Dec. 3, 1968 M. H. COMER ETAL 3,413,796

THERMOPLASTIC STRETCH YARN AND METHOD OF FORMING SAME

Filed July 14, 1966 2 Sheets-Sheet 1

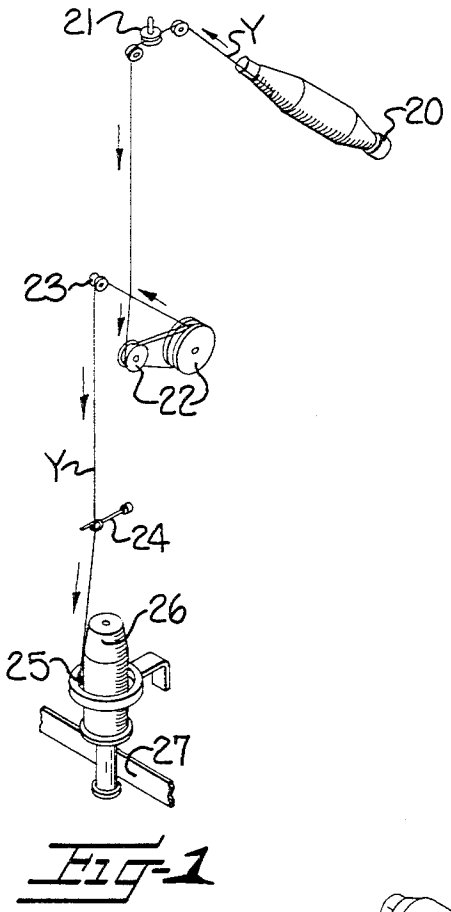


Fig-1

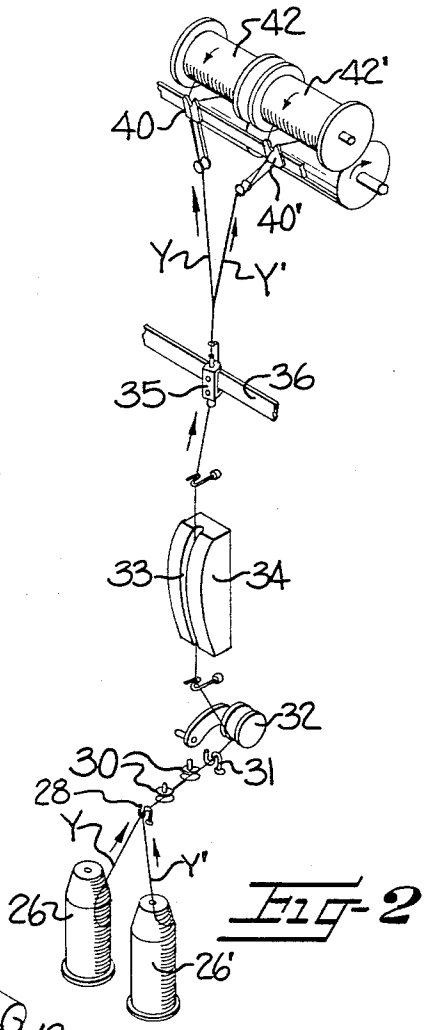


Fig-2

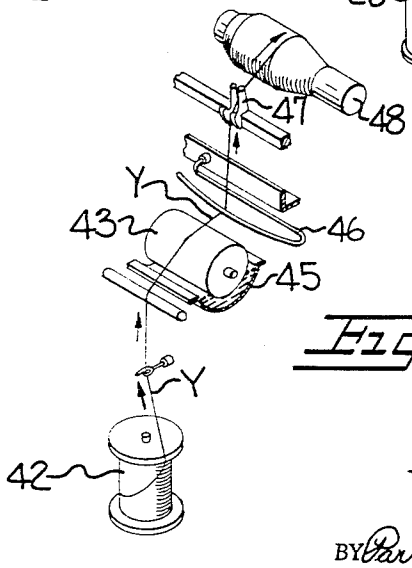


Fig-3

INVENTORS:
MARVIN H. COMER and
JAMES ROBERT McCRACKEN

BY Parrott, Bell, Seltzer, Park & Heard

ATTORNEYS

Dec. 3, 1968 M. H. COMER ET AL 3,413,796

THERMOPLASTIC STRETCH YARN AND METHOD OF FORMING SAME

Filed July 14, 1966 2 Sheets-Sheet 2

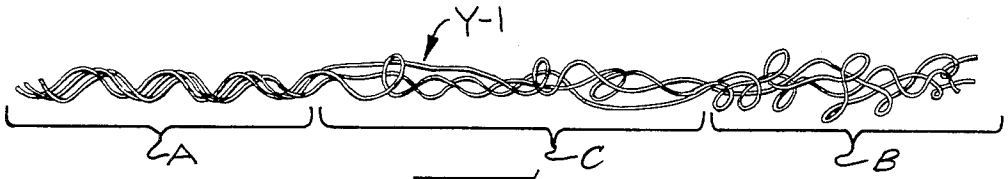


Fig. 4

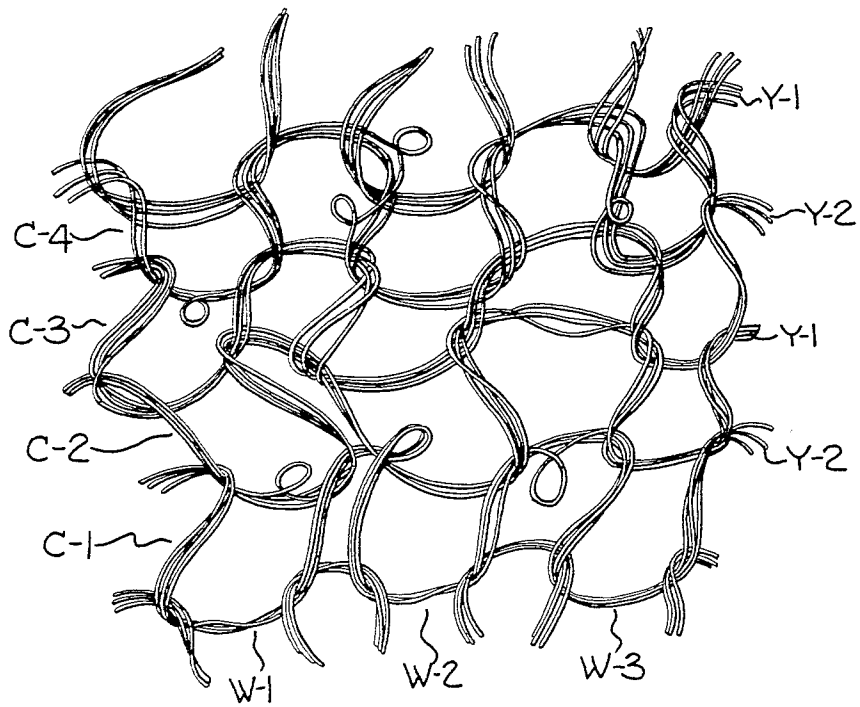


Fig. 5

INVENTORS:
MARVIN H. COMER and
JAMES ROBERT McCRACKEN

BY Parrott, Bell, Seltzer, Park & Heard

ATTORNEYS

United States Patent Office 3,413,796
Patented Dec. 3, 1968

3,413,796

THERMOPLASTIC STRETCH YARN AND METHOD OF FORMING SAME

Marvin H. Comer, Burlington, and James Robert McCracken, Graham, N.C., assignors to Alamance Industries, Inc., Burlington, N.C., a corporation of North Carolina

Filed July 14, 1966, Ser. No. 565,213
9 Claims. (Cl. 57—140)

ABSTRACT OF THE DISCLOSURE

A thermoplastic stretchable yarn suitable for the knitting of ladies' sheer hosiery and a method of forming the yarn which includes joining together pairs of the fine denier yarns (10 to 20 denier and having 2 to 10 filaments), false-twisting them with a high range of turns (75 to 120 turns per inch), and then separating the yarns and taking them up on separate take-up packages. The resulting stretchable yarn contains certain of the characteristics of a non-torque stretch yarn as well as certain of the characteristics of a torque stretch yarn.

This invention relates generally to a thermoplastic stretch yarn which is suitable for use in knitting sheer elastic fabric, such as ladies' sheer stockings and the like.

