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COMPOSITE STRETCH YARN AND FABRIC AND PROCESSES OF PRODUCING SAME

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This invention relates to a new type of composite stretch yarn and to a procedure for producing same and to textile products manufactured from the composite stretch yarn. More particularly, this invention is concerned with composite stretch yarns having as one component a multifilament, thermoplastic, heat set, torque, stretch yarn, plied with a spun staple yarn that has been twisted in the same direction as the torque in the thermoplastic continuous filament yarn, so that this spun yarn will not be permitted to untwist and it will counteract the torque in the thermoplastic yarn.

By using a thermoplastic, heat set, stretch yarn with a torque opposite to the torque of the spun yarn it is possible to ply the two yarns together in the same direction as the twist in the spun yarn and thus add strength to the spun yarn by giving it additional twist, whereas the normal composite yarns in order to be balanced or torque free are plied opposite to the direction of the spun yarn twist and thus the spun yarn is untwisted and weakened. Also, the continuous filament yarn and the spun yarn having final opposite torques, the untwist tendency of one counteracts that of the other and renders the composite yarn stable and substantially free of the original untwisting tendencies of these two yarns before they are plied together.

In the composite yarn of this invention, the twisted spun yarn, which has a tendency to untwist but is not "wild" or "lively," offsets or counteracts the wild or lively tendency of the twisted, heat set thermoplastic stretch yarn, but without disturbing the "stretch" properties of that yarn. The composite yarn formed by plying these two different yarns can be knit without difficulty and the knitted fabric will possess the so-called stretch property. In other words, the fabric produced from this composite yarn will have substantial stretchability that will render it suitable for the manufacture of men's stretch socks or other stretch garments.

The spun staple yarn that forms one component of the composite yarn of this invention as above described, may be a cellulosic yarn such as cotton yarn, or an animal fiber yarn such as wool, or a synthetic staple fiber such as Orlon or nylon. This spun yarn, in addition to controlling the torque in the twisted heat set thermoplastic stretch yarn, also serves the purpose of imparting a soft feel or "hand" to the composite yarn which property cannot be obtained from the thermoplastic yarn alone. In addition, the natural fiber spun yarn, such as cotton yarn, has the desired property of absorbing perspiration which is not possessed by the heat set thermoplastic synthetic yarn.

The heat set thermoplastic synthetic stretch yarn may be any suitable yarn of this character, such as, for example, nylon, Dacron (condensation polymer of ethylene glycol with terephthalic acid) or Orlon (polyacrylonitrile). In accordance with the present invention these synthetic yarns, which are to provide the stretch property in the composite yarn, are in continuous filament form

and are capable of being heat set, that is, the yarns may be heated, after uptwisting and before back-twisting, to an elevated temperature sufficient to "set" the twist in the yarn. A yarn so treated has a tendency to twist or torque in the direction in which it was originally twisted and heat set, that is, it tends to return to the position it was in when heat set. Thus, the torque in these heat set thermoplastic stretch yarns is in the same direction in which the yarns have been originally twisted.

The heat set thermoplastic stretch yarn component of the composite yarn of this invention may be either a single end or two or more ends. For example, this yarn may consist of a single end of twisted heat set nylon stretch yarn, or it may be a two ply twisted heat set nylon stretch yarn. The two ply yarn would consist of two ends of nylon stretch yarn, each of which has been twisted individually in the same direction, e.g., a Z twist, then heat set and untwisted. When these two nylon stretch yarn ends are plied together to form a two ply yarn construction, the resulting yarn is a lively stretchable yarn. This two ply yarn may then be plied or twisted with the staple spun yarn above mentioned to form the composite yarn of this invention.

The spun yarn component of the composite yarn of this invention is not a continuous filament yarn, but instead is a yarn spun (twisted) from cut staple fiber. This spun yarn may be twisted to the left to form a Z twist, with a resulting right torque, or it may be twisted to the right to form an S twist with a resulting left torque. Usually, only one spun yarn end is desired but two or more such yarn ends might be used and they could be plied together.

Where two or more ends of the heat set thermoplastic stretch yarn are used and are individually twisted in the same direction, as above described, e.g., twisted in the Z direction, and then plied in the Z direction, the plied yarn will have a Z torque for the reason that the yarn ends tend to go back to the state in which they existed at the time of heat setting.

If the twisted staple spun yarn has been twisted in the Z direction, the thermoplastic stretch yarn which has a Z torque may be plied with the spun yarn also in a Z direction.

Although these two different type yarns have been twisted and plied in the same direction, namely Z direction, they will tend to offset or counteract each other in the final composite yarn. The reason for this is that the non-heat-set staple spun yarn will tend to untwist in the direction opposite to its twist, that is, the S direction, whereas the heat set thermoplastic stretch yarn will tend to untwist in a Z direction corresponding to the twist present at the time the yarn was heat set. Since the two components of this composite yarn tend to untwist in opposite directions, one of the yarns will offset the other so that the spun yarn will not be permitted to untwist and will therefore not lose its strength. At the same time, the spun yarn will prevent the thermoplastic heat set yarn from twisting or kinking, and will thereby restrain its liveliness but will not adversely affect the stretch properties of this heat set yarn.

When the above described composite yarn is used to knit a fabric or garment, such as men's socks, it will impart stretchable properties to the fabric or garment and adequate strength since the stretch properties of the heat set thermoplastic stretch yarn and the strength of the non-heat set spun yarn have each been fully maintained.

Also, since the torque tendencies of both yarn components of this composite yarn have been restrained, the fabric or garment knitted therefrom will be stable or balanced and will not have any tendency to distort or "spiral," which occurs when the twist of the spun yarn

is not properly balanced or offset by the torque of the continuous filament yarn.

A commercially advantageous example of the composite stretch yarn of this invention is a 2-ply multifilament nylon yarn in which the two ends have been twisted individually in the same direction, e.g., Z twist, and these two ends plied together in the Z direction to produce a lively, stretch yarn, and this two-end plied nylon yarn in turn plied in the Z direction with a cotton yarn that has been twisted a suitable number of turns Z twist to give it the desired strength. Thus, this type of composite yarn which I have found very useful in the knitting of men's stretchable socks and other stretchable fabrics, might typically consist of two nylon yarn ends and one cotton yarn end each individually twisted a sufficient number of turns in a Z direction and plied in a Z direction.

The thermoplastic heat settable continuous filament torque stretch yarn for use in the composite yarn of this invention will usually be nylon yarn because of its availability, high strength, good heat settable properties, and relatively low cost. Other continuous filament thermoplastic heat settable yarns, which are suitable for use in the composite yarn of this invention include the following:

"Dacron" ---------- (a condensation polymer of ethylene glycol with terephthalic acid).

"Orlon" ---------- (an acrylonitrile polymer).

For the spun staple fiber yarn component of the composite yarn of this invention, cotton yarn is a logical first choice, in view of its availability, low cost, soft warm feel, and high perspiration absorbency. Other suitable spun yarns comprise wool, "Orlon," "Dacron," rayon, linen, ramie, silk, "nylon," "dynel," alpaca, cashmere, mohair and camels hair.

The nylon or other continuous filament yarn component should be of the multifilament type, so as to make this yarn component truly stretchable. The two ends of nylon yarns twisted as above described, and plied together with a few turns twist, to provide the continuous filament yarn component of the composite yarn of this invention, will be twisted sufficiently to produce a coiled structure in each of the yarn ends, and thereby render the yarns stretchable or capable of substantial elongation.

The staple fiber spun yarn component of the composite yarn of this invention, e.g., spun cotton, wool, "Orlon," etc., yarn will not be a stretchable yarn, like the nylon yarn, and is used in the composite yarn to provide soft feel, perspiration absorbency, etc. This yarn component will be twisted a number of turns in one direction, without any heat setting, and would normally tend to untwist in the direction opposite to that of the twist imparted. This undesired untwisting is prevented in the composite yarn by the torque of the thermoplastic heat set stretch yarn, as above described.

Wide variations in sizes, number of turns twist and processing conditions are permissible in preparing the composite yarn. For example, the denier of the multifilament thermoplastic continuous filament nylon or similar yarn may vary from about 40 denier to 400 denier. Similarly, the size of the spun yarn component, e.g., cotton yarn and other fibres spun on the cotton spinning system may vary from approximately 6's single to 100's single, or in the case of wool yarn and other fibres spun on the woolen system from approximately single 16 to single 200; or the same relative sizes in other numbering systems.

To obtain the desired stretchable properties imparted by the nylon or similar thermoplastic stretch yarn, and the desired soft feel and other properties imparted by the cotton or other spun yarn, these two components of the composite yarn may vary substantially in amount or

proportion so long as the composite yarn has a sufficient amount of the thermoplastic stretch yarn to impart worthwhile stretchable properties to the composite yarn, and so long as the cotton or other spun yarn component is present in a sufficient amount to provide worthwhile softness, etc. properties. For these purposes, the proportions of the two components should usually come within the range of about 20% to 80% of the thermoplastic continuous filament stretch yarn and the complement, i.e., 80% to 20% of the spun yarn.

The nylon or other thermoplastic yarn component may be prepared acording to conventional practices and involving usually twisting of separate nylon yarn ends to about 50 or more turns per inch, heating the twisted yarn to set the twist, and then reverse twisting the yarn in the opposite direction approximately the same number of turns as the original twist. When a two-ply thermoplastic yarn is to be used, the two ends of nylon yarn prepared as above could then be plied in a conventional manner with a few turns plying twist applied in the same direction as the individual ends were twisted when heat set, such as, for example, three to five turns, sufficient to combine the two yarn ends and to form a plied stretchable yarn, or the two single nylon yarns prepared as above could be plied directly with the spun yarn.

For preparation of the spun yarn component, such as, for example, cotton, the yarn may be spun on conventional cotton spinning equipment and twisted a suitable number of turns such as for example, about 13 to 16 turns twist per inch to hold the spun fibers together and give the yarn necessary strength. The usual direction for twisting cotton yarn in this manner is the Z direction so that the resulting yarn has a Z twist. Where desired, however, the cotton or other spun yarn could be twisted is an S direction so that the resulting twisted yarn would have an S twist.

Depending upon the twist direction of the spun yarn component, whether S or Z, the stretch nylon yarn should be plied with the twisted spun yarn in the same direction in which the spun yarn was twisted so that this plying twist would not tend to untwist the spun yarn.

The following are illustrative but non-limiting examples of the composite yarn of the present invention:

Example 1

Two ends of 70 denier 34 filament raw nylon yarn are separately twisted 65 turns per inch Z twist, heat set and backtwisted, S twist, 65 turns per inch. The resulting two stretch nylon yarns, which will have a Z torque, are plied together with approximately 1½ turns per inch Z twist to produce a plied coiled stretchable yarn. One end of 36's single combed cotton yarn is twisted approximately 18 turns per inch Z twist and this twisted yarn is then plied with two previously plied nylon stretch yarns, using two turns per inch of Z twist in the plying operation. The resulting yarn is stable since the torque in the nylon yarn is in the Z direction and is opposite to and off-sets the torque of the cotton yarn, which being originally twisted in the Z direction, tends to untwist or torque in the S direction.

Example 2

Two ends of 70 denier 34 filament nylon stretch yarn, each of which has been twisted 75 turns per inch Z twist, heat set and backtwisted 78 turns per inch, are plied together about 3 turns per inch in a Z direction to produce a coiled, stretchable yarn. An end of 20's single combed cotton yarn having about 14 turns per inch Z twist is plied with the resulting stretch yarn. In the final plying operation, 3 turns per inch of Z twist are imparted.

Example 3

A two-ply yarn consisting of two ends of 100 denier 34 filament nylon yarn, which have been separately twisted 65 turns per inch Z, heat set, and backtwisted 68 turns per inch S, and plied together 3 turns per inch Z, is plied with

an end of 20's single combed cotton yarn having a Z twist of 14 turns per inch. In the plying operation, three turns per inch of Z twist are imparted.

With regard to the number of turns twist used in the individual yarn components as well as in the final composite yarn, this invention contemplates, for example, the use of stretch yarns which have been produced on the well-known false twist spindle arrangement and in which no residual turns twist remain in the yarn; that is, the yarn is backtwisted the same or substantially the same number of turns which it is originally uptwisted. It is understood that this type of yarn may nevertheless contain about ½ turn twist, beyond the zero point, because of this amount of twist having been originally imparted to the yarn by the yarn producers and which is commonly known as producers' twist.

It is common practice to ply two yarn ends, each of which has been oppositely twisted and which have their final twists in opposite directions, i.e., S and Z. Upon plying, these two oppositely twisted yarns, which will have opposite torques, a balanced, coiled, stretchable plied yarn will be obtained. Examples of well-known yarns of this type are those sold under the trade names of "Superloft" and "Fluflon." The thermoplastic yarn of the present invention, whether single or multiple ply, is twisted in one direction and is itself not balanced. It is a lively yarn, which by itself would tend to kink or snarl when in a relaxed position, and if used alone it would make an unstable fabric which will spiral or twist out of shape. When it is plied with the spun yarn of opposite torque the resulting plied composite yarn is balanced and may be knitted without kinking or snarling, and fabric made from this yarn is not distorted.

A somewhat different type of stretch yarn which may also be used in accordance with this invention is one having definitely a greater number of turns twist in one direction than in the opposite direction, and therefore an appreciable number of turns residual twist in the yarn. A yarn of this type, for example, may be uptwisted approximately 65 turns in one direction, heat set, and then backtwisted approximately 68 turns, giving a residual twist of approximately 3 turns in the stretch yarn. This stretchable yarn may be plied with a similar end of stretch yarn twisted in the same manner.

The spun yarn component, e.g., cotton, may range in size from about 6's single to about 100's, or from 12's/2 to about 200's/2, and normally about 12's single to about 80's single. This yarn may be used as purchased, or may be twisted further before plying with the twisted thermoplastic yarn. Normally, cotton knitting yarns, as spun, will have a twist ranging from about 9 or 10 turns per inch for a 12's single yarn, to about 30 turns per inch for an 80's single yarn, or about 35 turns per inch for a 100's single yarn, whereas the twist in cotton warp yarns is generally slightly higher.

This invention has been described above in detail for illustrative purposes only and is not intended to be limited by this description or otherwise, except as defined in the appended claims.

I claim:

1. A process of producing a balanced composite yarn comprising twisting at least one continuous multifilament thermoplastic yarn, heat-setting said thermoplastic yarn and then twisting the thermoplastic yarn in the reverse direction to impart a torque thereto in the direction of original twist, twisting at least one end of a staple yarn a relatively few number of turns in the same direction as the original twist in said thermoplastic yarn to impart a torque to said staple yarn so that the torque in the staple yarn will be substantially equal to but in the direction opposite to the torque in the thermoplastic yarn when the yarns are plied, and plying said thermoplastic yarn with the staple yarn in the direction of the twist in said staple yarn.

2. A process of producing a balanced composite yarn comprising twisting at least one continuous multifilament thermoplastic yarn, heat-setting said twisted thermoplastic yarn and then twisting the thermoplastic yarn in the reverse direction approximately the same number of turns twist to impart a torque thereto in the direction of original twist, twisting at least one end of a staple spun yarn a relatively few number of turns in the same direction as the original twist in the thermoplastic yarn to impart a torque to said spun yarn so that the torque in the staple yarn will be substantialy equal to but in the direction opposite to the torque in the thermoplastic yarn when the yarns are plied, and plying said thermoplastic yarn with the spun yarn a relatively few number of turns in the direction of the twist in said spun yarn.

3. The process of producing a balanced composite yarn as set out in claim 1 wherein the thermoplastic yarn is a plied yarn.

4. The process of producing a balanced composite yarn as set out in claim 1 wherein the thermoplastic yarn is a nylon yarn.

5. The process of producing a balanced composite yarn as set out in claim 1 wherein the staple yarn is a spun cotton yarn.

6. The process of producing a balanced composite yarn as set out in claim 1 wherein the staple yarn is a spun wool yarn.

7. The process of producing a balanced composite yarn as set out in claim 1 wherein the staple yarn is an acrylonitrile polymer yarn.

8. A balanced composite yarn comprising at least one continuous multifilament thermoplastic yarn having a torque in one direction, at least one end of a staple yarn having a relatively few turns twist in said one direction so that the torque in the staple yarn is substantially equal to but in the direction opposite to the torque in the thermoplastic yarn, and said thermoplastic yarn and said staple yarn being plied together with the plying twist being in the same direction as the twist in said staple yarn, said thermoplastic yarn having approximately no twist except for the plying twist.

9. A fabric produced from a balanced composite yarn according to claim 8.

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