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MANUFACTURE OF NOVELTY NUB YARNS

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FIG. 1a



FIG. 1b



FIG. 1c



FIG. 1d



FIG. 1e



FIG. 1f

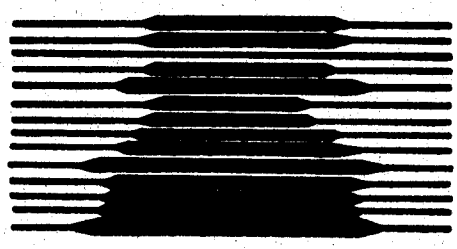


FIG. 2.

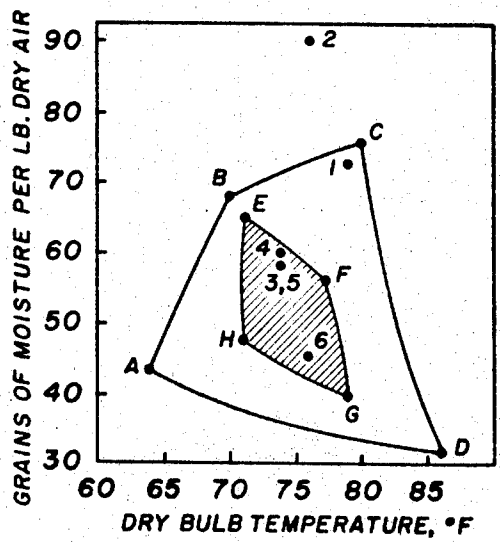



FIG. 3.

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# MANUFACTURE OF NOVELTY NUB YARNS

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8 Claims. (Cl. 264—167)

## ABSTRACT OF THE DISCLOSURE

A particular process for the production of nubby continuous filament yarn is disclosed. This is accomplished by stretching unoriented synthetic thermoplastic yarn having a moisture concentration of less than about 4.0% at less than the natural draw ratio thereof while maintaining the ambient air at drawing within a particular temperature and relative humidity relationship.

This application is a continuation-in-part application of application Ser. No. 374,434 filed June 11, 1964 (now abandoned).

This invention relates to the manufacture of novelty yarns and more particularly to the production of thick-and-thin or nubby continuous filament yarn composed of a synthetic organic polymer, as well as to a process for making such yarn.

Slub yarns or yarns with very greatly thickened sections are widely used. Such yarns are almost exclusively composed of staple fibers in which slubs are introduced as the roving is drawn on a draw frame. Synthetic continuous filament yarns have found little commercial use in the applications of thick-and-thin or slub-type yarns. Continuous filament yarns are not readily amenable to conversion into truly slub-type yarns; and it is only recently that methods for producing such yarns have been proposed, usually depending upon an intermittent bulking operation.

Continuous filament synthetic yarns are amenable to conversion into thick-and-thin or nub-type yarns, wherein the thickness of the nub is at most only 2 or 3 times greater than the thickness of the adjacent yarn sections. The literature on methods of producing such nub yarns is quite voluminous. Prior art methods are based upon two different principles singly or sometimes combined.

One method applies to the spinning operation. Polymer is extruded into filaments at a pulsating rate by pumps driven by eccentric gears. The spun filament then becomes thick while the extrusion rate is high but becomes thin as the extrusion rate decreases. Another method, principally applicable in melt spinning is to cool the spinning filaments with a cloud of liquid particles which rapidly cool small segments of the filaments which then do not draw down. Aside from other practical problems, both of these procedures are objectionable because the nubs are produced early in the manufacturing operation and further complicate handling of the yarn in subsequent drawing or stretching operations.

Another method applies solely to the drawing operation. Filaments of uniform size are spun; then are drawn in a non-uniform manner, leaving thick undrawn nubs spaced intermittently along the filaments. Prior art methods of accomplishing controlled non-uniform drawing



vary in complexity, but in every case they require relatively complicated equipment or treatment of the yarn prior to drawing. One procedure effectively plucks the threadline laterally to accelerate the stretching, then suddenly releases the threadline so that no drawing occurs while slack in the threadline is taken up, a nub resulting. Another general procedure is to heat the threadline intermittently such as by contacting the yarn with notched heated rolls, the heated segment drawing down while the unheated segment remains undrawn. Yet another procedure is to intermittently dent or deform the filaments so that drawing occurs at the dented portions leaving an intermediate undrawn nub; a recently disclosed variation of this idea depends upon chemical treatment of the yarn surface to induce cracks that become flaws at which drawing occurs.

