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(72) Inventor GRAHAM THOMAS WATERS



(54) NOVEL CORE YARNS AND METHODS FOR THEIR MANUFACTURE

(71) We, IMPERIAL CHEMICAL INDUSTRIES LIMITED, of Imperial Chemical House, Millbank, London, S.W.1. a British Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention concerns novel core yarns and methods for their manufacture.

Core yarns may be produced in several ways, the main ones of which are that of core-spinning, in which a core component is introduced into a wrapping component during the drafting or spinning process, and core-texturing, in which the two (or more) components are fed together but under different tensions and/or rates to a texturing device, such as an air jet.

Core yarns provide the possibility of achieving surface effects in fabrics equivalent to those of the wrapping component, whilst the extension characteristics of the yarn during and after fabrication are determined by those of the core component. In this way, bulky or nubby surface effects can be achieved with yarns which are more tension stable (i.e. withstanding the tensions inherent in fabrication, e.g. by weaving, and in wear, when the fabric is utilized in clothing) than would be the case were the entire yarn to be made as the wrapping component is made.

Another way in which interesting surface effects can be produced in fabrics is by fancy doubling, where two or more yarns are plied together with twist, e.g., on an uptwister. This process is, however, an expensive one; and one of the objects of this invention is the production of a novel core yarn which simulates the more expensive fancy doubled type of yarn.

According to the invention, we provide a

novel well-integrated core yarn comprising a core component of set false twisted synthetic continuous filaments and at least one wrapping component of synthetic continuous filaments which are formed in helices, the directions of which helices reverse at intervals along the yarn, there being substantially no intermeshing between the filaments of the core component and the filaments of the wrapping component in the regions where the helices reverse.

Preferably, at least 95% by number of the intervals between helix reversals along the yarn are of length less than 2 cm and at least 50% by number of the intervals between helix reversals along the yarn are of length less than 0.5 cm.

The wrapping component of reversing helices may be only intermittently wrapped around the core component. We have designated such yarns as core yarns of low order.

The nature and thickness of the synthetic filaments of the wrapping component or components are such as to cause the helices of that component(s) to stand out proud of the core component, and to provide the surface texture which, after fabrication, simulates that of a fancy doubled yarn, despite the presence of the reversals of helix direction to be contrasted with the unidirection helix of a doubled yarn. Indeed, the uniformity of the surface texture with our core yarns of low order is dependent on the reversals of helix direction occurring at frequency intervals along the yarn.

The low order core yarns are fluffier than the high order ones, and, despite the intermittency of the wrapping, they are a well-integrated filamentary body.

Both the low and the high order composite, core yarns referred to in this specification have the alternating-direction helices of the wrap-

ping component formed with a substantially constant radius of the helix. There is substantially no intermeshing between the filaments of the core component and the filaments of the wrapping component in the regions where the helices reverse.

Again, in the low order yarn, there will be likely to be some filaments of the wrapping component, especially as there are a relatively large number of filaments in that component, which will stand proud of the main body of the component.

The core yarn of the invention can be homogeneous in the sense of the core and wrapping components being made of filaments of the same synthetic fibres, as for instance, polyhexamethyl adipamide (nylon 66) or polyethylene terephthalate. However, this is not essential; and dye variations and other effects may be better obtained if the components or filaments differ in respect of chemical character, or at least the wrapping components differ when there are more than one of them. Filaments may be all of circular cross-section; or some, for instance in the wrapping component(s), may be of non-circular cross-section, e.g. tri-lobal.

Although possessing a set false twisted, and hence extensible, core component, the core yarn of the invention exhibits no sharply defined yield point under load at a constant rate of extension and can be regarded as being sufficiently tension-stable for weaving into woven fabric in which the textured effect of the helical wrapping component or components is adequately maintained.

