Feb. 28, 1967 C. A. MILES ET AL 3,306,081

SUPPORT STOCKING

Filed July 15, 1963

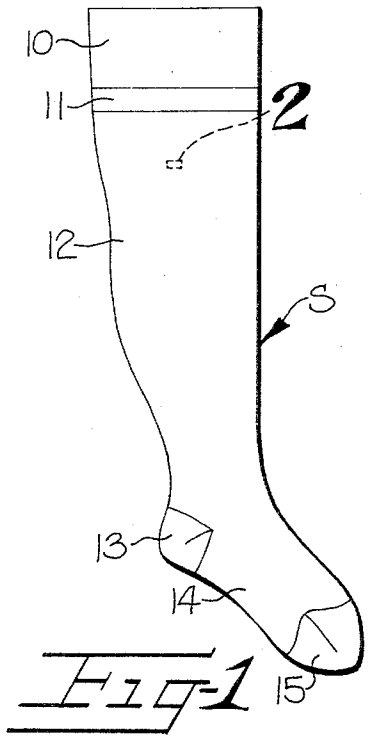

Fig-1

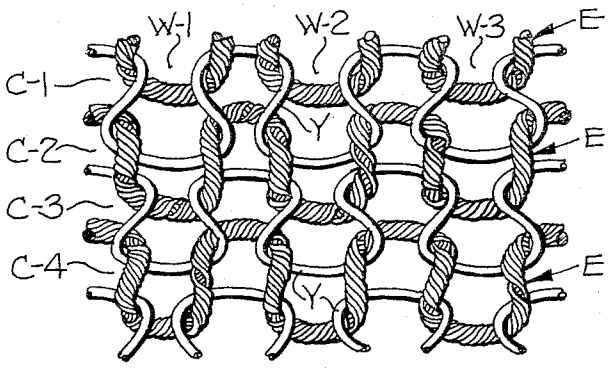

Fig-2

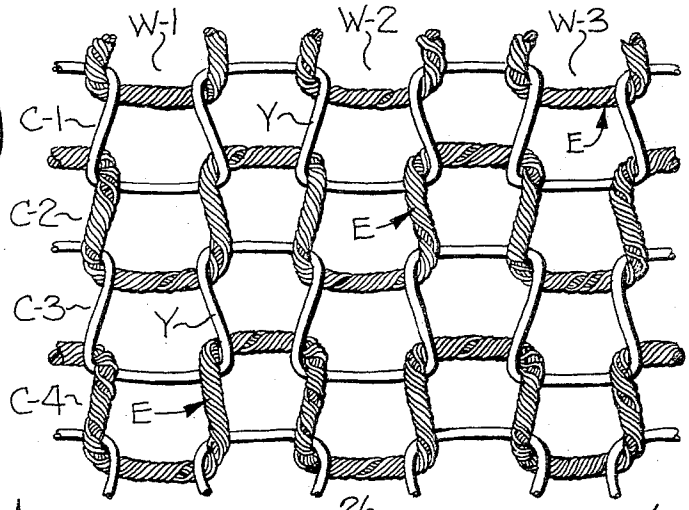

Fig-3

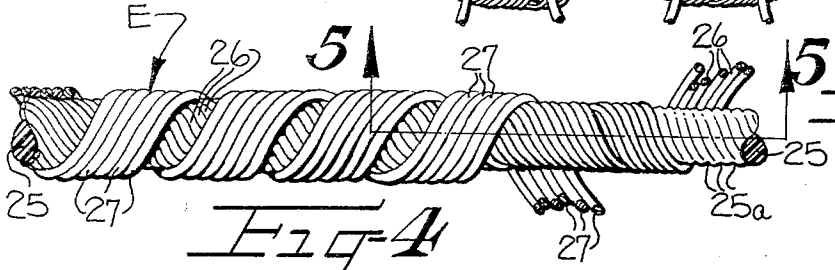

Fig-4

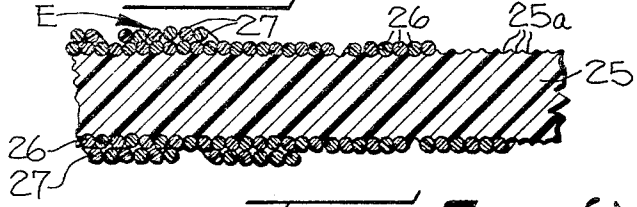

Fig-5

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SUPPORT STOCKING

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10 Claims. (Cl. 66—178)

This invention relates generally to surgical or support type stockings and more particularly to sheer ladies' stockings which provide a gentle yet effective support on the leg of the wearer without causing physical discomfort.

