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(71) Applicant: **The LYCRA Company UK Limited
Manchester M2 3DE (GB)**

(72) Inventors:
• **LIAO, Tianyi
Chadds Ford (US)**
• **LEUNG, Raymond, S. P.
Hong Kong (CN)**

(74) Representative: **Carpmaels & Ransford LLP
One Southampton Row
London WC1B 5HA (GB)**

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(54) **STRETCH YARNS AND FABRICS WITH MULTIPLE ELASTIC YARNS**

(57) Included herein is an articles and methods in-
cluding a core spun yarn. The core spun yarn includes a
sheath of hard fibers and two sets of elastic fibers wherein
the sets of elastic fibers have different properties. The

properties may differ in one or more ways such as having
a different denier, composition or draft. One or both of
the sets of elastic fibers can be pre-covered.

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Description**BACKGROUND OF THE INVENTION****Field of the Invention**

[0001] This invention relates to the manufacture of stretch composite yarns and fabrics. It specifically relates to the fabrics and methods including two sets of elastic core fibers within one yarn.

Summary of Related Art

[0002] Stretch fabrics with elastic composite yarn have been on the markets for long time. Fabric and garment manufacturers generally know how to make fabrics with the right quality parameters to achieve fabrics acceptable to consumers. In current commercially available fabrics, only one elastic fiber system exists inside yarn and fabrics. One elastic fiber provides double functions: stretch and recovery. It is difficult to obtain the fabrics which have easy stretch, high recovery and low shrinkage performance.

[0003] Easy stretch is one important characteristic for comfort garment. For garment with greater comfort, the fabric can be easy stretched out when garment is put on human body and move. They have low pressure exerted on the body by garment. The garment can be cut to achieve a more streamlined appearance and can conform better to the body, while still maintaining comfort for wearer in motion. Such performance can be achieved through low fabric tensile modulus by minimizing the garment's resistance to the body's demands in movement.

[0004] However, for the fabric with low tensile modulus, a typical quality issue is that the fabric can't quickly recovery to original size and shape after fabrics are over stretched out in some parts of the body, such as in knee, butt and waist, particularly for the fabrics with high stretch level. Usually, the fabric has low recovery power when the tensile modulus is low. Consumers see baggy and saggy issues after long time wear.

[0005] In contrast, in order to get fabric with good recovery, extra contractive force needed within fabrics. Higher content or more powerful elastic fiber could be added to fabrics. However, these fabrics have high extension modulus and higher restrict force. Consumers complain higher garment pressures and uncomfortable restriction during wearing and movement. In the same time, the fabric has poor dimension stability. Heatset is a necessary processing to control the fabric shrinkage. The garment comfort and freedom of movement are compromised by fabric shape retention and recovery function. The fabrics having easy stretch, high recovery and low shrinkage performance are still desired.

[0006] For many years, composite elastic yarns are well known. For example, by US patents number 4470250, 4998403, 7134265, 6848151, the elastomeric fibers, such as spandex, have been covered with relatively inelastic fibers in order to facilitate acceptable processing for knitting or weaving, and to provide elastic composite yarns with acceptable characteristics for various end-use fabrics. In US patent application US 2008/0268734A1 and USA 2008/0318485A1, a rigid filament is used, together with elastic filaments, as core inside core spun yarn.

[0007] Therefore, there is a need to produce stretch wovens, which have easy stretch, easy process, low shrinkage, friendly garment making, and excellent recovery power and low growth.

SUMMARY OF THE INVENTION

[0008] One aspect includes methods for making composite yarns with two sets of different elastic core fibers, referred to as a double elastic composite yarn. Also included are the double elastic composite yarns and the stretch fabrics and garments made from such yarns.

[0009] According to a first embodiment of the method, two sets of elastic fibers with different properties and a hard fiber are covered together to form a composite yarn, wherein the two sets of elastic fibers are stretched to different drafts of its original length during yarn covering process. The elastic fiber may be bare spandex yarn from 11 to 560 dtex, and the hard fiber with a yarn count from 10 to 900dtex. One suitable hard yarn is cotton. The elastic core fiber I and elastic core fiber II are independently selected from an elastomeric or non-elastomeric fiber.

[0010] According to a second embodiment of the method, two sets of elastic fibers (elastic core fiber I and elastic core fiber II) with different properties and a hard fiber are covered together to form a composite yarn, wherein the two sets of elastic fibers have different polymer compositions and with different stress-strain behaviors. The elastic fibers may be bare spandex yarn from 11 to 560 dtex, and the hard fiber with a yarn count from 10 to 900dtex. One suitable hard yarn is cotton.

[0011] According to a third embodiment of the method, two sets of different elastic core fibers (elastic core fiber I and elastic core fiber II) and a hard fiber are covered together to form a composite yarn, wherein at least one set of elastic core fibers is pre-covered elastic yarn. Another set of elastic core yarn may be bare spandex or pre-covered elastic yarn. The bare spandex yarn denier is from 11 to 560 dtex, and the hard fiber with a yarn count from 10 to 900 dtex. One

suitable hard yarn is cotton.

[0012] According to a fourth embodiment of the method, two sets of different elastic core fibers and a hard fiber are covered together to form a composite yarn, wherein at least one elastic core fiber is no-elastomeric stretch fibers. Another set of elastic core yarn may be bare elastomeric, such as spandex. The bare spandex yarn denier is from 11 to 560 dtex, and the hard fiber with a yarn count from 10 to 900 dtex. One suitable hard yarn is cotton.

[0013] A fabric is made by using the double elastic yarn produced by one of these alternate methods. The double elastic yarn is used in at least one direction of the fabric. Any forms of fabrics may be used, including wovens, circular knits, warp knits and narrow fabrics. Further processing may include scouring, bleaching, dyeing, drying, sanforizing, singeing, de-sizing, mercerizing, and any combination of such steps. The stretched fabric produced may be formed into a garment.

BRIEF DESCRIPTION OF THE FIGURES

[0014] The detailed description will refer to the following drawings, wherein like numerals refer to like elements and wherein:

FIG. 1 is an illustrated of core spun yarn with two elastic cores

Fig 2 is a schematic description of a core spinning apparatus with two draft devices for two bare elastic fibers.

Fig 3 is a schematic description of a core spinning apparatus with two draft devices with weighted roll.

Fig 4 is a schematic description of a core spinning apparatus with two draft devices for one bare elastic fiber and one pre-covered elastic yarn.

DETAILED DESCRIPTION OF THE INVENTION

[0015] Elastomeric fibers are commonly used to provide stretch and elastic recovery in woven fabrics and garments. "Elastomeric fibers" are either a continuous filament (optionally a coalesced multifilament) or a plurality of filaments, free of diluents, which have a break elongation in excess of 100% independent of any crimp. An elastomeric fiber when (1) stretched to twice its length; (2) held for one minute; and (3) released, retracts to less than 1.5 times its original length within one minute of being released. As used in the text of this specification, "elastomeric fibers" means at least one elastomeric fiber or filament. Such elastomeric fibers include but are not limited to rubber filament, biconstituent filament and elastoester, lastol, and spandex.

[0016] "Spandex" is a manufactured filament in which the filament-forming substance is a long chain synthetic polymer comprised of at least 85% by weight of segmented polyurethane.

[0017] "Elastoester" is a manufactured filament in which the fiber forming substance is a long chain synthetic polymer composed of at least 50% by weight of aliphatic polyether and at least 35% by weight of polyester.

[0018] "Biconstituent filament" a continuous filament or fiber including at least two polymers adhered to each other along the length of the filament, each polymer being in a different generic class, for example, an elastomeric polyetheramide core and a polyamide sheath with lobes or wings.

[0019] "Lastol" is a fiber of cross-linked synthetic polymer, with low but significant crystallinity, composed of at least 95 percent by weight of ethylene and at least one other olefin unit. This fiber is elastic and substantially heat resistant.

