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(54) **YARN AND METHOD OF MANUFACTURING THEREOF**

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(71) Applicant: **OLAH INC.**, New York, NY (US)

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(72) Inventors: **Michael Morrell**, New York, NY (US);
Bart D. Van De Woestyne, New York, NY (US)

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(57) **ABSTRACT**

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Embodiments of the present invention are directed to a tri-core yarn including a core including an elastomeric filament, a first cover, and a second cover, and a fiber sheath covering the core, wherein the first cover and the second cover are each wrapped around the elastomeric filament.

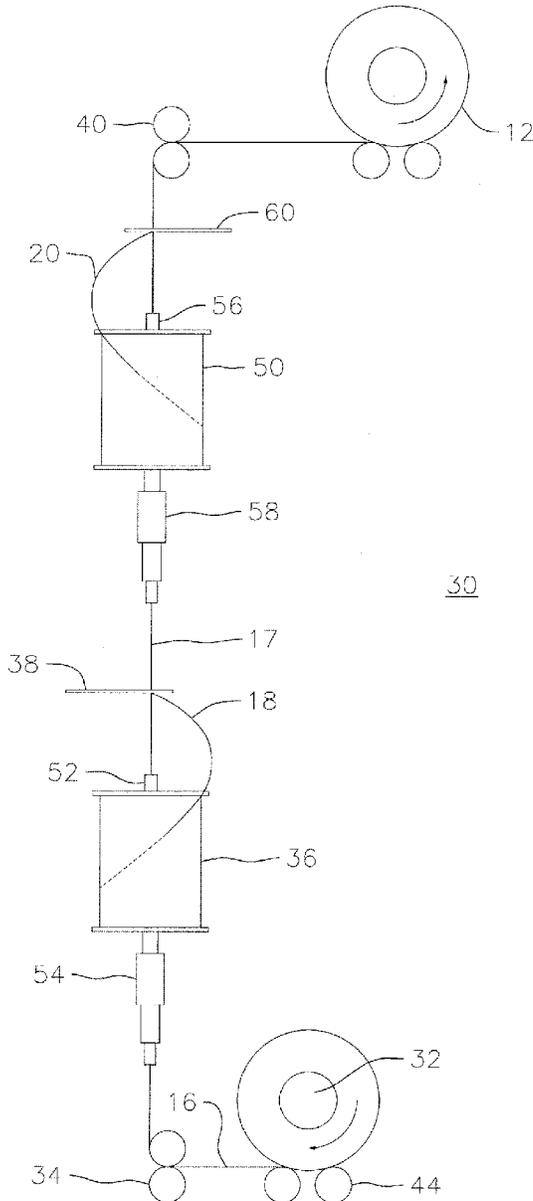


FIG. 1
PRIOR ART

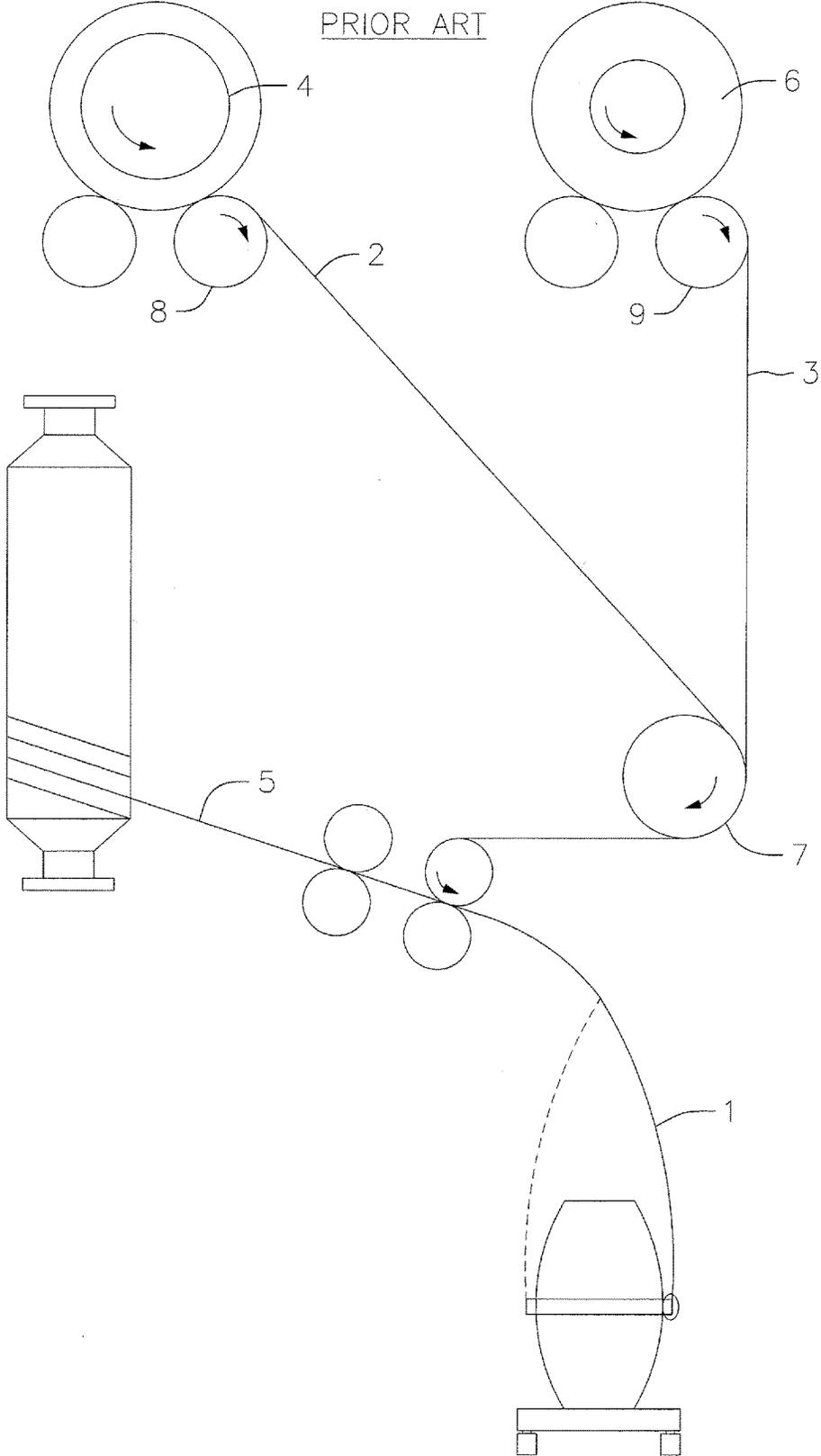


FIG. 2

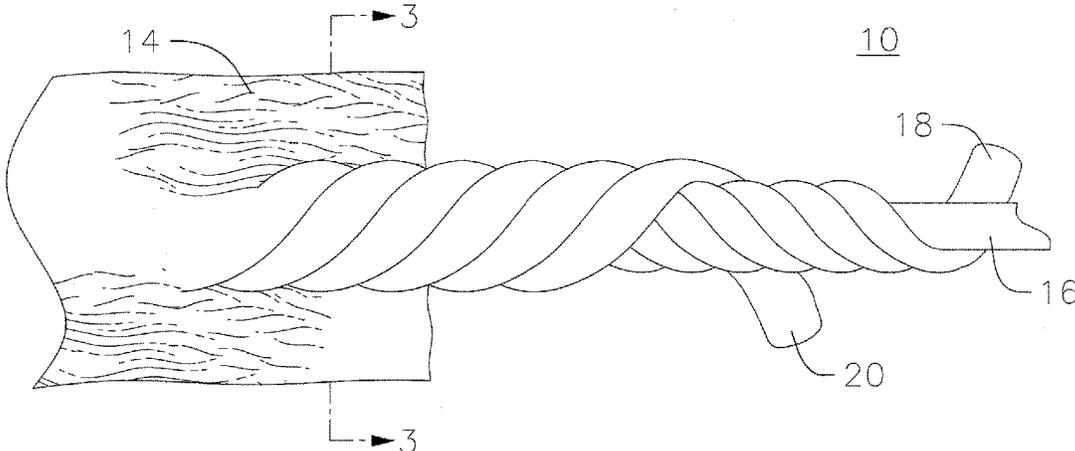


FIG. 3