There have been many prior attempts to produce satisfactory surgical or support type stockings by the use of covered elastic core yarns, such as rubber or more recently elastomeric or spandex. In some cases, stockings have been knit entirely of covered elastic yarns and in other cases courses of covered elastic yarn have been knit in alternation with courses of other types of yarns. In many instances, crimped or curled multifilament synthetic thermoplastic stretchable yarns have been knit in various combinations with covered elastic yarns and the thermoplastic stretchable yarns have also been used to cover the core yarns. In most cases, the stockings knit entirely of covered elastic yarn are too heavy and unsightly while those stockings knit of interspersed courses of covered elastic yarn and courses of other types of stretchable yarn do not have the desired sheerness and because the courses of stretchable yarn have been subjected to heat, their affinity for dye is not always the same as the covered elastic yarn and this causes coursewise streaks in the stocking.

There are several commercially available synthetic elastomeric or spandex yarns which have been used, both covered and uncovered, in the knitting of surgical stockings. It is recognized that a covered elastic yarn having an elastomeric or spandex core has many advantages over a covered yarn having a rubber core because the elastomeric core is not subject to deterioration by certain lubricants, by laundering and by age in the same manner as a rubber core. However, the elastomeric yarn has a very low degree of abrasive resistance, particularly when directly engaged by a fine strand of nylon yarn. When stitch loops of nylon yarn are connected to stitch loops of an elastomeric yarn, the nylon yarn rubs across the elastomeric yarn at the points of interengagement of the knitted loops and this soon results in the cutting or severing of the elastomeric yarn. The cutting of the elastomeric yarn results in unsightly runs and holes in the stockings with a loss in the constrictive force of the stocking on the leg of the wearer.

With the foregoing in mind, it is a primary object of the present invention to provide a sheer support stocking which is knit of interspersed courses of an inelastic yarn and courses of a covered spandex yarn in which the covering is formed of an inelastic thermoplastic synthetic yarn which is wound thereabout in such a manner as to completely cover the spandex core and to prevent abrasive engagement of the spandex core by the knitted loops of the inelastic yarn in the stocking.

It is another object of the present invention to provide a support stocking of the type described wherein the interspersed courses of inelastic and elastic yarns enhance the sheer appearance of the stocking while the inelastic yarn aids in shaping the stocking and in setting the limit of stretchability of the hose but does not prevent the easy drawing of the stocking over the leg of the wearer.

It is yet another object of the present invention to provide a method of forming a support stocking of the type described wherein the spandex core is initially covered with a raw thermoplastic synthetic yarn and then

subjected to a steaming operation to shrink the thermoplastic covering yarn, thereby tightening the helically wound thermoplastic yarn about and embedding the same in the spandex core to prevent slippage of the cover during the knitting operation and to prevent separation of the helically wound coils of the covering yarn during wear of the stocking.

It is a more specific object of the present invention to provide a support stocking of the type described wherein the spandex core is covered by a first inelastic thermoplastic yarn which is closely wound about the core in one direction with a large number of wraps per inch and a second inelastic thermoplastic yarn which is closely wound about the core in an opposite direction and with a slightly lesser number of wraps per inch than the first yarn.

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 side elevation of a ladies' sheer support stocking in accordance with the present invention;

FIGURE 2 is a greatly enlarged elevational view of a small portion of the fabric in that area of the leg of the stocking indicated by the dash-dot rectangle 2 in FIGURE 1, and illustrating the appearance of the stitch loops when the fabric is relaxed;

FIGURE 3 is a view similar to FIGURE 2 but illustrating the appearance of the stitch loops when the fabric is stretched in both walewise and coursewise directions;

FIGURE 4 is a greatly enlarged elevation of the covered elastic yarn with portions of both the first and second coverings being partially unwound from one end of the spandex core; and

FIGURE 5 is a vertical sectional view of a medial portion of the covered elastic yarn, taken substantially along the line 5—5 in FIGURE 4.

Referring particularly to FIGURE 1, there is shown a seamless support stocking S which has been knit on a circular knitting machine and finished, however, it is to be understood that full-fashion support stockings according to the invention may also be knit on full-fashioned knitting machines. The stocking S includes a turned welt 10, a shadow welt 11, a leg or boot 12, and a foot having a heel pocket 13, an instep portion 14, and a toe pocket 15. The turned welt 10 and the shadow welt 11 are formed in the conventional manner on a circular knitting machine and it is preferred that they be formed of a thermoplastic stretchable yarn of the type which has a crimp or curl heat-set therein.

The invention may be more easily understood by the following detailed example which has been found to produce a fully functional sheer support stocking which is highly satisfactory for therapeutic purposes, it being understood that the detailed example is given for purposes of illustration and the invention is not to be strictly limited thereto.

In the present instance, the stocking S is knit on a two-feed circular knitting machine having 400 needles and a 3½ inch needle cylinder. The welt 10 and shadow welt 11 are first knit by feeding a 40/2 strand of "Superloft" yarn at each knitting station. This particular type of stretch yarn is of the false-twist type which is formed by passing the yarn through a heated zone and then through a false-twist spindle to twist, heat-set and untwist the yarn in a single continuous operation.

After completion of the knitting of the welt 10 and the shadow welt 11, the knitting of the leg 12 is begun by feeding and knitting an inelastic yarn Y at one knitting station while feeding and knitting a covered elastic yarn E at the other knitting station to form alternating courses of these two yarns in the leg 12, as shown in FIGURES

2 and 3. In the present instance, the inelastic yarn Y is 20 denier raw or unshrunk monofilament nylon and the elastic yarn E includes a 70 denier spandex core, indicated at **25** in FIGURES 4 and 5, and 20/6 denier inelastic nylon yarns, indicated at **26** and **27**, which form respective first and second coverings to completely cover the core **25** and protect it against a cutting action by the stitch loops of inelastic yarn Y at their points of interengagement. The spandex core **25** is a polyurethane yarn produced by E. I. du Pont under the name "Lycra." The manner in which the covered elastic yarn E is formed will be presently described.

During the knitting of the leg **12**, the covered elastic yarn E is fed to the needles at the main knitting station and the inelastic yarn Y is fed to the needles at the auxiliary knitting station. The sizes of the stitch loops drawn at each knitting station are preferably balanced and since the covered elastic yarn E has a larger diameter than the inelastic yarn Y, the needles are lowered a slightly greater distance at the auxiliary knitting station than they are lowered at the main knitting station. As knitting of the leg **12** continues, the stitch loops are gradually reduced in a conventional manner to reduce the diameter of the tube being formed and it is preferred that the elastic yarn E be fed to the machine under a uniformly maintained tension of about 6 grams to uniformly elongate the strand of elastic yarn E throughout the knitting of the leg **12**.

After completion of the desired length of leg **12**, the machine switches into reciprocatory knitting in a conventional manner to form the narrowed and widened heel pocket **13**. The heel pocket **13** is formed of a 30/2 stretchable crimped nylon yarn of the same type as was used in forming the welt **10** and shadow welt **11**. After the heel pocket **13** is completed, the machine again switches to rotary knitting and the foot portion **14** is knit in the same manner as the leg portion **12** with the inelastic yarn Y again being knit in alternating courses with the covered elastic yarn E.

Upon completion of the knitting of the foot portion **14**, the narrowed and widened toe pocket **15** is formed in a conventional manner of the same type of yarn of stretchable crimped nylon yarn as was used in knitting the heel pocket **13**. As is well known, an opening is left at the end of the toe pocket **15** as the stocking S is completed, and this toe opening may be closed by either a seaming or looping operation, in a well-known manner.

The stocking is preferably preboarded at about 250° F., then dyed to the desired shade and final-boarded at a temperature of about 245° F. While the stocking S has sufficient stretchability to fit a range of foot and leg sizes, it is preferred that the stocking be knit in several different leg and foot sizes to accommodate a complete range of sizes and to afford the proper compressive force to each wearer.

As has been stated, the elastic yarn E is covered and processed in a special manner to completely cover and protect the spandex core **25** against abrasion by other yarns and a special covering machine has been constructed to produce the covered elastic yarn E. The spandex core **25**, as received from the producer, is unwound from a supply tube and fed to a take-up spool both of which are driven at predetermined speeds. The core **25** passes through first and second hollow spindles, both of which have supply spools mounted thereon. The supply spools on the first and second hollow spindles are rotated in opposite directions and each contains 20/6 denier multifilament raw nylon yarn having producers twist of about one-half of a turn per inch therein.

