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POLYPROPYLENE STRETCH STOCKING AND METHOD

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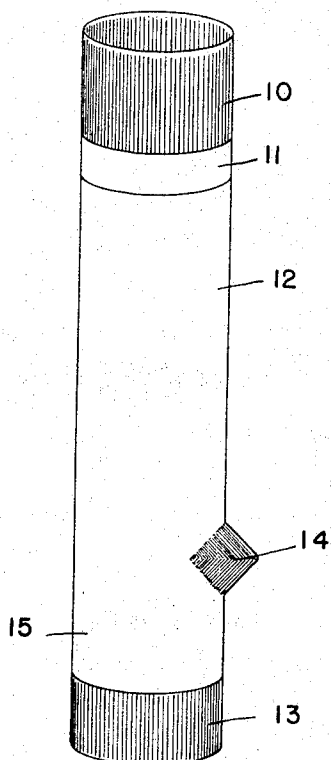


FIG. 1

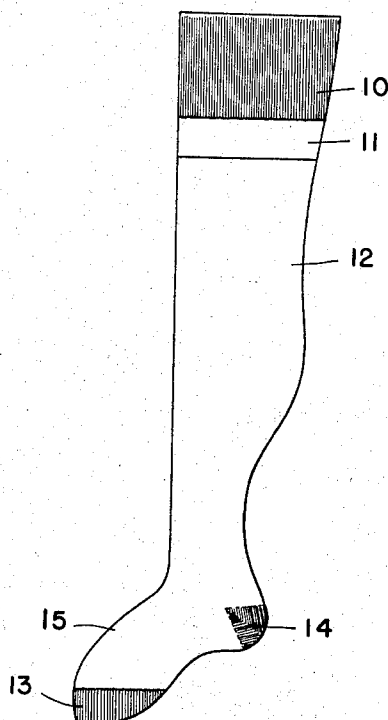


FIG. 2

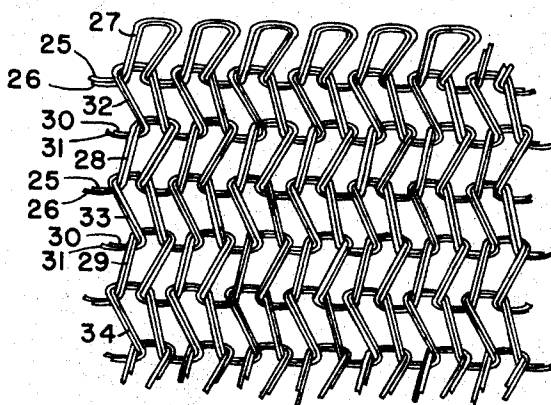


FIG. 4

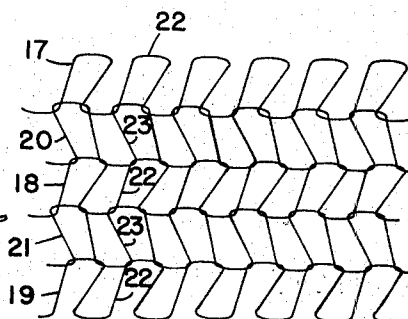


FIG. 3

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This invention relates to a highly stretchable and retractable ladies' stocking knit from polypropylene yarns and the method of processing polypropylene stockings to impart stretch characteristics, and relates more particularly to a knitted stocking in which one or more twisted but untreated polypropylene yarns are knit to form distorted stitches in the fabric and the activation of latent properties to release internal stresses in the polypropylene yarns during the processing of the stocking enabling the knitted stitches to relay sufficiently whereby subsequent boarding and steaming result in a highly stretchable and retractable stocking.

It is well known in the knitting art and particularly in the manufacture of ladies' stockings to produce stretchable stockings utilizing nylon yarns that have been subjected to a heat setting process to impart torque or crimp characteristics for liveliness and to knit the torque or crimp yarns selectively to form distorted stitches in the fabric which may then be heat set during the boarding operation thereby shrinking and stabilizing the fabric and imparting, by the heat setting operation during boarding, increased elasticity to the fabric as is disclosed in U.S. Patents 2,771,759, 2,771,757, 2,841,971 among others.

With the advent of fibers formed from highly crystalline, high molecular weight polymers of alpha olefins such as polypropylene, knitted fabrics, including hosiery, made from polypropylene fibers have been produced as disclosed in U.S. Patent No. 3,025,689. The physical characteristics of polypropylene lend themselves optimally to knitting ladies' stockings particularly for their increased snag resistance, light weight and sheerness. However, appreciable problems have been experienced in the shrinkage of the polypropylene yarns to relax the stitches and produce acceptable fitting qualities. Also, while polypropylene yarns compare favorably with nylon and are highly resistant to repeated stresses, the yarns made from polypropylene while they do not appear to harden appreciably and do not appear to retain strain to any great extent, have a high degree of toughness and are considerably elastic with high tenacity. It has been extremely difficult to obtain a satisfactory stretch stocking approaching the stretchability of conventional stretch nylon stockings employing the same procedures primarily because the knitted fabric of twisted polypropylene yarns has very little or no stretch or retraction when withdrawn from the knitting machine. Possibly the twisted yarns have taken on a "cold set" or stress during knitting that destroys the effect of the twist imparted to the untreated but twisted yarns. Stockings knit from polypropylene monofilament yarns exhibit a very limited degree of elasticity resulting from the inherent stretch imparted to a fabric due to the knitted stitches and the elongation of the yarns. However, the retractability of the fabric after elongation is extremely lazy and has resulted in some objections to this highly desirable fiber.

Therefore, it is an objective of this invention to provide stretch polypropylene stockings and a process for providing a highly stretchable and retractable knitted stocking made from polypropylene yarns in which the yarns are initially twisted and the stocking is knit from such yarns to form inclined stitches and subsequently processed to activate the latent properties in the fibers or to remove

stresses in the yarns to produce highly stretchable properties to the knitted fabric.

Another objective of this invention is to provide a method of producing a stretchable polypropylene stocking in which the knitted courses are formed of one or more polypropylene yarns twisted but not heat set and knit into a stocking forming courses with inclined stitches and thereafter removing the stresses to relax the stitches in the stocking thereby increasing the angle of stitch distortion before boarding and heat treating the stocking to set the relaxed stitches to form a highly stretchable and retractable fabric.

Still another objective of this invention is to provide a stretch polypropylene stocking made from oppositely twisted non-heat treated polypropylene yarns to form a highly stretchable and retractable fabric by subjecting the knitted stocking to a heated atmosphere for removing some yarn stresses and activating the yarn and permitting the stitches to assume a position in the fabric different from the position assumed by the stitches in the condition immediately after knitting, and subsequently heat treating the relaxed stitches to impart substantially permanent stretch characteristics to the fabric.

Other objects and advantages of this polypropylene stocking and the process for treating it will become more readily apparent to those skilled in the knitting art from the following detailed description taken in conjunction with the accompanying drawing and wherein:

FIG. 1 is a side elevational view of one type of circular knit stocking formed in a tube with reciprocatorily knit heel pocket as removed from a circular knitting machine embodying the invention;

FIG. 2 is a side elevational view of a final boarded finished stocking after the stocking of FIG. 1 has been toe closed and has been subjected to intermediate processing before final boarding;

FIG. 3 is an enlarged illustration of one form of knitted fabric of the leg portion of FIGS. 1 and 2 in which alternate courses are knit of polypropylene monofilament yarn twisted in one direction and intermediate courses are knit of polypropylene yarn twisted in an opposite direction forming oppositely inclined courses;

FIG. 4 is an enlarged illustration of a modified form of knitted fabric in which two ends of monofilament twisted polypropylene yarns are employed in each course to produce oppositely inclined knitted courses.

The fibers or yarns of polypropylene utilized for the stockings of this invention are generally solution dyed to the proper shade or tint and may be formed by melt extrusion of the polymer, or by either wet or dry spinning the solution in conventional ways to form the requisite yarn denier for the hosiery to be knit. As the polypropylene yarns received from the yarn producer are not subjected to any prior heat treatment or application to harden the yarns they are considered to be untreated although they are subsequently twisted in an unhardened or untreated condition. It has been found that polypropylene yarns for sheer ladies' stockings, in those denier available, are slightly stiffer than comparable deniers of nylon yarn and are subjected to an elongation during knitting substantially more than that to which nylon yarns have been subjected.

The preparation of the stretchable polypropylene stockings of this concept are preferably formed from monofilament yarns to which a twist is introduced imparting substantial liveliness or torque characteristics to the yarn. A polypropylene yarn of approximately 15 denier is provided with an S twist with from approximately 20 to 50 turns per inch without subjecting the yarn to any heat treatment. Similarly, another polypropylene yarn of approximately 15 denier will be provided with a Z twist

with approximately 20 to 50 turns per inch without any heat treatment as the yarn is received from the producer.

The S and Z twisted yarns are knit on a conventional two-feed circular knitting machine with normal tension being applied to the yarns to prevent snarling which may be produced in the event the yarns are slack. Suitable plastic disks may be used on the yarn packages to prevent snarling and slack as conventionally employed in the knitting of torque nylon yarns for stretchable stockings. In the knitting of the S twisted polypropylene yarn and the Z twisted polypropylene yarn, alternate courses are knit with the S twisted yarns and intermediate courses are knit with Z twisted yarns in the leg and foot portions of the stocking as will be described hereafter.