It is well known to knit ladies' sheer stretchable stockings of fine denier thermoplastic "stretch" yarn so that the stockings have sufficient elastic characteristics to fit a range of leg and foot sizes. Low denier thermoplastic "stretch" yarns suitable for knitting ladies' stockings are usually one or the other of two general types, one being known as a "torque" yarn and the other being known as a "nontorque" yarn.

The "torque" type stretch yarns are usually formed by either a false twisting operation or by a twisting, heat setting and untwisting procedure to impart substantial liveliness to the yarn so that when it is relaxed it will twist upon itself. This lively torque yarn has no inherent stretchability or elasticity, but when knit into a fabric, usually in alternating courses of opposite torque, the stitch loops distort and twist upon themselves so that they are inclined in a direction corresponding to the torque in the yarn, when the fabric is relaxed. When the fabric is stretched, the stitch loops are straightened and they have a strong tendency to return to the distorted condition so that the fabric has substantial elastic characteristics. This type of stretch "torque" yarn has been widely used in the knitting of ladies' sheer stockings and the distortion of the stitches in opposite directions in adjacent courses imparts a "herringbone" appearance to the stockings. An example of this type stretch "torque" yarn and a stretch stocking knit therefrom are described in detail in U.S. Patent No. 2,771,759.

The "nontorque" type stretch yarns have been produced by different processes so that when the yarn is relaxed it develops a series of small, closely spaced, substantially uniform, spring-like helical coils or curls and the rotational direction of the coils periodically changes to balance the overall torque of the yarn. This type of yarn has been produced by passing the same over a heated blade at a relatively sharp angle. The manner in which this type yarn is produced is described in detail in U.S. Patent No. 2,919,534. This type of nontorque stretch yarn has also been produced by joining together ends of thermoplastic yarn and simultaneously false twisting the joined together yarns in one direction and then again false twisting the joined together yarns in the opposite direction before separating the yarns. The details of this double false twisting process and the yarn produced thereby are described in U.S. Patent No. 3,162,995.

These "nontorque" type stretch yarns may be knit into a sheer ladies' stocking in a single feed manner and during finishing of the stocking, the curl or coil in the yarn is developed to a limited degree. When heat is applied to the stocking the yarn tries to assume the coiled condition but the interconnected stitch loop formation of the fabric limits the amount of curling which can take place so that the yarns of each stitch loop are distorted in a random manner to produce a "crepe" appearance in the stocking and provide stretchability thereto.

Thus, in sheer fabrics, such as ladies' stockings, knit of "torque" stretch yarns, the elasticity of the fabric is obtained by the substantially uniform distortion or inclination of the stitch loops, due to the lively nature of the yarn. In sheer ladies' stockings knit of "nontorque" stretch yarns, the elasticity of the fabric is obtained by the irregular distortion of the yarn in each of the stitch loops, as the yarn attempts to form the curls or coils therein.

Sheer stockings knit of low denier multifilament "nontorque" stretch yarns have been found to be highly susceptible to picks or pulls. This high susceptability to picks in this type of stocking is believed to be caused by the fact that the individual filaments of the yarn distort in an irregular manner so that they separate or "bloom" and some of the curls of the individual filaments extend or protrude outwardly from the fabric, where they may be easily picked and pulled.

With the foregoing in mind, it is an object of the present invention to provide a thermoplastic multifilament stretch yarn and method of forming the same wherein the yarn has the desirable characteristics of both a torque stretch yarn and a nontorque stretch yarn. The present yarn is particularly suitable for the knitting of sheer fabrics, such as ladies' stockings, and these stockings do not have the distinct herringbone pattern of torque yarn stockings. The stockings knit of the present yarn have a higher degree of pick resistance than stockings knit of the known types of nontorque stretch yarns.

It is a further object of the present invention to provide an economical method of forming the thermoplastic stretch yarn of the present invention. Generally, the present method includes imparting a low degree of twist to a multifilament thermoplastic yarn, simultaneously false twisting a joined together pair of the twisted yarns, and then separating the false twisted yarns.

The fact that the yarn of the present invention includes certain of the characteristics of both a "torque" stretch yarn and a "nontorque" stretch yarn provides advantages in each step of the formation of the yarn, in the knitting of the stockings, and in the stockings knit therefrom. For example, the yarn of the present invention has sufficient torque that it must be knit with yarns of opposite torque in alternating courses to provide overall balance in the stocking. However, the torque in the present yarn is not as great as the amount of torque in the conventional type of "torque" stretch yarn so that the present yarn may be handled more easily during the processing step, as well as in the knitting of the stockings.

In a sheer stocking knit of the stretch yarn of the present invention, the stretch characteristics are obtained by a combination of the inclined distoration of the stitch loops and by the distortion or curling of the yarn in each stitch. Thus, the stocking knit of the present yarn has certain of the characteristics of stockings knit with lively torque stretch yarn and certain of the characteristics of stockings knit with nontorque stretch yarn but does not have the disadvantages of stockings knit of either of these known types of stretch yarns.

The yarn of the present invention is preferably of a low denier, within the range of 10 to 20 denier, and has a

relatively low number of individual filaments therein from 2 to 10 filaments. Genarally, the yarn of the present invention is formed by initially imparting twist to the multifilament yarn, within the range of about 2 to 10 turns per inch. Two ends of this twisted yarn are joined together and simultaneously false twisted within the range of about 75 to 120 turns per inch while heat setting the false twist imparted thereto, and then the two yarns are separated and taken up on separate bobbins. Oppositely false twisted yarns are then knit in alternate courses of at least the leg of the stocking to provide overall balance of the torque in the stocking.

Some of the objects of the invention having been stated, other objects will appear as the description proceeds when taken in connection with the accompanying drawings in which:

FIGURE 1 is a somewhat schematic isometric view of one station of a twister frame and illustrating the manner in which the twist is initially imparted to the multifilament yarn in the first step of the method;

FIGURE 2 is a somewhat schematic illustration of one station of a false twisting machine and illustrating the manner in which two ends of the twisted yarn are joined together and simultaneously false twisted, then separated and taken up on separate bobbins;

FIGURE 3 schematically illustrates the machine for winding the false twisted yarn onto a suitable package for knitting and wherein a lubricating material may be applied to the yarn during this winding operation;

FIGURE 4 is a greatly enlarged fragmentary view of a portion of the yarn of the present invention, illustrating the manner in which the individual filaments of a three-filament yarn assume various configurations along the length of the yarn, the yarn being in a partially relaxed condition; and

FIGURE 5 is a greatly enlarged fragmentary portion of a knit fabric formed of the yarn of the present invention, the fabric being stretched a sufficient amount in both walewise and coursewise directions to show the interconnection of the stitch loops.

Referring to the drawings, FIGURE 1 schematically illustrates one type of apparatus that may be used to initially impart twist to the yarn in the first operation. The apparatus is illustrated as one section of a conventional downtwister with the yarn Y being withdrawn from a yarn supply pirn **20**. The pirn **20** is of the type on which the yarn is shipped by the yarn manufacturer and is suitably supported on the machine. The yarn Y passes over yarn guides and through suitable tension discs **21** after it is withdrawn from the pirn **20**. The yarn is then wrapped around positive feed wheels **22** and is directed downwardly by a guide roller **23**. The yarn Y passes through a suitable guide eye **24** and then through the usual traveler supported on a ring **25** as it is wound upon a take-up package **26**. The ring **25** traverses up and down to wind the yarn onto the take-up package **26**, in a well known manner. The take-up package **26** is rotated at the desired speed by any suitable means, such as a drive belt **27** so that the yarn is wound onto the take-up package **26** with a predetermined amount of twist imparted thereto.

In the second step (FIGURE 2) the twisted yarn Y is withdrawn from the package **26** while a second yarn Y', twisted the same amount and in the same direction, is withdrawn from a package **26'** and both yarns Y and Y' are passed through and simultaneously false twisted on a false twist machine, which may be of the type known as the Model 551 Superloft machine manufactured by Leesona Corporation. The pair of yarns Y and Y' pass upwardly and over a guide **28** where they are joined together and guided through suitable tension discs **30**. The yarns then pass beneath a yarn guide **31** and are then wound around a driven feed roll **32**, the joined together yarns Y and Y' are guided through a yarn receiving groove **33** in a heater block **34**.

