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(54) **Spun-like yarn with variable denier filaments and process for making such a yarn.**

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Description

The invention relates to novel processes for making from a yarn consisting of essentially continuous filaments a yarn simulating one spun from staple fibers.

It is known to treat certain types of continuous filament yarns by various processes to produce yarns which simulate to some degree yarns spun from staple fibers. Typical prior art processes which break the filaments so as to leave the broken ends protruding from the yarn bundle are Heinrich U.S. patent 3,857,232; Cardinal U.S. patent 3,857,233; and Yasuzuka U.S. patent 3,967,441. Fairley British Specification 971,573 discloses a similar process wherein the broken filament ends are stated to be entangled within the yarn bundle, rather than protruding from the bundle. In each of these and other known processes wherein filaments are broken, the breakable filaments are substantially uniform from end to end. That is, there is made no provision for preferred locations of breakage along the breakable filaments, and hence, less control of breakage than might be desired.

According to the present invention, this and other difficulties in the prior art are avoided by using a feed yarn having preferred locations for breakage along the breakable filaments.

Negishi et al U.S. Patent 4,059,950 described non-uniform drawing a partially oriented filament yarn, at below the natural draw ratio and at a temperature high enough to initiate crystallisation, to produce a yarn having thick and thin portions wherein the thick portions are brittle. Subsequent draw-texturing causes the thick brittle portions to break so that the resulting yarn has protruding thick broken ends. Fabrics made from the yarn have a coarse "touch".

Nakgawa et al. U.S. Patent 4,084,622 describes a similar hot drawing process leading to filaments having thick and thin portions. Breakage of the thick portions occurs but is preferably avoided.

The present invention comprises a yarn bundle comprising a plurality of quasi-continuous filaments, each of the plurality of filaments having a non-round cross-sectional area which varies repetitively from small values in thin regions to large values in thick regions along its length, the large values being at least 25% greater than the small values, the thick and thin regions being out of phase from filament to filament along the length of the yarn, and the filaments being repeatedly broken primarily in the thin regions to provide broken ends protruding from the bundle.

The process of the invention is one for making a spun-like yarn, comprising melt spinning a feed yarn by contacting molten polymer streams extruded at different velocity, the feed yarn so produced comprising a plurality of continuous filaments, each of the filaments

having a non-round cross-sectional area which varies repetitively from small values in thin regions to large values in thick regions along its length, the large values being at least 25% greater than the small values and subsequently drawing the feed yarn at a draw ratio such that a plurality of the filaments are broken primarily in the thin regions.

The term "quasi-continuous" is intended to reflect the fact that the filaments are not continuous throughout the length of the yarn, being repeatedly broken in the way defined, yet they are longer than "staple fibres" and otherwise behave as continuous filaments do in forming the main structure of the yarn.

Preferably the filaments in the yarn bundle have alternating S and Z helical crimp along their lengths.

According to another aspect of the invention, the yarn is false-twisted while being drawn.

According to another aspect of the invention, the yarn is false-twisted and heat-set while being drawn.

According to another aspect of the invention, the average distance between consecutive thick portions along each of the filaments is between 2 centimeters and 20 meters, and preferably between 20 centimeters and 5 meters.

According to another aspect of the invention, the large area values are at least 100% greater than the small area values, and preferably are between 300% and 500% of the small area values.

Other aspect of the invention are in part set forth below and will in part be obvious from the following description taken in connection with the accompanying Drawings wherein:

Figure 1 is a vertical sectional view of the preferred embodiment of a spinneret usable to make the feed yarns according to the invention;

Figure 2 is a bottom plan view of the Figure 1 spinneret, looking up;

Figure 3 is a cross-sectional view of a filament according to certain aspects of the invention;

Figure 4 is a side elevation view of the molten streams issuing from the Figure 1 spinneret according to certain aspects of the invention;

Figure 5 is a graph illustrating the variation in denier along a representative filament according to certain aspects of the invention; and

Figure 6 is a graph illustrating the distribution of the fluctuations illustrated in Figure 4 for a representative multiple orifice spinneret according to certain aspects of the invention.

Preparation of Exemplary Feed Yarn

The feed yarn for the process invention will be specifically exemplified using polyester polymer, it being understood that certain aspects of the invention are applicable to the class of melt-spinnable polymers generally. "Polyester" as used herein means fiber-forming polymers at

least 85% by weight of which is formable by reacting a dihydric alcohol with terephthalic acid. Polyester typically is formed either by direct esterification of ethylene glycol with terephthalic acid, or by ester interchange between ethylene glycol and dimethylterephthalate.