Referring to the drawing and particularly to FIG. 1, the welt 10 is knit of multifilament polypropylene yarn with the welt yarn filaments being plied together resulting in normal stretchability and retraction in the welt portion due to the inherent elasticity of the knitted fabric. The afterwelt 11 is also preferably knit from multifilament polypropylene yarn which may be of the same denier as in the welt 10. The leg or boot portion 12 that extends from the afterwelt lower portion to the toe reinforcing portion 13 is knit from one or more twisted untreated polypropylene monofilament yarns. In those instances where a heel pocket 14 is desired, multifilament polypropylene yarn of the type used in the welt and afterwelt may be utilized. However, where a nude heel is desirable, the same yarns as employed in the leg 12 may be knit throughout the heel portion with the heel being boarded into the stocking during final boarding. The toe or foot reinforcing portion 13 is preferably knit from multifilament polypropylene yarn of the type used in the welt 10.

Although the description of the preferred embodiment illustrates a tubular toe construction, this concept is obviously applicable to a looped toe construction in which the toe portion is reciprocatorily knit on the circular knitting machine.

In the knitting of the leg 12, one end of S twisted polypropylene yarn is fed at one yarn feeding station and one end of Z twisted polypropylene monofilament yarn is fed to another yarn feeding station continuously throughout the leg or boot portion of the stocking including the foot portion 15 residing between the heel 14 and the reinforcing yarns in the toe 13.

An enlarged somewhat exaggerated representation of the knitted fabric utilizing a single end of S twist yarn and a single end of Z twist yarn is shown in FIG. 3 representing only a small portion of the leg fabric. As shown in the plain knit fabric of FIG. 3, alternate courses 17, 18 and 19 are inclined to the right and alternate courses 20 and 21 of the Z twist yarn are inclined to the left thereby forming a herringbone pattern or configuration in the fabric, the individual stitches 22 in each alternate course being inclined to the right and each stitch 23 in the intermediate courses being inclined to the left, produce a zig-zag wale in both the sinker and needle wales of the fabric.

When the stocking is removed from the knitting machine the inclination of the stitches 22 and 23 in the alternate and intermediate courses are not accentuated and the fabric is substantially elongated with negligible stretchability and a minimum of elasticity. It is possible that one explanation may be that the polypropylene yarns have taken on a "cold set" during knitting disabling the twist in the yarns to become effective by reason of the internal stresses in the yarn produced by the sinuous path of the sinker and needle loops. The knitted stockings when removed from the knitting machine in the greige before any further treatment have a very lazy elastic action if any at all. Boarding and steaming the greige stocking taken directly from the knitting machine has failed to produce any appreciable elasticity.

After the toe portion of the stocking has been seamed or looped closed, by subjecting the stocking to an elevated temperature in a sealable cabinet or in a tumbler with

the temperature being in the range of from approximately 170 degrees F. to 220 degrees F., preferably in a dry atmosphere, without any appreciable moisture, the polypropylene yarn stitches become activated quite suddenly apparently having the internal stresses dissipated enabling the twisted yarns to become more active and the angle of inclination of the stitches in each of the courses becomes increased from a previous latent condition. While the stocking is subjected to the elevated temperature in the relatively dry atmosphere, the stretchable characteristics or elasticity in the stocking are developed and some residual shrinkage occurs in the fabric in proportion to the temperature and the time that the stocking remains in the elevated temperature atmosphere. It has been found desirable to subject a bundle of stockings to a temperature of 220 degrees F. for a period of approximately thirty minutes in order to obtain optimum stitch relaxation and inclination through the relaxation.

Although very desirable and surprising results have been achieved by placing the greige knit stockings into a Lydon box or sealable chamber and subjecting the chamber to the temperature range of from 170 degrees F. to 220 degrees F., equally desirable results have been obtained by the relaxation of the stitches or activation of the yarns permitting them to assume the more inclined angle by placing the stockings into a tumbler and tumbling the stockings while subjecting the interior of the tumbler and the stockings to the desired elevated temperature with circulation of relatively dry heated air in the range of 170 degrees F. to 220 degrees F. for a period of thirty minutes or less.

After the stockings have been removed from the heated chamber or tumbler, there is a distinct sharp inclination of the stitches and the stockings have been appreciably shortened in longitudinal length with the individual stitches assuming a clearly defined regular inclination appreciably greater than that illustrated in FIG. 3 resulting also in a longitudinal contraction of the fabric.

Each stocking is then placed on a boarding form that is usually of reduced length comparable to the length and configuration conventionally used in the hosiery industry for ladies' stretchable nylon stockings. The boarding forms with the stockings thereon are placed in a steam chamber or retort and subjected to a boarding temperature and steaming atmosphere of approximately 268 degrees F. for a period of approximately sixty seconds thereby heat setting the distorted stitches in their relaxed condition and shrinking the fabric sufficiently to impart to the stocking the contour of the boarding form as shown in FIG. 2. The boarded stockings removed from the boarding forms possess increased longitudinal elasticity or stretchability appreciably greater than when the stockings are boarded directly after knitting without any intermediate processing.

Desirable stretchability or elasticity in the polypropylene sheer seamless stocking has resulted from subjecting the raw yarn of polypropylene in the untreated or non-heat set condition to approximately 35 to 40 turns per inch for both the right or S twisted yarn and for the same number of turns for the left or Z twisted yarns. It being obvious that it is most desirable to have the same number of turns per inch in the S and the Z twisted yarns that are being used to knit the same stocking. As the melting point of polypropylene is approximately 320 degrees F. and the plasticizing temperature is approximately 310 degrees F., the boarding temperature is preferably maintained between 250 degrees F. and 270 degrees F. within the time cycle of from 45 to 60 seconds depending upon the percent of saturation of the steam.

In order to have a resulting stretchable polypropylene stocking, it is desirable that the stockings removed from the drying chamber that have been subjected to the heated atmosphere be pulled on the boarding form so that the overall length of the stocking is approximately 25 inches. The resulting stretch is preferably approximately 180%

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in the leg, 80% in the ankle, and 80% in the foot. It should be apparent that the extent of foot stretchability is determined by the boarding form foot length being used.

In FIG. 4 there is illustrated a modified embodiment of the fabric of the leg or boot 12 in that it is knit of two unplied ends of polypropylene monofilament yarn in each course with each of the ends 25 and 26 in alternate courses 27, 28 and 29 being twisted individually in the same rotational direction and with the two ends 30 and 31 in the intermediate courses 32, 33 and 34 being twisted in the opposite rotational direction from those yarns in the alternate courses. The use of two or more ends of 15 or greater denier yarn of S twist yarn in alternate courses and Z twist yarn in intermediate courses is desirable for service weight or support-type stockings as contrasted with the sheer weight stocking in which approximately 15 denier yarns are knit. After greige knitting and toe closing, the stocking having two or more ends in each course will be processed in a manner similar to the procedures described for the single end embodiment in order to achieve the requisite elasticity by removing stitch stresses thereby increasing stitch angle inclination or distortion in the knitted courses.

It has been found that by utilization of the intermediate heating process that the resulting fabric has an unusually clear stitch formation that is uniform throughout the fabric.

It will be readily apparent that the degree of longitudinal stretchability and retraction will depend upon the extent to which the stockings are elongated on the boarding form during final or preboarding at the boarding temperatures in the range of approximately 250 degrees F. to 270 degrees F.

It is further contemplated that a slight degree of plying may be used for the multiple end stocking or that one of the ends may be twisted and the other end in the same course may not have any twist with the stitch distortion being induced to the untwisted yarn by the twisted yarn and the stitch distortion after the intermediate heating process, heat set in the boarding operation.

Obviously many modifications may be made to the preferred procedures and the resulting stocking without de-

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parting from the purpose and spirit of this invention and such modifications are contemplated within the scope of the appended claims.

What is claimed is:

1. A stretchable seamless polypropylene stocking comprising a plurality of alternate and intermediate knitted heat set courses each having oppositely inclined relaxed knitted stitches, each of the courses formed from a twisted untreated monofilament polypropylene yarn with the twist in alternate courses being in one direction and the yarn twist in intermediate courses being in opposite direction.

2. A stretchable seamless stocking comprising a plurality of alternate and intermediate knitted heat set courses each having oppositely inclined knitted relaxed stitches, each of the courses formed from a plurality of independently twisted untreated monofilament polypropylene yarns with the direction of twist of all yarns in alternate courses being in one direction and all of the yarns in intermediate courses being twisted in an opposite direction from the twist direction of the yarns in the alternate courses.

References Cited

UNITED STATES PATENTS

2,736,945	3/1956	Burleson et al.	66—178
2,755,616	7/1956	Weller	66—178 X
2,841,971	7/1958	Bird et al.	66—178
2,940,962	6/1960	Verheyden et al.	
3,025,689	3/1962	Beghelli	66—202
3,094,834	6/1963	Deeley et al.	57—157
3,152,380	10/1964	Martin.	
3,256,258	6/1966	Herrman.	
3,313,011	4/1967	Loftin et al.	57—140 XR
3,323,190	6/1967	Boltniew.	

FOREIGN PATENTS

249,866	2/1964	Australia.
887,673	1/1962	Great Britain.
919,071	2/1963	Great Britain.
945,539	1/1964	Great Britain.
361,083	5/1962	Switzerland.

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