370. The corresponding values for Example 12 are about 300 and 400, respectively.

One of the major variables for controlling product characteristics is the overfeed, i.e., the rate at which the yarn is fed to the supply jet versus the rate at which it is withdrawn from the slubbing jet. The range can be varied within wide limits primarily to change slub size and frequency. Generally speaking, this overfeed can vary from 5–200% or more. A great many useful yarns can be prepared between the overfeed ranges of 6–70%, while a preferred range for some of the most interesting yarns is from 8–50%. As used herein, overfeed is defined as:

$$\text{Overfeed} = \frac{\text{Feed rate} - \text{withdrawal rate}}{\text{Withdrawal rate}} \times 100$$

It will be obvious that two or more yarns can be passed to the supply jet at the same or different rates of speed. Simultaneous, but individually random, slubbing of two ends to produce a plied yarn has unexpectedly overcome certain weaving problems. It is further obvious that the feed rate to the supply jet may be constant or varied. As another variation, one or more yarns of the same or different nature may be added immediately prior to the slubbing jet, e.g., at or through the foraminous surface. The composite yarn will then pass through the slubbing jet to the windup. Thus, a carrier-effect yarn may be obtained which is useful for specialized applications. This is particularly useful for plying slub yarn with a carrier yarn to strengthen any weak spots which would cause difficulty in weaving.

Table I.—Examples of Process Conditions

Example No.	Yarn Treated	Yarn Speed (y.p.m.)		Supply Jet		Slub Jet		(Distances in Inches)				
		Feed Rate	Wind up	Pressure (p.s.i.g.)	Temp. (° C.)	Pressure (p.s.i.g.)	Temp. (° C.)	Supply Jet to Screen	Slub Jet to Screen	Jet Separation	Jet Off-Set	Angle of Supply Jet, degrees
1	70/50/0 polyethylene terephthalate.	950	836	10–12	150	40	20	2¾	2½	6	¼	45
2	do	950	836	10–12	255	40	20	2¾	2½	6	¼	45
3	do	950	699	5	20	40	250	3⅛	3 15/16	5½	0	50
4	70/50/0 polyethylene terephthalate Trilobal.	950	723	5	20	40	225	3⅛	3 15/16	5½	0	50
5	70/50/0 polyethylene terephthalate.	950	633	5	20	40	290	3⅛	3 15/16	5½	0	50
6	do	950	863	3–5	20	40	20	2 15/16	1½	5½	0	45
7	do	950	863	3–5	20	40	20	2 15/16	1½	5½	½	45
8	do	950	863	3–5	20	40	20	2 15/16	1½	5½	1	45
9	300/150/0 polyethylene terephthalate.	950	783	20	20	100	20	2⅜	2	5	½	43
10	200/100/0 polyethylene terephthalate.	950	783	14–15	20	60	20	2⅜	2	5	½	43
11	100/50/0 polyethylene terephthalate.	950	783	14–15	20	80	20	2⅜	2	5	½	43
12	70/50/0 polyethylene terephthalate.	2700	2410	30–35	20	100	20	4	1½	8	0	45
13	1000/200/0 polyethylene terephthalate.	933	836	30	20	100	20	4	2	6	0	55
14	150/40/0 cellulose acetate	933	766	7	20	40	20	2¼	1½	4¾	5/8	42
15	100/34/0 66 nylon	933	766	7–10	20	80	20	2½	1¾	4¾	¼	35
16	200/80/0 acrylic fiber	933	766	20	20	80	20	2¼	1½	4¾	5/8	42
17	100/60/0 dull viscose rayon	933	766	10–12	20	30	20	2¼	1½	4¾	5/8	42
18	100/68/0 polyethylene terephthalate.	950	763	5–10	20	30	20	2¼	1½	5	⅛	90
19	do	950	763	5–10	20	30	20	2¼	2½	5	⅛	[1] 90–0
20	70/50/0 polyethylene terephthalate.	900	750	6	20	60	20	2¼	1¾	4¾	0	[2] 76
21	do	950	836	3–5	20	40	20	2¾	1¼	5⅜	0	45

[1] Jet is pivoted regularly toward and away from the slub jet at one swing per five seconds in Example 19.
[2] In Example 20 a 40/27/0 carrier yarn of polyethylene terephthalate is fed separately at 750 yards per minute to the entrance of the slub jet and the combined yarns are passed from the slub jet through a torque jet supplied with 60 p.s.i.g. air at 20°C.