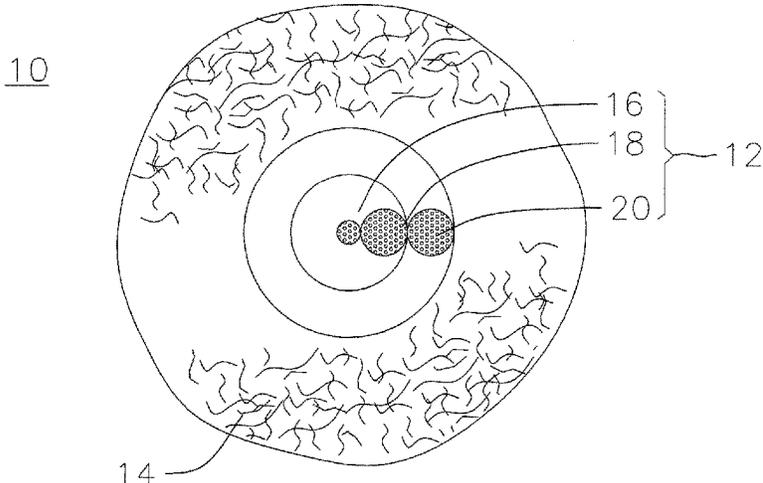


FIG. 4

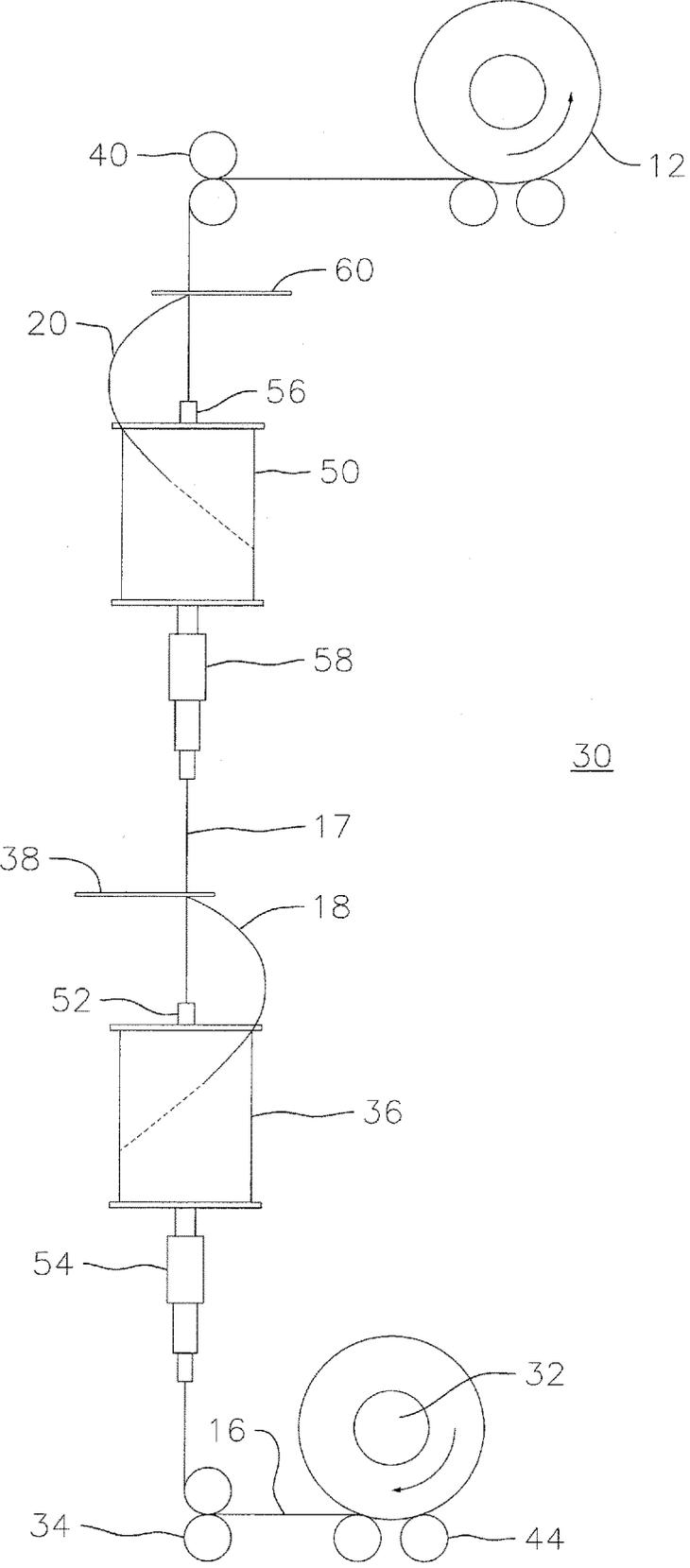


FIG. 5

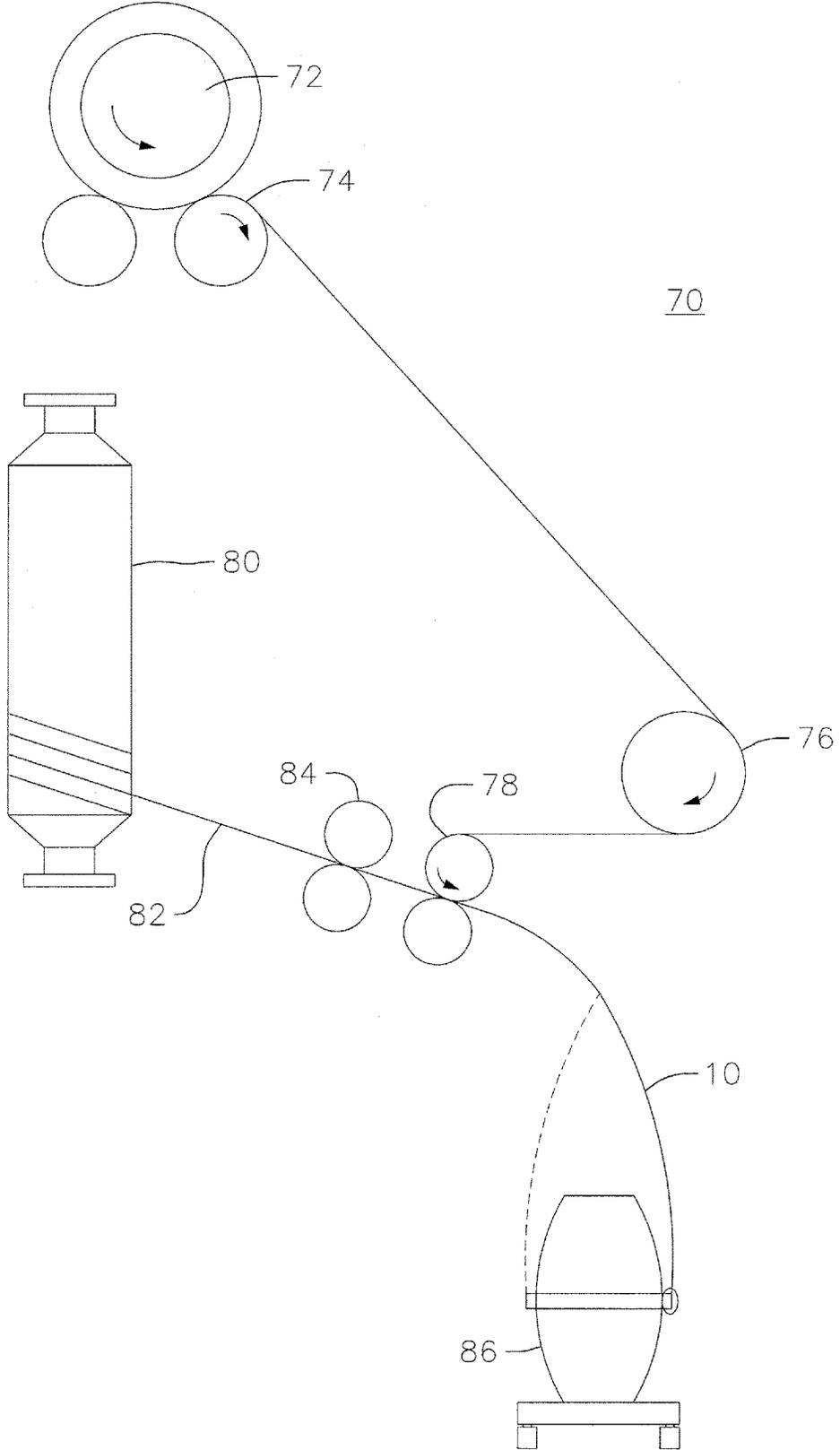


FIG. 6

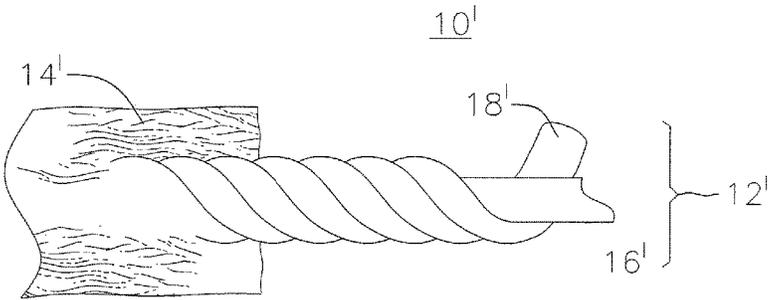


FIG. 7

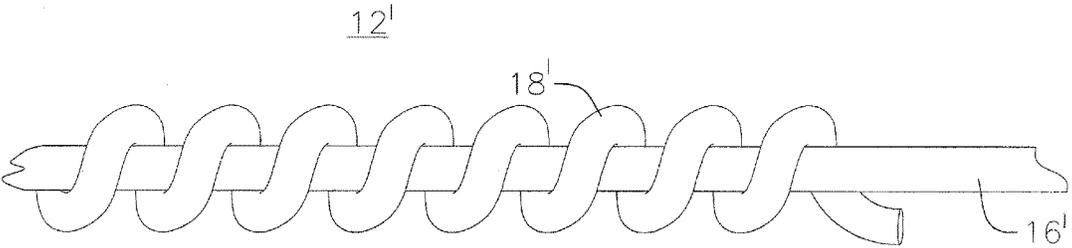


FIG. 8

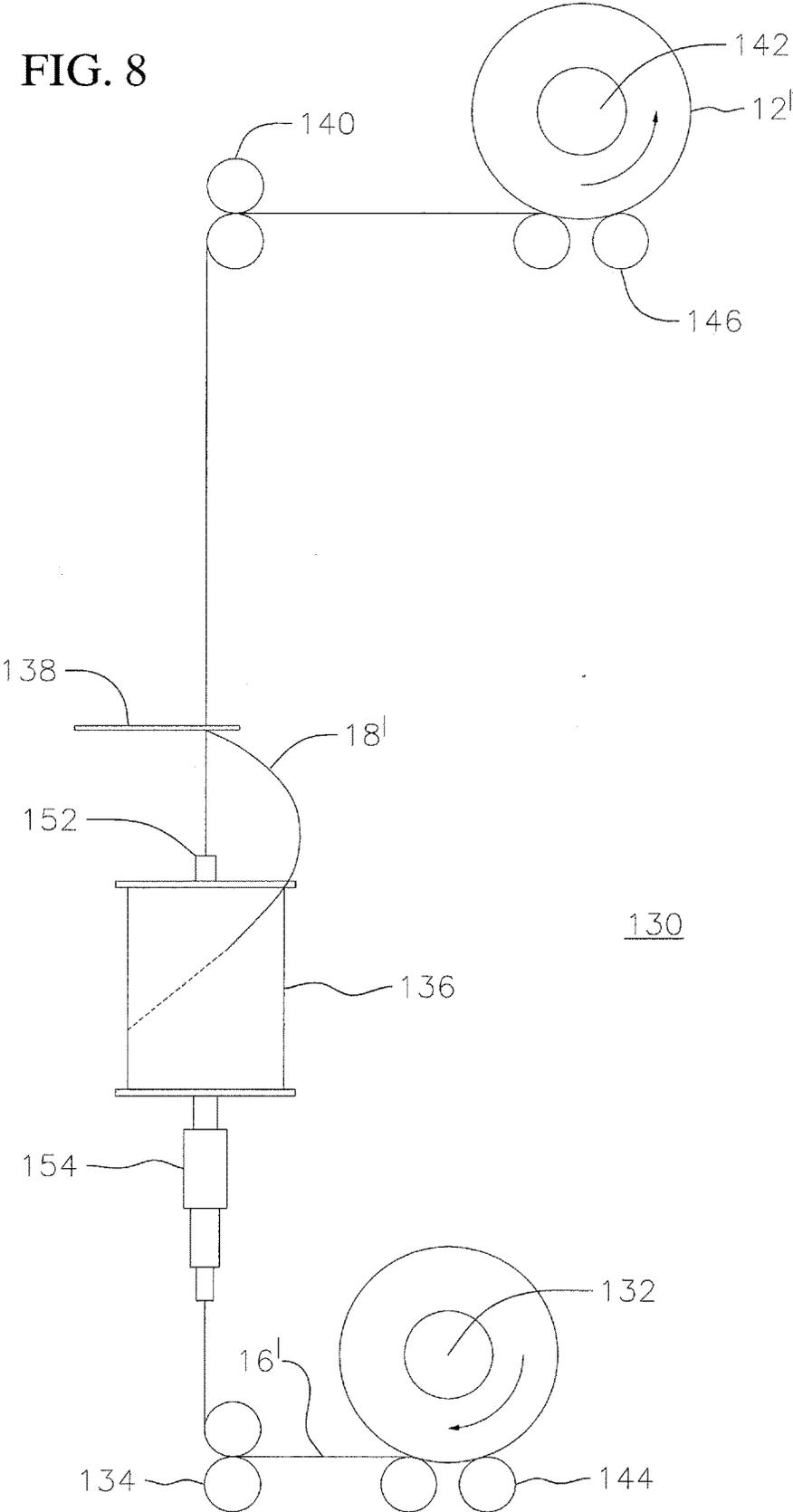


FIG. 9

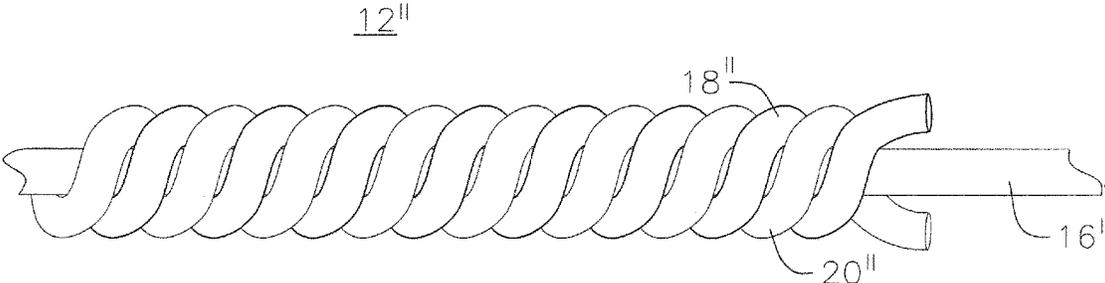


FIG. 10

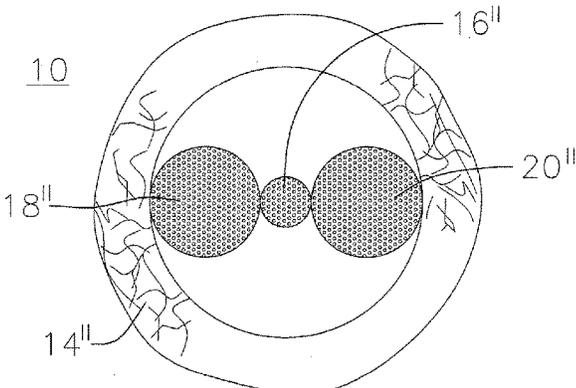


FIG. 11

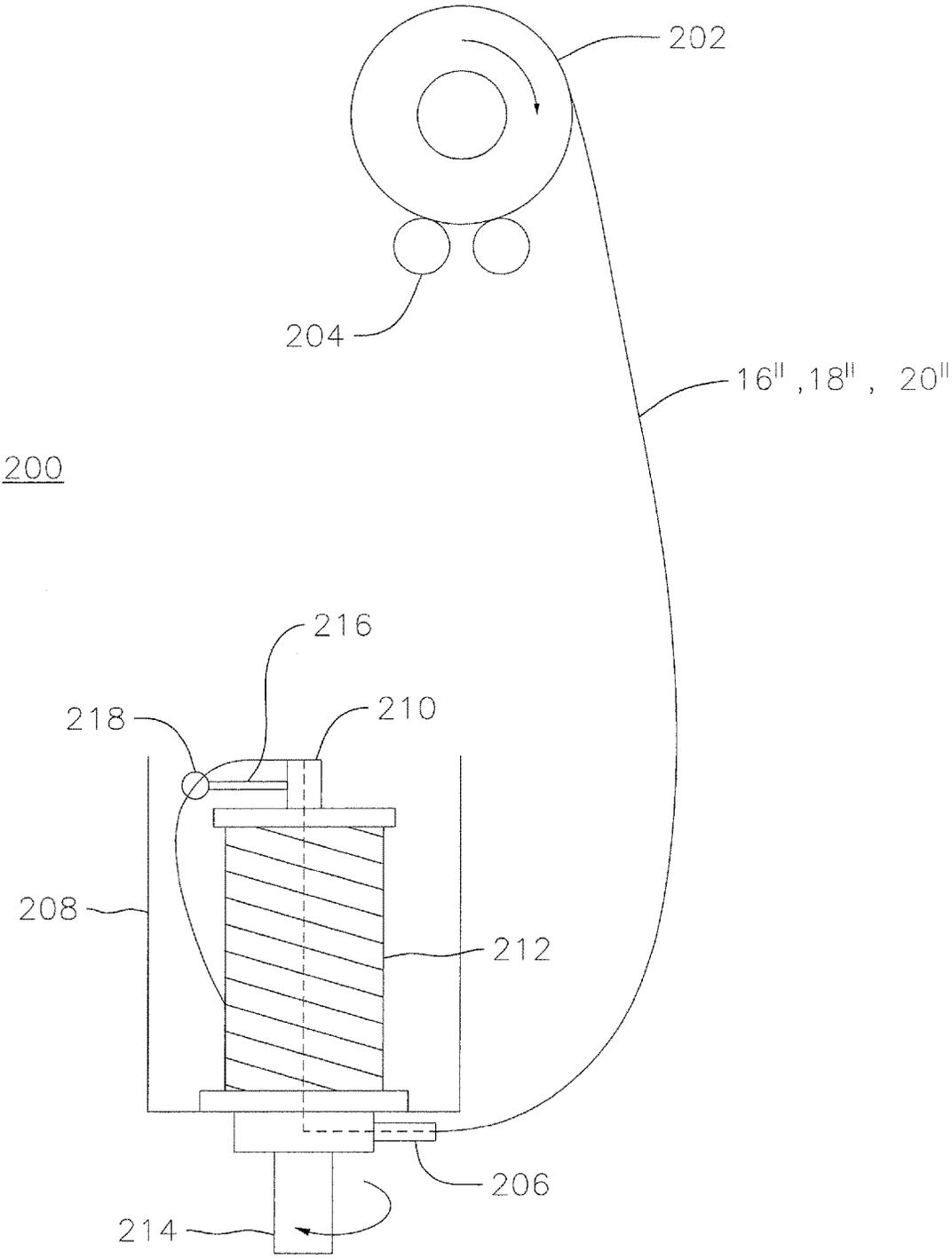


FIG. 12

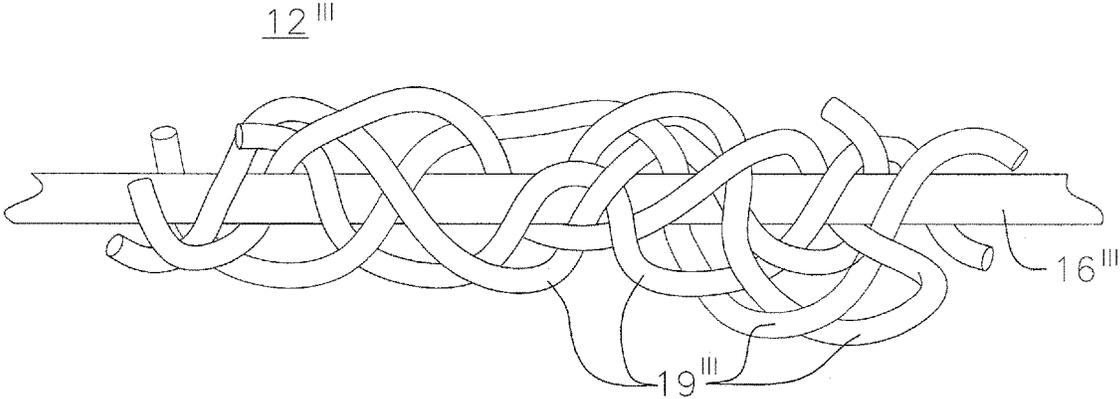


FIG. 13

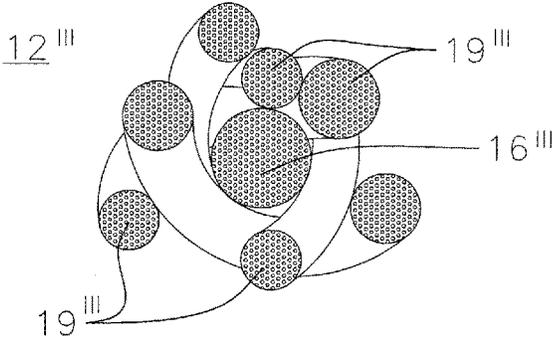
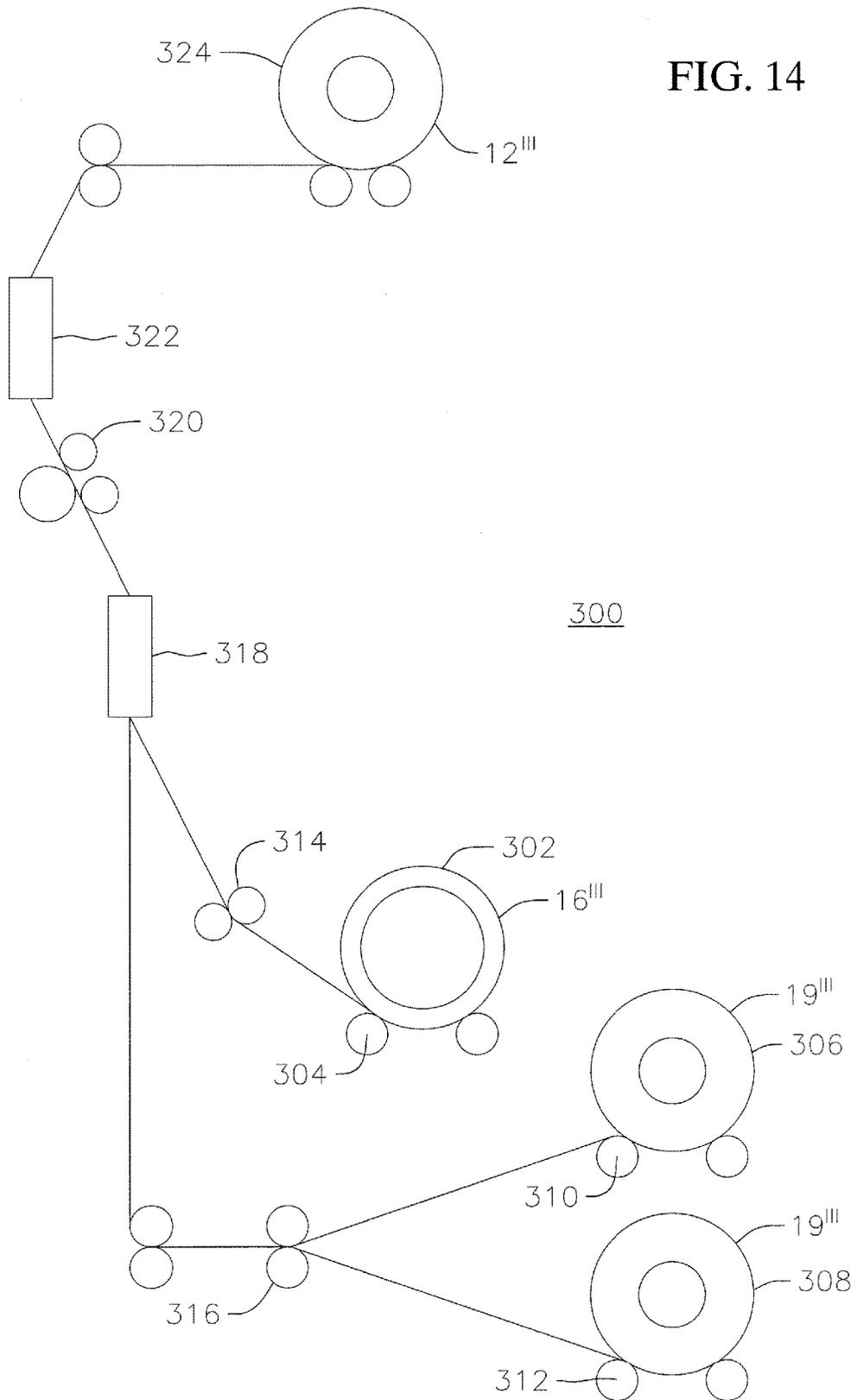


FIG. 14



YARN AND METHOD OF MANUFACTURING THEREOF

BACKGROUND

1. Field

[0001] Embodiments of the present invention relate to yarn and a method of manufacturing thereof.

2. Description of the Related Art

[0002] Composite elastic yarns are well-known. Generally, conventional composite yarns include an elastomeric filament or elastomeric fiber constituting a core covered by a relatively inelastic fibrous or filamentary sheath. Particularly, stretch fabrics including elastic composite yarn have recently seen increased popularity in the fashion and textiles markets due to their comfort, versatility, and durability.

[0003] A conventional composite yarn has been made, wherein a single elastic fiber (as a core) runs through a sheath of hard fibers. In this case, an “elastomeric fiber” is a continuous filament which has a break elongation in excess of 100% independent of any crimp and which when stretched to twice its length, held for one minute, and then released, retracts to less than 1.5 times its original length within one minute of being released. Such fibers include, but are not limited to, rubbers, spandex or elastane, polyetheresters, and elastoesters.

[0004] To produce a composite core spun yarn, a single core spinning attachment is attached to a spinning apparatus. In one example, the attachment is a metal plate bent to a shape suited for its purpose. The attachment may be coupled to the spinning apparatus such that a relative position of a roving, i.e., a strand of staple fibers in an intermediate state between sliver and yarn which are provided to be a continuous stream of staple fibers fed into the apparatus and the core filament may be kept constant at all times. Further, the attachment may include a porcelain guide that feeds the core filament at a precise position with respect to the front drafting rollers. The attachment also may have a pre-tensioner to allow variation of the input tension of the core filament.

[0005] However, conventional composite yarns do not provide all of the desired characteristics, namely, easy stretch, high recovery, and low shrinkage performance. Particularly, although these yarns provide some elasticity for stretch fabrics, the yarns exhibit poor recovery, and may result in saggy or baggy clothing over time.