For instance, a core yarn comprising a core component of 30 denier/10 filament nylon 66 wrapped with a wrapping component of 20 denier/2 filament nylon 66 maintains approximately similar helical spacing of the wrapping component on the core at loads between 0.1 gram/denier and 1.0 gram/denier. In fact, the textured effect appears to be slightly enhanced by tensioning within this range.

The core yarn of the invention, owing to its false-twisted components, possesses torque; and hence it may be desirable for two such yarns of opposite torque to be doubled to balance the torques, or for a single such yarn to be submitted to a subsequent heat treatment to cause the decay of the torque, in order that the yarn may be readily usable for knitting or weaving.

According to the invention we also provide a process for making a core yarn comprising supplying at least two synthetic continuous filamentary components to in sequence a feed means, a heating zone and a false twisting element and withdrawing said filamentary components from said sequence under a higher tension than that under which the said components were supplied to said sequence the filamentary components differing as to their

extensibility under the stresses on entering the yarn section of increasing twist gradient.

By a feed means we include a positive feed system such as a nip roll or feed roll assembly and a free feed system such as a tensioning device. The filamentary components may be supplied to separate feed means.

Preferably the false twisting is combined with drawing, in order that the difference between the extensibilities of the filamentary components may be large.

When a feed yarn composed of two undrawn filamentary components having differing values of extension under a given stress is submitted to a combined drawing and false twist crimping process, then, in the false twisting zone, that is, upstream of the twisting element, the component of greater extensibility forms a unidirectional helix of substantially constant radius around the other component which is a twisted yarn in which filament migration occurs. Downstream of the twisting element, the wrapping is of alternating helix direction.

Most practically, such method involves the employment of undrawn filaments having differing natural draw ratios or differing birefringence values, e.g. differing by 3—5 units as measured, for instance, by a Berek compensator with a polarised microscope. Details of a method for so measuring birefringence are given in our British Patent Specification No. 762,190.

"Natural draw ratio" is defined as the ratio of the cross-sectional areas of the yarn immediately on opposite sides of the "neck" (or localised draw point) at which the yarn draws, "Natural draw ratio" is thus a characteristic of the yarn, not of the machine to which the mechanical draw ratio is applied, such latter ratio being the ratio of the linear speeds at which the yarn is supplied to and withdrawn from the zone in which drawing occurs.

It is possible to prepare the undrawn filamentary components with differing natural draw ratios or differing spun birefringences either by spinning them from differing polymer feed stocks, or by using a common polymer feed stock and varying spinning parameters such as the wind-up speed on the spinning machine or the size of holes in the spinnerets or the temperature thereof.

It is also within the scope of the invention that certain of the filaments shall themselves be of the conjugate type, say those of two constituents, in sheath-and-core or side-by-side arrangement, in which one constituent may be of a material having a higher extensibility than the other under a given stress.

According to this invention, it is possible to have a feed yarn in which the filaments are of but two different types having differing values of extension under the drawing stress. Equally, however, it is possible to employ a

feed yarn having filaments of more than two such types, whereby a wider spectrum of effects may be obtained.

Such varying extensibility of filaments can be usefully achieved by varying the spun birefringence of the filaments that are combined to form the feed yarn, such filaments being of homogeneous polymeric feed-stock. For instance, polymeric material for extrusion into filaments by melt-spinning can be split into two or more fractions prior to extrusion, and the required differential potential can be provided for by treating the fractions differently in regard to their extrusion conditions. One such method involves the injection of a degradant for the polymer into one or more of the stream fractions within the spinning pack.

Alternatively, the variability can be achieved by employing filaments of different materials which differ in regard to this characteristic.

Core yarns according to the invention may be processed from such heterogeneous filament bundles concurrently with their production, or as a separate step following on after the preparation of the heterogeneous filament bundles and their supply in the form, for instance, of wound packages of undrawn filaments.

