Jan. 28, 1969 M. H. COMER ET AL 3,423,924

METHOD OF FALSE-TWISTING THERMOPLASTIC YARN

Filed Nov. 20, 1967 Sheet 1 of 2

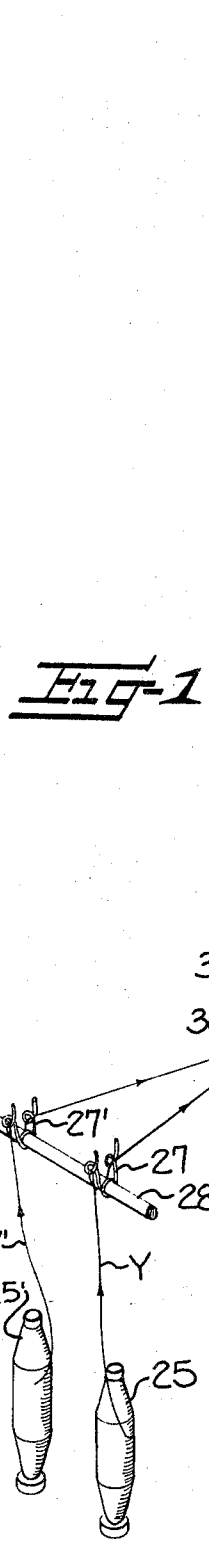


Fig-1

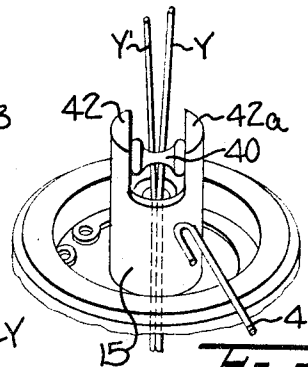


Fig-2

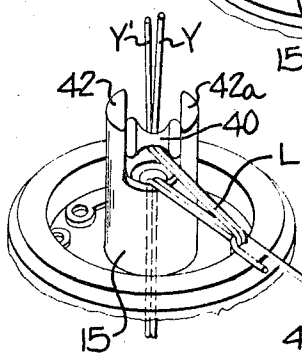


Fig-3

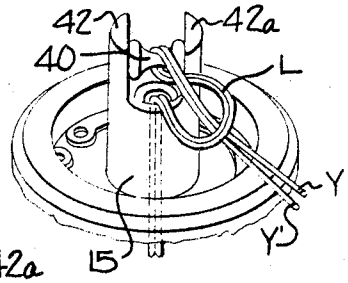


Fig-4

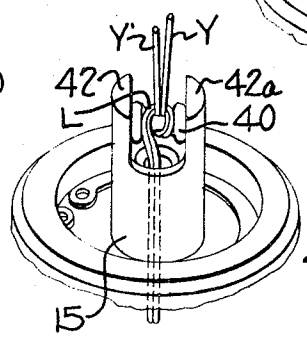


Fig-5

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METHOD OF FALSE-TWISTING THERMOPLASTIC YARN

Filed Nov. 20, 1967 Sheet 2 of 2

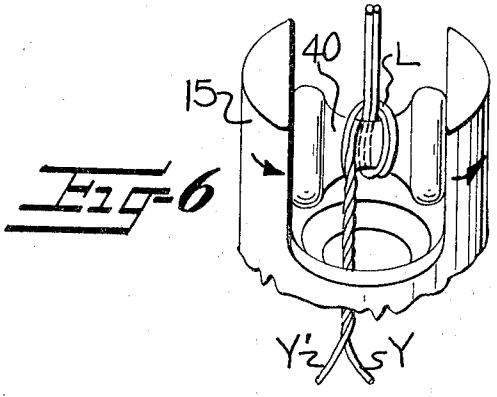


Fig-6

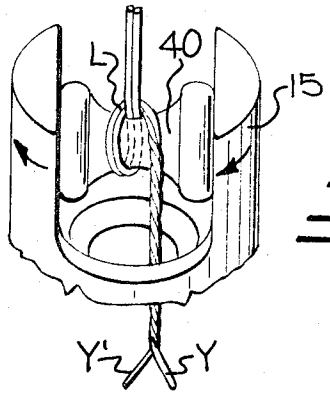


Fig-7

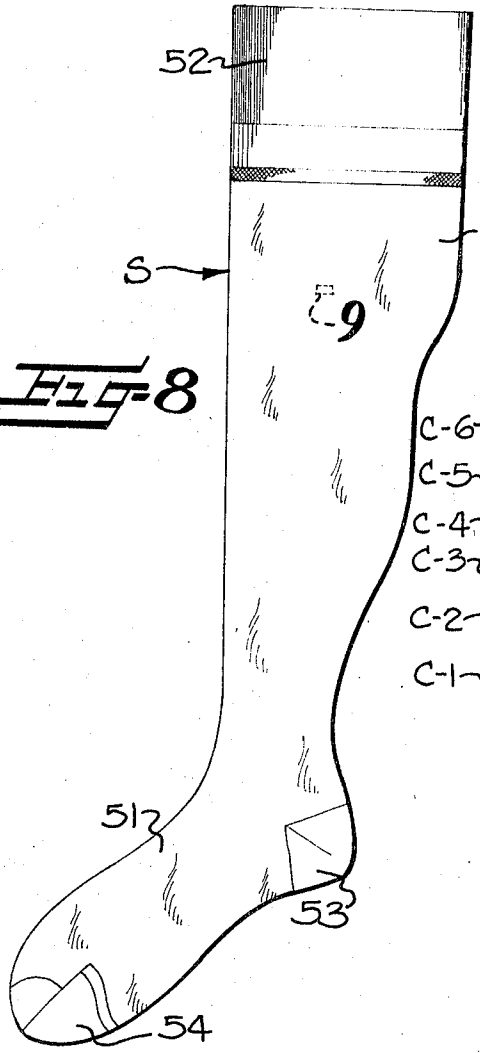


Fig-8

Fig-9

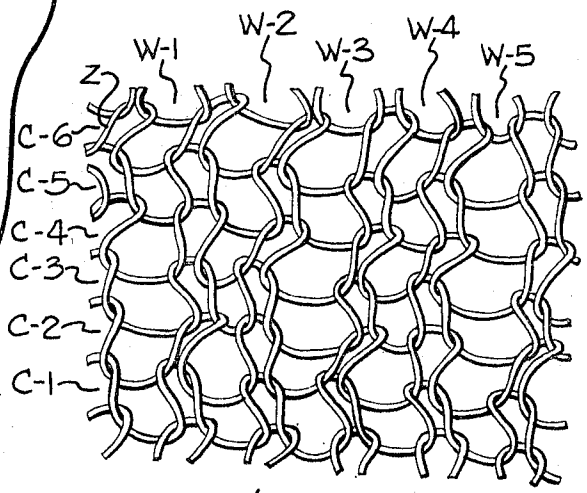


Fig-9

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3,423,924

METHOD OF FALSE-TWISTING THERMOPLASTIC YARN

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U.S. Cl. 57—157 11 Claims
Int. Cl. D02g 3/02; D01h 13/26, 7/46

ABSTRACT OF THE DISCLOSURE

Thermoplastic yarn is threaded about the exit pin of a false-twist spindle in a novel manner whereby the yarn rubs across and about itself to impart latent torsional stresses and torque to the yarn, and to provide an effective twist trap, thereby preventing twist from passing from one side to the other of the exit pin. When pairs of joined together thermoplastic yarns are simultaneously false-twisted and threaded about the exit pin in this manner, the individual yarns have sufficient torque characteristics and latent stresses imparted thereto that a fabric knit of this yarn, such as ladies' sheer hosiery, has a high degree of stretchability and a very uniformly crimped appearance when relaxed.

