

Sept. 10, 1963

R. F. DYER

3,103,098

VARIABLE LUSTER YARN AND METHOD OF MANUFACTURE

Filed Oct. 18, 1961

3 Sheets-Sheet 1

Fig. 2
SIZED MULTIFILAMENT
YARN BUNDLE

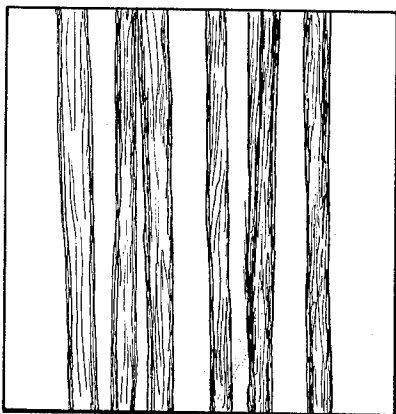


Fig. 1
LARGE DENIER
PER FILAMENT YARN

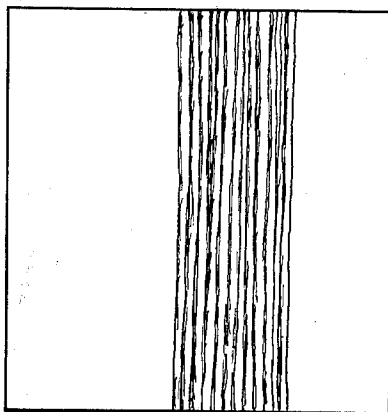


Fig. 3
ENTANGLED FILAMENT
YARN

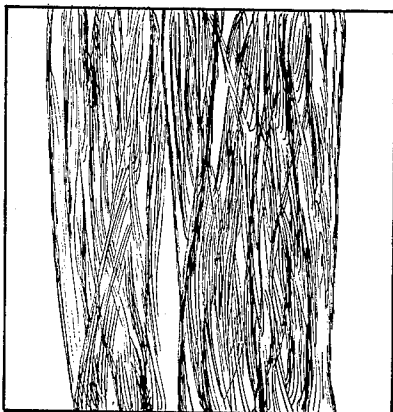


Fig. 4
ENTANGLED AND LOOPED
FILAMENT YARN



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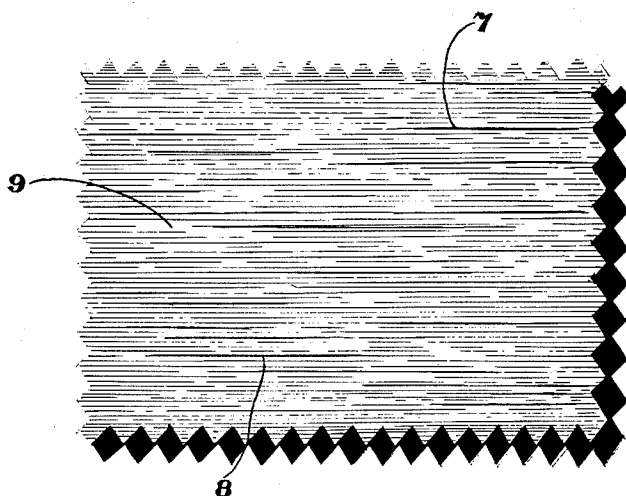


Fig. 5

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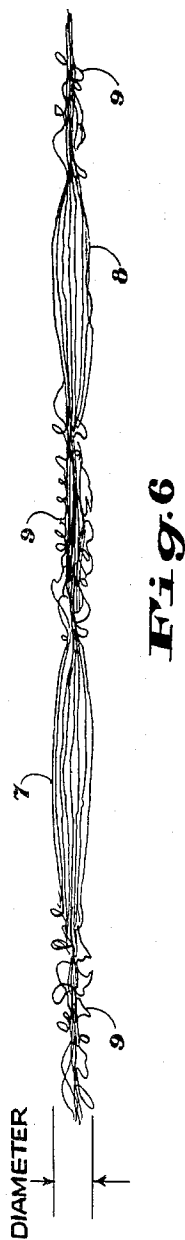
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VARIABLE LUSTER YARN AND METHOD OF MANUFACTURE

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3 Sheets-Sheet 3



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3,103,098

VARIABLE LUSTER YARN AND METHOD OF MANUFACTURE

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Filed Oct. 18, 1961, Ser. No. 145,887

6 Claims. (Cl. 57—140)

This invention relates to a continuous multifilament yarn characterized by randomly spaced zones of high and subdued light reflectance wherein the zones of high luster are composed of filaments have a greater denier per filament size than those zones of reduced luster. More particularly, this invention concerns a method or process for the manufacture of such novel variable luster yarns.

This invention is a continuation-in-part of my application Serial No. 400,544, filed December 28, 1953. In my aforesaid earlier application there has been described several novel yarns and methods of manufacture. These yarns include interlaced yarn and in particular a yarn which I have earlier described as intermittent bulk yarn. Said intermittent type yarn is to some extent a variable denier yarn in that it has zones of bulking and non-bulking. However, said zones in my earlier yarn are somewhat the reverse of the zones in the present new and improved yarn. In the manufacture of such earlier intermittent type yarns, an already formed multifilament yarn is subjected to an outside tension device positioned outside of a bulking jet before the yarn passes to the jet. By control and operation of said outside tension device, this permits producing in the yarn areas of bulk or no bulking, with entangling, interlacing or intermingling of the filaments as may be desired.

While such process has utility and permits the manufacture of interesting appearing and a useful yarn product, such process, as well as other earlier processes which will be referred to below, are slower of operation than the present process. Therefore, the expense of manufacturing novelty yarn by such prior processes is higher than by the simplified, improved process of the present invention.

In further detail, in the earlier art it has been shown that yarns of variable luster can be produced by alternating intermittent extrusion of clear spinning dope and pigmented spinning dope through a yarn extruder spinnerette. It has also been shown that continuous filament yarns can be made having randomly spaced zones of decreased luster by exposing the yarn in such delustered zones to chemical or mechanical treatment which roughens or disturbs the surface of the individual fibers or entangles and loops the filaments in said delustered zones. For example, U.S. Patent 2,783,609 refers to the feature of intermittent impulsing of the multifilament. U.S. Patent 2,780,833 refers to the producing of yarns of variable color or luster by alternate extrusion of two different spinning dopes. U.S. Patent 2,316,245 shows means for roughening yarn at intervals along its length. In general, such older methods have certain disadvantages or limitations. As compared to extrusion rates frequently used for dry spinning cellulose ester and the like yarns, any of the above type processes, the intermittent treatment, the roughened treatment or the like, are relatively slow speed operations. Therefore, the poundage of yarn produced by such prior art procedures and apparatus per apparatus position is small and, therefore, the capital investment in equipment is a relatively large amount. The intermittent impulsing or looping of the yarn, while it results in a delustered effect in the area of filament loops, may on occasion be undesirable because the loopy

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filaments drastically change the hand or feel of the yarn or fabric and also the apparent yarn diameter. The roughening or abrading process, while it dulls or delusters the yarn, results in broken filaments and changes the characteristic hand of the yarn from that of a continuous multifilament yarn to that of a staple spun or cotton-like yarn.

Accordingly, it is believed apparent that the development of improved processes for making such novel type yarns represents a highly desirable result. Therefore, if in the course of spinning multifilament yarns at high speeds the yarn characteristics may be varied in a controlled random manner such that in later processing of the yarn it would develop lustrous and delustered areas this would be advantageous. This is so in that such may be accomplished by the present invention without the need of attaching any special pulsating or the like devices to certain of the equipment used in the present invention.

It is an object of this invention, therefore, to disclose continuous multifilament yarn having intermittently and randomly occurring areas of bright lustrous appearance and equal or increased yarn diameter and other areas of reduced luster and equal or reduced yarn diameter. A further object is to disclose a simple high speed process for producing such a yarn. A further object is to disclose a unique means of mechanically delustering a continuous multifilament yarn without materially changing the hand and texture of the yarn or fabric produced from it. Other objects will appear hereinafter.

I have found that yarns comprised of filaments having unusual stiffness do not respond to the entangling, interlacing or looping action induced by bulking jets of the type disclosed in Dyer Patent No. 2,924,868, or Head Patent No. 2,884,756 or the like apparatus. Thus, by producing a continuous multifilament yarn having randomly occurring lengths where all the filaments are of substantially greater stiffness than in other areas, a yarn can be produced by passing it through a non-turbulent lofting jet wherein the zones of high fiber stiffness are not treated and remain lustrous, and the filaments in zones of low fiber stiffness are entangled, or both entangled and looped and take on a delustered appearance.

One manner of achieving the increased fiber stiffness is to increase the denier per filament of the individual filaments in the spinning of the fibers. A useful process and apparatus for carrying out this process is disclosed in my United States Patent No. 2,920,345. Other methods such as the random spot application of starchy or resinous sizing material to the yarn would also result in increased fiber stiffness or yarn coherence which would resist any treatment which would tend to separate, entangle, or loop the individual filaments.

In further detail, there would first be prepared a multifilament yarn having areas or zones of increased stiffness. The exact manner of making such yarn is not a limitation on the present invention and the yarn may be prepared by dry spinning, wet spinning, melt spinning or the like procedures. As pointed out above, I would prefer to employ a method generally in accordance with the method shown in my earlier Patent 2,920,345. A suitable spinning dope would be extruded into filaments. As the freshly spun still deformable filaments emerge from the spinnerette they are drafted in a variable manner as fully explained in said patent to produce a multifilament yarn having zones of increased denier, thickness and stiffness. The magnitude of the increased stiffness and other details will be further apparent from the examples which follow. In a similar manner melt spun polyester, polyamide and the like filaments may be processed to produce the zones of increased thickness and, hence, increase stiffness of the yarn. Or, wet spun acrylic fibers

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may be suitably made with enlarged or thickened sections. Or, any of the above type yarns of various compositions produced by conventional procedures may be treated with sizes, or polymeric bonding agents or the like at different zones on the multifilament yarn to produce zones of stiffness. It will be noted that this phase of the process may be carried out with existing apparatus and known procedures.

Then, in accordance with the broader aspects of the present invention, such multifilament yarns with sections or zones of increased stiffness, however produced, are passed through suitable high velocity fluid jets and blown with air or other gaseous fluid of a predetermined velocity. I have found that the areas of increased stiffness remain substantially unaffected whereas the non-stiff areas assume a dull appearance. Reference is here made to FIGURES 1, 2, 3, 4, and 5 on the attached drawings forming a part of this application.

FIGURE 1 is a 200 power enlargement showing the longitudinal arrangement of a large denier per filament yarn.

FIGURE 2 is a 200 power enlargement of a longitudinal view of a sized multifilament yarn bundle.

FIGURE 3 is a 200 power enlargement of a longitudinal view of an entangled multifilament yarn.

FIGURE 4 is a 10 power enlargement of a longitudinal view of three strands of an entangled and looped multifilament yarn.

FIGURE 5 is a schematic drawing depicting the general surface appearance of a fabric containing the yarns of this invention as filling.

FIGURE 6 is a schematic drawing representing the type yarn described in Examples I, III, IV, and V.

FIGURE 7 is a schematic drawing of the yarn product described in Example VII.

FIGURE 8 is a schematic drawing of the yarn product described in Example VIII.

In the case where the increased stiffness is due to an increase in the denier per filament size of the filaments, the increased section modulus or resistance to bending of these heavier filaments causes them to resist treatment and remain in a substantially parallel loose state as shown in FIG. 1. In the case where the increased stiffness of the yarn is achieved by application of a size or filament bonding material, the forces of the fluid jet treatment are inadequate to break the interfilament size bond, and the filaments remain closely compacted and parallel as shown in FIG. 2. In both cases the high degree of parallelism of the filaments results in a high light reflectance value, making the yarn appear lustrous.

On the other hand, in areas where the filaments are of lesser size and have a low section modulus or resistance to bending or where the filaments are not bonded together, the action of the fluid jet treatment causes them to become entangled as shown in FIG. 3 or to become both entangled and looped as shown in FIG. 4. In both the instance of filament entanglement or entanglement and loopiness, the parallelism of the fiber is destroyed; and the reflectance of light from the yarn becomes diffuse, giving the yarn a dulled or delustered appearance. I have further found that such procedure for making variable luster yarns is more rapid and economical than the prior art procedures. I have also found certain preferred relationships and other refinements for blowing the yarn as aforesaid in order to obtain the most desirable variable luster yarn, all as will be set forth hereinafter.

Referring now to FIG. 5 a fabric has been illustrated which contains the variable luster yarn of the present invention. It will be noted that certain portions of the yarn 7 and 8 stand out in the fabric in contrast to other portions 9.

A further understanding of my invention will be had from a consideration of the following examples which are set forth to illustrate certain preferred embodiments.

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Example I

A 450 denier bright luster cellulose acetate continuous multifilament yarn, composed of 114 filaments was extruded at 300 m./m. At randomly spaced intervals the denier of the individual filaments was increased from approximately 3.94 to a value of 15.8 or in a ratio of 4 to 1. As a result, the stiffness or relative resistance to bending of the enlarged zones of the filaments was increased by a ratio of about 16 to 1. The process and apparatus used for producing this variation in denier was as disclosed in Patent 2,920,345.

The spun yarn was wound up with 3 t.p.i. twist on a conventional bobbin. The bobbin of yarn was then subjected to a bulking process in the apparatus disclosed in Dyer 2,924,868. Surprisingly, it was found that if the apparatus was set up as in the following table, the areas of increased fiber stiffness were not treated but remained smooth, lustrous, and silky in appearance with a denier of about 1800 as shown in FIG. 1; whereas, the areas of decreased fiber denier and stiffness were looped and entangled as shown in FIG. 4 and had a rough, dull, worsted-like appearance and a denier of only 550.

The jet setup was as follows:

25	Diameter of inlet to nozzle 12	-----inches--	.125
	Diameter of outlet of nozzle 8	-----do----	.047
	Diameter of orifice hold 31	-----do----	.094
	Included angle of nozzle 8	-----degrees--	60
	Included angle of orifice 20	-----do----	90
30	Entrance angle of venturi 22	-----do----	35
	Venturi throat diameter 23	-----inches--	.106
	Venturi throat length 23	-----do----	.062
	Venturi exit angle 24	-----degrees--	10
	Air pressure	-----p.s.i. gage--	8

35 The yarn produced is schematically represented by the drawing of FIGURE 6. In this drawing the width of the yarn has been enlarged much more than the length for the purpose of more clearly illustrating the yarn structure. It will be noted that in the areas 7 and 8 the large diameter filaments remain substantially parallel and lustrous, while in the area 9 of small filament diameter and stiffness, the filaments are entangled and looped. It should also be noted that the effective over-all diameter of the yarn in the areas of filament entanglement and loopiness is substantially the same as the over-all diameter of yarn in the areas of increased filament diameter and stiffness.

Example II

50 The run of Example I was repeated using the same spun yarn but using an inlet nozzle of .156" inlet diameter and .145" outlet diameter, an orifice hole diameter of .177", a venturi throat diameter of .189", and an air pressure of 20 p.s.i. gage. The more violent action of this jet caused the stiffer filaments to become looped and entangled; and a variable luster or hand variation could not be detected along the yarn strand as in Example I. In addition, the bulk or diameter of this yarn varied along its length with the areas of stiff filament loopiness being 60 larger in diameter than the areas of loopy low filament stiffness.

Example III

65 A 2700 denier multifilament cellulose bright luster acetate yarn, composed of filaments having a nominal denier of 16 but with a denier per filament of 64 at randomly spaced intervals was spun. The filaments varied in stiffness by a factor of 16 to 1. This yarn was treated in the jet of Example II. The action of the jet was inadequate to cause any looping or entangling of the filaments in the areas of increased stiffness along the yarn strand. These areas remained relatively smooth and lustrous as in FIG. 1 with a total denier of about 10,800, while the zones of the yarn containing the smaller, less 75 stiff filaments were roughened and loopy in appearance

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and had a denier of about 3100 as shown in FIG. 4. The appearance of this yarn is depicted in FIGURE 6.

Example IV

A 600 denier 152 filament bright luster cellulose acetate continuous multifilament yarn was spun in such a manner that the nominal filament denier of about 4 was increased at random intervals, averaging 8 yards apart to a denier of 20. The resultant increase in stiffness was in the ratio of 25 to 1 in the thickened areas of the filaments. This yarn was treated in the bulking jet of Example I. The filaments in the areas of increased fiber stiffness remained unentangled and unlooped as in FIG. 1 and the yarn was smooth and lustrous in appearance in these zones. The denier of the yarn in these zones was about 3000. In the areas of low fiber stiffness, the filaments were looped and entangled as in FIG. 4 and had a rough, dull appearance and a denier of only 700. When woven as filling in a satin weave fabric, the fabric had an over-all dull sheen high-lighted by randomly occurring short streaks of a polished silver like luster with the result that the fabric had a unique novel and appealing appearance not heretofore obtainable in woven fabrics. Measurements of the specular reflectance of the bright luster areas gave a reading of 74, while the reflectance of the delustered areas of the yarn was only 16. The attached FIG. 5 depicts the appearance of this yarn with 7 and 8 denoting the lustrous areas and 9 denoting the areas of reduced luster. In the foregoing example the volume of the lustrous slub exceeded that of the delustered bulky yarn areas by a factor of about 5 to 3. For many fabric applications this emphasis by reason of volume or size in the lustrous area is desirable. In other applications it may be desirable to maintain the effective diameter or size of the yarn constant. Experience has shown that the process of bulking or looping a yarn by an air jet results in an effective volume increase of about 3/1 even though the denier of the yarn is increased only by a factor of about 1.25/1. By proper adjustment of the apparatus used in spinning a yarn, the variation in denier of the yarn can also be readily adjusted to a value of about 3/1. Thus, it is possible, as explained herein, to produce a yarn of constant effective diameter size wherein the areas of increased filament size are smooth and lustrous and the areas of lesser filament size are rough and dull. The appearance of this yarn is depicted in FIGURE 6.

Example V

A 300 denier bright luster 4 d./f. cellulose acetate yarn was spun using a variable denier apparatus attachment such that in randomly spaced areas the filament denier was increased to 12, and the fiber stiffness was increased by a factor of about 9 to 1. The yarn was then treated in the apparatus of Example I. The finished yarn had randomly occurring lengths like FIG. 1 of smooth, bright lustrous yarn and rough, dull yarn as in FIG. 4 but was substantially uniform in diameter throughout its length. When woven as filling into a fabric, the uniformity of size was demonstrated by the absence of distorted parallelism or linearity of the filling yarns which would otherwise have occurred if the yarn had varied in diameter along its length. The appearance of this yarn is depicted in FIGURE 6.

Example VI

In the foregoing examples the filament size was increased to achieve the desired resistance to filament entanglement and looping in the jet. In this Example VI a 300 denier, 4 d./f. bright luster cellulose acetate yarn was spun, and at random intervals a fiber bonding material in the form of a solution of polyvinyl alcohol was applied, causing the filaments in the areas of application to become stuck or bonded together. When this yarn was treated in the jet of Example I, the sized lengths of yarn were unaffected by the treatment and remained smooth

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and lustrous with a denier of 300, while in the lengths of unbonded yarn filaments, the filaments became entangled and looped with the yarn increasing to a denier of 350. When woven as filling in a fabric and scoured and finished to remove the size, the formerly sized yarn lengths appeared lustrous and smooth, while the unsized lengths were rough in texture and dull in appearance as shown in FIG. 5.

Example VII

In the foregoing examples, when treating the yarn in the jet, the yarn was overfed to the jet by an amount of not less than 10% and usually at least 20% so that the filaments might become both entangled and looped as described in my Patent 2,924,868. In some cases it may be desirable to avoid the drastic change in fabric hand and texture caused by a loopy filament bulk yarn and retain a smooth yarn hand or appearance. In such instances the yarn may be passed through the fluid jet with only sufficient slackness or absence of tension to allow the filaments to entangle but not to loop. As noted in my patent application Serial No. 400,544, of which this is a continuation in part, and in my copending continuation in part, Serial No. 75,396, it is possible to decrease the slackness in yarn tension in the jet by reducing the overfeed of the yarn so that the yarn retains substantially the same smooth appearance as a normal untreated yarn but still attain a degree of interfilament disarray or entanglement. If the amount of overfeed of the yarn is in the order of 0-2%, the luster of the yarn is not substantially reduced but if the overfeed is in the order of 2-15%, the filaments can be entangled with sufficient frequency and severity as to cause a marked delustering of the yarn but without, at the same time, causing any filament loopiness that would roughen the yarn. A similar delustering effect is noted in untreated yarn as the twist is increased, and the following table shows the approximate relationship between luster and twist and the conditions required to achieve an equivalent effect by filament entanglement by varying the overfeed of the yarn treated in a fluid jet.

Equivalent Twisted Yarn	Jet Treated Yarn		Brightness
	Overfeed, percent	Degree of Entanglement	Luster
Twist:			
0 t.p.i.	-1 to 0....	none.....	80-90
.3 to 2.0 t.p.i.	0 to 2....	slight....	60-75
10 to 30 t.p.i.	2 to 15....	very heavy..	15-30

While the foregoing values in the table may vary in some degree depending on the particular yarn composition, jet design, and process used in testing the yarn, they show the general relationships which exist. Putting into practice the unique effects shown by this table, the 450 denier spun yarn of Example I was processed as before except that the overfeed of the yarn was reduced to 5% so that the lengths of heavy denier per filament yarn were unaffected and remained smooth and lustrous with a denier of 1800 as in FIG. 1, while the lengths of normal 4 denier/filament yarn, as a result of the jet treatment, were caused to incur a very heavy degree of filament entanglement but without any loopiness as shown in FIG. 3, while the denier of the yarn in these entangled lengths remained substantially 450 denier. When woven into fabric as filling, the fabric had much the same dull appearance with lustrous streaks as shown in FIG. 5, but the hand of the fabric was smooth and silklike all over; whereas, in Example I it was rough and wool-like.

The yarn of this example is depicted in FIGURE 7. Here it will be noted that the lengths of yarn 7 and 8 which remain lustrous and are of a large diameter are composed of substantially parallel filaments, while the area 9 containing the filaments of low stiffness are delustered by the several multifilament entanglements.

Example VIII

70 denier, 33 filament per twist bright luster drawn polyester yarn was processed so that, at random intervals of about one yard on the average along its length, it was brought into contact with a size applicator; and a 3% solids solution of a water soluble acrylic binder was applied over a length of about 3 inches and cured. When this yarn was subjected to the fluid jet treatment at 20 p.s.i. air pressure and with an overfeed of 6%, the sized lengths remained untreated and lustrous; and the unsized lengths became characterized by a notable degree of inter-filament entanglement such that they appeared delustered. The denier of the yarn in both the treated and untreated lengths of yarn was substantially unchanged a 70.

The appearance of this yarn is depicted in FIGURE 8. The areas 7 and 8 which were subjected to the filament binding treatment containing filaments which are substantially parallel give a lustrous appearance, while the filaments in the unsized areas are heavily entangled and give the delustered appearance in the area designated as 9.

While the examples used to describe this invention have primarily related to bright luster cellulose acetate yarn, yarns of other compositions such as acrylics, modacrylics, polyesters, polyamides, and polyolefins prepared by melt spinning or other procedures may be treated in a comparable manner with similar results.

While specific methods or apparatus for varying the stiffness of the filaments and for treating them in an air jet have been used for illustrative purposes, the specific variable denier apparatus or type of air treating jet as indicated above is not a limiting factor. The present invention resides to a substantial extent in the discovery that fibers of increased stiffness entangle or loop less readily than those of low stiffness and that this can be effectively utilized by selection of the conditions of treating a yarn containing randomly occurring areas where all the filaments are of greater stiffness so that these areas of increased stiffness do not respond to the treatment; whereas, the areas of low fiber stiffness do respond. It also resides in the fact that an intermittently bulked yarn can be made wherein the actual diameter of the yarn remains constant or is greater in the areas of no bulk treatment than in the areas that responded to the bulk treatment.

The invention has been described in considerable detail with particular reference to certain preferred embodiments thereof, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention as described hereinabove, and as defined in the appended claims.

I claim:

1. The process of producing a randomly lustrous and non-lustrous yarn which comprises increasing the stiffness of the filaments in selected random lengths of the

yarn to the extent of at least 9 times compared to the non-stiff lengths and subjecting said yarn to a high velocity gaseous treatment such that said stiff length remain smooth and lustrous and are unaffected by high velocity gaseous treatment which causes the filaments in the zones of decreased stiffness to become entangled and assume a rough, delustered appearance.

2. The process of claim 1 wherein the stiffness of the filaments and the pressure of the high velocity gas are correlated so that said pressure is insufficient to materially change the said stiff, random lengths in said filaments.

3. The process of making a novel yarn having zones of luster which are of approximately the same denier as zones of low luster in said yarn, which comprises spinning a multifilament yarn with predetermined zones of increased denier and stiffness and wherein the other zones are of a denier correlated to the zones of stiff denier, subjecting said multifilament yarn to treatment in a jet with high velocity gas whereby said other zones are increased to a diameter approximately the diameter of said zones of increased denier and stiffness.

4. As a new article of manufacture a yarn containing smooth lustrous zones free from filament entanglement and loopiness and other zones of a rough loopy delustered appearance wherein the lustrous zones are of greater bulkiness than the delustered looped filament zones.

5. The process which comprises obtaining a multifilament yarn of a denier per filament from 4-100, which yarn has stiff zones, which stiff zones are several times stiffer than the other zones of the yarn, which process includes feeding the aforesaid yarn through a bulking jet supplied with high velocity gas whereby the stiff zones remain smooth and lustrous and are substantially unaffected and the remainder of the yarn acquires a low luster appearance and wherein the stiff zones are obtained by applying a filament binding media.

6. As a new article of manufacture a yarn containing smooth, lustrous zones free from filament entanglement and loopiness and other zones of a rough entangled delustered appearance, wherein the lustrous zones are of a greater bulkiness than the delustered entangled filament zones.

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