In yet another method by which the said core yarns may be made, we employ undrawn filamentary components of the same or differing birefringence values, and positively feed them at the same or differing speeds to a false twisting device and withdraw them therefrom under a tension, such that drawing has occurred in the yarn section of increasing twist gradient and the several components are submitted to differing heat treatments prior to drawing taking place. Such differing heat treatments can be imparted by contacting the filamentary components with a heated surface or surfaces having portions at different temperatures, as for instance with a heated feed roll having portions of its peripheral surface heated from internally, e.g. by electric resistance heaters, at different temperatures.

This method of making the said core yarns is especially adapted to the invention when to be carried out with filamentary components of polyester material, as for instance polyethylene terephthalate filaments. In this latter method, the temperature of portions of a heated feed roll, or a plurality of heated feed rolls, can differ in the range between, say, 80° C and 95° C.

When a core yarn according to the invention is made by a method wherein false twisting and drawing are combined, the synthetic filaments of the wrapping components may, or may not, be completely drawn, although it is preferred that they should be. The filaments of the core component will, however, be at least substantially fully drawn.

It is possible, however, to produce useful

core yarns from filamentary components wherein at least some of the filaments are already in a drawn state, or in a partially drawn state, provided that they nevertheless differ as to their extensibility under the stress to which they will be submitted in the false twisting process.

It is within the scope of this invention to provide for other differences between the filaments than that of extension under a given stress. Thus, the filaments may also be of different deniers, having been extruded through spinneret holes of different sizes in one or more groups of the spinneret.

Preferably, owing mainly to the higher throughput which it allows, the false twist crimping machine has twisting elements of the friction type, by which the false twist is inserted by the direction action of rotating annular friction means on the yarns.

It is usually to be preferred to decay the torque of the composite, core yarns, either before or after wind-up after drawing. One reason for this is that, when a final denier yarn of say, only 70 denier is the one desired for the particular fabrics in mind, the desired bulky effect in the core yarn is better achieved with only two components, i.e. one component as core and one component as wrapping, rather than by using an initial four (smaller) components in two core yarns which are then plied in a manner to neutralize each other's torques. With but two components, however, it is, as stated above, usually desired to decay the torque necessarily induced in the false twisting process; and such may be achieved by imparting a limited degree of heating to the composite, core yarn on the way to the wind-up, or after having been wound on the wind-up package.

Such limited degree of heating "on the run" may be provided by contact with a heated surface, e.g. a roll or a curved plate. In certain circumstances, if desired, the draw roll may be heated to serve for this purpose. Alternatively, the limited degree of heating "on the run" may be provided by passage of the composite, core yarn through a heated fluid, such as steam in a steaming tube or a jet.

Heating on the wind-up package may likewise be in steam, in a dry heat atmosphere or in a heated dyebath.

In either case of limited heating, the composite, core yarn may be heat treated while under a controlled tension and temperature depending on the nature of the bulkiness desired.

The invention will now be described with reference to the accompanying drawings, in which:—

Figure 1 is a schematic representation of a core yarn of high order according to the present invention.

Figure 2 is a schematic representation of a

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core yarn of low order according to the present invention.

Figure 3 is a diagrammatic representation of one embodiment of the process of the invention.

Referring now to Figure 1, there is shown a core yarn of high order having a core component 1 and a wrapping component 3 composed of individual filaments 5 formed in helices and continuously wrapped around said core component. The direction of the helix of each filament 5 around the core reverses at points 7 and 9. The length of the interval between helix reversals 7 and 9 is denoted by 1.

Referring to Figure 2, there is shown a core yarn of low order having a core component 1 and a wrapping component 3 composed of individual filaments 5 formed in helices and intermittently wrapped around said core component. Reversals of helix direction of individual filaments are shown at points 11 and 13.