[0020] "Polyester bi-component filament" means a continuous filament comprising a pair of polyesters intimately adhered to each other along the length of the fiber, so that the fiber cross section is for example a side-by-side, eccentric sheath-core or other suitable cross-section from which useful crimp can be developed. The fabric made with this filament, such as Elasterell-p, PTT/PET bi-component fiber, has excellent recovery characteristics.

[0021] "No-elastomeric elastic fibers" means a stretch filament without containing elastomeric fiber. However, the recoverable stretch of such yarn must be higher than 20% as tested by ASTM D6720 methods, such as textured PPT stretch filament, textured PET stretch filament, bi-component stretch filament fiber, or PBT stretch filament.

[0022] A "Pre-covered elastic yarn" is one surrounded by, twisted with, or intermingled with hard yarn before the core spun process. The pre-covered elastic yarn that includes elastomeric fibers and hard yarns is also termed a "pre-covered yarn" in the text of this specification. The hard-yarn covering serves to protect the elastomeric fibers from abrasion during textile processes. Such abrasion can result in breaks in the elastomeric fiber with consequential process interruptions and undesired fabric non-uniformities. Further, the covering helps to stabilize the elastomeric fiber elastic behavior, so that the elongation of pre-covered elastic yarn can be more uniformly controlled during textile processes than would be possible with bare elastomeric fibers. The pre-covered yarn also can increase the tensile modulus of the yarn and fabric, which is helpful to improve the fabric recovery power and dimensional stabilities.

[0023] The pre-covered yarns include: (a) single wrapping of the elastomer fibers with a hard yarn; (b) double wrapping of the elastomer fibers with a hard yarn; (c) continuously covering (i.e., corespun or core-spinning) an elastomer fiber with staple fibers, followed by twisting during winding; (d) intermingling and entangling elastomer and hard yarns with

an air jet; and (e) twisting an elastomer fibers and hard yarns together.

[0024] "Double elastic composite yarn" is a composite yarn comprising with two sets of elastic core fibers with single yarn, covered with hard staple fiber sheath. The term "double elastic yarn" is used interchangeably throughout the specification.

[0025] The stretch fabric of the some embodiments includes double elastic core spun yarn in weft direction. In some embodiments, a fabric with unexpectedly high recovery properties was achieved, especially for high stretch fabrics. This was accomplished by the use of core spun yarn containing with two different elastic fibers with different stretch properties. Those of skill in the art will recognize that where weft stretch is desired, the fabric may include such core spun yarn with double elastic fibers in weft direction.

[0026] As demonstrated in Fig 1, the double elastic yarn 8 according to the present invent will necessarily include two elastic filaments core: elastic core I (4, in Fig. 1) and elastic core II (6, in Fig 1). The elastic core filaments are surrounded, preferably along the entirety of its length by a fibrous sheath 2 comprised of spun staple fibers.

[0027] One embodiment of a representative core spinning apparatus 40 is shown in Fig. 2. Two separated fiber draft devices 46 and 64 are installed on the machine. During core spinning processing, elastic core filament I 48 and elastic core filament II 60 are put on deliver roll 46 and 64 separately and are combined with a hard yarn to form a composite core spun yarn. The core elastic filaments from tube 48 and tuber 60 are unwound in the direction of arrow 50 and 62 by the action of positively-driven feed rollers 46 and 64. The feed rollers 46 and 64 serve as a cradle for the tube 48 and tube 60 and deliver the elastic fiber of yarn 52 and 66 at a predetermined speed.

[0028] The hard fiber or yarn 44 is unwound from tube 54 to meet the elastic core filament 52 and 66 at the set of front rollers 42. The combined elastic core filaments 52, 66 and hard fiber 44 are core spun together at spinning device 56.

[0029] The elastic core filament I 52 and elastic core filament II 66 are stretched (drafted) before it enters the front rollers 42. The elastic filaments are stretched through the speed difference between feed rollers 46 or 64 and front rollers 42. The delivery speed of the front rollers 42 is greater than the speed of the feed rollers 46 and 64. Adjusting the speed of the feed rollers 46 and 64 gives the desired draft or stretch ratio.

[0030] The stretch ratio is normally 1.01X times to 5.0X times (1.01X to 5.0X) compared to the un-stretched fiber. Too low a stretch ratio will result in low quality yarns having grin-through and an un-centered elastic filament. Too high a stretch ratio will result in breakage of the elastic filament and core void.

[0031] Another embodiment of a representative core spinning apparatus 40 is shown in Fig. 3. Elastic core I is bare elastic filaments 48, while elastic core II 12 is pre-covered elastic yarn. The elastic core II from tube 12 is unwound in the direction of arrow 62 by the action of positively-driven feed rollers 64. The weighted roll 66 serves to maintain stable contact between the elastic core II and feed rollers 64 in order to deliver the elastic core II of yarn 68 at a predetermined speed. Other elements of Fig. 3 are as described for Fig. 2.

[0032] Another embodiment of a representative core spinning apparatus 40 is shown in Fig. 4. Elastic core I is bare elastic filaments 48, while elastic core II 12 is pre-covered elastic yarn. The elastic core II from tube 12 is taken off from end and then passes through tension control device and guide bar. The tension device serves to keep the yarn tension stable at a predetermined level. The stretch ratio for bare elastic fiber is normally 1.01X times to 5.0X times (1.01X to 5.0X) compared to the un-stretched fiber. Other elements of Fig. 4 are as described for Fig. 2.

[0033] According to some embodiment of the method, two elastic fibers with different properties and a hard fiber are covered together to form a composite yarn, wherein the two elastic fibers are stretched to different drafts of its original length during yarn covering process. The draft of two elastic fibers can be selected between drafts 1.01X times to 5.0X times. For the two core elastic fibers with different deniers or different filament numbers, the stretch ratio of core elastic I and elastic core II could be different from each other, depending the elastic fiber performances and requirement of fabric quality. In many cases, one core is drafted more to provide high stretch performance, while another core is stretched less to provide the fabrics with low shrinkage and high recovery power.

[0034] In conventional fabrics, if heat setting is not used to "set" the spandex, the fabric may have high shrinkage, excessive fabric weight, and excessive elongation, which may result in a negative experience for the consumer. Excessive shrinkage during the fabric finish process may result in crease marks on the fabric surface during processing and household washing. Creases that develop in this manner are frequently very difficult to remove by ironing.

[0035] By using low draft in one of elastic core fiber, the high-temperature heat setting step in the process can be avoided. This new process may reduce heat damage to certain fibers (i. e. cotton) and thus may improve the handle of the finished fabric. The fabrics of some embodiments may be prepared in the absence of a heat setting step including where the fabrics will be prepared into garments. As a further benefit, heat sensitive hard yarns can be used in the new process to make shirting, elastic, fabrics, thus increasing the possibilities for different and improved products. In addition, the shorter process has productivity benefits to the fabric manufacturer.

[0036] It was unexpectedly found that the core spun yarn with two different elastic core fibers has higher stretch and recovery power than the core spun yarn made from single core elastic filament with the same denier. For example, the core spun yarn with two core of 30d/3filament spandex plus 40D/4filament spandex, has more recovery power than a core spun made from single core of 70D/5filament yarn under the same draft. So, we can make the core spun yarn with

higher stretch and higher recovery power by using the same contents of the spandex.

[0037] Two elastic fibers with different properties could be used and are covered together with hard fiber sheath to form a composite yarn, wherein the two elastic fibers could have different polymer compositions and with different stress-strain behaviors. One example is to use two spandex fibers with different heatset efficiency together within one core spun yarn, such as normal LYCRA® spandex fiber T162C and easy set LYCRA® fiber T562B. The fabric can be heatset at the temperature higher than easy set LYCRA® fiber heatset temperature, but lower than normal LYCRA® fiber heatset temperature. So, the fabrics just get partial heatset which provide acceptable fabric shrinkage while good stretch and growth.

[0038] Another example is the core spun containing elastic core I with high tension modulus and elastic core II with low tension modulus. Elastic core I provide the fabric with high recovery power and low fabric growth, while elastic core II with low modulus give the fabric with easy stretch, lower shrinkage, resulting in the fabric with easy stretch, high holding force and high dimension stability. The elastic fibers with different chemical composition also can be combined together with one core spun yarn, such as polyolefin elastic fiber Lastol and spandex. Spandex fibers offer the high recovery power while Lastol fibers contribute the good heat resistance and lower shrinkage performance.