Table II.—Characterization Parameters of Various Slub Yarns

Slub Characterization Parameters	Ex. 4	Ex. 8	Ex. 9	Ex. 16	Ex. 18	Ex. 20	Ex. 21
Avg. Slub Length, inches	2.2	2.0	11.1	9.6	21.8	11.5	1.23
Avg. Slub Length, Std. Dev	2.9	2.2	21.5	15.1	37.4	22.3	1.6
Avg. Slub Length Coeff. of Variation Percent	131	109	164	157	133	195	130
Slubs/100 Yds	43	74	11	15	11	15	119
Avg. Denier Ratio of Slub to Base Yarn	5.5	5.5	3.5	5.5	3.3	4.6	4.0
Percent of Slubs Having a Length Greater than							
(a) Avg. Length	20	------	18	19	24	23	33
(b) 2 x Avg. Length	14	------	13	12	15	12	16
(c) 7 x Avg. Length	1.4	------	3	4	1.8	4.0	0.7
(d) 1 inch	31.6	32.3	57	54.2	80.3	59.7	30.5
(e) 5 inches	9.3	7.3	33	34.6	57.5	34.7	2.5
(f) 10 inches	------	------	------	------	40	25.0	0
Longest Slub in Samples Analyzed, inches	24	18	111	96	176	126	9
Base Yarn Coherency Factor	82	77	90	------	63	200	------
Slub Coherency Factor	161	130	165	------	102	300	------

The coherency factor given in Table II is determined by the "hook-drop test" described in detail starting in col-

Any synthetic or natural fiber yarns can be used to make the novel products described previously. Suitable materials include all the fiber-forming polyamides such as 6 nylon, 66 nylon, 610 nylon. The polyester yarns are all useful and include polyesters of terephthalic acid or isophthalic acid and a lower glycol, e.g., poly(ethylene terephthalate), poly(hexahydro-p-xylylene terephthalate). Another subclass of these general chemical classes are the spontaneously elongatable yarns—these are particularly interesting for novelty effects in the lower ranges of overfeed and especially if a heated fluid is used in the supply jet and/or the slubbing jet. Other conventional classes of fiber-forming materials include regenerated cellulose, the cellulose esters, and the acrylic, vinyl, and vinylidene polymers, as well as the many suitable fiber-forming copolymers of any of these groups. The natural fibers, such as cotton, wool, linen or silk, can be used alone or in combination.

Preferably, the yarn to be treated is a continuous multifilament yarn and at zero twist. Obviously, it is more economical to use a feed yarn in the twist-free state rather than putting it through an auxiliary untwisting operation. It may be desirable, however, for special effects or specific end uses to use a pretwisted yarn or, perhaps, to add a pretwisted yarn as a carrier yarn after the supply jet but prior to the slubbing jet. This process actually interlaces both the carrier yarn and the slub portion so that post-twisting is unnecessary. The yarn bundle and the slub have a high degree of coherency so that they are suitable "as is" for further textile processing. Here again, however, it is entirely possible to post-twist the slub yarns either to ply with some other material or to twist to some specific level for a specific end use.

Other suitable feed yarns include a sliver or roving of staple fibers. In such cases, the supply jet will preferably be an interlacing jet or a torque jet which, in addition to forwarding the yarn bundle, will provide adequate wrapping and/or intermingling of the filaments and the free-fiber ends to achieve a coherent staple yarn.

The feed yarns can also include monofils or twistlively yarns. These are difficult to handle and slub effectively, but they can be included for unusual results.

Almost any jet is suitable to slub the yarn provided that the fluid flow is counter-current to the yarn movement tension to the yarn bundle. The slubbing jet also intermingles and interlaces the slub and the base yarn and has a large enough diameter to allow the slub portion to pass through. It is not essential but a jet fluid flow pattern that induces a twisting action is advantageous to wrapping in the slub components. Other jets similar to those described under the section on supply jets can be used to slub the yarn.

Torque jets are a preferred species of slubbing jet. An interesting variation is adding a torque jet immediately after the slubbing jet. For economy of fluid consumption, however, it is preferred to combine the slubbing jet with the torqueing effect desired. Suitable types of torque jets are described in U.S. Patent No. 3,009,309.