FIGURES 1 and 2 illustrate the preferred embodiment of a spinneret design which can be employed for obtaining all aspects of the invention. The spinneret includes a large counterbore 20 formed in the upper surface 21 of spinneret plate 22. Small counterbore 24 is formed in the bottom of and at one side of large counterbore 20. A large capillary 26 extends from the bottom of large counterbore 20 at the side opposite small counterbore 24, and connects the bottom of large counterbore 20 with the lower surface 28 of plate 22. Small capillary 30 connects the bottom of counterbore 24 with surface 28. Capillaries 26 and 30 are each inclined four degrees from the vertical, and thus have an included angle of eight degrees. Counterbore 20 has a diameter of 0.113 inch (2.87 mm.), while counterbore 24 has a diameter of 0.052 inch (1.32 mm.). Capillary 26 has a diameter of 0.016 inch (0.396 mm.) and a length of 0.146 inch (3.81 mm.), while capillary 30 has a diameter of 0.009 inch (0.229 mm.) and a length of 0.032 inch (0.813 mm.). Land 32 separates capillaries 26 and 30 as they emerge at surface 28, and has a width of 0.0043 inch (0.108 mm.). Plate 22 has a thickness of 0.554 inch (14.07 mm.). Capillaries 26 and 30 together with counterbore 20 and 24 constitute a combined orifice for spinning various novel and useful filaments according to the invention, as will be more particularly described hereinafter.

As a specific example, molten polyester polymer of normal textile molecular weight is metered at a temperature of 290°C through a spinneret having 34 combined orifices as above specifically disclosed. The polymer throughput is adjusted to produce filaments of 8 average denier per filament at a spinning speed of 3400 yards per minute (3091 metres per minute), the molten streams being conventionally quenched into filaments by transversely directed quenching air.

Under these spinning conditions a remarkable phenomenon occurs, as illustrated in FIGURE 4. Due to the geometry of the spinneret construction, the polymer flowing through the smaller capillaries 30 has a higher velocity than that flowing through the larger capillaries. The speeds and momenta of the paired streams issuing from each combined orifice and the angle at which the streams converge outside the spinneret are such that the slower streams 34 travel in substantially straight lines after the points at which the paired streams first touch and attach, while each of the smaller and faster of the streams 36

forms sinuous loops back and forth between successive points of attachment 38 with its associated larger streams. This action can be readily observed using a stroboscopic light directed onto the streams immediately below the spinneret face 28. As the molten streams accelerate away from the spinneret, the slower stream attenuates between the points of attachment 38 and the loops of the faster stream become straightened until the faster stream is brought into continuous contact with the slower stream. The slower stream attenuates more between the points of first attachment than at the points of first attachment so that the resulting combined stream has a cross-section which is larger at the points of first attachment than in the regions between these points. The resulting combined stream is then further attenuated somewhat until it is solidified into a filament 40 by the transverse quench air.

Each solidified filament 40 has non-round cross-sectional areas which vary repetitively along its length. As illustrated qualitatively in FIGURE 5, when using the above spinning conditions, the filament cross-sectional area repetitively varies at a repetition rate of about one per meter, although this can be varied by modifying the spinning conditions and the geometry of the spinneret passages.

Due to minor differences between confined orifices, temperature gradations across the spinneret, and other like deviations from exactly the same treatment for each pair of streams, a multiple orifice spinneret will typically provide somewhat different repetition rates among the several resulting streams and filaments. An example of this is qualitatively shown in FIGURE 6, wherein is shown that various orifices produce somewhat different repetition rates as determined by stroboscopic examination of the combined streams just below the spinneret face. The repetition rate is proportional to the stroboscope frequency bringing about apparent cessation (or freezing) of movement of the thick and thin regions of the filament. A number of such frequencies are plotted along the horizontal axis of Figure 6, and on the vertical axis are plotted the number of orifices giving filaments wherein such freezing was observed, at each given stroboscope frequency. In the resulting multifilament yarn, each filament has a cross-sectional area which varies repetitively from small values in thin regions to large values in thick regions along its length, the large values being at least 25% greater than the small values. Improved spun-like effects in the ultimate textured yarn are obtained when the large values are at least 100% greater than the small values, with optimum results when the large values are between 300% and 500% of the small values.

An Exemplary Process of the Invention

The above feed yarn is simultaneously draw-textured on a Barmag FK-4 texturing machine,

using as the false-twist device a friction aggregate of the type disclosed in Yu U.S. Patent 3,973, 383. The draw ratio is set at 1.60 with a winding speed of 385 ypm (about 350 meters per minute). Both heaters are set at 200°C., with an overfeed to the second heater of 10.47% and an overfeed to the winder of 6.79%. The aggregate speed is set such that the yarn tensions just before and just after the aggregate are equal.

The resulting yarn has numerous filament breaks primarily in the thin regions, the broken ends protruding from the yarn bundle. The filaments are broken with considerably more control than those in the patents referred to above, and because of the variable denier, fabrics made from the resulting yarns have a much more soft and luxurious hand than those made from prior art yarns with the same average denier per filament. This softness of hand is particularly evident when the cross-sectional areas of the thick portions of the filaments are at least 100% greater than those of the thin portions, and values between 300% and 500% greater are particularly preferred.

Claims

1. A yarn bundle comprising a plurality of quasi-continuous filaments, each of the plurality of filaments having a non-round cross-sectional area which varies repetitively from small values in thin regions to large values in thick regions along its length, the large values being at least 25% greater than the small values, the thick and thin regions being out of phase from filament to filament along the length of the yarn, and the filaments being repeatedly broken primarily in the thin regions to provide broken ends protruding from the bundle.

2. A yarn bundle according to claim 1 in which the filaments have alternating S and Z helical crimp along their lengths.

3. A yarn bundle according to either Claim 1 or Claim 2, in which the average distance between consecutive thick regions along each of the filaments is between 2 centimeters and 20 meters.

4. A yarn bundle according to Claim 3, in which the said average distance is between 20 centimeters and 5 meters.

5. A yarn bundle according to any one of the preceding claims, in which the large values are at least 100% greater than the small values.

6. A yarn bundle according to any one of the preceding claims, in which the large values are between 300% and 500% of the small values.

7. A process for making a spun-like yarn, comprising melt spinning a feed yarn by contacting molten polymer streams extruded at different velocity, the feed yarn so produced comprising a plurality of continuous filaments, each of the filaments having a non-round cross-sectional area which varies repetitively from small values in thin regions to large values in

thick regions along its length, the large values being at least 25% greater than the small values, and subsequently drawing the feed yarn at a draw ratio such that a plurality of the filaments are broken primarily in the thin regions.

8. A process according to Claim 7, in which the yarn is false-twisted while the yarn is being drawn.

9. A process according to Claim 7, in which the yarn is false-twisted and heat-set while the yarn is being drawn.

10. A process according to any one of Claims 7 to 9, in which the large values are at least 100% greater than the small values.

11. A process according to Claim 10, in which the large values are between 300% and 500% of the small values.

Revendications

1. Faisceau pour fil comprenant un grand nombre de filaments quasi continus, chacun de ces filaments présentant une zone de section transversale non ronde qui varie de manière répétitive à partir de valeurs faibles dans des régions minces vers des valeurs élevées dans des régions épaisses dans le sens de sa longueur, les valeurs élevées étant supérieures d'au moins 25% aux valeurs faibles, les régions épaisses et minces étant décalées d'un filament à un autre dans le sens longitudinal du fil et les filaments étant rompus de manière répétée principalement dans les régions minces pour fournir des bouts rompus faissant saillie sur le faisceau.

2. Faisceau pour fil suivant la revendication 1, dans lequel les filaments présentent un crêpage hélicoïdal S et un crêpage hélicoïdal Z qui alternent dans le sens de leurs longueurs.

3. Faisceau pour fil suivant la revendication 1 ou 2, dans lequel la distance moyenne entre des régions épaisses successives le long de chacun des filaments est comprise entre 2 cm et 20 m.

4. Faisceau pour fil suivant la revendication 3, dans lequel la distance moyenne est comprise entre 20 cm et 5 m.

5. Faisceau pour fil suivant l'une quelconque des revendications précédentes, dans lequel les valeurs élevées sont supérieures d'au moins 100% aux valeurs faibles.

6. Faisceau pour fil suivant l'une quelconque des revendications précédentes, caractérisé en ce que les valeurs élevées sont supérieures de 300 à 500% aux valeurs faibles.

7. Procédé pour fabriquer un fil ressemblant à un filé, suivant lequel on file un fil d'alimentation à l'état fondu en amenant en contact des filets de polymère fondu extrudés à des vitesses différentes, le fil d'alimentation ainsi produit comprenant un grand nombre de filaments continus, chacun des filaments présentant une zone de section transversale non ronde qui varie de manière répétitive à partir de valeurs faibles situées dans des régions minces vers des valeurs élevées situées dans des régions

épaisses dans le sens de sa longueur, les valeurs élevées étant supérieures d'au moins 25% aux valeurs faibles et on étire ultérieurement le fil d'alimentation selon un rapport d'étirage tel que plusieurs filaments soient rompus principalement dans les régions minces.

8. Procédé suivant la revendication 7, dans lequel le fil est soumis à une fausse torsion pendant son étirage.

9. Procédé suivant la revendication 7, dans lequel le fil est soumis à une fausse torsion et à un thermofixage pendant son étirage.

10. Procédé suivant l'une quelconque des revendications 7 à 9, dans lequel les valeurs élevées sont supérieures d'au moins 100% aux valeurs faibles.

11. Procédé suivant la revendication 10, dans lequel les valeurs élevées sont supérieures de 300 à 500% aux valeurs faibles.

Patentansprüche

1. Garnbündel, bestehend aus einer Anzahl von quasikontinuierlichen Filamenten, wobei jedes der Filamente eine unrunde Querschnittsfläche aufweist, die sich entlang des Filaments wiederholt von kleinen Werten in dünnen Bereichen zu großen Werten in dicken Bereichen verändert, wobei die großen Werte mindestens 25% größer als die kleinen Werte sind, die dicken und dünnen Bereiche entlang des Garns von Filament zu Filament außer Phase sind und die Filamente wiederholt gebrochen sind, und zwar vorzugsweise in den dünnen Bereichen, derart, daß gebrochene Enden aus dem Bündel vorspringen.

2. Garnbündel nach Anspruch 1, bei welchem die Filamente entlang ihrer Länge eine alternierende schraubenförmige S- und Z-Kräuslung aufweisen.

3. Garnbündel nach Anspruch 1 oder 2, bei welchem der durchschnittliche Abstand zwischen aufeinanderfolgenden dicken Be-

reichen entlang eines jeden der Filamente zwischen 2 cm und 20 m liegt.

4. Garnbündel nach Anspruch 3, bei welchem der besagte durchschnittliche Abstand zwischen 20 cm und 5 m liegt.

5. Garnbündel nach einem der vorhergehenden Ansprüche, bei welchem die großen Werte mindestens 100% größer als die kleinen Werte sind.

6. Garnbündel nach einem der vorhergehenden Ansprüche, bei welchem die großen Werte zwischen 300 und 500% größer als die kleinen Werte sind.

7. Verfahren zur Herstellung eines Garns, das einem gesponnenen Garn ähnelt, bei welchem ein Beschickungsgarn durch Zusammenführen von mit unterschiedlicher Geschwindigkeit extrudierten geschmolzenen Polymerströmen schmelzgesponnen wird, wobei das so hergestellte Beschickungsgarn eine Anzahl kontinuierlicher Filamente aufweist, von denen jedes eine unrunde Querschnittsfläche aufweist, die sich entlang des Filaments wiederholt von kleinen Werten in dünnen Bereichen zu großen Werten in dicken Bereichen verändert, wobei die großen Werte mindestens 25% größer als die kleinen Werte sind, worauf das Beschickungsgarn mit einem solchen Verstreckverhältnis verstreckt wird, daß eine Anzahl der Filamente gebrochen wird, und zwar vorzugsweise in den dünnen Bereichen.

8. Verfahren nach Anspruch 7, bei welchem das Garn während des Verstreckens falschgezwirnt wird.

9. Verfahren nach Anspruch 7, bei welchem das Garn während des Verstreckens falschgezwirnt und wärmefixiert wird.

10. Verfahren nach einem der Ansprüche 7 bis 9, bei welchem die großen Werte mindestens 100% größer als die kleinen Werte sind.

11. Verfahren nach Anspruch 10, bei welchem die großen Werte zwischen 300 und 500% größer als die kleinen Werte sind.

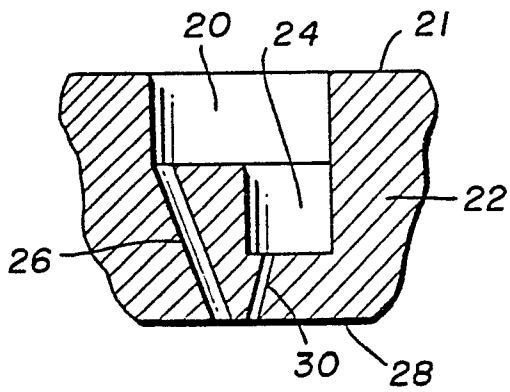


FIG. 1.