[0039] The combination of elastic core I and elastic core II could be elastic bare fiber plus elastic bare fiber; or elastic bare fiber plus pre-covered elastic yarn, or pre-covered elastic yarn plus pre-covered elastic yarn. The bare elastic fiber may be from about 11 dtex to about 444 dtex (denier - about 10D to about 400D), including 11dtex to about 180 dtex (denier 10D to about 162D).

[0040] The pre-covered elastic yarn includes various types, such as single wrapping of the elastomer fibers with a hard yarn; double wrapping of the elastomer fibers with a hard yarn; continuously covering (i.e., core-spinning) an elastomer fiber with staple fibers, followed by twisting during winding; intermingling and entangling elastomer and hard yarns with an air jet; and twisting an elastomer fibers and hard yarns together. The preferred pre-covered elastic yarn are spandex air jet covered yarns with textured polyester and nylon filaments, such as 40D or 70D spandex with 50D to 150D polyester air covered yarn. The pre-covered elastic yarn is made in a separated machine before the core spun yarn process.

[0041] The pre-covered elastic yarn can be present in any desired amount, for example from about 5 to about 35% weight percent based on total double elastic yarn weight. The linear density of the pre-covered yarn ranges from about 15 denier (16.5 dtex) to about 900 denier (990 dtex), including from about 30 denier to 300 denier (33dtex to 330 dtex). When the ratio of yarn denier between pre-covered yarn and total double elastic yarn is lower than 35%, the fabric has no substantial grin through. After the finishing process, two elastic core fibers, including in pre-covered yarn, are invisible and untouchable.

[0042] The deniers of bare elastic fiber (prior to covering to form pre-covered yarn) may be from about 11 dtex to about 444 dtex (denier - about 10D to about 400D), including 11dtex to about 180 dtex (denier 10D to about 162D). During the pre-covering process, the elastic fiber is drafted between 1.1X to 6X its original length. In pre-covering, the elastic fiber is pre-covered with one or more hard yarns, with hard yarn denier from 10 to 600 deniers.

[0043] Another combination of elastic core fiber I and elastic core fiber II could be one set of elastic bare fiber plus another set of no-elastomeric elastic fibers. The no-elastomeric elastic fibers can be textured PET stretch filament, textured PPT stretch filament, bi-component fiber, or PBT stretch fiber. It was surprise to find that when the no-elastomeric elastic fiber with recoverable stretch higher than 20% were used as one of the elastic core fibers, the performance of the core spun yarn and the fabric change dramatically. The fabrics have high stretch and high recovery power. The linear density of the no-elastomeric elastic fibers can range from about 15 denier (16.5 dtex) to about 450 denier (495 dtex), including from about 30 denier to 150 denier (33dtex to 165 dtex). When the denier is too high, the fabric could have substantial grin through.

[0044] The elastomer fiber content with double elastic core spun yarns are between about 0.1% to about 20%, including from about 0.5% to about 15%, and about 5% to about 10% based on the weight of the yarn. Elastomeric fiber content within the fabric may be from about 0.01% to about 10% by weight based on the total fabric weight, including from about 0.5% to about 5%.

[0045] The staple sheath fibers in double elastic yarn can be nature fibers, such as, cotton, wool or linen. They also can be the staple man made or synthetic fibers of mono component polyethylene terephthalate) and poly(trimethylene terephthalate) fiber, polycaprolactam fiber, poly(hexamethylene adipamide) fibers acrylic fibers, modacrylic, acetate fibers, Rayon fibers, Nylon and combinations thereof.

[0046] Such double elastic yarns can be used for making a stretch fabric where various weave patterns can be applied, including plain, poplin, twill, oxford, dobby, sateen, satin and combinations thereof. The fabrics of some embodiments may have an elongation from about 10% to about 45% in the warp or/and weft direction. The fabrics may have shrinkage of about 15% or less after washing. The stretch woven fabric may have an excellent cotton hand feel. Garments may be prepared from the fabrics described herein.

[0047] The warp yarn can be the same as, or different from, the weft yarns. The fabric can be weft-stretch only, or it can be bi-stretch, in which useful stretch and recovery properties are exhibited in both the warp and weft directions.

[0048] Air jet loom, rapier loom, projectile loom, water jet loom and shuttle loom can be used. Dyeing and finishing process are important in producing a satisfactory fabric. The fabric can be finished in continuous range processes and the piece dye jet processes. Conventional equipment found in a continuous finishing plant and piece dye factories are usually adequate for processing. The normal finishing process sequences include preparation, dyeing and finishing. In preparation and dyeing process, including in singeing, desizing, scouring, bleaching, mercerizing and dyeing, normal processing methods for elastic wovens are usually satisfactory.

ANALYTICAL METHODS:

Yarn Recoverable Stretch

[0049] The recoverable Stretch of elastic fibers used in the Examples was measured as follows. Each yarn sample was formed into a skein of 5000 +/-5 total denier (5550 dtex) with a skein reel at a tension of about 0.1 gpd (0.09 dN/tex). The skein was conditioned at 70 °F (+/-2 °F) (21 °C +/-1 °C) and 65% (+/-2%) relative humidity for a minimum of 16 hours. The skein was hung substantially vertically from a stand, a 6 mg/den (5.4 mg/dtex) weight (e.g. 30 grams for a 5550 dtex skein) was hung on the bottom of the skein, the weighted skein was allowed to come to an equilibrium length, and the length of the skein was measured to within 1 mm and recorded as "C_b". The 5.4 mg/dtex weight was left on the skein for the duration of the test. Next, a 1030 gram weight (206 mg/d; 185.4 mg/dtex) was hung from the bottom of the skein, and the length of the skein was measured to within 1 mm and recorded as "L_b".

[0050] The 1030 g weight was removed, and the skein was then immersed into boiling water for 10 minutes at 100 °C degree water, after which the skein were removed from the water and conditioned as above for 16 hours. This step is designed to simulate commercial fabric relaxation process, which is one way to develop the fabric stretch. The length of the skein was measured as above, and its length was recorded as "C_a". The 1030-gram weight was again hung from the skein, and the skein length was measured as above and recorded as "L_a". The after relaxation Yarn recoverable stretch (percent), "CC_a", was calculated according to the formula $CC_a = 100 \times (L_a - C_a) / L_a$. Yarn shrinkage was calculated according to formula $C_s (\%) = 100 \times (L_b - L_a) / L_b$.

Woven Fabric Elongation (Stretch)

[0051] Fabrics are evaluated for % elongation under a specified load (i.e., force) in the fabric stretch direction(s), which is the direction of the composite yarns (i.e., weft, warp, or weft and warp). Three samples of dimensions 60 cm × 6.5 cm were cut from the fabric. The long dimension (60 cm) corresponds to the stretch direction. The samples are partially unraveled to reduce the sample widths to 5.0 cm. The samples are then conditioned for at least 16 hours at 20°C +/- 2°C and 65% relative humidity, +/- 2%.

[0052] A first benchmark was made across the width of each sample, at 6.5 cm from a sample end. A second benchmark was made across the sample width at 50.0 cm from the first benchmark. The excess fabric from the second benchmark to the other end of the sample was used to form and stitch a loop into which a metal pin could be inserted. A notch was then cut into the loop so that weights could be attached to the metal pin.

[0053] The sample non-loop end was clamped and the fabric sample was hung vertically. A 17.8 Newton (N) weight (4 LB) is attached to the metal pin through the hanging fabric loop, so that the fabric sample is stretched by the weight. The sample was "exercised" by allowing it to be stretched by the weight for three seconds, and then manually relieving the force by lifting the weight. This cycle was carried out three times. The weight was allowed then to hang freely, thus stretching the fabric sample. The distance in millimeters between the two benchmarks was measured while the fabric was under load, and this distance is designated ML. The original distance between benchmarks (i.e., unstretched distance) was designated GL. The % fabric elongation for each individual sample as calculated as follows:

$$\% \text{ Elongation (E\%)} = ((ML - GL) / GL) \times 100$$

[0054] The three elongation results were averaged for the final result.

Woven Fabric Growth (Unrecovered Stretch)

[0055] After stretching, a fabric with no growth would recover exactly to its original length before stretching. Typically, however, stretch fabrics will not fully recover and will be slightly longer after extended stretching. This slight increase in length is termed "growth."

[0056] The above fabric elongation test must be completed before the growth test. Only the stretch direction of the fabric was tested. For two-way stretch fabric both directions were tested. Three samples, each 55.0 cm × 6.0 cm, were

cut from the fabric. These were different samples from those used in the elongation test. The 55.0 cm direction should correspond to the stretch direction. The samples were partially unraveled to reduce the sample widths to 5.0 cm. The samples were conditioned at temperature and humidity as in the above elongation test. Two benchmarks exactly 50 cm apart were drawn across the width of the samples.

[0057] The known elongation % (E%) from the elongation test was used to calculate a length of the samples at 80% of this known elongation. This was calculated as

$$E(\text{length}) \text{ at } 80\% = (E\%/100) \times 0.80 \times L,$$

where L was the original length between the benchmarks (i.e., 50.0 cm). Both ends of a sample were clamped and the sample was stretched until the length between benchmarks equaled L + E (length) as calculated above. This stretch was maintained for 30 minutes, after which time the stretching force was released and the sample was allowed to hang freely and relax. After 60 minutes the % growth was measured as

$$\% \text{ Growth} = (L2 \times 100)/L,$$

where L2 was the increase in length between the sample benchmarks after relaxation and L was the original length between benchmarks. This % growth was measured for each sample and the results averaged to determine the growth number.

Woven Fabric Shrinkage

[0058] Fabric shrinkage was measured after laundering. The fabric was first conditioned at temperature and humidity as in the elongation and growth tests. Two samples (60 cm × 60 cm) were then cut from the fabric. The samples were taken at least 15 cm away from the selvage. A box of four sides of 40 cm × 40 cm was marked on the fabric samples.

[0059] The samples were laundered in a washing machine with the samples and a loading fabric. The total washing machine load was 2 kg of air-dried material, and not more than half the wash consisted of test samples. The laundry was gently washed at a water temperature of 40°C and spun. A detergent amount of 1g/l to 3 g/l was used, depending on water hardness. The samples were laid on a flat surface until dry, and then they were conditioned for 16 hours at 20°C +/- 2°C and 65% relative humidity +/- 2% rh.

[0060] Fabric sample shrinkage was then measured in the warp and weft directions by measuring the distances between markings. The shrinkage after laundering, C%, was calculated as

$$C\% = ((L1 - L2)/L1) \times 100,$$

where L1 was the original distance between markings (40 cm) and L2 is the distance after drying. The results are averaged for the samples and reported for both weft and warp directions. Negative shrinkage numbers reflect expansion, which was possible in some cases because of the hard yarn behavior.

Fabric Weight

[0061] Woven Fabric samples were die-punched with a 10cm diameter die. Each cut-out woven fabric sample was weighed in grams. The "fabric weight" was then calculated as grams/square meters.

Examples:

[0062] The following examples demonstrate the present invention and its capability for use in manufacturing a variety of fabrics. The invention is capable of other and different embodiments, and its several details are capable of modifications in various apparent respects, without departing from the scope and spirit of the present invention. Accordingly, the examples are to be regarded as illustrative in nature and not as restrictive.

[0063] For each of the following denim fabric examples, 100 % cotton open end spun yarn or ring spun was used as warp yarn. For denim fabrics, they included two count yarns: 7.0 Ne OE yarn and 8.5 Ne OE yarn with irregular arrangement pattern. The yarns were indigo dyed in rope form before beaming. Then, they were sized and made the weaving beam. For bottom weight fabrics, the warp yarn are 20Ne 100% cotton ring spun yarn. They were sized and made the weaving beam.

[0064] Table 1 lists four examples of core spun yarn with traditional one elastic core filament and innovative yarn containing two sets of elastic cores.

[0065] Several core spun yarns with double elastic core fibers were used as weft yarn. Various elastic core fibers, including bare spandex, pre-covered polyester/LYCRA® spandex fiber or pre-covered nylon/spandex yarn were used as in the core. Table 2 lists the materials and process ways that were used to make the core spun yarn for each example. Table 3 shows the detail fabric structure and performance summary for each fabric. Lycra® spandex are available from Invista, s. á. r. L., Wichita, KS. For example, in the column headed spandex 40D means 40 denier; 3.5X means the draft of the Lycra® imposed by the core spinning machine (machine draft). In the column headed 'Rigid sheath Yarn', 20's is the linear density of the spun yarn as measured by the English Cotton Count System. The rest of the items in Table 1 and table 2 are clearly labeled.

[0066] Stretch woven fabrics were subsequently made, using the core spun yarn of each example in Table 2. Table 3 summarizes the yarns used in the fabrics, the weave pattern, and the quality characteristics of the fabrics. Some additional comments for each of the examples are given below. Unless otherwise noted, the fabrics were woven on a Donier air-jet or rapier loom. Loom speed was 500 picks/minute. The widths of the fabric were about 76 and about 72 inches in the loom and greige state respectively. The loom has double weaving beam capacity.

[0067] Each greige fabric in the examples was finished by a jiggle dye machine. Each woven fabric was pre-scoured with 3.0 weight % Lubit®64 (Sybron Inc.) at 49°C for 10 minutes. Afterwards it was de-sized with 6.0 weight % Synthazyme® (Dooley Chemicals. LLC Inc.) and 2.0 weight % Merpol® LFH (E. I. DuPont Co.) for 30 minutes at 71°C and then scoured with 3.0 weight % Lubit® 64, 0.5 weight % Merpol® LFH and 0.5 weight % trisodium phosphate at 82°C for 30 minutes. Fabric finishing was followed by dry in a tente frame at 160 °C for 1 minute.

TABLE 1: Examples of yarns with double elastic core fibers

Example	Rigid sheath yarn	Elastic Core I fiber types	Elastic Core I fiber deniers	Elastic Core I fiber draft	Elastic Core II fiber types	Elastic Core II fiber denier	Elastic Core II fiber draft	Yarn Twist level, twisters per inch	Cotton Roving draft	Core spun yarn recoverable Stretch, %	Core spun yarn Shrinkage, %
Yarn A	16' cotton	T162B LYCRA® fiber	44/3f dtex (40D)	3.5X	No	No	No	18	22X	17.71	2.1
Yarn B	16' cotton	T162B LYCRA® fiber	22/2f dtex (20D)	3.5X	T162B LYCRA® fiber	22/2f dtex (20D)	3.5X	18	22X	20.63	2.4
Yarn C	16' cotton	T162B LYCRA® fiber	77/5f dtex (70D)	3.8X	No	No	No	18	22X	38.71	2.28
Yarn D	16' cotton	T162B LYCRA® fiber	44/3 dtex (40D)	3.8X	T162B LYCRA® fiber	33/3f dtex (30D)	3.8X	18	22X	40.88	2.33

TABLE 2: Weft yarn description

Example	Rigid sheath yarn	Elastic Core I fiber types	Elastic Core I fiber deniers	Elastic Core I fiber draft	Elastic Core II fiber types	Elastic fiber draft in Core II	Yarn Twist level, twisters per inch	Cotton Roving draft	Core spun yarn recoverable Stretch	Core spun yarn Shrinkage
1	20' cotton	T162B LYCRA® fiber	44 dtex (40D)	3.5X	No	No	18	22	17.24	1.79
2	20' cotton	T162B LYCRA® fiber	44 dtex (40D)	3.5X	40D T162B LYCRA® fiber	1.8X	18	22	47.22	1.25
3	20' cotton	T162B LYCRA® fiber	44 dtex (40D)	3.5X	40D T562B Easy Set LYCRA® fiber	3.5X	18	22	62.24	1.68
4	16' cotton	T162B LYCRA® fiber	44 dtex (40D)	3.5X	40D polyolefin elastic fiber	3.6X	18	22	36.6	1.2
5	20' cotton	T162B LYCRA® fiber	44 dtex (40D)	1.8X	Pre-covered 40D T162C LYCRA® fiber with 40D/34F Nylon	3.2X	18	22	44.2	2.07
6	20' cotton	T162B LYCRA® fiber	44 dtex (40D)	3.5X	Pre-covered 40D T162C LYCRA® fiber with 40D/34F Nylon	3.2X	18	22	58.04	2.01
7	16' cotton	T162B LYCRA® fiber	44 dtex (40D)	3.5X	Pre-covered 40D T162C LYCRA® fiber with 50D/24F polyester	1.8X	16	16	36.29	2.63
8	16' cotton	T162B LYCRA® fiber	44 dtex (40D)	3.5X	Pre-covered 40D T162C LYCRA® fiber with 50D/24F polyester	2.6X	16	16	49.3	2.5
9	16' cotton	T162B LYCRA® fiber	44 dtex (40D)	3.5X	PBT Stretch polyester	1.15X	16	16	24.6	2.7

TABLE 3: Fabric Example List

Example	Weft yarn	Warp yarn	Base weaving pattern	Fabric on loom (warp EPI X weft PPI)	Width on loom	Finished fabric width, inch	Fabric weight OZ/Y ²	Fabric Stretch, %	Fabric Growth, %	Fabric Shrinkage, % (warp X weft)
1	20s cotton+3.5X LYCRA® fiber	20s cotton	3/1 RHT	96X56	76	50.5	8.95	37.6	8.7	-0.91 X -0.91
2	20s cotton+3.5X LYCRA® fiber+1.8X LYCRA® fiber	20s cotton	3/1 RHT	96X56	76	50.5	8.88	35.4	6.4	-1.57 X -0.13
3	20s cotton+3.5X LYCRA® fiber+3.5X LYCRA® fiber	20s cotton	3/1 RHT	96X56	76	50.2	9.19	38.4	7.9	-1.31 X -0.65
4	16s cotton+3.5X LYCRA® fiber+40D polyolefin elastic fiber	7.0' OE + 8.4' OE cotton indigo	3/1 RHT	64X54	72	55.5	11.39	47.8	6.5	-2.21 X -0.91
5	16s cotton+1.8X LYCRA® fiber+3.2X pre-covered 40D LYCRA® fiber	20s cotton	3/1 RHT	96X56	76	50.5	8.79	35.9	5.3	-1.31 X -0.65
6	16s cotton+3.5X LYCRA® fiber+3.2X pre-covered 40D LYCRA® fiber	20s cotton	3/1 RHT	96X56	76	50.5	8.96	37.8	5.9	0 X -1.96
7	16s cotton+3.5X LYCRA® fiber+1.8X pre-covered 40D LYCRA® fiber	7.0' OE + 8.4' OE cotton indigo	3/1 RHT	64X54	72	56	12.80	35.3	3.5	-1.31 X -0.65
8	16s cotton+3.5X LYCRA® fiber+2.6X pre-covered 40D LYCRA® fiber	7.0' OE + 8.4' OE cotton indigo	3/1 RHT	64X54	72	54.7	13.27	40.4	3.9	-1.31 X -0.65

(continued)										
Example	Weft yarn	Warp yarn	Base weaving pattern	Fabric on loom (warp EPI X weft PPI)	Width on loom	Finished fabric width, inch	Fabric weight OZ/Y^2	Fabric Stretch, %	Fabric Growth, %	Fabric Shrinkage, % (warp X weft)
9	16s cotton+3.5X LYCRA® fiber+1.15X PBT fiber	7.0' OE + 8.4' OE cotton indigo	3/1 RHT	64X54	72	55.2	10.79	40.7	6	-2.10 X -0.85

Example Yarn A: Typical core spun yarn with one elastic core fiber.

[0068] This is not an innovative yarn. This core spun yarn is 16Ne with one 40d LYCRA® spandex fiber covered by cotton sheath. The draft of the LYCRA® fiber is 3.5X during covering process. The cotton twist level TM is 18 twisters per inch. This yarn has 17.71 % recoverable stretch after boil off.

Example Yarn B: Core spun yarn with two core elastic fibers

[0069] The core spun yarn is 16Ne with two sets of LYCRA® spandex fiber covered by cotton sheath. Elastic core I fiber is 20D T162B and Elastic core II fiber is 20D T162B as well. The total denier of the elastic finer is 40 denier. The draft of the LYCRA® fiber is 3.5X during covering process. The cotton twist level TM is 18 twisters per inch. Therefore, this core spun yarn has the same structure with Example Yarn A, including in yarn count, LYCRA® fiber denier and yarn twist level, except with 2 sets of core elastic filaments instead of one end of core spun yarn. The recoverable stretch of this yarn is 20.63%, which has 2.92 unit percent higher than yarn in sample A. That means the yarn with two sets of filaments core has high recoverable stretch than the yarn with one set of filament core under the same content of spandex. In this way, the innovative yarn can provide high stretch and high recovery power for the fabrics by using the same amount of elastic fibers.

Example Yarn C: Typical core spun yarn with one elastic core fiber.

[0070] This is not an innovative yarn. The core spun yarn is 16Ne with one 70d LYCRA® spandex fiber covered by cotton sheath. The draft of the LYCRA® fiber is 3.8X during covering process. The cotton twist level TM is 18 twisters per inch. This yarn has 38.71 % recoverable stretch after boil off and the yarn have 2.28 shrinkage.

Example Yarn D: Core spun yarn with two core elastic fibers

[0071] The core spun yarn is 16Ne with two sets of LYCRA® spandex fibers covered by cotton sheath. The elastic core I fiber is 30D T162B and elastic core II fiber is 40D T162B. The total denier of the elastic finer is 70 denier. The draft of both LYCRA® fiber is 3.8X during covering process. The cotton twist level TM is 18 twisters per inch. Therefore, this core spun yarn has the same structure with Example Yarn C, except with 2 sets of core elastic filaments instead of one set of core spun yarn. The recoverable stretch of this yarn is 40.88%, which has 2.17 unit percent higher than yarn sample C. That shows that the yarn with two sets of filaments core has high recoverable stretch than the yarn with one set of filament core under the same content of spandex. In this way, the innovative yarn can provide high stretch and high recovery power for the fabrics by using the same amount of elastic fibers.

Example 1: Typical stretch woven bottom weight fabric

[0072] This is a comparison example, not according to the invention. The warp yarn was 40/2 Ne count of ring spun yarn. The weft yarn was 20 Ne cotton with 40D Lycra® core spun yarn. Lycra® draft is 3.5X. This weft yarn was a typical stretch yarn used in typical stretch woven khakis fabrics. Loom speed was 500 picks per minute at a pick level 56 Picks per inch. Table 3 summarizes the test results. The test results show that after finishing, this fabric had weight (8.95 g/m²), stretch (37.6 %), width (50.5 inch), weft wash shrinkage (0.91 %) and fabric growth (8.7%). The data indicate that this combination of stretch yarns and fabric construction caused high fabric growth.

Example 2: Stretch Fabric with double elastic fibers

[0073] This sample had the same fabric structure as in example 1. The only difference was the use of 20s weft yarn containing double core elastic fibers: 40D LYCRA® fiber with 3.5X draft and 40d LYCRA® fiber with 1.8X draft. The warp yarn was 40/2 Ne ring spun cotton. The loom speed was 500 picks/minute at 56 picks per inch. Table 3 summarizes the test results. It is clearly shows that this sample has similar stretch but lower fabric growth level (6.4%). Therefore, by using two different drafts of elastic core fibers within the same yarn, the covered yarn and the fabric can achieve different characters. For example, the high draft in elastic core I fiber give the fabric with high stretch, while the lower draft in elastic core II fibers give the fabric with low growth, high recover but not increase the fabric shrinkage. In this way, the fabrics with high stretch, high recovery and low shrinkage can be produced.

Example 3: Stretch Fabric containing double elastic fibers

[0074] This sample had the same fabric structure as in example 1. The only difference was the use of core spun yarns

in weft: 40D T162B LYCRA® fiber with 3.5X draft and 40d Easyset LYCRA® fiber with 3.5X draft. The warp yarn was 20 Ne 100% cotton ring spun yarn. 3/1 twill weaving pattern was applied. The finished fabric had weight (9.19g/m²), 38.4.0 % stretch and 7.9 % growth in the weft direction. It is clear shows, Easyset LYCRA® fiber in elastic core II maintain the fabrics stretch level while reducing the fabric growth from 8.7% in example 1 to 7.9%.

[0075] Easyset LYCRA® fiber can be heatset at about 170°C degree, which is about 20°C lower than the heatset temperature of T162B LYCRA® fiber. Therefore, when the fabrics are heatset in a temperature between 170°C and 190°C, the fabric got partially heatset. Only Easyset LYCRA® fiber is set and T162B is not set. In this way, the fabric keeps better stretch and recovery while the shrinkage keep under certain level.

Example 4: Stretch fabric with spandex and elastic polyolefin fiber

[0076] The warp yarn was 7.0 Ne count and 8.4 Ne count mixed open end yarn. The warp yarn was indigo dyed before beaming. The weft yarn is 16Ne core spun yarn with 40D T162B Lycra® spandex and 40D elastic polyolefin fiber. The Lycra® fiber and elastic polyester fiber were drafted 3.5X during covering process. Table 3 lists the fabric properties. The fabric made from such yarns exhibited good cotton hand, good stretch (47.8%) and good recovery (6.5% growth). All test results indicate that the combination of spandex and elastic polyolefin filaments can produce good fabric stretch and growth. Fabric has no grin through. Elastic filaments can't be seen from both fabric surface and fabric back.

[0077] As compared with spandex, elastic polyolefin fiber or Lastol fiber has lower recovery power, but better heat resistance, better chemical resistance, low fabric shrinkage and good cotton hand touch feeling. The fabrics contained with both spandex and elastic polyolefin can provide good stretch and good recovery with better heat resistance, lower shrinkage and better chemical resistance, such as chlorine resistance in swimming pool and denim bleaching processes.

Example 5: Stretch Fabric containing spandex and pre-covered elastic yarn

[0078] This sample had the same fabric structure as example 1. The difference was the core spun yarn in weft direction, which containing one bare 40D LYCRA® fiber and one pre-covered elastic yarn (40D/34f Nylon/40D Lycra® air covered yarn) in the core of the yarn. The draft of bare 40D LYCRA® fiber is 1.8X and the draft of LYCRA® fiber in pre-covered elastic yarn is 3.2X. This fabric used the same warp and structure as Example 1. Also, the weaving and finishing process were the same as Example 1. Table 3 summarizes the test results. We can see that this sample had good stretch (35.9 %), good weft direction wash shrinkage (0.65 %) and good fabric growth (5.3%). The fabric appearance and handle was excellent. After adding pre-covered elastic yarn (40D/34f Nylon/40D Lycra® fiber AJY yarn), the fabric growth remarkably reduced.

Example 6: Stretch fabric containing spandex and pre-covered elastic yarn

[0079] This sample had the same fabric structure as in example 5. The only difference was the draft of 40D bare LYCRA® fiber during covering process. The bare LYCRA® fiber draft is 3.5X while it was 1.8X in Example 5. The fabric weight was 8.96 OZ/yd², and the weft elongation was 37.8 %. The Fabric had very low growth (5.9%) in weft. This sample further confirms that adding additional elastic composite yarn can produce high performance stretch fabrics with low growth. Double elastic yarn makes the fabric growth to 5.9% from 8.7% in Example 1. As compared with Example 5, the draft increase also results in higher weight and stretch.

Example 7: Stretch denim containing spandex and pre-covered elastic yarn

[0080] This example had the same warp yarn and same fabric structure as Example 4. The warp yarn was 7.0 Ne count and 8.4 Ne count mixed open end yarn. The warp yarn was indigo dyed before beaming. The weft yarn is 16Ne core spun yarn with 40D Lycra® spandex and 50D/24f polyester 40D LYCRA® fiber air jet covered yarn. Lycra® draft is 3.5X and 1.8X in bare and composite core. This sample is an innovation fabric. Loom speed was 500 picks per minute at a pick level 44 Picks per inch. Table 3 summarizes the test results. The test results show that after washing, this fabric had weight (12.80 OZ/Y²), 35.3% weft stretch and 3.5% growth in weft.

Example 8: Stretch denim containing spandex and pre-covered elastic yarn

[0081] This example had the same warp yarn and same fabric structure as Example 7, except the LYCRA® fiber draft in pre-covered elastic yarn (2.6X draft in Example 8 vs. 1.8X draft in example 7)). Table 3 summarizes the test results. It is clear that this sample had good stretch (weft 40.4%) as compared with sample 7.

Example 9: Stretch fabric with spandex and PBT stretch fiber

[0082] This example had the same warp yarn and same fabric structure as Example 7 and 8, except using 50D/26f PBT stretch fiber as elastic core II fiber. This bare 50D/26f PBT fiber have 40.23% recoverable stretch and 3.44% shrinkage tested with ASTM D6720 Method. The elastic core I Lycra® fiber was drafted 3.5X during covering process. Table 3 lists the fabric properties.

[0083] The fabric made from such yarns exhibited good cotton hand, good stretch (40.7%) and good recovery (6.0% growth). All test results indicate that the combination of spandex and no-elastomeric stretch filaments can produce good fabric stretch and growth. Fabric has no grin through; elastic filaments can't be seen from both fabric surface and fabric back.

The following are numbered clauses of the invention:

[0084]

1. An article comprising a core spun yarn comprising:

- a) a sheath of hard fibers;
- b) one set of elastic fiber (elastic core fiber I); and
- c) a second set of elastic fiber (elastic core fiber II);

wherein the elastic core fiber I and the elastic core fiber II have different elastic properties.

2. The article of clause 1, wherein the elastic core fiber I and elastic core fiber II have different deniers or different filaments.

3. The article of clause 1, wherein the elastic core fiber I and elastic core fiber II have different drafts.

4. The article of clause 1, wherein the elastic core fiber I and elastic core fiber II have different polymer compositions.

5. The article of clause 1, wherein at least one elastic core fiber comprises elastomeric fiber having denier of about 10 denier to about 450 denier.

6. The article of clause 5, wherein at least one elastic core fiber comprises spandex fiber.

7. The article of clause 1, wherein at least one elastic core fiber comprises elastic polyolefin fiber having denier of about 10 denier to about 450 denier.

8. The article of clause 7, wherein the elastic polyolefin fiber is lastol fiber.

9. The article of clause 1, wherein at least one set of elastic core yarns are pre-covered elastic yarn having denier of about 15 denier to about 300 denier.

10. The article of clause 9, wherein the pre-covered elastic yarns include a covering selected from the group of air covered yarn, single wrapped yarn, double wrapped yarn, and combinations thereof.

11. The article of clause 9, wherein the pre-covered elastic yarn is a polyester and spandex air covered yarn.

12. The article of clause 1, wherein at least one elastic core fiber includes a non-elastomeric elastic fiber having a denier of about 15 to about 450 denier.

13. The article of clause 12, wherein the non-elastomeric elastic yarn is selected from the group of filaments with yarn recoverable stretch higher than 20% tested with ASTM D6720-07 method

14. The article of clause 13 wherein said non-elastomeric elastic yarn comprises at least one fiber selected from the group consisting of polyester, nylon, PTT fiber, PBT fiber, bi-component fiber, and combinations thereof.

15. The article of clause 1, wherein the sheath of hard fibers is selected from the group consisting of wool, linen,

silk, polyester, nylon, olefin, cotton, and combinations thereof.

16. An article comprising a woven fabric having warp yarns and weft yarns, wherein at least one of the warp yarns and weft yarns includes a core spun yarn comprising:

- a) a sheath of hard fibers;
- b) one set of elastic fiber (elastic core fiber I); and
- c) a second set of elastic fiber (elastic core fiber II);

wherein the elastic core fiber I and the elastic core fiber II have different elastic properties.

17. The article of clause 16, wherein the fabric has stretch in the weft direction between about 10 and about 45%.

18. The article of clause 16, wherein said fabric comprises a garment.

19. A method of making an article comprising a woven fabric having warp yarns and weft yarns. Either warp yarn or weft yarn or both warp and weft yarns have core spun yarn, wherein, the core spun yarn comprising:

- a) a sheath of hard fibers;
- b) one set of elastic fiber (elastic core fiber I); and
- c) a second set of elastic fiber (elastic core fiber II);

wherein the elastic core fiber I and the elastic core fiber II have different elastic properties.

20. A stretch fabric comprising a core spun yarn comprising:

- a) a sheath of hard fibers;
- b) one set of elastic fiber (elastic core fiber I); and
- c) a second set of elastic fiber (elastic core fiber II);

wherein the elastic core fiber I and the elastic core fiber II have different elastic properties.

21. The article of clause 20, wherein the fabric is woven, or warp knit, or circular knit fabric.

Claims

1. An article comprising a core spun yarn (8) comprising:

- a) a sheath of hard fibers (2);
- b) elastic core fiber I (4), wherein elastic core fiber I (4) is one set of elastic fiber comprising spandex; and
- c) elastic core fiber II (6), wherein elastic core fiber II (6) is a second set of elastic fiber comprising spandex;

wherein the elastic core fiber I (4) and the elastic core fiber II (6) have different properties, and wherein the elastic core fiber I and elastic core fiber II have different drafts.

2. The article of claim 1, wherein the draft of each elastic core fiber is selected between drafts of 1.01X times to 5.0X times.

3. The article of claim 1, wherein the elastic core fiber I (4) and elastic core fiber II (6) have different deniers or different filaments.

4. The article of claim 1, wherein elastic fiber I (4) and elastic fiber II (6) are elastic bare fiber plus elastic bare fiber, elastic bare fiber plus pre-covered yarn or pre-covered yarn plus pre-covered yarn.

5. The article of claim 4, wherein at least one of elastic fiber I (4) and elastic fiber II (6) is elastic bare fiber having a linear density of from about 10g/9000m to about 400g/9000m (about 10 to about 400 denier), optionally from about 10g/9000m to about 162g/9000m (about 10 to about 162 denier).

6. The article of claim 4, wherein at least one of elastic fiber I (4) and elastic fiber II (6) is pre-covered elastic yarn having a linear density of about 15g/9000m to about 900g/9000m (about 15 denier to about 900 denier), optionally from about 30g/9000m to about 300g/9000m (about 30 to about 300 denier).

7. The article of claim 4, wherein the pre-covered elastic yarn includes a covering selected from the group of air covered yarn, single wrapped yarn, double wrapped yarn, and combinations thereof.

8. The article of claim 4, wherein the pre-covered elastic yarn is a polyester and spandex air covered yarn.

9. The article of claim 8, wherein the pre-covered elastic yarn is 40g/9000m (40 denier) or 70g/9000m (70 denier) spandex with 50g/9000m to 150g/9000m (50 to 150 denier) polyester air covered yarn.

10. The article of claim 1 wherein the article comprises a woven fabric having warp yarns and weft yarns, wherein at least one of the warp yarns and weft yarns includes the core spun yarn.

11. The article of claim 1, wherein the fabric has stretch in the weft direction between about 10 and about 45%.

12. The article of claim 1, wherein said article is a garment.

13. The article of claim 1, wherein the article is a stretch fabric.

14. The article of claim 13, wherein the fabric is woven, or warp knit, or circular knit fabric.

15. A method of making an article comprising a woven fabric having warp yarns and weft yarns, wherein either warp yarn or weft yarn or both warp and weft yarns have core spun yarn, wherein, the core spun yarn (8) comprises:

a) a sheath of hard fibers (2);

b) elastic core fiber I (4), wherein elastic core fiber I (4) is one set of elastic fiber comprising spandex; and

c) elastic core fiber II (6), wherein elastic core fiber II (6) is a second set of elastic fiber comprising spandex;

wherein the elastic core fiber I and the elastic core fiber II have different properties, and wherein the elastic core fiber I and elastic core fiber II have different drafts.

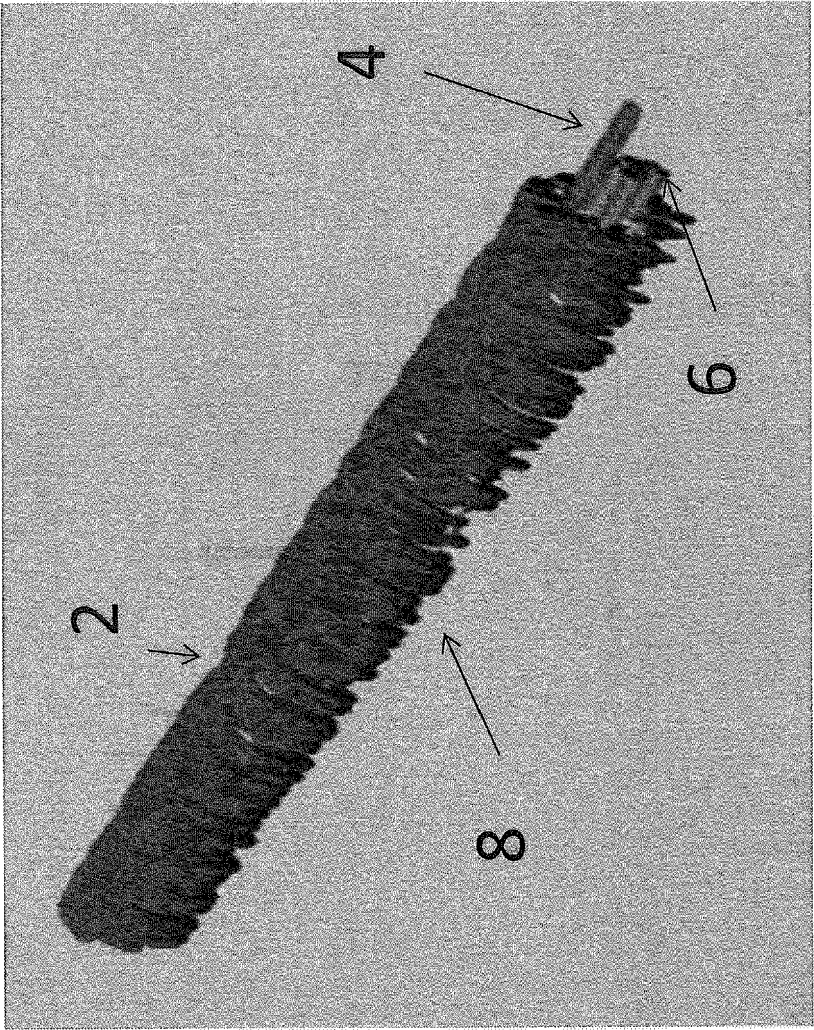


FIG. 1

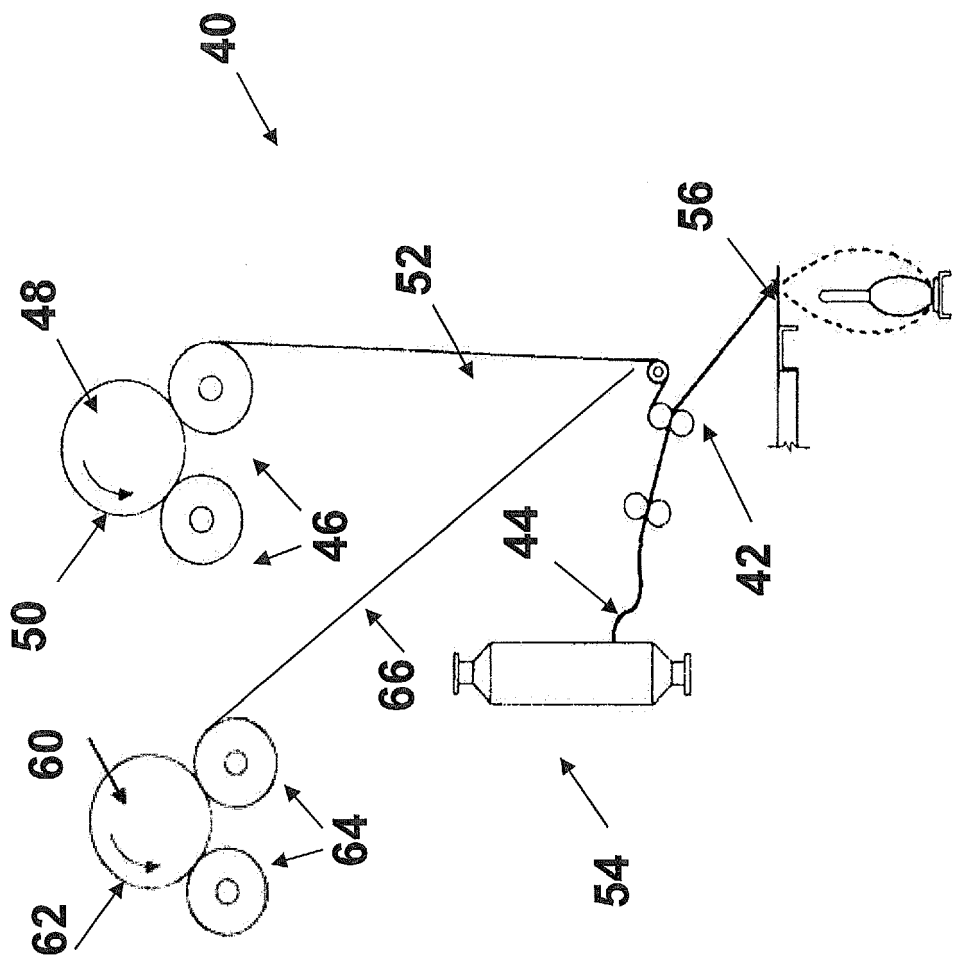


FIG 2

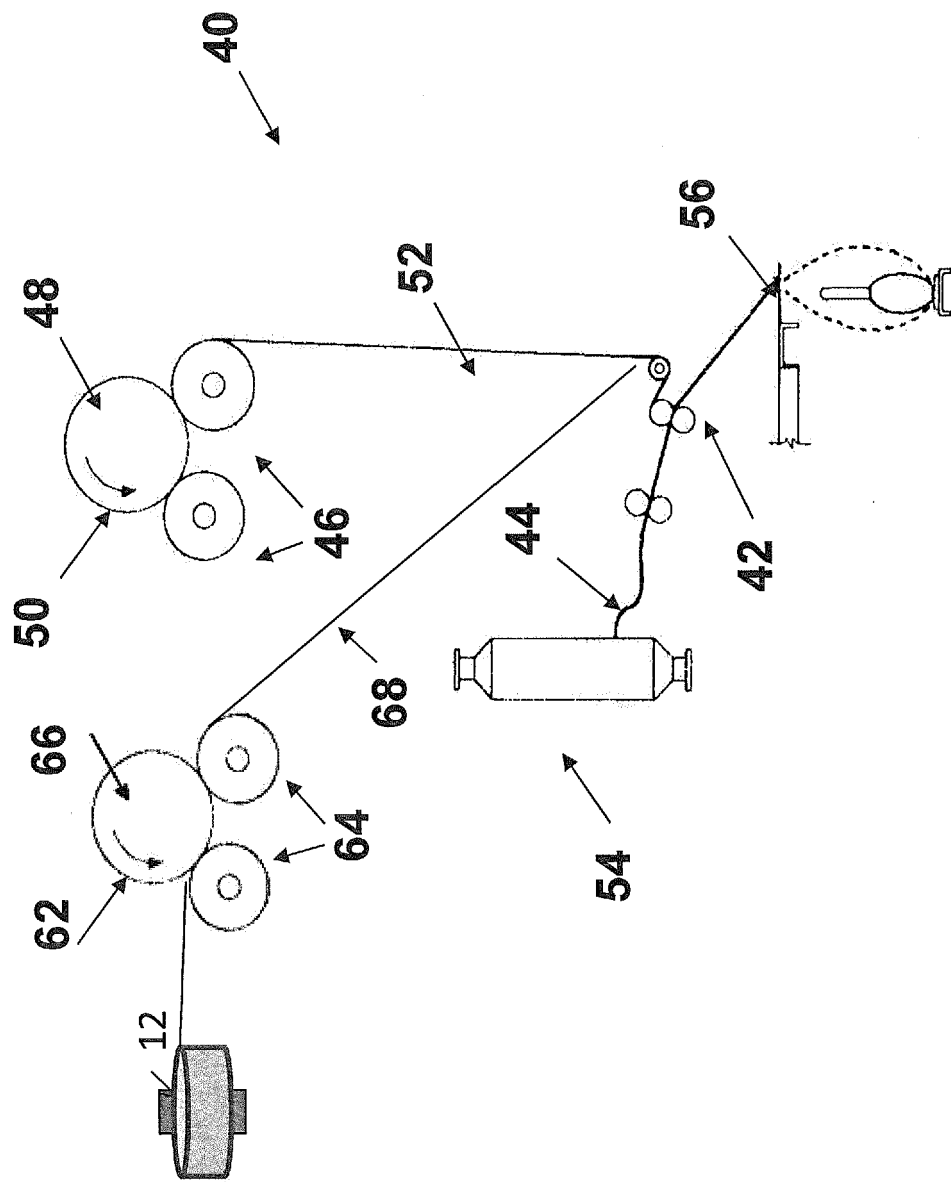


FIG 3

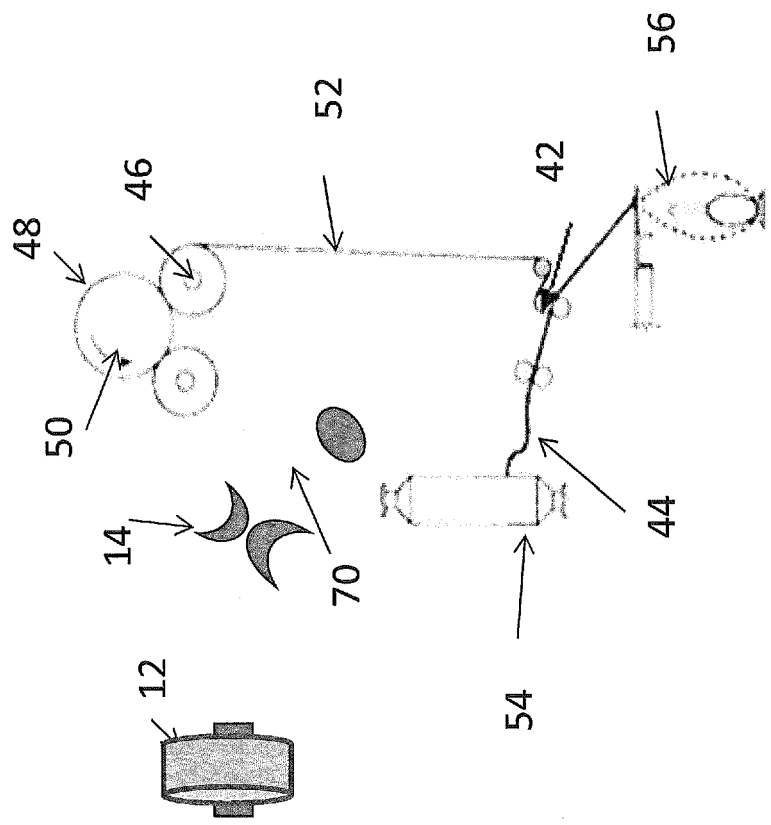


FIG 4

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 4470250 A [0006]
- US 4998403 A [0006]
- US 7134265 B [0006]
- US 6848151 B [0006]
- US 20080268734 A1 [0006]
- US 20080318485 A1 [0006]