As the core **25** passes through the hollow spindles, it is elongated about 153% of its relaxed length as it is being wrapped with the respective first and second covering yarns **26** and **27** (FIGURES 4 and 5). The first spindle, which applies the first covering yarn **26** to the core **25** rotates at 12,300 r.p.m. and about 20 to 55 grams of tension is applied to the covering yarn **26** so that it is tightly wrapped about the core **25**. The second spindle, which applies the second covering yarn **27** to the core **25** rotates at 10,500 r.p.m. and in a direction opposite the direction of rotation of the first spindle. About 20 to 80 grams of tension is applied to the outer covering yarn **27** so that it is tightly wrapped about the first covering yarn **26**. While the spandex core **25** is passing through the hollow spindle and elongated 153%, about 58 wraps per inch of the first covering yarn **26** are wound thereabout and about 48 wraps per inch of the second covering yarn **27** are wound around the first covering. The covered elastic yarn E passes around a driven pulley and is then taken up on the take-up spool under about 0 to 2 grams of tension and in a partially relaxed condition. Since the core **25** is elongated while the covering yarns are wrapped thereabout, the number of wraps per inch of the covering yarns is increased when the covered elastic yarn is relaxed. For example, with the covered elastic yarn E in relaxed condition, it has been found that there are 140 wraps per inch of the first covering yarn **26** and that there are 117 wraps per inch of the second covering yarn **27**.

The take-up spools of covered elastic yarn E are then placed in a steam cabinet and steamed at about 160° to 170° F. for one hour. This steaming operation shrinks the raw nylon covering yarns **26** and **27** about the core **25**, setting the spiraled helical coils in the nylon covering yarn and tightening the covering yarns around the core **25**.

As shown in FIGURES 4 and 5, the six filaments of the covering yarns **26** and **27** are flattened out in ribbon fashion as they are wrapped about the core **25**. After the covered elastic yarn E is steamed, the inner cover tightens about the core **25** and is embedded therein, actually forming helical indentations therein, as indicated at **25***a* in FIGURES 4 and 5. This steaming operation and subsequent tightening of the covering yarns about the core prevents slippage of the covering yarns on the core so that the core is always protected by the covering yarns.

The steaming of the covered elastic yarn E has also been found to increase the breaking strength and the compressive force of the covered elastic yarn. The steaming operation also slightly reduces the maximum elongation of the covered elastic yarn, however, this reduction in elongation is not enough to affect its performance in the stocking. It has also been found that this steaming operation decreases the diameter of the covered yarn E slightly and also reduces the number of wraps per inch of the first and second covering yarns. For example, before the steaming operation, the covered elastic yarn E will break under 165 grams of tension and a six inch loop will stretch 6 inches when a two ounce weight is hung on the loop. The relaxed elastic yarn E has a diameter of 0.0065 of an inch, the botto mcovering yarn **26** has 140 wraps per inch and the top covering yarn **27** has 117 wraps per inch. After the steaming operation, the covered elastic yarn E will break under 210 grams of tension and a six inch loop will stretch 5¼ inches when a two ounce weight is hung on the loop. The relaxed elastic yarn E has a diameter of .006 of an inch, the bottom covering yarn **26** has 125 wraps per inch and the top covering yarn **27** has 105 wraps per inch.

After the yarn E is covered and steamed, it is unwound from the covering machine take-up spools and onto suitable knitting cones under very little tension and while adding 15% oil to the yarn to aid in the knitting thereof.

The stocking knit is accordance with the above specific example has been found to have a stitch density of 1,392 stitches per square inch when the fabric in the upper portion of the leg is stretched to substantially its outermost limits in both coursewise and walewise directions, it being understood that the stretched stitch density of the fabric will increase slightly as the stitch loops are drawn tighter in the lower portion of the leg **12** and the foot **14**.

When the stocking S is drawn onto the leg and the fabric is stretched, in substantially the manner shown in FIG-

URE 3, the inelastic yarn Y engages the covered elastic yarn E at each of the points of interconnection of the stitch loops from one course to the next course. When the stocking is worn, the fabric is flexed and stretched, particularly in the area of the knee, so that the inelastic yarn Y moves longitudinally against the covered elastic yarn E at the points of interconnection of the stitch loops and the inelastic yarn Y tends to work or saw its way into the covered elastic yarn E. If the spandex core **25** of the covered elastic yarn E is not sufficiently protected by the covering yarns **26** and **27**, the inelastic yarn Y will engage and soon cut the core **25**, causing a run or hole in the stocking. However, in the stocking of the present invention, the core **25** is completely covered and protected by the covering yarns **26** and **27** to prevent engagement of the inelastic monofilament nylon yarn Y therewith.

Although the raw monofilament inelastic yarn Y in the interspersed courses throughout the fabric necessitates the close wrapping of the covered elastic yarn E, it is a necessary component of the stocking. For example, the courses of raw inelastic yarn Y contribute substantially to the sheer appearance of the fabric, they provide a limit to the stretchability of the fabric, and they also aid in the shrinking and shaping of the fabric during the preboarding and finishing operations.

While it has been found that the particular yarns set forth above provide a fully functional surgical or support stocking of satisfactory sheerness when knit on the particular seamless machine described, it is to be understood that support stockings having a greater sheerness may be formed by utilizing yarns of smaller denier and a heavier service weight support stocking may be formed by using yarns of greater denier.

The support stockings of the present invention preferably have a stretched stitch density within the range of about 1,000 to 2,000 stitches per square inch. The covering yarns 26 and 27 can range from about 15 to 30 denier and it is preferred that they contain a relatively small number of filaments, from about 3 to 17, in order to maintain a sheer appearance in the stocking. The spandex core yarn **25** should be within the range of about 40 to 140 denier and the covering yarns should be applied thereto in accordance with the following chart:

WRAPS PER INCH

	Before Steaming	After Steaming
Inside Cover	110 to 179	105 to 173
Outside Cover	100 to 135	96 to 130

The wraps per inch listed in the above chart are determined while the elastic yarn E is relaxed. It is to be understood that the amount of coverage of the spandex core is primarily determined by the number of wraps per inch which are applied to the covering yarns and the denier of the covering yarns, regardless of the number of filaments in each end of the covering yarn. It is preferred that the interspersed courses of inelastic yarn Y be formed of a monofilament nylon yarn within the range of about 10 to 30 denier.

Although in the specific example disclosed, the inelastic yarn Y and the covered elastic yarn E alternate in a one-by-one construction, the stocking is not limited to this specific construction but also covers other constructions in which the inelastic yarn Y and the elastic covered yarn E are interspersed in various other combinations, such as two-by-one, two-by-two, three-by-one, three-by-three, etc. Also, support stockings may be made in accordance with this invention which are full length, partial length and with closed or open type foot portions.

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. An elastic knit fabric comprising

(a) courses of a monofilament inelastic thermoplastic synthetic yarn within the range of about 10 to 30 denier, and

(b) courses of a covered elastic yarn alternating with the courses (a), said covered elastic yarn including

(1) a spandex core within the range of about 40 to 140 denier,

(2) a first covering of inelastic thermoplastic synthetic yarn helically wrapped in one direction about and being embedded in said core, said first covering yarn being within the range of about 15 to 30 denier, said embedded relationship of said covering serving to prevent longitudinal movement of the covering relative to the core, and

(3) a second covering of inelastic thermoplastic synthetic yarn helically wrapped about said first covering and in a direction opposite the direction of said first covering, said second covering yarn being within the range of about 15 to 30 denier,

(c) said coverings being wrapped within the range of about 96 to 179 wraps per inch and completely covering said spandex core to prevent abrasive engagement of the inelastic yarn of courses (a) with the spandex core of the elastic yarn of courses (b),

(d) said fabric having an average stretched stitch density of at least 1000 stitches per square inch.

2. An elastic knit sheer fabric comprising

(a) courses of a monofilament inelastic thermoplastic synthetic yarn of about 20 denier, and

(b) courses of a covered elastic yarn alternating with the courses (a), said covered yarn including

(1) a spandex core of about 70 denier,

(2) a first covering of inelastic thermoplastic synthetic yarn of about 20/6 denier helically wrapped in one direction about said core with about 125 wraps per inch and being embedded in said core, said embedded relationship of said covering serving to prevent longitudinal movement of the covering relative to the core, and

(3) a second covering of inelastic thermoplastic synthetic yarn of about 20/6 denier helically wrapped about said first covering and in a direction opposite the direction of said first covering, said second covering being wrapped with about 105 wraps per inch,

(c) said coverings completely covering said spandex core to prevent abrasive engagement of the inelastic yarn of courses (a) with the spandex core of the elastic yarn of courses (b),

(d) said fabric having an average stretched stitch density of at least 1000 stitches per square inch.

3. A support stocking having a welt, a leg portion, and a foot including heel and toe pockets and an instep portion, the leg and instep portions comprising

(a) courses of a monofilament inelastic thermoplastic synthetic yarn within the range of about 15 to 40 denier, and

(b) courses of a covered elastic yarn alternating with the courses (a), said covered elastic yarn including

(1) a spandex core within the range of about 40 to 140 denier,

(2) a first covering of multifilament inelastic thermoplastic synthetic yarn helically wrapped in one direction about said core within the range of about 105 to 173 wraps per inch, said first covering yarn being within the range of about 10 to 30 denier, said covering yarn being embedded in said core, said embedded relationship of said covering serving to prevent longitudinal

movement of the covering relative to the core, and

(3) a second covering of inelastic thermoplastic synthetic yarn helically wound about said first covering in a direction opposite the direction of wind of said first covering and within the range of about 96 to 130 wraps per inch, said second covering yarn being within the range of about 10 to 30 denier,

(c) said coverings completely covering said spandex core to prevent abrasive engagement of the inelastic yarn of courses (a) with the spandex core of the elastic yarn of courses (b),

(d) said leg and instep portions having an average stretched stitch density of at least 1000 stitches per square inch.

4. In a stocking according to claim **3** wherein said monofilament inelastic yarn of courses (a) is 20 denier nylon.

5. In a stocking according to claim **3** wherein said spandex core of the covered elastic yarn of courses (b) is a 70 denier elastimeric polyurethane yarn.

6. In a stocking according to claim **3** wherein said first and second inelastic covering yarns of the covered elastic yarn of courses (b) are both 20/6 nylon.

7. In a stocking according to claim **3** wherein said first inelastic covering yarn is wound about said core with about 125 wraps per inch, and said second inelastic covering yarn is wound about said first covering yarn with about 105 wraps per inch.

8. A sheer support stocking having a welt, a leg portion, and a foot portion, at least the major portion of said leg portion comprising

(a) courses of a monofilament 20 denier nylon yarn, and

(b) courses of a covered elastic yarn interspersed with the courses (a), said covered elastic yarn including

(1) a 70 denier elastomeric polyurethane core,

(2) a first covering of 20/6 inelastic nylon yarn helically wound in one direction about said core with about 125 wraps per inch, said covering yarn being embedded in said core, said embedded relationship of said covering serving to prevent longitudinal movement of the covering relative to the core, and

(3) a second covering of 20/6 inelastic nylon yarn helically wound about said first covering in a direction opposite the direction of wind of said first covering with about 105 wraps per inch,

(c) said coverings completely covering said spandex core to prevent abrasive engagement of the inelastic yarn of courses (a) with the spandex core of the elastic yarn of courses (b),

(d) the said major portion having an average stretched stitch density of at least 1000 stitches per square inch.

9. A knitted sheer stocking whose leg portion comprises alternating courses of helically wrapped spandex yarn and nylon yarn; said wrapped spandex yarn having a 70 denier spandex core, a first wrapping of 20 denier multifilament nylon yarn helically wrapped in one direction about said core; the range of wraps per inch of said first wrapping being in excess of 100; a second wrapping of 20 denier multifilament nylon yarn helically wrapped about said first wrapping in the opposite direction thereto; said second wrapping being wrapped with a lesser number of wraps per inch than said first wrapping; said first-mentioned nylon yarn having a total denier not in excess of about 30; said stocking having an average stretched stitch density in the leg portion of at least 1000 stitches per square inch.

10. A knitted sheer stocking whose leg portion comprises alternating courses of helically wrapped spandex yarn and nylon yarn; said wrapped spandex yarn having a spandex core within the range of about 40 to 140 denier, a first wrapping of multifilament nylon yarn helically wrapped in one direction about said core; said first wrapping yarn being within the range of about 15 to 30 denier; the range of wraps per inch of said first wrapping being in excess of 100; a second wrapping of multifilament nylon yarn helically wrapped about said first wrapping in the opposite direction thereto; said second wrapping yarn being within the range of about 15 to 30 denier; said second wrapping being wrapped with a lesser number of wraps per inch than said first wrapping; said first-mentioned nylon yarn having a total denier not in excess of about 30; said stocking having an average stretched stitch density in the leg portion of at least 1000 stitches per square inch.

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