[0006] More recently, yarns being spun with two sets of elastic yarns in the core have been introduced, so called “dual core” yarns. These “dual core” yarns 1 (see FIG. 1) include a first elastic yarn 2 and a second elastic yarn 3 which are substantially parallel to each other and a fiber sheath 5 is used to cover the two elastic yarns 2, 3. However, to run two sets of different elastic core fibers (i.e., the first elastic yarn 2 and the second elastic yarn 3), special and costly attachments are required. For example, referring to FIG. 1, two separate fiber draft devices may need to be installed on a core spinning apparatus. The core spinning apparatus includes two separate core filaments (i.e., the first elastic yarn 2 and the second elastic yarn 3) respectively accommodated on a respective bobbin 4, 6. The bobbins 4, 6 are respectively positioned on feed rollers 8, 9, and are each controlled by a separate fiber draft device. The two

elastic core fibers 2, 3 are then fed to one draft roller 7. Further, two attachments, such as the one described above, may be required. Even further, because the two elastic core fibers 2, 3 typically have different draft ratios, the tensioning of the two elastic core fibers 2, 3 may require additional programming or software to facilitate and drive the separate fiber draft devices.

[0007] Accordingly, dual core yarns result in an exponential increase in the cost of stretch woven fabrics. Further, the dual core yarns are susceptible to slippage of one elastomeric yarn, which is inserted at a higher draft relative to the other core yarn, which further raises costs of fabrication, may have adverse effects on elasticity, recovery, and may result in sagging.

[0008] Alternative to core spun yarns, covered yarns have also been used. In a covered yarn, one or more polyester or nylon filaments are wound around an elastomeric core. However, these covered yarns often have a harsh, synthetic feel, and therefore may be disfavored by a garment wearer.

[0009] In general, it is desirable for stretch fabrics to be comfortable for a wearer, to have stretchability, and to have high recoverability, such that the garment returns to the same or substantially the same shape after stretching. Without high recoverability, a garment may sag or become baggy after long-term or repeated wear. Additionally, it is desirable for stretch fabrics to be manufactured economically to keep the price reasonable, particularly if the economically provided fabrics also exhibit improved performance.

SUMMARY

[0010] Accordingly, there is a desire for a yarn and a method of manufacturing a yarn that reduces manufacturing costs while providing a yarn with comfort, stretch, and recovery characteristics. Particularly, there is a desire for a multiple fiber core yarn that is core spun to achieve such characteristics.

[0011] A yarn according to one or more embodiments of the present invention includes a single core that is comfortable, provides high stretch, good recovery, low growth, and prevents or reduces the likelihood of slipping and/or creating stretch voids.

[0012] In one or more embodiments of the present invention, a tri-core yarn includes a core including an elastomeric filament, a first cover, and a second cover, and a fiber sheath covering the core, wherein the first cover and the second cover are each wrapped around the elastomeric filament.

[0013] In some embodiments, the first cover may be wrapped in a first direction and the second cover may be wrapped in a second direction.

[0014] In some embodiments, the elastomeric filament, the first cover, and the second cover may be twisted together.

[0015] In some embodiments, the first cover and the second cover may be different materials.

[0016] In some embodiments, the elastomeric fiber may be in a range of about 10 denier to about 300 denier.

[0017] In some embodiments, the first cover may include polyester or nylon.

[0018] In some embodiments, the first cover may be partially oriented yarn or fully drawn yarn.

[0019] In some embodiments, the first cover may be in a range of about 10 denier to about 600 denier.

[0020] In some embodiments, the core may be in a range of about 10 denier to 600 denier.

[0021] In some embodiments, the fiber sheath may include cotton, polyester, viscose, rayon, modal, lyocell, cupro, nylon, acrylic, wool, linen, hemp, ramie, and/or polyethylene.

[0022] In some embodiments, the first cover yarn may be wrapped around the elastomeric filament and the second cover yarn may be wrapped around the first cover yarn.

[0023] According to one or more embodiments of the present invention, a method of manufacturing yarn includes covering an elastomeric filament with a first cover yarn and a second cover yarn to form a core and core-spinning the core to add a fiber sheath.

[0024] In some embodiments, the covering of the elastomeric filament may include wrapping the first cover yarn around the elastomeric filament in a first direction and wrapping the second cover yarn around the elastomeric filament in a second direction.

[0025] In some embodiments, the covering of the elastomeric filament may include intermingling or air-covering the elastomeric filament with the first cover yarn and the second cover yarn.

[0026] In some embodiments, the covering of the elastomeric filament may include aligning the elastomeric filament, the first cover yarn, and the second cover yarn and twisting the elastomeric filament, the first cover yarn, and the second cover yarn together.

[0027] According to one or more embodiments of the present invention, a stretch fabric includes a yarn, and the yarn includes a core including an elastomeric filament, a first cover; and a second cover; and a fiber sheath covering the core, wherein the first cover and the second cover are each wrapped around the elastomeric filament.

[0028] In some embodiments, a weft and a warp of the fabric may include the yarn.

[0029] In some embodiments, the fabric includes plain, poplin, twill, oxford, dobby, sateen and/satin fabric.

[0030] In some embodiments, the stretch fabric may be stretched to between 10% and 100% of its original size in a warp direction.

BRIEF DESCRIPTION OF THE DRAWINGS

[0031] These and other features and aspects of embodiments of the present invention will be better understood by reference to the following detailed description, when considered in conjunction with the accompanying figures. Like numbers are used throughout the figures to reference like features and components.

[0032] FIG. 1 is a schematic view of a conventional dual core yarn covering apparatus for preparing a core.

[0033] FIG. 2 is a side view of a partially wrapped tri-core yarn according to one or more embodiments of the present invention.

[0034] FIG. 3 is a cross-sectional view of the tri-core yarn of FIG. 2 taken along the line 3-3 of FIG. 2.

[0035] FIG. 4 is a schematic view of a tri-core yarn covering apparatus for preparing a core according to one or more embodiments of the present invention.

[0036] FIG. 5 is a schematic view of a tri-core yarn spinning apparatus for preparing a completed tri-core yarn according to one or more embodiments of the present invention.

[0037] FIG. 6 is a side view of a partially wrapped yarn according to one or more embodiments of the present invention.

[0038] FIG. 7 is a side view of a core of the yarn of FIG. 6.

[0039] FIG. 8 is a schematic view of a covering apparatus for preparing the core of FIG. 7.

[0040] FIG. 9 is a side view of a core of a yarn according to one or more embodiments of the present invention.

[0041] FIG. 10 is a cross-sectional view of the core of FIG. 9 and a sheath.

[0042] FIG. 11 is a schematic view of an apparatus for covering the core of FIG. 9.

[0043] FIG. 12 is a side view of a core of a yarn according to one or more embodiments of the present invention.

[0044] FIG. 13 is a cross-sectional view of the core of FIG. 12.

[0045] FIG. 14 is a schematic view of an apparatus for covering the core of FIG. 12.

DETAILED DESCRIPTION

[0046] Embodiments of the present invention relate to a yarn including a single core having an elastomeric fiber that is covered by one or more cover fibers, and then core spun inside a sheath of hard fibers. In other words, the yarn includes a multiple-fiber core, for example, a core having two, three, or more fibers, such multiple fiber core then being located within a sheath of fibers core spun to produce the yarn.

[0047] Despite the yarn having a core including multiple fibers, which would usually each require separate attachment to the spinning apparatus, embodiments of the present invention include such multiple fiber cores that can be produced without requiring a separate attachment for each core yarn. Rather, the fibers that make up the core may first be combined together to produce a covered core yarn, whereby one, two, or more cover fibers are combined with an elastomeric fiber, for example, by wrapping the cover fiber(s) around the elastomeric fiber.

[0048] After the covered core yarn has been produced, the covered core yarn can then be core spun with the sheath fibers to produce the final yarn. Even though the covered core yarn contains multiple fibers, it effectively forms a single strand that can be fed into a spinning apparatus to then be core spun with the sheath fibers.

[0049] As such, traditional single core spinning equipment may be used to fabricate the yarn. In other words, while conventionally produced core spun yarns having multiple core fibers may be known, as noted above, such yarns typically require a separate attachment for each of the core fibers. However, embodiments of the present invention provide for the manufacture of multiple-fiber core spun yarns that are producible by using a single core spinning apparatus.

[0050] Further, while core spun yarns are known having two core fibers, embodiments of the present invention provide for a core spun yarn that has at least three core fibers. Additionally, such a three core (or tri-core) spun yarn can also be produced on an apparatus having only a single core spinning attachment rather than requiring multiple spinning attachments.

[0051] The drawings depict some example embodiments for illustrative purposes only, and it will be apparent that modifications may be made without departing from the spirit and scope of the invention, and also that the present invention may be used in other applications in the same or similar

fields. Moreover, the figures contained in this application are not necessarily drawn to scale and various features may be exaggerated.

[0052] Referring now to FIGS. 2-5, a composite yarn (or a “tri-core yarn”) 10 includes a core 12 that is covered by a fiber sheath 14. The core 12 may be interchangeably referred to herein as a “covered core yarn.”