The fluid used in either jet may be heated, at room temperature, or refrigerated. Suitable compressible fluids include air, steam, gases, vapors, and the like, to twist, intermingle loop, slub or forward the yarn. Heat, water vapor, or other plasticizing means may be used if it is desired to plasticize the yarn so that crimping, relaxation or permanent filament twist results. The only upper limit to the treating temperature is the yarn melting or degradation point. The salvogenic action of solvent vapors or other plasticizers should be adjusted so that the continuity of the yarn bundle is maintained.

Obviously, the type, temperature, and pressure of fluid can be varied over a very wide range. The fluid conditions in each jet may be the same or different depending upon the characteristics of the slub yarn product desired. Thus, one can greatly augment the types of novelty yarns by this new process. The supply jet normally interlaces the yarn to a certain extent, but at the same time, it can be used to precrimp the yarn by the process described in Belgian Patent No. 573,230, or to make loopy yarn as described in U.S. Patent No. 2,783,609.

The fluid flow in either or both jets can be adjusted and/or the yarn may be selected so that the fluid turbulence breaks some of the filaments. This gives loopy slub yarns with free-fiber ends analogous to some of the products produced in U.S. Patent No. 2,869,967.

The process can be operated at very high yarn speeds of the order of 3000 or more yards/minute. Conventional textile processing speeds of 200–2000 yards/minute are easily obtained, and a preferred range for some types of slub yarns is from 400–1000 yards/minute. The only real upper limit to processing speeds is the rate at which the yarn can be accurately metered to the supply jet and the rate at which the yarn can be wound up onto a suitable backwindable package.

This process produces a whole new family of completely random slub yarns. The random nature avoids any periodicity with resultant unsightly, geometric patterns in the fabric prepared from such yarns. Since the process is capable of being operated at very high speeds, it can be easily coupled to the spinning and/or drawing operations of conventional synthetic yarns without the need for an intermediate packaging operation.

Since many different embodiments of the invention may be made without departing from the spirit and scope thereof, it is to be understood that the invention is not limited by the specific illustrations except to the extent defined in the following claims.

We claim:

1. The process for forming slubs in a yarn which comprises continuously feeding the yarn to a supply jet, forwarding the yarn through the jet with a high velocity stream of compressible fluid, forwarding the yarn in the stream to impinge against a forminous surface at an angle, continuously withdrawing the yarn from the surface at a rate at least 5% less than the rate of feed, directing a second high velocity stream of compressible fluid from a slubbing jet against the foraminous surface so that the yarn passes through the stream in a counter-current direction to produce slubs composed of yarn loops consolidated into the yarn by filament entanglement, and collecting the slub yarn.

2. A process as defined in claim 1 wherein said slubbing jet is an interlacing jet and the yarn is withdrawn from the surface through said jet to stabilize the slub configuration by interlacing the yarn filaments.

3. A process defined in claim 1 wherein said slubbing jet is a torque jet and the yarn is withdrawn from the surface through said jet to twist consolidate the slub yarn.

4. The process for forming slubs in a yarn which comprises jetting two converging high velocity streams of compressible fluid against a foraminous surface at adjacent points to form a zone of turbulence between the streams, continuously feeding yarn to one of said streams and forwarding the yarn concurrently with the flowing fluid to the surface, continuously withdrawing the yarn from the surface through the other stream counter-currently to the flowing fluid at a rate at least 5% less than the yarn feed rate to form loops in the yarn during passage through the zone of turbulence between the streams and to consolidate the loops into the yarn as stable slubs during passage through the counter-current stream, and collecting the resulting slub yarn.

5. A process as defined in claim 4 wherein the counter-current stream includes at least one fluid vortex having a steep velocity gradient which separates and intermingles the yarn filaments to provide a stable interlaced slub yarn.

6. A process as defined in claim 5 wherein two yarns are fed to the surface and combined into a single slub yarn.

7. The process for forming slub yarn which com-

prises forming loops in a yarn by continuously forwarding the yarn onto a foraminous surface at a high rate of feed and withdrawing the yarn at a slower rate providing a 5% to 200% overfeed to the surface, and consolidating the loops into the yarn as stable slubs by withdrawing the yarn through a counter-current stream of compressible fluid jetted at high velocity against the yarn on the foraminous surface.

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