Referring to Figure 3, one embodiment of the process of the invention will now be described. Undrawn yarns 15 and 17, of differing birefringence values, are withdrawn from supply packages 16 and 18 by feed roll assembly 21, comprising a feed roll 23, a separator roll 25, and a nip roll 26, the undrawn yarns having been brought together at thread guide 19. From the feed roll assembly the yarns pass to a false twisting and drawing stage comprising a heater plate 27, a friction twisting element 29 and a draw roll assembly 31 comprising a draw roll 33 and a separator roll 35. On leaving the feed roll assembly 21, the yarns enter a section of increasing twist gradient due to the insertion of twist into the yarns by friction twisting element 29. The twist gradient reaches a maximum value on the heater plate 27. The draw roll is rotated at a given higher speed compared with the feed roll and drawing takes place on the heater plate 27. The yarns are subjected to stresses on entering the yarn section of increasing twist gradient due to the higher speed of the draw roll 33 compared with the feed roll 23 and the insertion of twist by friction twisting element 29. Since yarns have differing birefringence values they differ as to their extensibilities under the stresses on entering the yarn section of increasing twist gradient. In this section, that is, upstream of twisting element 29, the component of greater extensibility forms a unidirectional helix of substantially constant radius around the other component which is a twisted yarn in which filament migration occurs. Downstream of twist element 29, the core yarn produced has a set false twisted core and a wrapping component of alternating helix direction. From the draw roll assembly the core yarn passes to a heater plate 37 and thence

to a relax roll assembly 39 comprising a relax roll 41 and a separator roll 43.

The extent of relaxation achieved is governed by the temperature of heater plate 37 and the speed at which relax roll 41 is operated compared with draw roll 33. Increasing overfeed across the relax heater plate 37, that is decreasing the speed of relax roll 41 compared with the speed of draw roll 33, increases the order of the core yarn produced. Increasing the temperature of heater plate 37, decreases the order of the core yarn produced. From the relax roll assembly 39, the core yarn is passed to a conventional wind-up assembly (not shown) for orderly collection.

The following examples illustrate but do not limit our invention.

EXAMPLE 1

The core component comprised 84 denier/10 filament undrawn poly(hexamethylene adipamide) yarn of natural draw ratio 2.8 and the wrapping component comprised 75 denier/2 filament undrawn poly(hexamethylene adipamide) yarn of natural draw ratio 3.8.

The two undrawn yarn components were fed together by the feed roll of a positive-feed friction false twisting machines, the take-out (draw) roll of which was rotated at a given higher speed compared with the feed roll such as to draw the yarn components together whilst they were being false twisted, drawing occurring an inch or two along the length of a 2 foot long heater plate, maintained at 220° C and positioned between the feed roll and the annular false twisting device.

The linear speed of the composite yarn at the draw roll was 1000 feet/minute and the draw ratio 2.57.

The ratio of twisting device r.p.m. to throughput speed in feet/minute of the composite cored yarn was 9.

The tension of the yarn within the yarn length of increasing twist gradient was 30 g. The tension of the yarn on withdrawing from the false twisting device was 46g.

The core yarn so produced was of a high order. The wrapping component was formed in helices around the core component, the direction of which helices reversed at intervals along the yarn. At least 95% and 50% by number of the intervals between helix reversals along the yarn were of length less than 0.7 cm. and 0.3 cm. respectively.

EXAMPLE 2

An example of a low-ordered core yarn according to the invention comprises a polyamide yarn of heterogeneous filaments processed according to the following conditions:—

The undrawn yarn was 210 denier/20 filaments melt-spun from a spinneret containing two groups of 10 holes each. Through one such group standard filaments of polyhexa-

methylen adipamide were extruded such that the 10 filaments had a total denier of 90 and a natural draw ratio of 3. Through the other such group modified filaments of poly-hexamethylene adipamide were extruded such that the 10 filaments had a total denier of 120 and a natural draw ratio of 4, the modification consisting in that the polymer was of a kind which had been nucleated with calcium fluoride (of an average particle size of less than 0.5 microns diameter) in such manner that the mean maximum nucleant separation distance was given by the expression:—

$$S \leq 2 \int_0^{x_0} G dt.$$

Linear speed of yarn at draw roll	1,500 feet/minute
Heater length	2 feet
Heater temperature	220° C
Draw Ratio	2.71
S/V ratio	11

(where S is the r.p.m. of the twisting device and V is the speed of the yarn in feet/minute).

The tension of the yarn within the yarn length of increasing twist gradient was 40 g. The tension of the yarn on withdrawing from the false twisting device was 70 g.

EXAMPLE 3

The core component comprised 96 denier/10 filament undrawn poly(ethylene terephthalate) yarn of spun birefringence value 8×10^{-3} ; and the wrapping component comprised 96 denier/2 filament undrawn poly(ethylene terephthalate) yarn of spun birefringence value 5×10^{-3} .

The two component undrawn yarns were fed together by the feed roll of a positive-feed friction false twisting machine, the take-out (draw) roll of which was rotated at a given higher speed compared with the feed roll such as to draw the component yarns together whilst they were being false twisted, drawing occurring an inch or two along the length of a 2 foot long heater plate, positioned between the feed roll and the annular false twisting device, which plate was maintained at 187° C.

The linear speed of the composite yarn at the draw roll was 1000 feet/minute and the draw ratio 3.00.

The ratio of twisting device r.p.m. to throughput speed in feet/minute of the composite, cored yarn (S/V) was 9.

The bulked, cored yarn so produced was of a high order.

EXAMPLE 4

The core component comprised 96 denier/

where

G is the linear rate of crystallisation at a temperature T

S is the mean maximum nucleant separation distance and

XC is the distance of the solidification point from the spinneret for un-nucleated polymer when spun into filaments.

The yarn, in undrawn state, was used as the supply for a drawing and false twisting machine in which yarn was positively forwarded by a feed roll into a combined drawing and false twisting zone consisting in sequence of a heater, a friction false twisting device and a draw roll. The conditions of drawing and false twisting according to this example were:—

10 filament undrawn poly(ethylene terephthalate) yarn of spun birefringence value 8×10^{-3} and the wrapping component comprised 96 denier/10 filament undrawn poly(ethylene terephthalate) yarn of spun birefringence value 5×10^{-3} .

The two undrawn yarn components were fed together by the feed roll of a positive-feed friction false twisting machine, the draw roll of which was rotated at a given higher speed compared with the feed roll such as to draw the yarn components together whilst they were being false twisted, drawing occurring an inch or two along the length of an 18 inch long heater plate, maintained at 210° C. and positioned between the feed roll and the annular false twisting element.

The linear speed of the composite yarn at the draw roll was 1500 feet/minute and the draw ratio 2.80.

The ratio of twisting element r.p.m. to throughput speed at the draw roll in feet/minute of the core yarn was 9.5.

The yarn was then fed along an 18 inch long heater plate, maintained at 240° C, to a relax roll, the ratio of the draw roll speed: the relax roll speed being 1.0435:1.

The yarn so produced was a core yarn of low order.

The above example was repeated except that the ratio of the draw roll speed: the relax roll speed was 1.135:1.

The yarn so produced was a core yarn of higher order than that produced previously.

EXAMPLE 5

Both a single wrapping and the core components of the yarn were of filaments of poly-

hexamethylene adipamide and each was of 84 denier (undrawn)/10 filaments.

The two component yarns, when still in undrawn state, were fed together by the feed roll of a positive-feed friction false twisting machine, the take-out (draw) roll of which was rotated at a given higher speed compared with the feed roll such as to draw the component yarns together whilst they were being false twisted, drawing occurring an inch or two along the length of a 2 foot long heater plate positioned between the feed roll and the annular false twisting device, which plate was maintained at 210° C.

The feed roll of stepped form, providing peripheral surfaces of differing diameter and hence capable of forwarding the respective components at different speeds. In this case the wrapping component was fed by the higher diameter portion at a feed speed 18% greater than the core component.

The throughput speed, at the draw roll, was 1000 feet/minute; and the ratio of twisting device r.p.m. to throughput speed (S/V) was 9. The draw ratio was 2.85.

The core yarn so produced was of low order.

WHAT WE CLAIM IS:—

1. A well-integrated core yarn comprising a core component of set false twisted synthetic continuous filaments and at least one wrapping component of synthetic continuous filaments which are formed in helices, the directions of which helices reverse at intervals along the yarn, there being substantially in intermeshing between the filaments of the core component and the filaments of the wrapping component in the regions where the helices reverse.

2. A core yarn according to claim 1 in which at least 95% by number of the intervals between helix reversals along the yarn are of length less than 2 cm.

3. A core yarn according to either Claim 1 or Claim 2 in which at least 50% by number of the intervals between helix reversals along the yarn are of length less than 0.5 cm.

4. A core yarn according to any one of the preceding claims in which the wrapping component of reversing helices is intermittently wrapped around the core component.

5. A core yarn according to any one of the preceding claims in which at least some of the synthetic continuous filaments are of non-circular cross-section.

6. A core yarn according to any one of the preceding claims which contains filaments differing in respect of chemical character.

7. A core yarn according to any one of the preceding claims in which at least some of the synthetic continuous filaments are poly-(hexamethylene adipamide) filaments.

8. A core yarn according to any one of

the preceding claims in which at least some of the synthetic continuous filaments are poly-(ethylene terephthalate) filaments.

9. A core yarn according to any one of the preceding claims in which at least some of the synthetic continuous filaments are conjugate filaments.

10. A core yarn according to any one of the preceding claims which has been stabilised to decay torque.

11. A core yarn comprising core and wrapping components substantially as hereinbefore described.

12. A woven structure containing core yarns according to any one of the preceding claims.

13. A knitted structure containing core yarns according to any one of claims 1—11.

14. A process for making a core yarn according to any one of claims 1—9 comprising supplying at least two synthetic continuous filamentary components to in sequence a feed means, a heating zone and a false twisting element and withdrawing said filamentary components from said sequence under a higher tension than that under which the said components were supplied to said sequence the filamentary components differing as to their extensibility under the stresses on entering the yarn section of increasing twist gradient.

15. A process according to Claim 14 in which the filamentary components supplied to the sequence are in an undrawn state and the filamentary components are withdrawn from said sequence under a tension such that drawing has occurred in the yarn section of increasing twist gradient.

16. A process according to either claim 14 or claim 15 in which the filamentary components differ as to their birefringence values on entering the yarn section of increasing twist gradient.

17. A process according to any one of claims 14—16 in which the filamentary components differ as to their natural draw ratios on entering the yarn section of increasing twist gradient.

18. A process according to any one of claims 14—17 in which the filamentary components enter the yarn section of increasing twist gradient at different speeds.

19. A process according to any one of claims 14—18 in which the filamentary components are subjected to different heat treatments before entering the yarn section of increasing twist gradient.

20. A process according to any one of claims 14, 16, 18 or 19 in which at least one of the filamentary components supplied to the sequence contains filaments in a drawn state.

21. A process according to any one of claims 14, 16, 18 or 20 in which at least one of the filamentary components supplied to the sequence contains filaments in a partially drawn state.

hexamethylene adipamide and each was of 84 denier (undrawn)/10 filaments.

5 The two component yarns, when still in undrawn state, were fed together by the feed roll of a positive-feed friction false twisting machine, the take-out (draw) roll of which was rotated at a given higher speed compared with the feed roll such as to draw the component yarns together whilst they were being false twisted, drawing occurring an inch or 10 two along the length of a 2 foot long heater plate positioned between the feed roll and the annular false twisting device, which plate was maintained at 210° C.

15 The feed roll of stepped form, providing peripheral surfaces of differing diameter and hence capable of forwarding the respective components at different speeds. In this case the wrapping component was fed by the higher diameter portion at a feed speed 18% greater than the core component.

20 The throughput speed, at the draw roll, was 1000 feet/minute; and the ratio of twisting device r.p.m. to throughput speed (S/V) was 9. The draw ratio was 2.85.

The core yarn so produced was of low order.

WHAT WE CLAIM IS:—

30 1. A well-integrated core yarn comprising a core component of set false twisted synthetic continuous filaments and at least one wrapping component of synthetic continuous filaments which are formed in helices, the directions of which helices reverse at intervals along the yarn, there being substantially in intermeshing between the filaments of the core component and the filaments of the wrapping component in the regions where the helices reverse.

40 2. A core yarn according to claim 1 in which at least 95% by number of the intervals between helix reversals along the yarn are of length less than 2 cm.

45 3. A core yarn according to either Claim 1 or Claim 2 in which at least 50% by number of the intervals between helix reversals along the yarn are of length less than 0.5 cm.

50 4. A core yarn according to any one of the preceding claims in which the wrapping component of reversing helices is intermittently wrapped around the core component.

55 5. A core yarn according to any one of the preceding claims in which at least some of the synthetic continuous filaments are of non-circular cross-section.

6. A core yarn according to any one of the preceding claims which contains filaments differing in respect of chemical character.

60 7. A core yarn according to any one of the preceding claims in which at least some of the synthetic continuous filaments are poly-(hexamethylene adipamide) filaments.

8. A core yarn according to any one of

the preceding claims in which at least some of the synthetic continuous filaments are poly-(ethylene terephthalate) filaments.

9. A core yarn according to any one of the preceding claims in which at least some of the synthetic continuous filaments are conjugate filaments.

10. A core yarn according to any one of the preceding claims which has been stabilised to decay torque.

11. A core yarn comprising core and wrapping components substantially as hereinbefore described.

12. A woven structure containing core yarns according to any one of the preceding claims.

13. A knitted structure containing core yarns according to any one of claims 1—11.

14. A process for making a core yarn according to any one of claims 1—9 comprising supplying at least two synthetic continuous filamentary components to in sequence a feed means, a heating zone and a false twisting element and withdrawing said filamentary components from said sequence under a higher tension than that under which the said components were supplied to said sequence the filamentary components differing as to their extensibility under the stresses on entering the yarn section of increasing twist gradient.

15. A process according to Claim 14 in which the filamentary components supplied to the sequence are in an undrawn state and the filamentary components are withdrawn from said sequence under a tension such that drawing has occurred in the yarn section of increasing twist gradient.

16. A process according to either claim 14 or claim 15 in which the filamentary components differ as to their birefringence values on entering the yarn section of increasing twist gradient.

17. A process according to any one of claims 14—16 in which the filamentary components differ as to their natural draw ratios on entering the yarn section of increasing twist gradient.

18. A process according to any one of claims 14—17 in which the filamentary components enter the yarn section of increasing twist gradient at different speeds.

19. A process according to any one of claims 14—18 in which the filamentary components are subjected to different heat treatments before entering the yarn section of increasing twist gradient.

20. A process according to any one of claims 14, 16, 18 or 19 in which at least one of the filamentary components supplied to the sequence contains filaments in a drawn state.

21. A process according to any one of claims 14, 16, 18 or 20 in which at least one of the filamentary components supplied to the sequence contains filaments in a partially drawn state.



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22. A process according to any one of claims 14—21 in which the feed means comprises a roll assembly.

5 23. A process according to any one of claims 14, 18—21 in which the feed means comprises a tensioning device.

24. A process according to any one of claims 14—23 in which the false twisting element is of the friction type.

10 25. A process according to any one of

claims 14—24 in which the filamentary components are withdrawn and subsequently heat treated while under a controlled tension and temperature.

26. A process according to claim 14 and 15 substantially as hereinbefore described.

D. VINCENT,
Chartered Patent Agent.

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