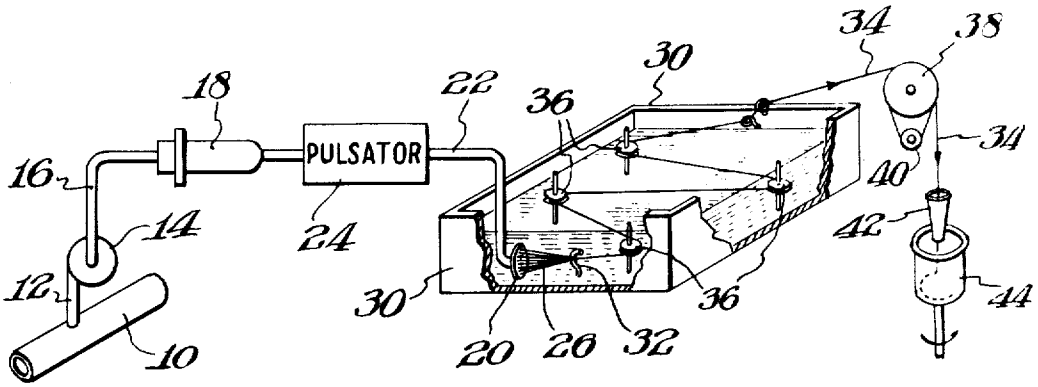
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PROCESS FOR SPINNING CONTINUOUS FILAMENT NUB YARN

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PROCESS FOR SPINNING CONTINUOUS FILAMENT NUB YARN

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The present invention relates to an improved process for spinning continuous filament yarn having an uneven or irregular denier. More particularly it relates to an improved method for producing continuous filament regenerated cellulose yarn with frequent and sharp variations in denier using high spinning speeds.

The production of continuous artificial filaments with denier variations may be effected by any of several methods disclosed in the prior art. We are here concerned primarily with those methods for spinning regenerated cellulose wherein a pulsating motion is imparted to the filament-forming solution passing through the spinneret. This pulseting motion may be initiated by devices mounted between the metering pump and the spinneret which momentarily interrupt the flow of filament-forming solution, or by introducing a pulsating flow of filament-forming solution into the line leading from the metering pump to the spinneret. Some specific types of pulsators for providing this pulsating motion include: a variable drive for the spinning pump, plunger pumps with plungers of unequal diameter, gear-type pumps with gears having uneven teeth, gear-type pumps in which some of the teeth have been removed from the gears, a main pump with auxiliary pumps which act in a variable manner to supply extra spinning solution periodically, and pumps which do not supply spinning solution but merely function to alter the pressure in the line leading from the spinning pump to the spinneret.

Most of the above-described methods are primarily concerned with merely producing continuous artificial filaments of varying denier wherein the variations are not particularly frequent nor sharp. These methods will satisfactorily produce such a yarn without much difficulty. The variation in denier is usually quite gradual. In most cases the thick portions of the filaments, while of sufficient thickness, are quite long and separated by relatively long spaces of thin portions. To obtain thick portions that are relatively short, sharp and of high frequency, the devices used must be precisely constructed and their operation must be rigidly and accurately controlled. Some of the pulsators, such as the device described in U. S. Patent No. 2,391,973 to A. S. Hunter, are designed specifically to produce sharp and frequent variations in denier. However, in all cases, despite precautions, it has been found to be impossible to successfully spin acceptable continuous artificial filament yarns having sharp and frequent denier variations at spinning speeds greater than about 50 yards per minute. The yarn resulting from high speed sipnning, despite precautions taken in the design of pulsating mechanism, has previously been of substantially constant denier.

Therefore, it is an object of this invention to provide a method for producing continuous filament regenerated cellulose yarn of markedly uneven denier at high spinning speeds. It is a further object of the invention to provide a method for producing such uneven denier yarn at high spinning speeds wherein the unevenness or irregularity of denier varies frequently and sharply. Other

objects of the invention will become apparent from the following description and claims.

The single figure of the drawing illustrates schematically an apparatus for carrying out the process of this invention.

Viscose from the main supply pipe 10 is withdrawn through pipe 12 to a conventional viscose gear-type pump 14. The pump meters the viscose at the desired overall rate and forces it through pipe 16 to a candle filter 18 and on to the spinneret 20. In the pipe 22 leading from the filter to the spinneret is arranged a pulsator pump 24 which superimposes a pulsating pressure on the pressure created by gear pump 14. There are several suitable types of pulsators, one of which is disclosed in U. S. Patent No. 2,391,973 to A. S. Hunter. This is a gear-type pump in which some of the teeth have been removed or modified to form one or more pockets, so that the pump delivers an uneven or pulsating flow. Another type of pulsator known to those skilled in the art employs a reciprocating piston pump which robs the line of some of the viscose to reduce the pressure on the upstroke and then returns the viscose to the line to increase the pressure on the return stroke of the piston.

The filaments 26 extruded from spinneret 20 pass into a coagulating and regenerating bath 28 contained in a trough 30, a portion of which is broken away in the drawing to show the inside more clearly. The filaments pass first around a convergence guide 32. This is shown as a hook-shaped bar, which may be of glass or other smooth bath-resistant material. However, any of the other types of convergence guides known to the art may be used. The converged filaments now pass as a yarn bundle 34 about a plurality of roller guides 36, or the like, the purpose of which is to provide a sufficiently long travel through the bath. Of course, a series of coagulating and regenerating baths contained in separate troughs can be provided if desired. From the bath the yarn bundle travels several times around a positively driven feed wheel 38 and a snubber roller 40. After leaving the feed wheel the yarn bundle passes into reciprocating funnel 42 which guides it into a rotating bucket 44, where the yarn is collected as a cake. The equipment described in the above paragraph will be recognized as conventional in the art.

The improvement of this invention comprises extruding the filament-forming solution in a pulsating fashion through the spinneret and then converging the filaments into a bundle by means of a convergence guide within an unusually short distance after they leave the spinneret. The normal convergence distance is about 20 or more inches for spinning the regenerated cellulose filaments of the prior art. In accordance with this invention it has been found that the spinning of desirable uneven denier yarn at speeds greater than about 50 yards per minute can be accomplished successfully only if the filaments making up the yarn are converged within a distance of not over 12 inches after the filaments leave the spinneret, and the best results are obtained with about 6 inches or even shorter distances. However, the convergence distance should not be so short that stuck filaments are produced, and convergence should generally be at least 3 inches from the spinneret for speeds up to 110 yards per minute.

At this point it will be helpful to define some of the conditions and terms involved in the description of this invention. "Nubs" refer to the thicker portions of the uneven denier yarn. "Nub denier" is the corresponding denier of these thicker portions, which may be determined by physical measurements made on these portions of the yarn but is more readily determined by electrical means known to the art. "Base denier" refers to the denier

of the thinner portions. "Nub prominence" is defined as the difference between nub denier and base denier. For low denier yarn, where the nub denier is of the order of 400 to 600 denier, a nub prominence of approximately 150 denier is required for the preparation of fabrics which display a satisfactory crepe effect. For heavier denier yarn, where the nub denier is of the order of 2300 or higher, a nub prominence of approximately 800 is required for a satisfactory ratine effect in the fabric. In general, the percent nub prominence, calculated as nub prominence/nub denier×100, must be greater than 30%. "Base length" refers to the space between nubs or, in other words, the length of the thin portion between thick portions. In the spinning of uneven denier yarn with sharp and frequent changes in yarn denier it is possible to produce base lengths of ⅛ inch or lower and nub lengths of ¼ inch or lower for yarns of 400 to 600 nub denier. For yarns of 2300 to 3000 nub denier base lengths of ⅜ inch and lower and nub lengths of ¾ inch and lower may be produced by this process. It should be emphasized, however, that the process of this invention will also produce satisfactory denier variations ranging up to about 5 times the above values for nub and base lengths at the increased spinning rates. Satisfactory uneven denier yarn, having a nub prominence which is at least 30% of the nub denier at these higher values of nub and base lengths or at the extremely short lengths given previously, cannot be produced at high spinning speeds without reducing the convergence distance to 12 inches or less, as described in this invention.

The examples which follow describe the production of yarns of uneven denier, wherein regenerated cellulose filaments are produced by the viscose process. However, this is merely for purposes of illustration and should not be considered limitative. It should be understood that the invention is also applicable to the spinning of cuprammonium, cellulose nitrate and other filaments produced by extruding a filament-forming solution into a liquid coagulating bath.

EXAMPLE I

A viscose solution analyzing 7% cellulose and 6% alkali was spun into a bath containing 11% H_2SO_4, 19.75% Na_2SO_4, 0.7% $ZnSO_4$ and 2% glucose at a temperature of 53° C. Pulsations were produced by the use of a piston pulsator. This device was inserted in the viscose line between the spinning pump and the spinneret. It employs a reciprocating piston driven by a crank. This piston motion operates directly on the spinning solution going from the spinning pump to the spinneret. The piston alternately robs the line of spinning solution on its upstroke (decreases pressure) and supplies this additional viscose on its downstroke (increases pressure). By altering overall delivery of viscose solution to the spinneret and varying the take-up speed in a manner well known to those skilled in the art, the nub denier was controlled within a range of 400–600 denier. The spinning speeds and the convergence distance were systematically varied. After the filaments were extruded and converged into yarns they travelled through the bath until substantially complete regeneration had occurred. The yarns were collected as cakes in rotating buckets. The yarns were purified by treatment with water and dried. The characteristics of the yarn were then determined. The variation in yarn denier was measured electrically by recording the capacitance change in the yarn as it is passed between two condenser plates. Average nub lengths of ¼ inch and average base lengths of ⅛ inch were determined by cutting and measuring for all the following yarns spun by the above method at various take-up speeds. The results are summarized below:

Spinning or Take-Up Speed (Yards/Minute)	Convergence Distance (Inches)	Nub Denier	Base Denier	Nub Prominence	Percent Nub Prominence
100	3	595	145	450	76
100	7	481	190	291	61
100	17	407	326	81	20
50	3	494	175	319	65
50	7	467	228	239	51
50	17	432	267	165	38
25	3	520	113	407	78
25	7	522	77	445	85
25	17	533	103	430	81

These data illustrate the necessity for reducing the convergence distance when increasing the rate of spinning of this type of yarn. When the convergence distance is reduced, the yarn produced at the increased rates of spinning contained sharp and frequent variations in denier at a nub denier of 400–600. It should be noted that reduction of the convergence distance at the usual prior art spinning speed of 25 yards per minute did not materially improve the nub prominence and, when the distance was reduced to 3 inches, the nub prominence was even affected adversely.

EXAMPLE II

A viscose solution analyzing 7% cellulose and 6% alkali was spun into a bath containing 11% H_2SO_4, 19.75% Na_2SO_4, 0.7% $ZnSO_4$ and 2% glucose at a temperature of 53° C. Pulsations were produced in a manner described in Example I. The nub denier was controlled within a range of 2300–2900. The spinning speeds and convergence distances were systematically varied. The yarns were spun according to the so-called bucket process. After collection of the yarns as cakes in rotating buckets, the cakes were removed and purified and finally dried. The characteristics of the yarns were determined. The average nub lengths were ⅛ inch and the average base lengths were ⅓ inch. The results are summarized below:

Spinning or Take-Up Speed (Yards/Minute)	Convergence Distance (Inches)	Nub Denier	Base Denier	Nub Prominence	Percent Nub Prominence
100	2	2,590	910	1,680	65
100	6	2,645	1,100	1,545	59
100	12	2,515	1,495	1,020	41
100	24	2,280	2,080	200	9
50	3	2,760	1,425	1,335	48
50	6	2,715	1,715	1,000	37
50	12	2,730	1,990	740	27
50	24	2,660	2,225	435	16
25	3	2,845	860	1,985	70
25	6	2,725	670	2,055	76
25	12	2,835	735	2,100	74
25	24	2,905	1,040	1,865	64

These data illustrate the necessity for substantially reducing the convergence distance upon increasing the rate of spinning "nubby" yarn. The yarn produced in this series of tests displayed a nub denier of 2380–2905. Again it should be noted that changing the convergence distance at a spinning speed of 25 yards per minute does not indicate that this may be a method of materially affecting the nub prominence at the higher spinning speeds.

EXAMPLE III

A viscose solution analyzing 7% cellulose and 6% alkali was spun into a bath containing 11% H_2SO_4, 19.75% Na_2SO_4, 0.7% $ZnSO_4$ and 2% glucose at a temperature of 49° C. Pulsations were produced by two methods. The first method, Method A, is disclosed in U. S. Patent No. 2,391,973. Pulsations were produced by the use of a gear-type pump in which some of the teeth were removed from the gears. The second method, Method B, was the piston pulsator described in Example I. The yarns were spun and collected according to the well known bucket process at a spinning speed of 100

yards per minute. Nub deniers were maintained within a range of 2240–2425. The results are summarized below:

Method A

Convergence Distance (Inches)	Nub Length (Inches)	Base Length (Inches)	Nub Denier	Base Denier	Nub Prominence	Percent Nub Prominence
6	1⅛	⅜	2,244	1,056	1,188	53
12	1⅛	½	2,328	1,486	842	36
22	1⅛	½	2,291	1,726	565	25

Method B

Convergence Distance (Inches)	Nub Length (Inches)	Base Length (Inches)	Nub Denier	Base Denier	Nub Prominence	Percent Nub Prominence
8	1	⅛	2,424	810	1,614	67
16	⅛	⅛	2,300	1,513	787	34

These data illustrate that this invention is not dependent on the pulsating mechanism employed for producing the nubs. At a spinning speed of 100 yards per minute, regardless of the pulsating mechanism used, it is necessary to substantially reduce the convergence distance to produce the desired yarn.

Heretofore, attempts to produce "nubby" yarn displaying sharp and frequent denier variations at high spinning speeds have resulted in yarn of almost constant denier. The reason for this difficulty is not entirely understood but may be explained by the following theory:

The yarn consists of many filaments, each filament containing short nubs separated by relatively short distances. At high spinning speeds the nubs on each of the filaments are believed to become "out of phase" so that, instead of lining up with the nubs side by side, the nubs on each filament line up with the base portions of neighboring filaments. This would result in an even denier yarn.

In accordance with this invention the surprising discovery was made that, whatever the cause, the undesired production of even denier yarn is avoided by gathering the nascent filaments into a yarn bundle as soon as possible after extrusion. If the above theory regarding the cause is correct this result is achieved because the "out of phase" condition is prevented. Theoretically there would appear to be no minimum limit for the convergence distance in the production of uneven denier yarn with acceptable nub prominence. However, reduction of this distance below 3 inches has resulted in stuck filaments and in general, poor spinnability. The composition and temperature of the bath and the filament-forming solution may be altered to substantially improve spinnability and permit reduction of this distance to a value somewhat below 3 inches.

This invention provides an improved and an inexpensive method for producing "nubby" yarns with sharp and frequent denier variations. These yarns have extensive uses in the preparation of dress goods, upholstery and drapery fabrics. This method requires no unusual equipment. By reducing the convergence distance to the critical distance of 12 inches or less, this method makes possible the production of "nubby" yarn at considerably increased rates of spinning.

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.

What is claimed is:

1. In the process of spinning continuous filament yarn with frequent and sharp variations in denier by extruding viscose with a pulsating motion through a spinneret into a coagulating and regenerating bath to form filaments and converging the filaments to form a yarn bundle, the improvement which comprises spinning the yarn at a speed greater than 50 yards per minute and converging the filaments into a yarn bundle at a distance within 12 inches of the spinneret which does not produce stuck filaments.

2. In the process of spinning continuous filament yarn with frequent and sharp variations in denier by extruding viscose with a pulsating motion through a spinneret into a coagulating and regenerating bath to form filaments and converging the filaments to form a yarn bundle, the improvement which comprises spinning the yarn at a speed of 50 to 110 yards per minute and converging the filaments into a yarn bundle at a distance of 3 to 12 inches from the spinneret.

3. In the process of spinning continuous filament yarn with frequent and sharp variations in denier by extruding viscose with a pulsating motion through a spinneret into a coagulating and regenerating bath to form filaments and converging the filaments to form a yarn bundle, the improvement which comprises spinning the yarn at a speed greater than 50 yards per minute and converging the filaments into a yarn bundle at a distance of about 6 inches from the spinneret.

4. The process of spinning continuous filament yarn with frequent and sharp variations in denier which comprises extruding viscose under a pulsating pressure through a spinneret into a coagulating and regenerating bath to form a bundle of filaments, withdrawing the filaments at a speed greater than 50 yards per minute, converging the filaments into a yarn bundle at a distance within 12 inches of the spinneret which does not produce stuck filaments, and varying said pulsating pressure sufficiently to produce yarn having a nub prominence which is at least 30% of the nub denier.

5. The process of spinning continuous filament yarn with frequent and sharp variations in denier which comprises extruding viscose under a pulsating pressure through a spinneret into a coagulating and regenerating bath to form a bundle of filaments, withdrawing the filaments at a speed of 50 to 110 yards per minute, and converging the filaments into a yarn bundle at a distance of 3 to 12 inches from the spinneret, said pulsating pressure being controlled to produce yarn having a nub prominence of at least 30% of the nub denier, a nub length of ⅛ to 2 inches, and a base length of ¼ to 4 inches for 400 to 3000 nub denier yarn.

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