These known methods are characterized by one or more of these undesirable features:

(1) Nubs are not distributed randomly along the threadline;

(2) The nub length is limited to a small range by the fixed structure of the apparatus (e.g., a notched roll or gear) and the nub length does not vary in a truly random manner;

(3) Production rate of the nub yarn is quite low compared with the production rate of standard yarns; and

(4) Relatively complicated special equipment expensive or unduly difficult to maintain is required.

The importance of feature (1) is that when the nubs occur on a regular cycle, fabrics produced from such yarn show an undesirable repetitive pattern of nubs which reduces the aesthetic appeal of the speckled or streaked fabric. Many means have been proposed to insure a random distribution of nubs, some being highly elaborate, such as using the random hits of cosmic radiation to trigger a control mechanism. Other methods do not actually provide random distribution, but do lengthen the cycle of repetition sufficiently that for many applications in fabrics the nubs can be considered random.

Undesirable feature (2) leads to some of the same objections as feature (1); but, it is less serious to the textile user of the yarn. It does, however, seriously handicap the producer of the yarn, since many different pieces of equipment must be maintained to produce a variety of nub lengths in the yarn. The range of spacing of the nubs also tends to be relatively fixed, i.e., yarns with an average nub spacing of 3 inches or of 30 inches cannot be readily produced on the same apparatus.

Features (3) and (4) obviously are undesirable since both increase production costs, making yarn too expensive for practical production.

Textile fabric producers recognize that the four undesirable features mentioned above are basic reasons why synthetic continuous filament nub yarns have not attained much commercial significance. Those yarns which were inexpensive enough for consideration did not have the necessary quality characteristics, and those which may have been physically suitable were too expensive to use in commercial fabrics. Heretofore, the fabric designer has therefore had to forego the stylistic and aesthetic advantages such nub yarns afford.

It is an object of this invention to provide a process for the production of nub-type continuous filament yarns, the process being free of the four undesirable features recited above.

Another object of the invention is to provide synthetic continuous filament yarns in which undrawn nubs occur

randomly along the length of the filaments, the nubs themselves also having a random distribution of length along the threadline, nubs across the bundle of filaments in multifilament yarns being substantially equal in length, however.

These objects are accomplished by properly controlling the operating conditions in the spinning, storing, and subsequent drawing or drawtwisting of the yarn. Highly useful nub-type yarns can be produced at an economic production rate on ordinary equipment such as that used by major producers of synthetic melt-spun yarns. The essential factors which must be controlled in a relatively narrow range are the moisture in or on the yarn, and the temperature-humidity of the air to which the yarn is exposed during the drawing operation, the yarn being drawn at a draw ratio lower than the natural draw ratio of the yarn.

The invention provides a new and useful nub-containing yarn. The yarn preferably is continuous and is composed of many filaments. The yarn drawn below the natural draw ratio has individual filaments exhibiting molecularly oriented sections and molecularly unoriented nub sections. The nub sections are randomly distributed along the length of the yarn but occur at substantially the same position in the filaments. The average nub length is in the range of ¼ inch to 3½ inches, and the average nub spacing is in the range of 3 inches to 13 inches. The nub lengths of the individual filaments for a given nub position are substantially equal.

Reference is now made to the attached drawing wherein:

FIGURES 1*a–f* are representative of photomicrographs of the cross section of some non-circular filaments to which the process of the invention is particularly applicable;

FIGURE 2 is a sketch illustrating a multi-filament yarn bundle showing how the undrawn nubs occur at substantially the same position in substantially all filaments comprising the threadline and have about the same length, one filament in the group, however, being completely drawn at this particular cluster of nubs; and

FIGURE 3 is a plot of the dry bulb temperature of the air versus the absolute humidity of the air.

Air humidity-temperature conditions essential to the successful operation of the process of the invention are defined by points on the boundary and within the area bounded by the kite-shaped quadrilateral ABCD. The cross-hatched curvilinear trapezium EFGH encloses the preferred operating air conditions, particularly for nylon-66 and nylon-6 yarns. Small solid circles with superscript numerals locate conditions that were used in test runs in working examples set forth hereinbelow.

In the practice of the invention standard well-known melt spinning equipment is used to spin the yarn by conventional procedures. The yarn may be drawn on the usual commercial drawing equipment used for standard yarns; for example, drawwinders or drawtwisters manufactured by Whitin Machine Works (U.S.A.) or by Rieter (Switzerland). It is preferred to use a drawpin around which the yarn is wrapped a few times for snubbing between feed roll and draw roll. However, a drawpin is not essential and free drawing between the feed roll and draw roll is quite satisfactory, especially with heavy denier yarns (i.e., yarns above about 1000 denier drawn).

The process of the invention is characterized by operating such that these three conditions are fulfilled simultaneously:

(1) Total moisture concentration on the yarn being processed is less than about 4.0% by weight, and is preferably in the range of 0.2% to 3.0%.

(2) The yarn, as it is wound on the bobbin in spinning and is subsequently stored or lagged and as it is drawn, is exposed only to ambient air, the temperature and absolute humidity of which is specified by a point falling within the boundary ABCD shown in FIGURE 3 and preferably is within the boundary EFGH of FIGURE 3.



(3) The yarn is drawn below its natural draw ratio at the existing conditions of the drawing operation (i.e., at the humidity, temperature, yarn snubbing, and drawing speed being used).

For a controlled reproducible process it is essential that all of the conditions be met simultaneously at all times during the processing of the yarn. To insure that the yarn will be uniform in properties from position-to-position on the spinning machine and drawtwister and uniform with time throughout the run, the air conditions must, of course, be controlled at a set condition. That is, nubs will be produced with conditions within the range bounded by ABCD in FIGURE 3 but the size and distribution of nubs will change if the air conditions are permitted to shift around unduly. Normal commercial air condition control limits in yarn processing plants are adequate, however, and highly specialized air conditioner controllers are not necessary, standard control equipment being adequate.

Moisture is not only absorbed from the air by the yarn as it is spun but moisture is usually added with the finish emulsion, and it is the total amount of moisture in the yarn which must be at the prescribed low level. It is possible because of this surface moisture to have total moisture concentration that is higher than the normal moisture regain of dried yarn. Nascent man-made filaments, as a rule, do not show a high order of molecular orientation and have a relatively low load bearing capacity. To orient the filaments and thereby to increase greatly the strength thereof, they are stretched a desired extent, as is well known. In order to obtain optimum physical properties, the filaments normally are stretched using a natural draw ratio. This results in an extension of the filaments which is sufficient to change them from their undrawn state to a uniformly drawn and highly oriented state without straining them to introduce surface cracks or filament breaks. When one employs a draw ratio lower than the natural draw ratio, some sections of the filaments will draw at the natural draw ratio while other sections, in the main, will not draw at all.

The natural draw ratio depends upon the temperature and moisture or other plasticizer content of the yarn, the rate of drawing, snubbing, etc. When a sample of yarn is strung up on the drawing equipment and is drawn very little, say 1.5×, undrawn segments will be left in the yarn. When the drawn ratio is gradually increased, a point will finally be reached at which a little less drawing leaves undrawn nubs and a little greater drawing eliminates all nubs. This intermediate draw ratio at which all nubs are drawn out is considered the natural draw ratio.

In actual practice, however, the natural draw ratio is seldom determined, since it is of little practical value to know its magnitude. Instead, the draw ratio is changed in fairly large increments either decreasing or increasing depending upon whether a greater or lesser proportion of nubs is desired. With only a few trials the desired operating draw ratio may be determined. The total proportion of undrawn yarn in the form of nubs is, of course, dependent upon how much the operating draw ratio is below the natural draw ratio.