[0053] In one or more embodiments, the covered core yarn 12 includes an elastomeric fiber (or filament) 16, a first cover (or first cover yarn) 18, which is wrapped around the elastomeric fiber 16, and a second cover (or second cover yarn) 20, which is wrapped around the elastomeric fiber 16 and the first cover 18. The covered core yarn 12 is then covered by the fiber sheath 14 to form the tri-core yarn 10. The elastomeric fiber 16 may be in a range of between about 10 denier to about 300 denier. The first cover 18 and the second cover 20 may include a rigid or slightly elastic yarn, such as partially oriented yarn (“POY”), drawn textured yarn (“DTY”) and/or fully drawn yarn (“FDY”), and may be in a range of between about 10 denier to about 600 denier. The first cover 18 may be wrapped around the elastomeric fiber 16 in a first direction (e.g., a clockwise direction) and the second cover 20 may be wrapped around the elastomeric fiber 16 in a second direction (e.g., a counterclockwise direction). It will be appreciated that although the figures show the first cover 18 tightly wrapped around the elastomeric fiber 16 such that the second cover 20 and the elastomeric fiber 16 do not contact each other, in some embodiments, the second cover 20 and the elastomeric fiber 16 may contact each other. For example, when the first cover 18 is wound such that openings or gaps are formed between each winding of the first cover 18, when the second cover 20 is wrapped around the first cover 18 and the elastomeric fiber 16, the second cover 20 may contact the elastomeric fiber 16.

[0054] As shown in FIG. 4, a covering apparatus 30 is provided to produce the covered core yarn 12 having the first cover 18 and the second cover 20. In one embodiment, the covering apparatus 30 includes a first core yarn bobbin 32 rotatably mounted on a first support roller 44. The first core yarn bobbin 32 accommodates the elastomeric fiber 16, which is unwound from the first core yarn bobbin 32 to provide a supply of a first core fiber. The elastomeric fiber 16 extends from the first core yarn bobbin 32 over a first feed roller 34.

[0055] The covering apparatus further includes a first hollow bobbin 36 having a channel 52 extending along a longitudinal axis therethrough and a first spindle 54 arranged between the first hollow bobbin 36 and the first feed roller 34. The first hollow bobbin 36 includes a supply of a first wrapping fiber 18 wound thereon. The first hollow bobbin 36 having the first wrapping fiber 18 wrapped around it is located at a position between the first feed roller 34 and a second hollow bobbin 50 and is rotatable about its longitudinal axis. The first wrapping fiber 18 extending between the first feed roller 34 and the second hollow bobbin 50 extends through the channel 52 of the first hollow bobbin 36.

[0056] The first spindle 54 may generate (or control) rotational speed and a wrapping ratio of the elastomeric fiber 16 and the first wrapping fiber 18. When the first hollow bobbin 36 is rotated in a first direction (for example, a clockwise direction), the first wrapping fiber 18 located on the outside of the first hollow bobbin 36 is wrapped around the elastomeric fiber 16 exiting the channel 52 of the first hollow bobbin 36, thereby forming an intermediate core 17.

In one embodiment, the first wrapping fiber 18 is guided through a first ring guide 38 to ensure that it is evenly and accurately wrapped around the elastomeric fiber 16 to form the intermediate core 17.

[0057] The second hollow bobbin 50 and the first hollow bobbin 36 may have substantially the same structure. As such, the second hollow bobbin 50 may have a channel 56 extending along a longitudinal axis therethrough, and includes a supply of a second wrapping fiber 20 wrapped thereon. The second hollow bobbin 50 having the second wrapping fiber 20 wrapped around it is located at a position between the first hollow bobbin 36 and a second feed roller 40, and is rotatable about its longitudinal axis.

[0058] The second wrapping fiber 20 extending between the first hollow bobbin 36 and the second feed roller 40 extends through the channel 56 of the second hollow bobbin 50.

[0059] A second spindle 58 may be arranged between the second hollow bobbin 50 and the second feed roller 40 and may generate (or control) rotational speed and a wrapping ratio of the intermediate core 17 and the second wrapping fiber 20. When the second hollow bobbin 50 is rotated in a second direction (for example, a counterclockwise direction), the second wrapping fiber 20 located on the outside of the second hollow bobbin 50 is wrapped around the intermediate core 17. Particularly, the second wrapping fiber 20 is guided through a second ring guide 60 to ensure that it is evenly and accurately wrapped around the intermediate core 17 to produce the three-fiber covered core yarn 12 including the elastomeric fiber 16, the first wrapping fiber 18, and the second wrapping fiber 20.

[0060] In some embodiments, the second hollow bobbin 50 and the first hollow bobbin 36 are rotated in different (or opposite) directions, such that the first wrapping fiber 18 is wrapped around the elastomeric fiber 16 in one direction and the second wrapping fiber 20 is wrapped around the elastomeric fiber 16 in a different direction.

[0061] Referring to FIG. 5, a core spinning apparatus 70 is provided to produce the tri-core yarn 10 using the covered core yarn 12. In some embodiments, the core spinning apparatus 70 includes a first core yarn bobbin 72 rotatably mounted on a first feed roller 74. The covered core yarn 12 is wound around the first core yarn bobbin 72 to provide a core of the yarn 10. The covered core yarn 12 extends from the first core yarn bobbin 72, around a first feed roller 76 and to a second feed roller 78. The covered core yarn 12 may include three yarns or filaments (e.g., the elastomeric fiber 16, the first cover 18, and the second cover 20), as described above.

[0062] The core spinning apparatus 70 further includes a roving 80 having a fiber (e.g., cotton) 82 wound thereon. The cotton 82 is wound around the roving 80 and extends from the roving 80 to a third feed roller 84. The cotton 82 and the covered core yarn 12 are both fed through the second feed roller 78 and the cotton 82 is wrapped around the core 12 to form the sheath 14 around the covered core yarn 12, and thereby forming the tri-core yarn 10. The tri-core yarn 10 is then wrapped around a skein 86.

[0063] The fiber sheath 14 may include cotton, polyester, viscose, rayon, modal, lyocell, cupro, nylon, acrylic, wool, linen, hemp, ramie, polyethylene, or any combination thereof.

[0064] It will be appreciated that the covered core yarn 12 may provide elasticity, yet may be used on a traditional

bobbin in a traditional core spinning process or a ring spinning process. Because the elastomeric fiber 16 of the covered core yarn 12 is covered, the covered core yarn 12 may be used on a traditional bobbin, without the need for a second, separate elastomeric fiber 16 in the core, and the covered core yarn 12 may easily receive the fiber sheath 14 during spinning. As such, fabrication of the composite yarn 10 may be simplified by using the covered core yarn 12, and manufacturing costs may be significantly reduced, while still providing elasticity and recovery. Further, by covering the elastomeric fiber 16 in the covered core yarn 12, the elastic qualities of the elastomeric fiber 16 may be provided to the covered core yarn 12, but the covered core yarn 12 is capable of receiving the fiber sheath 14.

[0065] The covered core yarn according to embodiments of the present invention may include one wrapping fiber, or may include two or more wrapping fibers. For example, as illustrated in FIGS. 6 and 7, in some embodiments a composite yarn 10' may have a covered core yarn 12' including an elastomeric fiber 16' and a first cover 18'. The elastomeric fiber 16' may be in a range of between about 10 denier to about 300 denier. The first cover 18' may include a rigid or slightly elastic yarn, such as polyester and/or nylon yarn, and may be POY, DTY, and/or FDY, and may be in a range of between about 10 denier to about 600 denier.

[0066] As shown in FIG. 8, a covering apparatus 130 is provided to produce the covered core yarn 12'. In one embodiment, the covering apparatus 130 includes a first core yarn bobbin 132 rotatably mounted on a first support roller 144. The elastomeric fiber 16' is wound around the first core yarn bobbin 132 to provide a supply of a first core fiber. The elastomeric fiber 16' extends from the first core yarn bobbin 132 over a first feed roller 134.

[0067] The covering apparatus further includes a hollow bobbin 136 having a channel 152 extending along a longitudinal axis therethrough and a spindle 154 arranged between the hollow bobbin 136 and the first feed roller 134. The hollow bobbin 136 includes a supply of a first wrapping fiber 18' wound thereon. The hollow bobbin 136 having the first wrapping fiber 18' wrapped around it is located at a position between the first feed roller 134 and a second feed roller 140 and is rotatable about its longitudinal axis. The first wrapping fiber 18' extending between the first and second feed rollers 134, 140 extends through the channel 152 of the hollow bobbin 136.

[0068] The spindle 154 may generate (or control) rotational speed and a wrapping ratio of the elastomeric fiber 16' and the first wrapping fiber 18'. When the hollow bobbin 136 is rotated, the first wrapping fiber 18' located on the outside of the hollow bobbin 136 is wrapped around the elastomeric fiber 16' exiting the channel 152 of the hollow bobbin 136. Particularly, the first wrapping fiber 18' is guided through a ring guide 138 to ensure that it is evenly and accurately wrapped around the elastomeric fiber to produce the two-fiber covered core yarn 12' including the elastomeric fiber 16' and the first wrapping fiber 18'.

[0069] The covered core yarn 12' is then fed over the second feed roller 140 and is wound around a winding bobbin 142 which is rotatably mounted on a second support roller 146. The two-fiber covered core yarn 12' can then be used as the core of the composite yarn 10'. For example, the covered core yarn 12' may be used in the core spinning apparatus 70 described above with respect to FIG. 5 to produce the composite yarn 10'.

[0070] As yet another example, referring to FIGS. 9-14, a composite yarn may include a covered core yarn including an elastomeric fiber and a plurality of cover yarns. The elastomeric fiber may be in a range of between about 10 denier to about 300 denier. The plurality of cover yarns may be twisted, intermingled, or entangled by winding or using an air jet to cover the elastomeric fiber. The cover yarns may include a rigid or slightly elastic yarn, such as polyester and/or nylon yarn, and may be POY, DTY, and/or FDY, and may be in a range of between about 10 denier to about 600 denier.

[0071] In one or more embodiments, referring to FIGS. 9-11, a composite yarn 10" may have an elastomeric fiber 16", a first cover 18", and a second cover 20" which are aligned and twisted together to form a twist covered core yarn 12".

[0072] Referring to FIG. 11, the covered core yarn 12" may be prepared using a twist covering apparatus 200. In one embodiment, the twist covering apparatus 200 includes a bobbin 202 rotatably mounted on a support roller 204. The elastomeric fiber 16", the first cover 18", and the second cover 20" are each wound in parallel around the bobbin 200 (e.g., to form semi-parallel yarn).

[0073] The elastomeric fiber 16", the first cover 18", and the second cover 20" are then guided through a nozzle 206 and into a twisting pot 208. For example, the elastomeric fiber 16", the first cover 18", and the second cover 20" may be fed through a channel 210 extending along a longitudinal axis of a skein 212 inside the twisting pot 208, and a spindle 214 may be arranged between the skein 212 and the support roller 204 to generate (or control) rotational speed of the elastomeric fiber 16", the first cover 18", and the second cover 20". The elastomeric fiber 16", the first cover 18", and the second cover 20" are then guided through the channel 210 through an eye 218 at the end of a twisting arm 216. Accordingly, the elastomeric fiber 16", the first cover 18", and the second cover 20" are twisted together to form the composite core 12", which is then wound onto the skein 212.

[0074] As another example, in one or more embodiments, the covered core yarn may include a plurality of cover yarns. For example, referring to FIGS. 12-14, a composite yarn 10''' may have an elastomeric fiber 16''', and a plurality of cover yarns 19''' which cover the elastomeric fiber 16''' to form a covered core yarn 12'''.

[0075] Referring to FIG. 14, the covered core yarn 12''' may be prepared using an air covering apparatus 300. In one embodiment, the air covering apparatus 300 includes a first bobbin 302 having the elastomeric fiber 16''' wound thereon, that is rotatably mounted on a first support roller 304, a second bobbin 306 having one of the plurality of cover yarns 19''' wound thereon, that is rotatably mounted on a second support roller 310, and a third bobbin 308 having one of the plurality of cover yarns 19''' wound thereon, that is rotatably mounted on a third support roller 312.

[0076] The elastomeric fiber 16''' is fed through a first draw roller 314 and the cover yarns 19''' are fed through a second draw roller 316. The elastomeric fiber 16''' and the cover yarns 19''' are then fed into a stop motion 318, which gathers the elastomeric fiber 16''' and the cover yarns 19''' together. The gathered elastomeric fiber 16''' and the cover yarns 19''' are then guided through additional rollers 320 to an air nozzle 322 which intermingles the elastomeric fiber 16''' and the cover yarns 19''', thereby forming the covered core yarn 12''', which is then wound onto a bobbin 324.

[0077] The tri-core yarn **10** may be used for making various stretch fabrics capable of having weave patterns. For example, the tri-core yarn **10** may be used for plain, poplin, twill, oxford, dobby, sateen, satin, and combinations thereof, providing stretch that may vary from 10% to 100% in warp and/or weft direction. Further, the tri-core yarn **10**, and the resulting stretch fabric, may have a natural hand feel.

[0078] The tri-core yarn **10** may be used for weft and/or for warp. The tri-core yarn **10** used for warp can be the same as or different from the tri-core yarn **10** used for weft in producing stretch fabric. The stretch fabric may be weft stretch and/or bi-stretch.

[0079] As such, the tri-core yarn **10** is easily stretchable without overly restricting or constricting on a user, as is common with other fibers having similar stretch characteristics, such as shapewear.

[0080] The tri-core yarn **10** according to embodiments of the present invention may have greater stretch and may provide improved stability. In addition, the tri-core yarn **10** may provide greater stretch with improved recovery and less shrinkage, while providing a wider width and thus a lower cost.

[0081] Specific examples of composite yarns which are embodiments of the present invention are provided below. Additionally, data relating to the stretch, recovery, and shrinkage are provided for the listed examples as well as comparison data for traditional composite yarns.

EXAMPLE 1

[0082] In Example 1, 70 denier FIBER J® (FIBER J is a registered trademark of Lubrizol Advanced Materials, Inc.) was used as the elastomeric fiber, 30 denier nylon was used as the first wrapping fiber, and 30 denier nylon was used as the second wrapping fiber to form a tri-core covered core yarn.

[0083] The tri-core covered core yarn was then core spun using a single core spinning apparatus to produce a tri-core composite yarn. To produce a fabric (Tri-Core Fabric 1), 21 (Ne 21/1) of this tri-core yarn was used for the weft, and 12 SB (Ne 12/1 slub) for the warp. The resulting composition of the Tri-Core Fabric 1 in Example 1 was 90% cotton, 7% nylon, and 3% spandex. This produced the Tri-Core Fabric 1 having a width of 52.5 inches, and a weight before wash of 9.0 ounces per square yard and a weight after wash of 10.2 ounces per square yard.

[0084] Using the Tri-Core Fabric 1 having the tri-core composite yarn described above, the Tri-Core Fabric 1 exhibited a stretch of 74%, recovery of 85.6% 30 minutes after stretching, and 12-14% shrinkage.

[0085] In a similar trial of a dual-core yarn as is known in the art (a Dual-Core Fabric 1), a dual-core yarn having a first core of 75 denier T400® (T400 is a registered trademark of Invista North America S.A.R.L. Corporation Luxembourg) and a second core of 40 denier LYCRA® (LYCRA is a registered trademark of Invista North America S.A.R.L. Corporation Luxembourg), were used. In particular, the

Dual-Core Fabric 1 was prepared with a warp of 12 SB and a weft of 21 of the dual-core yarn described above. The resulting composition of the Dual-Core Fabric 1 was 90% cotton, 8% T400®, and 3% LYCRA®. This produced the Dual-Core Fabric 1 having a width of 49.5 inches, and a weight before wash of 9.4 ounces per square yard and 10.8 after wash ounces per square yard.

[0086] Using the Dual-Core Fabric 1 having the dual-core yarn described above, the Dual-Core Fabric 1 exhibited a stretch of 71%, recovery of 87.9% 30 minutes after stretching, and 13-15% shrinkage. The pro-rated cost to prepare the Dual-Core Fabric 1 at a comparable width of 52.5 inches was 14% higher than the cost to prepare the Tri-Core Fabric 1.

[0087] In a similar trial of single core yarn as is known in the art (a Single-Core Fabric 1), a single-core yarn having a 70 denier LYCRA® core was used. In particular, the Single-Core Fabric 1 was prepared with a warp of 14 Even and a weft of 21 with the 70 denier LYCRA® core. The resulting composition of the Single-Core Fabric 1 was 97% cotton and 3% LYCRA®. This produced the Single-Core Fabric 1 having a width of 51 inches, and a weight before wash of 8.5 ounces per square yard and 10.7 after wash ounces per square yard.

[0088] Using the Single-Core Fabric 1 having the single core yarn described above, the Single-Core Fabric 1 exhibited a stretch of 82%, recovery of 81.2% 30 minutes after stretching, and shrinkage of 22-24%. The pro-rated cost to prepare the Single-Core Fabric 1 at a comparable width of 52.5 inches was approximately 6% higher than the cost to prepare the Tri-Core Fabric 1.

[0089] As demonstrated by the above results, the Single-Core Fabric 1 exhibited 76% more shrinkage for 15% more stretch and with decreased recovery characteristics as compared to the Tri-Core Fabric 1. Further, the Single-Core Fabric 1 did not meet industry standards for recovery of denim, which are set at 85%. Even further, the width of the Single-Core Fabric 1 was smaller than the width of the Tri-Core Fabric 1.

[0090] In addition, the Tri-Core Fabric 1 according to the first example requires 67% less energy to stretch as compared to the Dual-Core Fabric 1. As such, the Tri-Core Fabric 1 including the tri core composite yarn typically feels less restrictive as compared to the Dual-Core Fabric 1 including the dual core yarn, yet it may still provide characteristics of shapewear fabrics.

[0091] Even further, the prorated cost of fabrication of the Tri-Core Fabric 1 including the tri core composite yarn provides a cost savings of approximately 5% as compared to the Single-Core Fabric 1 including the single core yarn and a cost savings of approximately 12% compared to the Dual-Core Fabric 1, while the Dual-Core Fabric 1 including the dual core yarn requires an 8% cost increase as compared to the Single-Core Fabric 1 including the single core yarn.

[0092] A table relating to Example 1 is provided below:

TABLE 1

Fabric	Warp	Weft (Denier)	Width (In.)	Stretch (%)	Recovery (% After 30 mins.)	Shrinkage (%)	Relative Cost
Tri-Core Fabric 1	12 SB	21s 30D Nylon, 30D Nylon, 70D FIBERJ®	52.5	74	85.6	12-14	1.0

TABLE 1-continued

Fabric	Warp	Weft (Denier)	Width (In.)	Stretch (%)	Recovery (% After 30 mins.)	Shrinkage (%)	Relative Cost
Dual-Core Fabric 1	12 SB	21s 75D T400®, 40D LYCRA®	49.5	71	87.9	13-15	1.12
Single-Core Fabric 1	14 Even	21s 70D LYCRA®	51	82	81.2	22-24	1.05

EXAMPLE 2

[0093] In Example 2, 40 denier spandex was used as the elastomeric fiber, 50 denier polyester was used as the first wrapping fiber, and 50 denier polyester was used as the second wrapping fiber to form a tri-core covered core yarn.

[0094] The tri-core covered core yarn was then core spun using a single core spinning apparatus to produce a tri-core composite yarn. To produce a fabric (Tri-Core

[0095] Fabric 2), C16 (Ne 1/16) of this tri-core yarn was used for the weft, and 10 SB (Ne 10/1 slub) for the warp. This produced the Tri-Core Fabric 2 having a width of 56 inches, and a weight before wash of 9 ounces per square yard and a weight after wash of 10.4 ounces per square yard.

[0096] Using the Tri-Core Fabric 2 having the tri-core composite yarn described above, the Tri-Core Fabric 2 exhibited a stretch of 40%, recovery of 78% 30 seconds after stretching and 83% 30 minutes after stretching, growth of 8.8% 30 seconds after stretching and 6.8% 30 minutes after stretching, and 13-15% shrinkage.

[0097] In a similar trial of a dual-core yarn as is known in the art (a Dual-Core Fabric 2), a dual-core yarn having a first core of 75 denier T400® and a second core of 40 denier spandex were used. In particular, the Dual-Core Fabric 2 was prepared with a warp of 10 and a weft of C16 of the dual-core yarn described above. This produced the Dual-Core Fabric 2 having a width of 56 inches, and a weight before wash of 8.8 ounces per square yard and 10.4 after wash ounces per square yard.

[0098] Using the Dual-Core Fabric 2 having the dual-core yarn described above, the Dual-Core Fabric 2 exhibited a stretch of 37.6%, recovery of 71.3% 30 seconds after stretching and 78.7% 30 minutes after stretching, growth of 10.8% 30 seconds after stretching and 8.0% 30 minutes after stretching, and 13-15% shrinkage. The cost to prepare the Dual-Core Fabric 2 was approximately 2% higher than the cost to prepare the Tri-Core Fabric 2.

[0099] In a similar trial of single core yarn as is known in the art (a Single-Core Fabric 2), a single-core yarn having a 40 denier spandex core was used. In particular, the Single-Core Fabric 2 was prepared with a warp of 10 SB and a weft of C16 with the 40 denier spandex core. This produced the Single-Core Fabric 2 having a width of 55 inches, and a weight before wash of 9.2 ounces per square yard and 10.5 after wash ounces per square yard.

[0100] Using the Single-Core Fabric 2 having the single core yarn described above, the Single-Core Fabric 2 exhibited a stretch of 33.6%, recovery of 65.5% 30 seconds after stretching and 75% 30 minutes after stretching, growth of 11.6% 30 seconds after stretching and 8.4% 30 minutes after stretching, and 13-15% shrinkage. The cost to prepare the Single-Core Fabric 2 was approximately 2% lower than the cost to prepare the Tri-Core Fabric 2.

[0101] As demonstrated by the above results, although the Single-Core Fabric 2 exhibited similar shrinkage characteristics as compared to the Tri-Core Fabric 2, the Single-Core Fabric 2 exhibited 16% less stretch and decreased recovery (16% less recovery after 30 seconds and 10% less recovery after 30 minutes) as compared to the Tri-Core Fabric 2.

[0102] Similarly, although the Dual-Core Fabric 2 exhibited similar shrinkage characteristics as compared to the Tri-Core Fabric 2, the Dual-Core Fabric 2 exhibited 6% less stretch and decreased recovery (9% less recovery after 30 seconds and 5% less recovery after 30 minutes) as compared to the Tri-Core Fabric 2.

[0103] Even further, the cost of fabrication of the Tri-Core Fabric 2 including the tri core composite yarn provides a cost savings of approximately 2% compared to the Dual-Core Fabric 2, while the Dual-Core Fabric 2 including the dual core yarn requires a 4% cost increase as compared to the Single-Core Fabric 2 including the single core yarn.

[0104] A table relating to Example 2 is provided below:

TABLE 2

Fabric	Warp	Weft (Denier)	Stretch (%)	Growth (% After 30 mins.)	Recovery (% After 30 mins.)	Shrinkage (%)	Relative Cost
Tri-Core Fabric 2	10SB	C16 50D Nylon, 50D Nylon, 40D Spandex	40	6.8	83	13-15	1.0
Dual-Core Fabric 2	10SB	C16 75D T400®, 40D Spandex	37.6	8.0	78.7	13-15	1.02
Single-Core Fabric 2	10SB	C16 40D Spandex	33.6	8.4	75	13-15	0.98

[0105] While this disclosure has been described in detail with particular references to some exemplary embodiments thereof, the exemplary embodiments described herein are not intended to be exhaustive or to limit the scope of the disclosure to the exact forms disclosed. It is understood that the drawings are not necessarily to scale. Persons skilled in the art and technology to which this disclosure pertains will appreciate that alterations and changes in the described structures and methods of assembly and operation can be practiced without meaningfully departing from the principles, spirit, and scope of this disclosure, as set forth in the following claims and their equivalents.

What is claimed is:

1. A tri-core yarn comprising:
 - a core comprising:
 - an elastomeric filament;
 - a first cover; and
 - a second cover; and
 - a fiber sheath covering the core,
 wherein the first cover and the second cover are each wrapped around the elastomeric filament.
2. The yarn of claim 1, wherein the first cover is wrapped in a first direction and the second cover is wrapped in a second direction.
3. The yarn of claim 1, wherein the elastomeric filament, the first cover, and the second cover are twisted together.
4. The yarn of claim 1, wherein the first cover and the second cover are different materials.
5. The yarn of claim 1, wherein the elastomeric fiber is in a range of about 10 denier to about 300 denier.
6. The yarn of claim 1, wherein the first cover comprises polyester or nylon.
7. The yarn of claim 6, wherein the first cover is partially oriented yarn or fully drawn yarn.
8. The yarn of claim 1, wherein the first cover is in a range of about 10 denier to about 600 denier.
9. The yarn of claim 1, wherein the core is in a range of about 10 denier to 600 denier.
10. The yarn of claim 1, wherein the fiber sheath comprises cotton, polyester, viscose, rayon, modal, lyocell, cupro, nylon, acrylic, wool, linen, hemp, ramie, and/or polyethylene.

11. The yarn of claim 1, wherein the first cover yarn is wrapped around the elastomeric filament and the second cover yarn is wrapped around the first cover yarn.

12. A method of manufacturing yarn, the method comprising:

- covering an elastomeric filament with a first cover yarn and a second cover yarn to form a core;
- core-spinning the core to add a fiber sheath.

13. The method of claim 12, wherein the covering of the elastomeric filament comprises:

- wrapping the first cover yarn around the elastomeric filament in a first direction; and
- wrapping the second cover yarn around the elastomeric filament in a second direction.

14. The method of claim 12, wherein the covering of the elastomeric filament comprises intermingling or air-covering the elastomeric filament with the first cover yarn and the second cover yarn.

15. The method of claim 12, wherein the covering of the elastomeric filament comprises aligning the elastomeric filament, the first cover yarn, and the second cover yarn and twisting the elastomeric filament, the first cover yarn, and the second cover yarn together.

16. A stretch fabric comprising a yarn, the yarn comprising:

- a core comprising:
 - an elastomeric filament;
 - a first cover; and
 - a second cover; and
- a fiber sheath covering the core,

wherein the first cover and the second cover are each wrapped around the elastomeric filament.

17. The stretch fabric of claim 17, wherein a weft and a warp of the fabric comprise the yarn.

18. The stretch fabric of claim 16, wherein the fabric comprises plain, poplin, twill, oxford, dobby, sateen and/ or satin fabric.

19. The stretch fabric of claim 16, wherein the stretch fabric is configured to be stretched to between 10% and 100% of its original size in a warp direction.

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