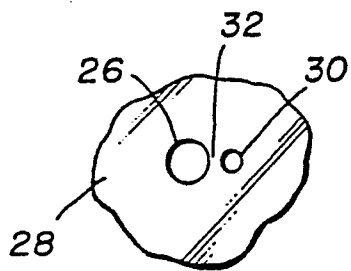


FIG. 2.

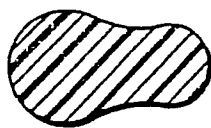


FIG. 3.

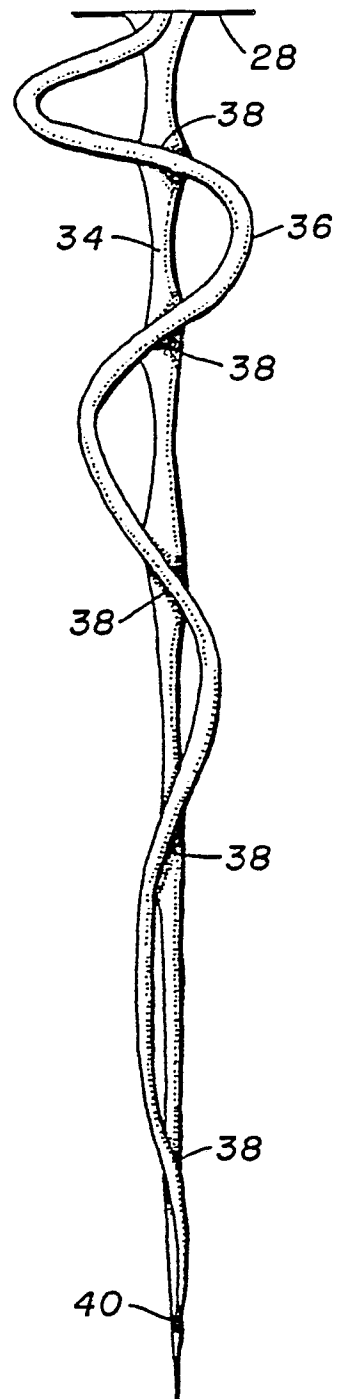


FIG. 4.

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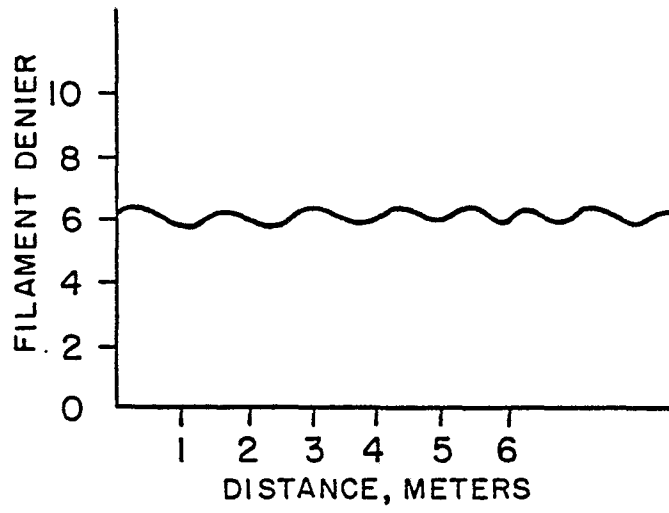


FIG. 5.

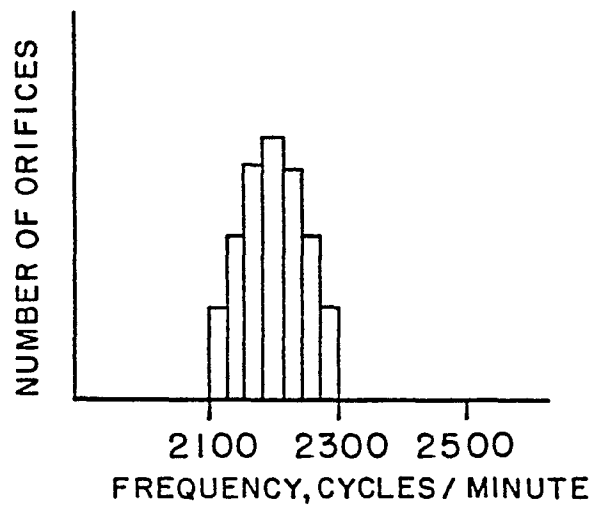


FIG. 6.