From the heater block **34**, the joined together yarns pass upwardly through a false twist spindle **35** which is rotated by means of a belt **36**. The belt **36** is driven at the speed required to impart the desired number of turns of false twist to the joined together yarns as they pass therethrough. As the yarns leave the false twist spindle, they are separated or split-out and individually directed by yarn traversing guides **40**, **40'** onto separate take-up bobbins or spools **42**, **42'**. In order to obtain satisfactory results, it is necessary to thread up the false twist machine and separate the false twisted yarns Y and Y' in a particular manner, to be presently described.

The yarns on the take-up bobbins **42**, **42'** are in condition for knitting at this point; however, it is preferred that the yarn be rewound from the take-up spools **42**, **42'** onto a package more suitable for knitting. This is carried out on a conventional winding machine of the type shown in FIGURE 3 wherein the yarn Y is withdrawn from the spool **42**, passes over a lubricant-applying roll **43** which rotates in a trough **45** filled with a light weight oil to be applied to the yarn to aid in knitting. The yarn Y then passes through a guide wire member **46** and upwardly through a traversing guide block **47** and is wound onto a suitable tube or pirn **48** which is subsequently used as a supply bobbin on the knitting machine. The yarn Y is preferably wound onto the bobbin **48** in a conventional manner so that it may be easily withdrawn therefrom as it is fed to a circular knitting machine.

In order to insure the proper separtion of the yarns Y and Y' after they leave the false twist spindle (FIGURE 2) and to control the amount of twist trapped so that the ends do not break, special procedures must be followed in threading up the yarns in this false twisting step. When beginning the false twist step both yarn ends Y and Y' are initially wound onto the same take-up bobbin. With the yarn running and after the false twist spindle has reached full speed, one of the ends is separated from the other and started around the other take-up bobbin. As the yarns Y and Y' are feeding onto their respective take-up bobbins **42**, **42'**, the split-out or separation point remains fairly constant at a point just above the upper end of the false twist spindle **35**.

It has been found that a very satisfactory sheer seamless stretch stocking can be knit of a low denier thermoplastic multifilament yarn processed in accordance with the present invention. As a specific but nonlimiting example, a 15 denier type 6 nylon yarn having 3 filaments has been processed in the following specifically described manner and then knit to form seamless stretch stockings. This yarn is supplied by the manufacturer with approximately one-fourth of a turn per inch of twist in a Z direction. In the first step (FIGURE 1) the twister is set up so that 3½ turns S twist are imparted to a first bath of the yarn and 3½ turns Z twist are imparted to a second batch of the yarn. The machine is set up to account for the one-fourth turn Z twist in the yarn as received, so that in the first batch of yarn 3¾ turns S twist are imparted to the yarn. In the second batch of yarn 3¼ turns Z twist are imparted to the yarn.

In the second step (FIGURE 2) two packages **26**, **26'** of the 3½ turns Z twist yarn are processed together on the false twist machine and pass together through the same false twist spindle. The false twist spindle **35** is rotated at a speed of 147,000 revolutions per minute to impart 95 turns per inch of false twist thereto in an S direction. While the running yarns Y and Y' are being simultaneously false twisted, the heater block temperature is maintained at 405° F. and the yarn is run with zero percent overfeed. It is preferred that the pretension on the yarn be approximately 5 grams and that the take-up tension on the separated yarn end be about 9 to 13 grams as they are wound onto the bobbins **42**, **42'**.

The resulting stretch yarn has a definite torque, such that it will twist upon itself when fully relaxed. In order to obtain another similar yarn, having torque in the oppo-

site direction, two ends of 3½ turns S twist yarn are processed through the false twist machine (FIGURE 2), under the same conditions as the first yarn except that the false twist spindle 35 is rotated in the opposite direction to apply a Z false twist thereto.

As previously noted, the yarn of the present invention (FIGURE 4) has certain of the characteristics of a torque stretch yarn and certain of the characteristics of a nontorque stretch yarn. The yarn, indicated at Y–1 in FIGURE 4, includes certain randomly disposed sections, such as indicated at A in FIGURE 4, where all three of the filaments follow substantially the same coiled path of travel, having substantially the appearance of a coiled spring. This section A has much the same appearance and characteristics as a nontorque stretch yarn of the type normally produced by passing the yarn over a heated blade.

Other sections of the yarn, as indicated at B in FIGURE 4, appear to have substantial torque or liveliness in each of the filaments so that when the yarn is partially relaxed, the filaments independently loop and curl upon themselves in a random manner. This section B has much the same appearance and characteristics as torque stretch yarn of the type normally produced by highly twisting or false twisting a multifilament yarn having a relatively low number of filaments.

Still other sections of the yarn appear to have certain characteristics of a torque stretch yarn and certain characteristics of a nontorque stretch yarn combined in the same section. As illustrated at the section indicated at C in FIGURE 4, portions of some of the filaments appear to have a lively nature and a tendency to curl and kink upon themselves while corresponding portions of the other filaments have a coiled configuration, and portions of certain filaments appear to be devoid of any crimp or liveliness.

The sections A–C of FIGURE 4 do not recur in any determinable repeated pattern and are not usually of equal length. The major portion of the length of the yarn is made up of sections such as B and C where the filaments form curls and coils or loops which are out of phase with those of adjacent filaments, when the yarn is substantially relaxed. When the yarn is stretched, the curls, coils and loops straighten out so that the yarn has a completely straight appearance with the straight filaments twisted together. As soon as the longitudinal tension on the yarn is relaxed, the curls, coils and loops are again formed in the yarn.

When the yarns of the present invention, having opposite torque therein, are knit in alternating courses, such as indicated in FIGURE 5, a sheer stretchable stocking is produced which has a somewhat pebbled or creped bulky appearance when in relaxed condition. However, when the stocking is drawn on the leg, the fabric is stretched and the distorted stitch loops and yarns will substantially straighten out and the stitches assume their normal shape, thereby presenting a sheer appearance when worn on the leg. The fabric shown in FIGURE 5 is in a partially relaxed condition to illustrate the manner in which the yarns of oppôsite torque, indicated at Y–1 and Y–2, cause a distortion of the stitch loops as well as a distortion of the individual filaments of each yarn. When the fabric is stretched, as when being worn, the filaments are in close contact and the yarn assumes a substantially round shape with twist therein.

To aid in a discussion of the portion of fabric shown in FIGURE 5, the courses have been numbered C–1 through C–4 and the wales have been numbered W–1 through W–3. The yarn Y–1 is knit in alternating courses C–2 and C–4 while the yarn Y–2 is knit in the intervening courses C–1 and C–3, and the yarns Y–1 and Y–2 have opposite torque, as evidenced by the opposite inclination or angular position of certain of the stitch loops in adjacent course knit of these two yarns. The alternate knitting of the opposite torque yarns may be most efficiently carried out on a two feed machine wherein both feeds are in operation during the leg of the stocking and one of the yarns is fed at one of the knitting stations while the other yarn is fed at the other knitting station so that two courses are formed with each rotation of the needle cylinder, in a well known and conventional manner.

In addition to the distortion illustrated in FIGURE 5, the stitch loops are also distorted in planes at right angles to the paper; i.e., so that certain of the yarns shown in FIGURE 5 are closer to the observer and protrude outwardly from the fabric, while other yarns are positioned further away from the observer and protrude inwardly of the fabric. Although all of the stitch loops are initially drawn the same length by the needles, they assume different sizes in the knit fabric and contribute to the creped or pebbled appearance of the fabric. For example, in wale W–3 of courses C–2 and C–3, the stitch loops are smaller than the corresponding stitch loops in wale W–2 and the sinker loops therebetween are distorted and greatly enlarged. In certain of the stitch loops, the individual filaments tend to separate and appear to be trying to assume a curled or coiled condition while the filaments in other stitch loops are twisted together. As is most readily apparent in wales W–1 and W–2 in courses C–1 and C–2, certain of the stitch loops are twisted and incline at an angle, corresponding to the direction of the torque in the yarns.

In order to provide some relative comparison of size, the coils in section A of FIGURE 4 are about 1/64 of an inch in diameter when a 15/3 yarn is processed as specifically described above. When this yarn is knit into a stocking, the length of the stitch loops (FIGURE 5) ranges from about 1/64 of an inch to 3/64 of an inch.

The stockings knit of the present yarn may be subjected to the usual finishing operation which may include preboarding, dyeing, secouring and then final-boarding. The heat setting of the stocking during the boarding operation tends to remove a certain amount of the curl or coil present in the greige stocking, since the stocking is maintained under some tension and in a slightly stretched condition on the boarding form. However, the stocking still has sufficient stretch to fit a range of foot and leg sizes.

In the drawings and specification, there has been set forth a preferred embodiment of the invention, and although specific terms are employed, they are used in a generic and descriptive sense only and not for purposes of limitation, the scope of the invention being defined in the claims.

We claim:

1. A thermoplastic stretchable yarn suitable for the knitting of sheer fabrics such as hosiery and the like and including certain of the characteristics of a nontorque stretch yarn as well as certain of the characteristics of a torque stretch yarn, said yarn being within the range of from 10 to 20 denier and being composed of from 2 to 10 filaments, and the partially relaxed yarn comprising randomly recurring:
   (a) sections wherein all the filaments remain in substantially side-by-side relation and form small closely spaced, substantialy uniform, spring-like helical coils,
   (b) sections wherein the individual filaments each have sufficient lively torque that they loop and twist upon themselves in out-of-phase relationship to adjacent filaments, and
   (c) sections wherein certain of the filaments form said spring-like helical coils while other filaments loop and twist upon themselves.

2. A yarn according to claim 1 wherein the filaments are twisted about each other within the range of from 2 to 10 turns per inch.

3. A yarn according to claim 1 having a total denier of 15, consisting of 3 filaments, and being nylon.

4. A method of processing a thermoplastic multifilament yarn to produce a stretchable yarn suitable for the

knitting of sheer fabrics such as hosiery and the like, said yarn having a total denier in the range of from 10 to 20, including from 2 to 10 filaments, said method comprising the steps of:

(a) separately twisting first and second ends of the thermoplastic yarn within the range of from 2 to 10 turns per inch,

(b) drawing the first and second twisted yarns from separate yarn supply sources and joining them together,

(c) simultaneously false twisting the joined together yarns within the range of from 75 to 120 turns per inch while heat setting the yarns, and

(d) separating the two false twisted yarns and taking up the separated yarns on separate bobbins.

5. A method according to claim **4** wherein the yarns are separately twisted in the same direction in step (a).

6. A method according to claim **5** wherein the joined together yarns are simultaneously false twisted in step (c) in a direction opposite the direction of individual twist applied in step (a).

7. A method according to claim **6** wherein the total denier of the yarn is 15, the number of filaments is 3, the individual twist applied in step (a) is 3½ turns per inch, and the false twist applied in step (c) is 95 turns per inch.

8. A method of simultaneously false twisting a pair of joined together thermoplastic multifilament yarns to produce stretchable yarns therefrom, said method comprising the steps of:

(a) drawing first and second multifilament yarns from separate yarn supply sources and joining them together,

(b) passing the joined together yarns through a heat setting zone,

(c) simultaneously false twisting the joined together yarns,

(d) initially feeding the false twisted and joined together yarns onto a single take-up bobbin, and

(e) separating one of the joined together false twisted yarns initially being fed to the take-up bobbin and feeding it to a separate take-up bobbin.

9. A method according to claim **8** including the step of separately twisting the two yarns prior to joining them together.

References Cited

UNITED STATES PATENTS

2,111,209	3/1938	Dreyfus.	
2,483,455	10/1949	Camp	57—157
2,890,568	6/1959	Willens	57—157
2,906,001	9/1959	Stuewer et al.	57—157 XR
2,963,848	12/1960	Finlayson et al.	57—157 XR
3,069,838	12/1962	Wallays	57—157

FOREIGN PATENTS

791,610	3/1958	Great Britain.
817,768	8/1959	Great Britain.

FRANK J. COHEN, *Primary Examiner.*

W. H. SCHROEDER, *Assistant Examiner.*