This invention relates generally to a method of processing thermoplastic yarn on a false-twist machine and more particularly to a novel method of threading the yarn around the exit pin of a false-twist spindle to impart latent torsional stresses and torque to the yarn, and to provide an efficient twist trap.

In the texturizing of thermoplastic yarn by the false-twist method, a single yarn end is usually withdrawn from a supply bobbin, passed through a heated zone, through a rotating false-twist spindle, passed around the exit pin with a single 360 degree wrap, and is then wound onto a take-up bobbin. Twist is set in the yarn in the heating zone below the false-twist spindle and the yarn is untwisted above the false-twist spindle. The yarn then has a strong tendency to return to the twisted condition in which it was heat-set.

When a high denier yarn having a relatively large number of individual filaments is false-twisted in the manner described above, the resulting yarn is known as a "stretch" yarn. In this stretch yarn the individual filaments loop, curl and kink in a random manner as the yarn is relaxed and the individual filaments straighten as the yarn is stretched.

On the other hand, when a low denier monofilament yarn, or a low denier yarn having only a few filaments is false-twisted, the resulting yarn is known as a "torque" yarn. This torque yarn is not inherently stretchable but has a high degree of torque or liveliness so that it will twist upon itself when relaxed. In a knit fabric, the torque in the yarn causes the stitch loops to twist and incline in accordance with the direction of the torque in the yarn and the stitch loops straighten when the fabric is stretched.

Thus, the conventional false-twist method produces irregular loops or curls in the individual filaments of a torque or liveliness is produced in a low denier thermo-heavy denier thermoplastic yarn and a high degree of plastic yarn. Although the heavy denier stretch yarn has some torque, its stretch characteristics are derived from the irregular loops, curls or kinks in the individual filaments.

It is also known to produce latent torsional stresses in a low denier thermoplastic yarn by simultaneously false-twisting a pair of joined ends of yarn in one direction, false-twisting the joined yarns in the opposite direction,

and separating the ends and taking them up on separate bobbins. When a sheer ladies' stocking is knit of this yarn and finished, the yarn in the stitch loops tends to form closely spaced reversing curls or coils which impart stretch characteristics to the stocking. This double false-twisting process is disclosed in detail in U.S. Patent No. 3,162,995.

In the conventional production of either a stretch or a torque yarn by the false-twist method, the single 360 degree wrap around the exit pin permits some twist to pass from one side of the pin to the other in an irregular manner so that the yarn does not have uniform characteristics throughout its length. In an attempt to overcome this problem, it has been proposed that the yarn be wrapped around the exit pin more than one time; i.e., 720 degrees. It has also been proposed that the false-twist spindle be modified in an attempt to trap the twist at the exit end of the spindle. These modifications have included various types and shapes of exit pins or wires, such as illustrated in the Boillat et al. Patent No. 2,863,277 and various types of yarn threading blocks and the like, such as illustrated in the Schrenk et al. Patent No. 2,893,198 and the Kingsbury et al. Patent No. 2,813,393. While these devices operate with varying degrees of effectiveness to trap the twist, they are objectionable for several reasons, including the fact that they require extensive modification of the false-twist spindle.

With the foregoing in mind, it is an object of the present invention to provide a method of false-twisting thermoplastic yarn which includes simultaneously false-twisting a plurality of joined together yarn ends while threading the multiple ends around the exit pin of the false-twist spindle in such a manner that the yarns pass over and rub across themselves as they pass around the exit pin. These false-twisted yarns are then separated and each yarn end has the characteristics of a torque yarn as well as latent torsional stresses. The torque characteristics are sufficient to cause some inclination of the stitch loops of a fabric knit of this yarn and the latent torsional stresses cause the yarn to have a strong tendency to curl and form reversing coils therealong. When the fabric is conventionally finished, the latent torsional stresses are released so that the yarn distorts in an irregular manner.