In determining the desired nub proportions and distribution and, hence, the desired draw ratio, it has proved most practical to proceed empirically. Small quantities of yarn are drawn and a sample is checked for nubs on a common nub counter or a continuous evenness tester, such as the Uster Evenness Tester, Type GGP–C6, manufactured by Zellweger Ltd., Uster, Switzerland. A denier difference of about 50% indicates the presence of a nub and the frequency and duration of the 50% deflection indicates the spacing and length of the nubs. This procedure quickly indicates whether or not the draw ratio is too high. However, the desired nub characteristics are largely a subjective judgment of the appearance of a fabric. Therefore, samples of yarn with nubs are promptly knitted

on a circular knitter and dyed; this is somewhat slow but not unduly so, and the choice is then finally made on the basis of the appearance of the natural fabric. Once a standard set of nub yarn fabrics have been made, they may be used thereafter for control or reproduction of the yarn process somewhat the same way as color swatches are used to control dyeing of fabrics by comparing the desired standard with that being currently produced.

For large-scale applications such as upholstery yarns it appears that fabric designers prefer nub yarn with a distribution of nubs such that there appears on the average about 3 to 25 speckles or streaks per square inch of fabric face, but since the number of spots per unit area depends upon the precise fabric construction and especially upon the number of ends of nub yarn relative to the number of non-nub yarn ends in the fabric, no specific rules can be given. Most fabric samples that have been considered very favorably have used nub yarns in which the average nub length was in the range ¼ inch to 3½ inches, the actual nub lengths and spacings are, of course, randomly variable so that the term "average" is only meaningful when a fairly long length of yarn is examined and measured, say not less than 5 yards.

The present process is not suited to producing very short nubs closely spaced, but such yarns probably are not important commercially anyway. By the process one can successfully and reproducibly produce nub yarns with actual nub lengths in the range ⅛ inch to 17 inches and with nub spacings in the range 1 inch to 47 inches. The actual spacing and length of individual (not the total proportion of nubs which depends on the draw ratio) nubs depends to a considerable degree upon the amount of snubbing of the yarn in the draw zone, the snubbing being determined by the number of wraps around the drawpin and the diameter of the drawpin and the surface finish of the pin. These factors are to be considered in selecting the best combination of conditions to give a yarn which satisfies the specific aesthetic requirements of the fabric designer.

It has been found that the process works satisfactorily with either ordinary circular section filaments or with non-circular filaments, but non-circular filament yarns are preferred. Not only do non-circular yarns appear to develop distinct nubs more readily but in fabric, because of their greater covering power and optical properties, the fabric appears more attractive. FIGURE 1 illustrates the cross-sectional configuration of several of the non-circular yarns that can be successfully processed. In addition, the yarn can be tubular or have discontinuous voids. The thick and thin yarn can be prepared from a variety of polymers, including polyamides, polyesters, polyurethanes, polyacrylonitrile, polyethylene, polypropylene and polyvinyl chlorides, as well as many other materials. It is preferred that the yarn be made of polymeric ethylene terephthalate or of nylon, a class of polyamides. In particular nylon-6 and nylon-66 can advantageously be employed.

As previously noted, the process not only avoids the necessity for special costly equipment and can be operated at yarn speeds comparable to standard yarn processes, but the nub size and spacing both vary in a truly random manner. Neither in knitted tubes of a single bobbin of yarn, nor in woven fabrics with many ends of nub-yarn in the warp has any of the objectionable "butterfly" patterning of nubs been observed.

The true explanation of the random formation of nubs by the process is not fully understood but it is thought that the result is tied in with the stochastic nature of frictional phenomena. As undrawn yarn accumulates in the draw zone, drawing is ultimately interrupted when the tension drops below some threshhold value required to overcome internal friction in the yarn; similarly the frictional drag at the drawpin of the recurrently slackening and tightening of the yarn must be sporadic and random in magnitude. This view is thought to be supported by the fact that in multi-filament yarns the nubs tend to occur in the individual filaments at the same position along the threadline but there is a minor difference in the lengths of the nubs in the different filaments, and occasionally a few filaments may be completely drawn in a given cluster of nubs. Such a nub group is shown in the 14-filament threadline illustrated in FIGURE 2. However, there is no intention to limit the invention by any tentative explanations which may subsequently prove erroneous.

The practice of the present invention and the critical nature of the limits previously mentioned are further illustrated but not intended to be limited by the following examples.

Yarns referred to in the following illustrative examples were melt spun by conventional methods on standard spinning equipment, details of which are not included since this is a common well-known operation.

It should be recalled, however, that the filaments as spun normally contain some moisture, usually less than about 0.3%, but because of the hydroscopic nature of most newly spun polymeric materials, moisture is rapidly absorbed from the ambient atmosphere, raising the concentration of moisture in the yarn. Furthermore, a "finish" emulsion comprised of a dispersion or solution of non-aqueous lubricating components in water is normally applied to the freshly spun filaments to reduce static and to insure a coherent bundle of filaments and a stable package of spun yarn; a considerable fraction of the water in the emulsion is absorbed by the yarn with high surface moisture for a short period. The final amount of moisture in the yarn can be considered the sum of the quantities of water arising from these three sources.

As previously indicated, to insure that the moisture level does not rise above the critical limit of about 4.0%, the yarn should be exposed as little as possible to ambient air in which the humidity-temperature conditions fall outside the range specified in the invention. It has been observed in practice that when properly conditioned packages of undrawn yarn on the drawtwister are exposed to air with conditions outside those conditions prescribed in FIGURE 3 for several minutes, the exposed yarn on the outside of the package draws with few nubs resulting in a useless "heel" of non-nubby yarn. The initial concentration of moisture in the spun yarn wound on the bobbin depends mainly upon the amount of moisture applied in the finish emulsion. In practice, then, the finish emusion should be as concentrated as possible (i.e., contain as little water as is practicable) in order to necessarily apply a minimum of water to the yarn. This is a practical expedient in maintaining the moisture level in the yarn at the requisite low concentration.

Except in Example II, the finish emulsions contained 28%–30% non-aqueous components: in Example II, 15% finish was used. The term, "percent finish on yarn" refers to the percent by weight of non-aqueous finish components on the yarn, the remainder being moisture and the polymeric components of the yarn itself.

Since the suitability of the nub distribution and size in a given style of fabric is primarily a matter of aesthetic judgment, only a descriptive or qualitative characterization is practicable. To avoid circumlocution and repetition, a series of "Nub Grades" were drawn up based upon the visual judgement of several qualified observers. Samples of the yarns were knitted into a tube on a circular knitting machine, several different bobbins being used to produce adjacent panels of fabric. These tubes were then dyed with Chromacyl Black W dye and with Anthroquinone Blue SWF dye according to standard procedures. The resultant speckled or random streaked fabric was observed and could be classified according to a "Nub Grade," which applies purely to appearance due to size, frequency, and contrast of nub color and lighter background color; other factors, such as handle and shape are not considered in the Nub Scale.

| Nub grade: | Characteristic appearance |
|---|---|
| 0 | No nubs, uniformly colored fabric. |
| 1 | Slight trace of nubs and speckles, but of no aesthetic appeal. |
| 2 | Definite nubs and streaks present, but nubs too small or lack sufficient contrast between speckle and background. |
| 3 | Well developed nubs, good random distribution and size of nubs, adequate color contrast between nubs and background, satisfactory for actual use in fabrics. |
| 4 | Excellent size and distribution of nubs, strong, clearly defined contrast between depth of color of nubs and background color. Fabric highly attractive and aesthetically pleasing. |

Several samples of the yarns were also woven into more complex and patterned fabrics of highly pleasing appearance. These results showed that the comparatively rapid and simple knit-tube characterization of the yarns is entirely adequate for determining suitability of the product and for control in establishing and maintaining conditions to be used to produce yarn with a desired size and frequency of nubs.

Air conditions were controlled by automatic adjustment of the commercial air conditioning equipment, the sensing elements being located within the air stream emerging from the main air ducts into the operating area. The dew point and dry bulb temperature were recorded continuously with a standard Barber-Coleman recorder. Humidity at various points in the operating area was also checked occasionally with a sling psychometer which measured the wet bulb temperature and dry bulb temperature, the different sets of measurements being compared on a large scale psychrometric chart published by the Carrier Corporation. Air conditions were controlled quite closely with only very small variations occurring. The values quoted in the examples are averages taken over the course of the run, which in some cases were of several days duration.

Yarn speed refers to the linear speed of the drawn yarn as it is taken up on the bobbin. The draw ratio is the machine draw ratio; i.e., the ratio of the actual peripheral speed of the draw roll to the peripheral speed of the feed roll on the drawtwister.

## Example I

Nylon-66 polymer containing 0.3% $TiO_2$ delustrant was melt spun into multi-filament yarn comprised of 14 individual filaments of circular cross section, the total denier being 952. Finish emulsion was applied to the yarn at a rate to yield 1% finish on yarn, and the moisture concentration just prior to drawing was determined to be 3.6%. Ambient air to which the yarn was exposed during storage and drawtwisting had these characteristics:

| | |
|---|---|
| Dry bulb temperature (DB) ° F | 79 |
| Grains moisure per lb. of dry air (gr./#) | 73 |

Samples of this yarn were drawn on a standard RG–4 drawtwister manufactured by Whitin Machine Works. Drawing speed was 210 yards per minute (y.p.m.); and 1 turn per inch (t.p.i.) of Z-twist was imparted to the yarn. Samples were produced at three different draw ratios and the resultant yarns were knitted and dyed, and were given a Nub Grade as follows:

| Draw Ratio | Nominal Denier | Nub Grade |
|---|---|---|
| 4.48 | 224 | 0 |
| 3.57 | 280 | 2+ |
| 3.37 | 296 | 4 |

It is seen here that under the given operating conditions the natural draw ratio of this yarn is less than 4.48 but greater than 3.57, the actual natural draw ratio not being determined since knowledge of its value is not of practical importance.

All of the preceding spinning conditions and air conditions were maintained, except that spinnerets were changed in order to produce 14-filament yarns with trilobal cross section filaments similar to that shown in FIGURE 1*a*, and 14-filament yarns with trinodal cross section filaments such as illustrated in FIGURE 1*b*. Total denier was again 950. These yarns were drawn at only two different draw ratios with the following result:

| Draw Ratio | Nub Grade | |
|---|---|---|
| | Trilobal | Trinodal |
| 4.48 | 0 | 0 |
| 3.57 | 4 | 4 |

It was somewhat surprising that the non-circular filament yarns should have such a decidedly superior Nub Grade at the lower draw ratio compared with circular section yarn, since the actual natural draw of circular filaments is significantly higher than for non-circular filaments. However, it has been found that non-circular filaments yield a more pleasing combination of nub length and distribution and color depth contrast than similarly treated circular section yarns. This may be a result of the inherently asymmetrical stresses that are set up when a non-circular filament is stretched; when the accumulated undrawn yarn releases at the draw pin it does so more abruptly than the circular yarn.

## Example II

Nylon-66 polymer containing no delustrant but to which had been added a small quantity of ionic copper (less than 50 p.p.m.) to improve heat stability was spun into multi-filament yarn. The yarn had a total denier of 750 and was comprised of 17 individual filaments having the "sharp-Y" cross section illustrated in FIGURE 1*c*.

The spun yarn was then drawn on a Whitin drawtwister to yield nominal 200 denier yarn (actually 210 denier), the relevant conditions being:

| | |
|---|---|
| Finish on yarn, percent | 1.2 |
| Moisture concentration, percent | 5.8 |
| Air conditions: | |
| DB ° F | 76 |
| Gr./# | 90 |
| Draw ratio | 3.51 |
| Z-twist, t.p.i. | 0.75 |
| Yarn speed, y.p.m. | 320 |
| Nub Grade | 0 |

The resultant yarn contained no useful nubs due to the adverse air conditions and the high moisture concentration in the yarn.

## Example III

Yarn similar to that produced in Example II was spun at slightly higher speed (lower natural draw ratio) and had a total spun denier of 640 and an actual drawn denier of 210. Conditions of the process were:

| | |
|---|---|
| Finish on yarn, percent | 0.6 |
| Moisture concentration, percent | 1.5 |
| Air conditions: | |
| DB ° F | 74 |
| Gr./# | 58 |
| Draw ratio | 2.91 |
| Yarn speed, y.p.m. | 320 |
| Z-twist, t.p.i. | 0.75 |
| Nub Grade | 4 |

Several thousand pounds of yarn were produced in this extended test run which demonstrated the practical stability of the process. The yield of drawn yarn was unusually high because of the low incidence of broken filaments and wraps in the drawtwisting operation. After the process conditions had been judged satisfactory by the Nub Grade technique, all subsequent inspection was made visually by technicians who simply visually exam-

ined the bobbins of drawn yarn to cull out any bobbins which appeared to have inadequate nubs; only a very few bobbins (less than 5%) were rejected for unsatisfactory nub formation although the drawtwister had 72 drawing positions and several thousands of bobbins of yarn were produced. The process and system of operation was fully practical and could be used for large scale commercial production.

Samples of the yarn were woven into several differently constructed fabrics, the nub yarn generally being used in the warp with a standard commercial nylon yarn, in the filling, some constructions yielding a subtle embossed checkered effect. Samples of the fabrics were exhibited to several professional fabric designers and stylists, whose judgment was that the fabrics were highly attractive and that the nub yarn provides many styling possibilities. This particular yarn is excellent for use in upholstery fabric and laminated fabrics for outer wear garments.

By actually counting and measuring the nubs it was determined that the average length of nubs was about 1¼ inches, some being as short as ¼ inch; the average spacing of the nubs along the yarn was about 5½ inches (i.e., on the average there were about 6 or 7 nubs per yard). A check of several samples of yarn on an Uster Evenness Tester confirmed this estimate of average nub length and frequency, the actual lengths and spacing of the nub groups being, of course, highly variable and random.

In a short extension of this example all conditions were maintained the same except that the spinnerets were changed to produce a 17-filament yarn with filaments having a triangular cross section as illustrated in FIGURE 1*d*. The Nub Grade of this yarn was 4. Because of the bright scintillating luster that is characteristic of the triangular section filament, knitted fabrics of the yarn were especially attractive. The luster of the deep-dyed nubs was appreciably subdued compared with the lighter background of drawn yarn, but the nub color had unusual clarity due to internal reflections. Such scintillating triangular section nub yarn can be combined with the other types of nub yarn to give a wide range of stylistic effects.

## Example IV

Nylon-66 polymer was prepared without delustrant but with small additions of ionic copper and benzene phosphinic acid, the latter increasing not only the whiteness of the polymer but also its dye acceptance. This polymer was spun into a 34-filament yarn with sharp-Y section filaments (FIG. 1*c*), the total spun denier being 1595. The denier of the drawn nub yarn was 550. Processing conditions were:

| | |
|---|---|
| Finish on yarn, percent | 0.8 |
| Moisture concentration, percent | 2.1 |
| Air conditions: | |
| DB, °F | 74 |
| Gr./# | 60 |
| Draw ratio | 3.04 |
| Yarn speed, y.p.m. | 386 |
| Z-twist, t.p.i. | 0.41 |
| Nub Grade | 4 |

Samples of yarn were converted into woven pile fabric which was dyed several different colors. Again it was concluded that such fabrics are especially attractive for upholstery.

## Example V

Nylon-66 polymer of the same composition as used in the test cited in Example IV was spun into 68-filament yarn in which the filaments had sharp-Y cross sections whose average modification ratio was maintained in the range 2.85–3.1. The total spun denier was 3400 and the drawn denier was 1109. Processing conditions for this heavy denier nub yarn were:

| | |
|---|---|
| Finish on yarn, percent | 0.9 |
| Moisture concentration, percent | 2.4 |
| Air conditions: | |
| DB, °F | 74 |
| Gr. /# | 58 |
| Draw ratio | 3.04 |
| Yarn speed, y.p.m. | 386 |
| Z-twist, t.p.i. | 0.41 |
| Nub Grade | 4 |

The drawtwisting operation was performed on a Whitin RG–6 drawtwister, and again drawtwisting performance and yarn yield were good.

In tufted fabric the yarn proved highly attractive with the random speckled appearance. This yarn was found to be excellent for domestic furniture upholstery, as well as for automotive upholstery.

## Example VI

Nylon-66 polymer similar in composition to that described in Example IV was spun into 34-filament yarn in which the filaments had sharp-Y cross sections having an average modification ratio of 3.0. Total denier of the spun yarn was 1560 and denier of the drawn yarn was 545. Processing conditions under which this nub yarn was produced were:

| | |
|---|---|
| Finish on yarn, percent | 0.9 |
| Moisture concentration, percent | 2.5 |
| Air conditions: | |
| DB, °F | 76 |
| Gr./# | 46 |
| Draw ratio | 3.08 |
| Yarn speed, y.p.m. | 157 |
| Z-twist, t.p.i. | 1.0 |
| Nub Grade | 4 |

Drawtwisting performance on a Whitin RG–4 drawtwister was very good with a high yield of first quality drawn yarn.

This yarn was notable for its excellent regularity of nub characteristics; i.e., drawn yarn directly adjacent the barrel of the takeup bobbin was indistinguishable from yarn on the outside or interior regions of the yarn package. This fact is mentioned to further emphasize the desirability of operating under low humidity air conditions. Dyed knitted fabrics had a very pleasing speckled appearance.

Thus, it is seen that the present invention provides a convenient and economical process for producing a nub-containing multi-continuous filament yarn. The rate at which the yarn can be produced is notably high and the equipment required for the process is not unduly complicated and expensive to maintain. The nub formation in the yarn is truly random; the size and frequency of which can be controlled. When the yarn is dyed, the nub sections have a noticeably darker color than the drawn sections. Fabric made therefrom has a novel and pleasing two-toned color effect.

It will be apparent that many widely different embodiments of this invention may be made without departing from the spirit and scope thereof and, therefore, it is not intended to be limited except as indicated in the appended claims.

What is claimed is:

1. A process for manufacturing novelty nub-containing yarn comprising the steps of:
   (a) providing a source of substantially unoriented synthetic thermoplastic yarn having a moisture concentration therein of less than about 4.0% by weight;
   (b) forwarding the yarn through a stretch zone;
   (c) maintaining ambient air in said zone having the temperature and absolute humidity specified by a point falling within the boundary ABCD shown in FIGURE 3;
   (d) stretching the yarn in said zone at less than the natural draw ratio thereof, whereby some molecu-

larly oriented sections are randomly formed along the length of the yarn; and

(e) collecting the resulting nub-containing yarn in an uniform manner.

2. A process for manufacturing novelty nub-containing yarn comprising the steps of:

(a) providing a source of substantially unoriented synthetic thermoplastic yarn having a moisture concentration therein in the range of 0.2% to 3.0% by weight;

(b) forwarding the yarn through a stretch zone;

(c) maintaining ambient air in said zone having the temperature and absolute humidity specified by a point falling within the boundary ABCD shown in FIGURE 3;

(d) stretching the yarn in said zone at less than the natural draw ratio thereof, whereby some molecularly oriented sections and some nubby molecularly unoriented sections are randomly formed along the length of the yarn; and

(e) collecting the resulting nub-containing yarn in an uniform manner.

3. A process for manufacturing novelty nub-containing yarn comprising the steps of:

(a) providing a source of substantially unoriented synthetic thermoplastic yarn having a moisture concentration therein in the range of 0.2% to 3.0% by weight;

(b) forwarding the yarn through a stretch zone;

(c) maintaining ambient air in said zone having the temperature and absolute humidity specified by a point falling within the boundary EFGH shown in FIGURE 3;



(d) stretching the yarn in said zone at less than the natural draw ratio thereof, whereby some molecularly oriented sections and some nubby molecularly unoriented sections are randomly formed along the length of the yarn; and

(e) collecting the resulting nub-containing yarn in an uniform manner.

4. The process of claim 1 wherein the yarn is made of nylon.

5. The process of claim 1 wherein the yarn is made of polyester.

6. The process of claim 4 wherein the nylon is nylon-66.

7. The process of claim 4 wherein the nylon is nylon-6.

8. The process of claim 1 wherein the cross section of the yarn is non-circular.

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264—290

# UNITED STATES PATENT OFFICE

# CERTIFICATE OF CORRECTION

Patent No. 3,415,918 December 10, 196

James R. Holton et al.

It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

In the heading to the printed specification, lines 3 to 7, "James R. Holton, English Cove Apartments, C-19, 201 Pensacolo Beach Road, Gulf Breeze, Fla. 32561; Wesley A. Parker, 2210 S. Rayburn Court, Pasadena, Tex. 77502; and James G. Sims, 501 N. 17th Ave., P.O. Box 2304, Pensacola, Fla. 32501" should read -- James R. Holton, Gulf Breeze, Fla., Wesley A. Parker, Pasadena, Tex. and James G. Sims, Pensacola, Fla., assignors to Monsanto Company, St. Louis, Mo., a corporation of Delaware --.

Signed and sealed this 17th day of March 1970.

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents