

July 15, 1952

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2,602,964

PRODUCTION OF SPUN YARNS AND FIBERS

Filed Jan. 29, 1947

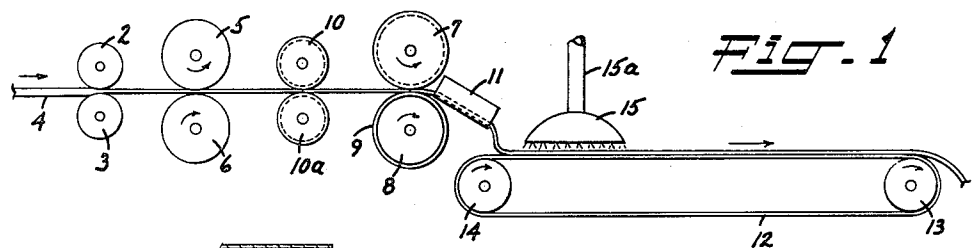


Fig. 1

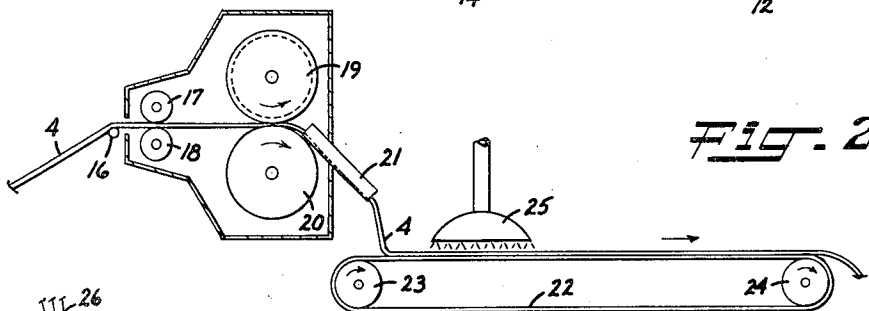


Fig. 2

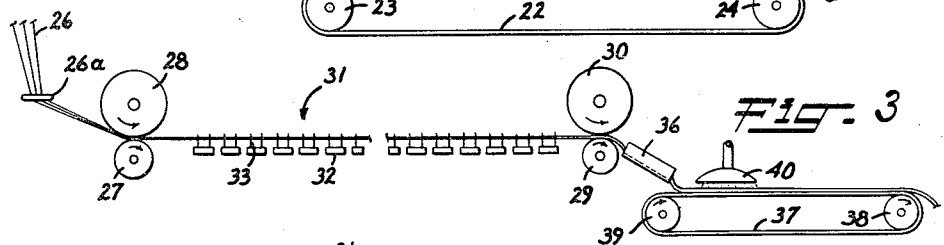


Fig. 3

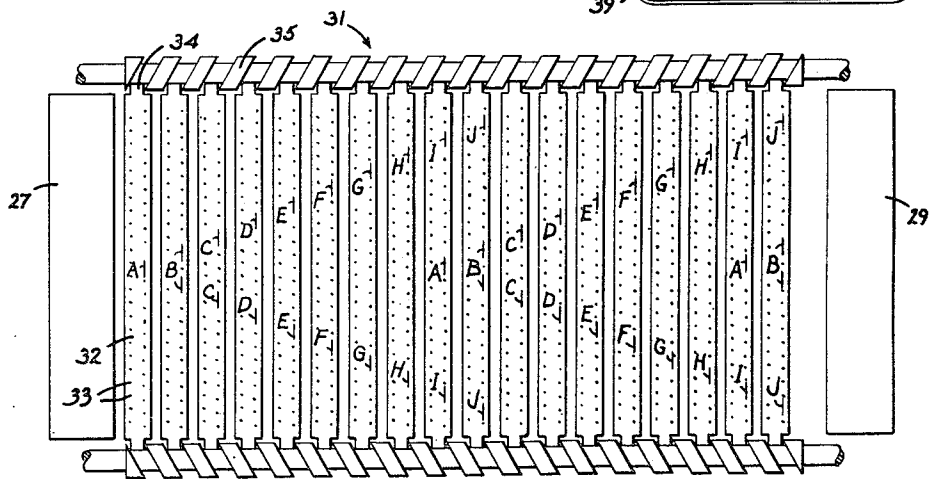


Fig. 4

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2,602,964

PRODUCTION OF SPUN YARNS AND FIBERS

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Application January 29, 1947, Serial No. 724,979

8 Claims. (Cl. 19—1)

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This invention relates to improvements in the manufacture of spun yarns and fabrics comprising the same.

The invention is directed to a method wherein a bundle of continuous filaments in untwisted or only slightly twisted condition is converted directly to a bundle of discontinuous fibers, without loss of substantial parallelism of the fibers or continuity of the structure.

It has been proposed, heretofore, to convert bundles of continuous filaments directly to a top or sliver, by methods involving breaking, cutting, or abrading the continuous filaments in bundle form to obtain a seemingly continuous structure comprising discontinuous fibers of the desired regular or irregular lengths, so as to avoid the carding and combing operations required by the more conventional methods of manufacturing spun yarns. Thus far, such methods have not been entirely satisfactory for the reason that the discontinuous fibers in the top or sliver obtained are in uncrimped condition, or show only slight crimpiness. As is well known, it is preferred, in making spun yarn, to have the fibers in crimped condition, the greater the degree of crimpiness the better, because the crimpiness insures cohesion of the fibers and facilitates handling of the top or sliver during the drafting or drawing down operations involved in spinning the yarn. A top or sliver comprising uncrimped, or only slightly crimped, fibers lacks coherence and is a loose structure which, even after compacting or condensing, is difficult to handle without losing continuity thereof and parallelism of the fibers. Such loose structures are always obtained when bundles of continuous filaments of conventional or normal type are converted directly to a top or sliver, and the problem is especially troublesome when it is attempted to convert normal regenerated cellulose filaments directly to a top or sliver. Normal regenerated cellulose fibers are inherently straight. Although they may be crimped to some extent by mechanical and/or chemical crimping treatments, the crimp is not permanent, and is pulled out if the fibers are subjected to tension. In the more conventional methods of making spun yarns from regenerated cellulose filaments, the continuous filaments are cut to discontinuous fibers which are allowed to fall into a bath in which they curl or crimp to some extent, and the mass is then carded and/or combed to effect parallelization of the fibers before spinning them into a yarn.

The discontinuous fibers cannot be curled or crimped in that manner in the case where the

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continuous filaments, in bundle form, are converted directly to a top or sliver. There, if the normal filaments are mechanically or chemically crimped, and the bundle is subjected to tension to break the filaments to obtain discontinuous fibers, the breaking tension is sufficient to pull the crimp out of the fibers. Also, if the filaments in the bundle are cut to discontinuous fibers, without loss of continuity of the structure, the resulting fibers show little, if any, crimpiness, particularly if the cutting is effected simultaneously with drafting to produce a sliver. A common expedient has been to jam the structure comprising the discontinuous fibers through a crimping tube or the like, before forwarding it to the drafting rolls used in spinning it into a yarn. However, the fibers cannot be given sufficient crimpiness by that means to effect any substantial improvement in the handling properties of the structure.

The primary object of the present invention is to provide a method of manufacturing spun yarns in accordance with which each of the discontinuous fibers in a seemingly continuous structure obtained directly from a large denier bundle of untwisted or only slightly twisted continuous filaments is in highly crimped condition immediately prior to the drafting of the seemingly continuous structure to produce the spun yarn. A further object is to provide a spun yarn comprising crimped or potentially self-crimpable fibers. An additional object is to provide spun yarns suitable for the manufacture of wool-like fabrics characterized by a persistent and substantially permanently recoverable bulk and fullness.

The objects of this invention are accomplished by forming continuous filaments which are reversibly convertible between a straight, substantially uncrimped condition and an inherent crimped condition into a bundle of high total denier, converting the bundle of continuous filaments directly to a bundle of discontinuous fibers, without loss of substantial parallelism of the fibers and continuity of the structure, subjecting the discontinuous fibers in situ in the seemingly continuous structure to the action of an activating agent which has the effect of at least partially plasticizing the fibers under conditions such that the fibers of the bundle or structure are relaxed, to effect independent conversion of each of the fibers to the crimped condition; setting the fibers in the bundle in the crimped condition, and then converting the seemingly continuous bundle of

individually crimped, substantially parallelized discontinuous fibers to a spun yarn.

Any filaments which are reversibly convertible by plasticization and setting thereof between an inherent crimped condition obtainable by setting under relaxation and a straight condition obtainable by setting under tension may be utilized in practicing the method of this invention.

The filaments may be those obtained from a single fiber-forming material under conditions such that each filament has different internal strains distributed transversely of its cross-section giving rise to different shrinkage characteristics and the capacity of reversible convertibility between a straight condition and a crimped condition in the manner and under the conditions hereinabove described; or they may be composite or conjugated filaments obtained from two or more different fiber-forming materials, the several components of each composite filament having different characteristics, including different orientations in the two components as a result of stretching the composite filament beyond the elastic limit of at least one component, and preferably beyond the elastic limit of all of the components of the filament, where this can be accomplished without rupture, after an at least partial setting thereof which different characteristics render the filaments reversibly convertible between a straight condition and an inherent crimped condition by plasticization and setting as described above.

Filaments suitable for use in this invention may be obtained from a single viscose in accordance with the procedure disclosed in Merion and Sisson U. S. Patent 2,517,694.

Composite or conjugated filaments which may be utilized in practicing the method of this invention may be obtained as described in Kulp et al. U. S. Patent 2,386,173 by extruding two or more filament-forming materials of different properties, in a fused or plasticized state or in the form of solutions thereof, in separate or only partially intermingled phases through a common orifice or a plurality thereof, where they are joined together, in eccentric or side-by-side relation, into a setting medium which may be either gaseous or liquid and may function either by a cooling, precipitating or evaporative effect to form unitary filaments in each of which the different materials form separate portions of the body of the filament but are joined by coalescence and disposed with a portion of the peripheral surface of each component entirely outside the periphery of each other component throughout the entire length of the filament.

The several components of each composite filament have different characteristics, including different orientations in the two components as a result of stretching the composite filament beyond the elastic limit of at least one of its components after an at least partial setting thereof, whereby the composite filament is rendered reversibly convertible between an inherent crimped condition and a straight condition in the manner described above. The composite filaments may be formed from any filament-forming material, including different viscoses, different proteins such as caseins and soya bean proteins, different cellulose derivatives such as cellulose acetate and ethyl cellulose, and different resins, such as different nylons, different vinyl resins, especially the copolymers of vinyl chloride and vinyl acetate, different vinylidene halides, etc. The composite filaments may be formed from two or more cel-

lulose xanthates or viscoses which differ as to either age, cellulose content, sodium hydroxide content, carbon disulfide content, as to type of cellulose from which they are made, such as wood pulp or cotton pulp, or as to any two or more of these factors. Also, the composite filaments may be formed from cellulose esters or ethers or solutions thereof which differ as to viscosity, cellulose content, or as to degree of polymerization or substitution of the cellulose chains therein. The composite fibers may also be formed from resin solutions which differ as to kind of resin, viscosity, and the degree of polymerization of the resin; or they may be formed from spinning materials of different classes, such as a protein and a viscose, a protein and a cellulose acetate, or a cellulose acetate and a vinyl resin. Because the two components of the filament are derived from different fiber-forming materials, it is possible to selectively control final characteristics and the crimping capacity of the conjugated filaments and for this reason, in many instances, the conjugated filaments represent a preferred group of filaments for use in the method of the invention.

Generally after-stretching of the reversibly convertible filaments, whatever the specific character thereof, is desirable, and preferably such stretching is effected after an at least partial setting of the filaments. By after-stretching is meant a stretch given the filaments in addition to the jet stretch, the jet stretch being the stretch to which the filaments are subjected as they are drawn away from the face of the jet. The filaments may or may not be in partially plastic condition at the time of stretching. The filaments may be stretched simultaneously with reduction thereof to discontinuous fibers and such stretching may be the only after-stretch to which the filaments are subjected, or it may supplement prior after-stretch. Thus, when a bundle of freshly prepared continuous filaments of high total denier is passed between breaker rolls and subjected to sufficient pull to convert the filaments to discontinuous fibers, the stretch to which the filaments are subjected between the breaker rolls may be the only after-stretch to which the filaments are subjected, that is, the filaments may proceed directly to the breaker rolls from the spinning bath or from the after-treating stages in the case of regenerated cellulose filaments. When the continuous filaments comprising the bundle are cut to discontinuous fibers, in the bundle form, stretching of the filaments will, in some cases at least, preferably precede the cutting. The filaments may be in the crimped condition initially, that is, at the time of their reduction to discontinuous fibers.

After reduction of the continuous filaments to discontinuous fibers, the seemingly continuous structure comprising the fibers is passed, in relaxed condition, through a zone in which it is subjected to the action of a plasticizing agent for the fibers. The plasticizer depends upon the particular material or materials of which the filaments are constituted. Thus, when the filaments comprise regenerated cellulose, the fibers may be converted to the crimped condition in the seemingly continuous bundle by subjecting the bundle to the action of steam. Upon drying of the steam-treated fibers, while the bundle is relaxed, the fibers are set in the individually crimped condition. When the filaments are formed from thermoplastics, such as the cellulose esters or ethers, vinyl resins, nylons, or the like, mere heat-

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ing of the bundle comprising the discontinuous fibers is sufficient to convert the fibers to the crimped condition, in which they may be set by cooling the bundle while it is relaxed.

In the case of regenerated cellulose filaments, the usual after-treatments, such as desulfiding, bleaching, washing, etc. may be performed on the filaments prior to their formation into a bundle of high total denier, after assembling a number of ends together to form the bundle, or after conversion of the bundle of continuous filaments to a top or sliver.

At any appropriate stage of the yarn spinning, the reversibly convertible fibers may be blended with wool fibers and the latter may be used in small proportion.

In the drawing illustrative of the invention:

Figure 1 is a diagrammatic elevation of apparatus suitable for carrying out one embodiment of the invention,

Figure 2 is a diagrammatic elevation of another embodiment of the invention,

Figure 3 is a side elevation of a modification of the invention embodying a gill drafting frame; and

Figure 4 is an enlarged top plane view of a portion of the apparatus shown in Figure 3.

Referring to Figure 1, there is shown a pair of spreader rolls 2 and 3 through which the bundle 4 of continuous regenerated cellulose filaments as described above is passed to breaking rolls comprising two pairs of spaced rolls 5, 6, and 7, 8. Rolls 7 and 8 are fluted and driven at a higher peripheral speed than rolls 5 and 6 in order to tension the filament bundle and effect breaking of the continuous filaments, and a rubber apron 9 lies over the surface of roll 8. Mounted between the pairs of breaking rolls are two rolls, 10 and 10a which are provided with sharp flutings which assist in breaking the continuous filaments. From rolls 7 and 8 the top comprising the discontinuous fibers in substantially parallelized condition passes downwardly over the guide 11 to the surface of an endless foraminous conveyor belt 12 which passes around the driven pulleys 13 and 14. Supported above the surface of the belt at the end thereof adjacent the breaking rolls is a spray head 15 attached to a pipe 15a and through which steam is ejected to effect crimping of the broken fibers as the top is carried in relaxed condition on the belt 12. By the time the steam treated fibers comprising the top leave the surface of the belt they are set in the crimped condition resulting from the steam treatment. The top may be forwarded to any suitable condensing, compacting, and/or deforming device or it may be sent directly to a gill box or the like in which it may be blended with wool or other fibers, if desired.

In Figure 2 the bundle 4 of continuous crenulated regenerated filaments as described herein and which have been stretched by about 40% in a previous operation passes over the guide 16 and is led between tension rolls 17 and 18, and a pair of hard steel rolls 19 and 20. The surface of roll 19 is provided with protruding V-shaped cutters having flattened edges. Rolls 19 and 20 are driven at equal peripheral speeds and spaced apart a predetermined distance to insure cutting of the filaments. The tension rolls 17 and 18 are driven at a peripheral speed slightly less than that of rolls 19 and 20 to tension the bundle. The cut fibers, in substantially parallel condition, and as a seemingly continuous structure or top, are guided downwardly over the surface of a

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guide 21 and are laid upon the surface of an endless foraminous conveyor belt 22 which passes around the driven pulleys 23 and 24. On belt 22 the top is treated, in substantially relaxed condition, with steam ejected from a spray head 25 supported above the surface of the belt, to effect crimping of the fibers. The top comprising the crimped fibers may be forwarded after leaving the belt 22, to further processing, or manipulating stages preliminary to spinning it into a yarn, or it may be converted directly to a spun yarn.

Referring to Figures 3 and 4, numeral 26 designates a bundle of the continuous regenerated cellulose filaments supplied from any suitable source (not shown) which passes through a guide 26a in its passage to a gill drafting frame. The frame comprises the usual retaining rolls which, in the form shown, comprise a driven roll 27 and a heavy or weighted floating roll 28 cooperating therewith. The drawing rolls comprise a driven roll 29 and a heavy or weighted floating roll 30 cooperating therewith. The drawing rolls 29 and 30 are driven so that the peripheral speed thereof is higher than the peripheral speed of the retaining rolls 27 and 28, so that the bundle is drafted. Intermediate the retaining rolls 27 and 28, and the drawing rolls 29, 30, there is provided a gill bed, generally designated 31. The gill bed comprises a plurality of gill bars 32, each of the gill bars being provided with a plurality of gill pins 33. As shown, each gill bar is provided with two rows of gill pins 33 arranged in staggered relation. The pins may be arranged in a different relation, if desired, such as parallel and either a single row or a plurality of rows of pins may be used. Each gill bar is provided with the usual boss 34, designed to engage a groove of high pitch spiral screw conveyor 35. It will be understood that there is also provided a pair of high pitch screws, similar to screws 35, in a plane beneath the plane occupied by the screws 35. Normally, the pitch of the lower pair of screws is higher than the pitch of screws 35, so that the gill bars may be transferred and elevated quickly to operative position. As is usual, the screws 35 are driven (by means not shown) to effect travel of the gill bars, during operative position, at a speed slightly in excess, usually about 10% higher, than the peripheral speed of the retaining rolls 27 and 28.

As shown in Figure 4, the gill bars are provided with a plurality of knives A to J inclusive, arranged in a triangular pattern. The spacing of the knives relative to each other determines the extent of the staggered relationship of the staple fibers, while the spacing of the correspondingly positioned knives A and A, B and B, etc. determines the length of the discontinuous or staple fibers. The length of the staple fibers and the degree of staggering also depend on the relative speeds of the retaining rolls 27, 28, the drafting rolls 29, 30, and the gill bed 31, which can be adjusted as desired.

In operation, as the bundle of untwisted or only slightly twisted continuous regenerated cellulose filaments 26 is fed from the retaining rolls 27 and 28, each of the knives on the faller bar, which is elevated into operative position, engages and severs the portion of the bundle which it contacts, the bundle being simultaneously drafted to produce a sliver. From the drawing rolls 29 and 30, the sliver comprising the cut fibers passes along the surface of a chute-like guide 36, and is laid upon the surface of an endless con-

veyor belt 37 which passes around the driven pulleys 38 and 39. Supported above the belt, adjacent the guide 36 is a spray head 40 through which steam is ejected to effect crimping of each of the fibers in the sliver. The fibers in the sliver leaving the belt are set in the crimped condition. The sliver is then ready for spinning into a yarn, either directly, or after compacting or condensing thereof, and with or without subjecting it to additional gillings.

Apparatus similar to that shown in Figures 1 to 4, inclusive may be utilized, also when the continuous filaments are formed from thermoplastic materials, except that in that case, instead of treating the bundle of discontinuous fibers with steam, a heating element is provided, either above or below the surface of the conveyor belt to effect heating of the fibers and conversion thereof to the crimped condition.

As a result of the independent conversion of each individual fiber to a crimped condition in situ in the top or sliver, the top or sliver produced in accordance with this invention is a coherent structure in which the individual fibers are crimped to an interlocked condition, and stabilized in that condition. The structure can be handled without loss of continuity thereof. This possibility of producing a coherent top or sliver directly from a bundle of continuous filaments greatly enhances the practicality of direct tow-to-top or tow-to-sliver conversion procedures, since in addition to the elimination of the usual carding and combing steps, by the present method, crimpiness of the fibers, after reduction of the continuous filaments, is assured up to and during at least the earlier stages of the yarn drafting operations.

The invention has the further advantage that since the top or sliver comprises fibers which are permanently and inherently reversibly convertible between a substantially straight uncrimped condition and a crimped condition, it is immaterial if the fibers in the final spun yarn are in substantially straight condition as a result of the severe drafting or "drawing down" to which the top or sliver is subjected during spinning of the yarn. If crimpiness of the fibers in the spun yarn and fullness or bulkiness of the yarn as a whole is desirable or necessary for any purpose, the fibers may be again converted to the crimped condition, in situ in the spun yarn, by subjecting the yarn, in relaxed condition, to the action of the plasticizing agent, and returning the fibers to the unplasticized state while the yarn is still relaxed.

Spun yarns produced in accordance with the invention and comprising the reversibly convertible fibers are well suited to the manufacture of fabrics characterized by a full, soft, luxurious hand or feel, and a persistent substantially permanently recoverable bulk and fullness resembling or simulating the properties of fabrics formed wholly from natural wool fibers. Such fabrics may be made by fabricating the spun yarns, as by weaving, knitting, netting, knotting, or braiding, in such manner as to produce an initial fabricated article of loose construction, and then treating the fabric, in relaxed condition, with a plasticizing agent for the reversibly convertible fibers, to effect independent crimping of each of the said fibers in situ in the fabric. As a result of the independent crimping of each of the individual fibers in the fabric, the fibers are well-opened, to provide numerous air spaces in the yarns, the yarns themselves being bulked up to fill the fabric interstices so that the yarns,

and the fabric as a whole, has a full bulky appearance. The fabric is set in the full, bulky condition by bringing the plasticized fibers to the unplasticized state while the fabric is relaxed.

The spun yarns may be treated to effect conversion of the fibers to the crimped condition, or to increase the crimpiness of the fibers, prior to their fabrication, and the fabricated article may be treated to restore any crimp lost as a result of passage of the yarns through the textile working machines, or the spun yarn may be loosely fabricated while the reversibly convertible fibers are in the substantially straight uncrimped condition, the fibers being converted to and set in the crimped condition after fabrication of the yarns.

It will be apparent that modifications and variations may be made in carrying out the procedures specifically illustrated herein without departing from the spirit and scope of the invention, and the invention is not to be limited, therefore, except as necessitated by the appended claims.

I claim:

1. The method of producing a bundle consisting entirely of substantially parallelized crimped discontinuous fibers suitable for spinning into a yarn, from a large total denier bundle of substantially parallelized continuous wet-spun straight regenerated cellulose filaments characterized by being reversibly convertible by plasticization and setting thereof between an inherent crimped condition obtainable by setting under relaxation, and a straight condition obtainable by setting under tension, in at most only slightly twisted condition, which comprises subjecting the bundle of continuous filaments to sufficient tension to break the filaments, after the filaments are withdrawn from the spinning bath and while they are still in the wet condition, thereby converting all of the filaments to substantially parallelized discontinuous fibers without disruption or loss of continuity of the bundle, relaxing the bundle of discontinuous fibers, and drying the fibers while the bundle is relaxed to thereby set the fibers in the bundle in crimped condition.

2. The method of claim 1, wherein the continuous filaments are crenulated filaments of not greater than 10 deniers per filament and each of which shows, in cross section, a thick skin constituting only a portion of the periphery of the filament, and another peripheral portion thereof having a skin of relatively thin to negligible thickness.

3. The method according to claim 1, wherein the continuous filaments are crenulated filaments of not greater than 10 deniers per filament and each of which shows, in cross section, a skin of substantially uniform thickness constituting the periphery of the filament but which is more highly serrated at one portion of the periphery of the filament than at remaining peripheral portions thereof.

4. The method according to claim 1, wherein each of the continuous filaments comprises two eccentrically arranged components derived from two different viscoses and joined by coalescence and extending side by side the length of the filament, each of said components having a portion of its peripheral surface disposed outside the periphery of the other component throughout the entire length of the filament.

5. The method of making a yarn consisting entirely of discontinuous fibers from a large total denier bundle of substantially parallelized con-

tinuous wet-spun straight regenerated cellulose filaments from viscose of not greater than 10 deniers per filament and characterized by being reversibly convertible by plasticization and setting thereof between an inherent crimped condition obtainable by setting under relaxation, and a straight condition obtainable by setting under tension, in at most only slightly twisted condition, which comprises subjecting the bundle of continuous filaments to sufficient tension to break the filaments, after the filaments are withdrawn from the spinning bath and while they are still in wet condition, thereby converting all of the filaments in the bundle to substantially parallelized discontinuous fibers without disruption or loss of continuity of the bundle, relaxing the bundle of discontinuous fibers, drying the fibers while the bundle is relaxed to thereby set the fibers in crimped condition, and subjecting the bundle of crimped discontinuous fibers to strong drafting to produce a spun yarn, the fibers in the bundle remaining in the crimped condition during at least the earlier stages of the drafting operations incidental to production of the spun yarn.

6. The method of claim 5, wherein the continuous filaments are crenulated filaments each of which shows, in cross section, a thick skin constituting only a portion of the periphery of the filament and another peripheral portion thereof having a skin of relatively thin to negligible thickness.

7. The method of claim 5, wherein the continuous filaments are crenulated filaments each of which shows, in cross section, a thick skin of substantially uniform thickness constituting the periphery of the filament but which is more highly serrated at one portion of the periphery of the filament than at remaining peripheral portions thereof.

8. The method of claim 5, wherein each of the continuous filaments comprises two eccentrically arranged components of regenerated cellulose from viscose joined by coalescence and extending side by side the length of the filament, each of said components having a portion of its peripheral surface disposed outside the periphery of the other components throughout the entire length of the filament, said components having different characteristics rendering the filament reversibly convertible by plasticization and setting thereof between an inherent crimped condition obtainable by setting under relaxation, and a straight condition obtainable by setting under tension.

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