The present method permits the economical production of yarn having the combined characteristics of torque and reversing latent torsional stresses because it requires only a single false-twisting step and it requires the application of a relatively low number of turns of false twist. The yarn is also subjected to a lower temperature in the heating zone so that the resulting yarn is very pliable and has a high percentage of residual shrinkage. Fabric knit of the yarn produced by the present method has a very strong tendency to quickly return to the relaxed condition after it is stretched and released.

It is a further object of the present invention to provide a method of threading thermoplastic yarn around the exit pin of a false-twist spindle which prevents twist from passing from one side to the other of the exit pin and thereby provides an efficient twist trap. Since the twist is trapped, there can be no variation in the number of turns heat-set in the yarn below the false-twist spindle and the yarn has uniform characteristics throughout its length.

Yarns processed in accordance with the method of this application are particularly adapted for knitting ladies' fine gauge seamless stockings. The stockings have a surprisingly soft hand and a uniform appearance characterized by an absence of outwardly protruding loops or curls when in the relaxed condition. This absence of outwardly protruding loops or curls of yarns makes the stockings less susceptible to picks. The stockings have

sufficient stretch properties to fit a range of leg and foot sizes and the yarn of the greige stocking has sufficient shrinkage remaining therein that the stocking will easily conform to the boarding form during the boarding operation.

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 schematic isometric view of one station of a false-twist machine which has been suitably modified to simultaneously false-twist a pair of thermoplastic yarns;

FIGURE 2 is a greatly enlarged isometric view of the upper or exist end of the false-twist spindle, illustrating the first step in threading the yarns around the exit pin in accordance with the present invention;

FIGURES 3, 4 and 5 illustrate the subsequent steps in the threading operation;

FIGURES 6 and 7 are enlarged views of the exit pin illustrating the manner in which the yarns pass around the exit pin and are wrapped about themselves as they rub across themselves and pass around the false-twist pin and illustrating the manner in which opposite torque is inserted therein;

FIGURE 8 is a side elevation of a ladies' seamless stocking knit of the yarn produced by the method of the present invention; and

FIGURE 9 is a greatly enlarged view of the fabric in the leg of the stocking, taken in the area of the dotted rectangle **9** in FIGURE 8, and showing the manner in which the stitch loops are inclined by the torque and distorted by the torsion in the yarn.

Referring to the drawings, FIGURE 1 illustrates one station of a conventional false-twist machine of the type known as the Model 551 Superloft machine manufactured by Leesona Corporation, having been modified somewhat to carry out the method of the present invention. This machine is usually provided with false-twisting stations closely spaced along each side of the machine and a single yarn end is usually processed at each station.

The conventional parts of each false-twisting station include a driven feed roll **10**, a heater plate or block **11** having a yarn receiving groove **12** therein, yarn guide wires **13**, **14**, a false-twist spindle **15** which is supported for movement into and out of engagement with a drive belt **16**, and a yarn guide wire **17** supported on the upper end of the false-twist spindle. A single end of false-twisted yarn is normally guided onto the take-up bobbin **20** by means of a traversing bar **21** and a traversing yarn guide **22**. The take-up bobbin is rotated at the desired speed, relative to the feed roll **10** and the rotational speed of the false-twist spindle **15** by means of a cork drive roll **23**, the outer peripheral surface of which engages the surface of the take-up bobbin **20** and the yarn wound thereon to provide a surface-to-surface drive.

When operated in the conventional manner, a single yarn end, such as indicated at Y in FIGURE 1, is withdrawn from a supply bobbin **25**, and then directed upwardly and through conventional tension discs, not shown, which are normally supported on a plate frame member **26**. The yarn Y then passes around the feed roll **10**, through the heater plate **11**, false-twist spindle **15**, and is taken up on the take-up bobbin **20**.

In accordance with the present invention, an additional yarn end Y′ is withdrawn from a supply bobbin **25′** and the yarns Y and Y′ pass through respective yarn guide wires **27**, **27′** (which are suitably supported on a rod **28**, The yarns Y and Y′ are joined together at a yarn guide wire **30**, then wound approximately 1½ turns in a counterclockwise direction around a snubber post **31**, the lower end of which is supported in the plate **26**. The joined yarns are then wound 1¾ turns in a clockwise direction about a small V-grooved guide wheel **32** which is provided with suitable ball bearings to facilitate rotation thereof. The joined yarns Y and Y′ then pass beneath a yarn guide wire **33** before they are directed upwardly and wrapped several turns around the yarn feed roll **10** and a conventional separator member **34**.

The joined yarn ends Y and Y′ pass from the feed roll **10** upwardly through the groove **12** in the heater block **11**, through the guide wires **13**, **14** and then through the false-twist spindle **15** where they are wrapped about the exit pin in a novel manner, to be presently described. From the false-twist spindle **15**, the yarns are directed upwardly over a guide rod **35** and are split apart or separated, as at **36**. The separated yarns Y and Y′ then engage respective V-grooved guide rollers **37**, **37′** which are rotatably supported on a bracket **38** fixed on the traversing bar **21**. The yarn Y is then wound onto the take-up bobbin **20** while the yarn Y′ is wound onto a take-up bobbin **20′**.

The novel manner in which the joined yarns Y and Y′ are threaded or wrapped around the exit pin **40** of the false-twist spindle **15** is illustrated in FIGURES 2–5. The yarns Y and Y′ are withdrawn from the respective packages **25**, **25′**, joined together and threaded up to the false-twist spindle **15** in the manner indicated in FIGURE 1. The yarns are drawn upwardly through the hollow false-twist spindle **15** by means of the usual threading hook, the end of which is indicated at **41** in FIGURE 2, and the spindle **15** is rotated so that the yarns are behind the exit pin **40** (FIGURE 2).

The central yarn engaging portion of the exit pin **40** is small, on the order of .030 of an inch. The pin **40** is formed of a hard, wear-resistant, ceramic material, such as Alsimag, and opposite end portions are fixed in upstanding opposite side portions **42**, **42*a***. The pin **40** tapers inwardly to the small central portion so that the yarn is maintained in the central yarn engaging portion. As is well known, the yarn is normally wrapped one single time around the exit pin **40** and in some instances, it is the practice to wrap the yarn two complete wraps around the pin.

The threading hook **41** is then passed beneath the false-twist exit pin **40** to engage both yarns Y and Y′ and then drawn forwardly, as illustrated in FIGURE 3, to form a loop L of the yarns. The free end portions of the joined yarns Y and Y′ are then passed through the loop L, either from left to right, as illustrated in FIGURE 4, or from right to left, depending upon the direction in which the spindle **15** is to be rotated. The spindle **15** shown in FIGURES 2–6 is to be rotated in a counterclockwise direction, looking downwardly thereon, so that torque is imparted to the yarns in a Z direction.

The free end portions of yarns Y and Y′ are then directed upwardly, over the guide rod **35**, and both yarns are initially passed through one of the traverse guides **22**, **22′** and onto the corresponding take-up bobbin **20**, **20′**. As the yarns are threaded upwardly, the excess yarn in the loop L is drawn down around and over the joined yarns as they leave the exit pin **40**, as shown in FIGURE 5.

When the joined yarns are being properly fed onto one of the take-up bobbins, one of the yarn ends is split away from the other in the area above the false-twist spindle **15** and the separated end is led up to and around the other take-up bobbin. With continued operation of the machine, the yarns Y and Y′ are continuously split apart as at **36** in FIGURE 1, and taken up on the respective bobbins **20**, **20′**.

As the yarn is continuously withdrawn from the supply bobbins **25**, **25′** and taken up on the bobbins **20**, **20′**, the rotating false-twist spindle **15** twists the yarns together in one direction below the exit pin **40**, depending upon the direction in which the spindle **15** is rotated. As illustrated in FIGURE 6, when the spindle is rotated in a counterclockwise direction, the yarns Y and Y′ are twisted together in a Z direction from the exit pin **40** of false-

twist spindle **15** back down to the feed roll **10** and while in this twisted condition, they pass through the heating zone provided by the heater block **11** so that the yarns are heat-set in this twisted together condition. The yarns are twisted in the opposite direction above the exit pin **40** so that there is no twist in the yarns and they may be split apart before being wound up.

The running yarns (FIGURE 6) thus form the loop L on one side of the exit pin **40** and the upperbight portion of the loop L extends above the pin and continuously rubs against and across the yarns as they leave the exit pin **40**. This rubbing action of the yarns across themselves imparts latent torsional stresses to the yarn and this action combined with the heat-setting of the twisted together yarns below the false-twist spindle provides both torque and latent torsional stresses which may be activated to cause the yarn to curl or coil in a periodically reversing manner. The resulting yarn has sufficient torque to cause the stitch loops of a knit fabric to be sufficiently inclined in a direction corresponding to the torque therein so that yarns of opposite torque must be alternately knitted in order to obtain a balanced fabric. That is, a yarn having a Z torque is alternately knit in courses with a yarn having an S torque so that the fabric has overall balance.

A yarn having an S torque is produced by rotating the spindle in the opposite direction; i.e., a clockwise direction, and threading the yarn around the exist pin **40** in a different manner, as illustrated in FIGURE 7. The yarn is oppositely threaded by passing the free end portions of the yarns through the loop L from right to left and in the opposite direction from that illustrated in FIGURE 4. As the loop is tightened (FIGURE 7), the running bight of the loop L rubs across and around the portion of the yarn leaving the pin **40** from right to left. On the other hand, the running bight of the loop L in FIGURE 6 rubs across and around the portion of the yarns leaving the exit pin **40** from left to right.

Generally, the method of the present invention is particularly adapted for the false-twisting of thermoplastic yarns of a relatively low denier range, such as the yarns normally utilized in knitting ladies' sheet hosiery and the like. As an illustrative, but non-limiting example, very satisfactory hosiery yarns have been produced in accordance with the present method by the following specific example.

Single ends of 15 denier monofilament nylon are withdrawn from the supply bobbins **25**, **25'** (FIGURE 1), joined together and passed upwardly through the false-twist station, separated as indicated at **36**, and taken up on the corresponding packages **20**, **20'**. In this false-twisting step, the joined yarns Y and Y' are threaded around the exist pin **40** in the manner indicated in FIGURES 5 and 6 while the false-twist spindle **15** is rotated in a counterclockwise direction. Other pairs of 15 denier monofilament nylon yarns are processed in an identical manner, except that the yarns are wrapped about the exit pin **40** in the manner indicated in FIGURE 7 and the false-twist spindle **15** is rotated in the opposite direction; i.e., in a clockwise direction.

The temperature of the heater block **11** is maintained at 335° F., the false-twist spindle is rotated at 147,000 r.p.m., the speed of take-up bobbins **20**, **20'** and the feed roll **10** are adjusted to impart 77 turns of false-twist per inch to the yarn while maintaining 10 to 12 grams of tension on the yarn from the spindle to the take-up bobbins **20**, **20'**. The yarns processed in accordance with this example have torque characteristics, as well as latent torsional stresses which may be fully developed by subjecting the yarn to heat while in a relaxed condition. Stockings or other fabrics may be knit of the yarns and the latent characeteristics developed when the fabric is subjected to heat during the usual finishing operation, such as dyeing, boarding and the like.

Yarns produced in accordance with the above example are particularly adapted for knitting the leg portion **50** and the foot portion **51** of the ladies' seamless stocking indicated at S in FIGURE 8. The welt **52**, heel **53** and toe **54** may be knit of a heavier denier yarn processed in accordance with the present invention or with another suitable type of stretchable yarn. The stocking S is preferably knit on a conventional two-feed seamless circular hosiery knitting machine. During the knitting of the leg portion, the 15 denier yarn having torque in an S direction is fed to the needles at one knitting station, while a 15 denier yarn having torque in a Z direction is fed to the needles at the other knitting station. The stocking is then finished in the usual manner which normally includes preboarding, dyeing, scouring and then final boarding.

The full elasticity and distortion of the yarn in the stitch loops is developed without requiring excessive agitation of the fabric during the dyeing and scouring steps and the yarn in the finished stocking exhibits some of the characteristics of a torque yarn as well as certain of the characteristics of a coiled or curled yarn. The irregular distortion of the yarn and the generally inclined condition of the stitch loops is illustrated in FIGURE 9. The courses C–**1**, C–**3** and C–**5** are knit of yarn processed to produce a torque in one direction; e,g., in an S direction, while the courses C–**2**, C–**4** and C–**6** are knit of yarn processed to produce torque in a Z direction.

The general inclination of the stitch loops in the wales W–**1** through W–**5** shows a definite tendency on the part of the stitch loops to incline in directions corresponding to the direction of torque in the yarns in the corresponding courses. However, the inclination of the stitches is not as extreme or uniform, as is the inclination of the stitch loops in stretch stockings knit of a conventional torque yarn. Also, it will be noted in FIGURE 9 that some of the stitches are larger than others and the stitches are distorted in an irregular manner. In addition to the distortion shown, the stitch loops are also distorted in the plane toward and away from the drawing. The variation in the size of the stitch loops is at least in part caused by the tendency of the yarn to form reversing curls or coils, the complete development of the curls and coils in the yarn being prevented by the interconnection of the yarns at the cross-overs of the stitch loops.

While the processing of a particular yarn (15 denier monofilament nylon) has been described in detail, it is to be understood that other types of yarn may also be processed in accordance with the method of the present invention. For example, monofilament yarns from about 7 to 30 denier may be processed in the manner described and with about 60 to 95 turns per inch of false-twist applied thereto.

Multifilament yarns can also be satisfactorily processed in accordance with this method. When processing paired ends of multifilament yarns, it has been found necessary to apply some prior twist to the individual yarn ends before joining and false-twisting them. For example, about 2 to 12 turns per inch of prior twist should be applied to the individual yarn ends having a relatively low number of filaments, from about 14/2 up to 40/7. These prior twisted yarns are joined and false-twisted from about 60 to 95 turns per inch. More specifically, it has been found that 14/2 yarns should have about 3½ turns of prior twist applied thereto and 40/7 yarns should have about 10 turns of prior twist applied thereto. This prior twist tends to hold the yarns together and aids in the splitting apart of the yarns after they have been joined together and simultaneously false-twisted.

Multifilament yarns having more than 7 filaments may also be processed in accordance with the present method. For example, the following types of yarns may be used: 30/10, 40/13, 50/17, 60/20, 70/17 and 70/34. These individual yarn ends should also be twisted prior to being simultaneously false-twisted. The twist in these yarns should be within the range of about 5 to 15 turns per inch. This prior twisting of the yarns tends to hold the individual filaments of the yarn ends together during the false-

twisting step and aids in the splitting apart of the yarns after they have been simultaneously false-twisted. The range of turns of false-twist applied to these yarns should be from about 40 to 90 turns per inch.

The manner in which the yarn is threaded around the exit pin of the false-twist spindle prevents twist from passing from one side of the exit pin to the other and provides an efficient twist trap. As shown in FIGURES 6 and 7, the upper bight of the loop L rubs across the yarn leaving the exit pin **40** and prevents the passage of twist thereby. This threading of the yarn can be used when false-twisting single or multiple yarn ends and produces a yarn having uniform characteristics throughout its length.

The relatively low temperature of about 335° F. maintained in the heater block **11** prevents excess shrinkage of the yarn as it is being false-twisted. Thus, a greige stocking knit of the yarn has a greater degree of residual shrinkage which permits it to be easily drawn in to conform to the boarding form in the narrow ankle and foot area. The relatively low temperature also causes the false-twisted yarn to be more soft and pliable than yarns subjected to higher temperatures, the higher temperature causing the yarns to become stiff and brittle.

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 method of processing thermoplastic yarn on a false-twist machine including a false-twist spindle with an axial bore through which the yarn is adapted to pass, a pin supported at one end of said spindle and including a yarn engaging central portion extending over the axial bore in said spindle, means for imparting rotation to said spindle in a given direction, a heating zone positioned in advance of said false-twist spindle and through which the yarn passes prior to moving through the spindle, said method comprising the steps of

(a) withdrawing a pair of yarns from corresponding supply sources and guiding the same in joined together relationship through said heating zone and said false-twist spindle,

(b) threading the yarn about said exit pin by passing the joined together yarns upwardly on one side of said exit pin and then downwardly on the same side of said exit pin to form a looped portion in the yarn, passing the yarn down around and beneath said exit pin and upwardly on the opposite side of the exit pin and through the looped portion whereby the yarn rubs across itself at the bight of the looped portion,

(c) false-twisting the thus threaded and joined together yarns,

(d) separating the joined together yarns, and

(e) collecting the separated yarns on corresponding take-up packages, the twisting and heat-setting of the paired yarns and the rubbing action of the yarns imparting torque and latent torsional stresses thereto.

2. A method according to claim **1** wherein each end of yarn is within the range of about 7 to 70 denier.

3. A method according to claim **2** wherein the joined yarns are false-twisted within the range of about 40 to 95 turns per inch.

4. A method according to claim **1** wherein each end of yarn is multifilament and has from 2 to 34 filaments, and including the step of applying twist to the individual yarn ends prior to the false-twisting step.

5. A method according to claim **4** wherein the individual multifilament yarns are each pre-twisted within the range of about 2 to 15 turns per inch before being false-twisted.

6. A method according to claim **4** wherein each end of yarn is 40/7 and each end is pre-twisted 10 turns per inch prior to being joined and false-twisted.

7. A method according to claim **4** wherein each end of yarn is 14/2 and each end is pre-twisted 3½ turns per inch prior to being joined and false-twisted.

8. A method according to claim **1** wherein the heating zone includes a heater block and wherein the temperature of the heater block is maintained at about 335° F.

9. A method according to claim **1** wherein each end of yarn is 15 denier monofilament.

10. A method according to claim **9** wherein the joined yarns are false-twisted with about 77 turns per inch.

11. A method of drawing a thermoplastic yarn around the exit pin of a false-twist spindle to provide an efficient twist trap and thereby prevent twist from passing from one side to the other of said exit pin, said method comprising the steps of

(a) passing the yarn upwardly on one side of the exit pin,

(b) forming a loop in the yarn above the exit pin,

(c) passing the yarn downwardly on said one side of the exit pin, and

(d) passing the yarn upwardly on the other side of said exit pin and through the loop above the exit pin so that the running yarn is wrapped about the exit pin and crosses itself as it moves to and away from the exit pin.

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JOHN PETRAKES, *Primary Examiner.*

U.S. Cl. X.R.

28—72; 57—34, 51.5, 77.3, 77.33

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,423,924 January 28, 1969

Marvin H. Comer et al.

It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, lines 63 and 64, "torque or liveliness is produced in a low denier thermo- heavy denier thermoplastic yarn and a high degree of" should read -- heavy denier thermoplastic yarn and a high degree of torque or liveliness is produced in a lower denier thermo- --.

Signed and sealed this 7th day of April 1970.

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents