United States Patent [19]

Holliday

[11] **3,910,075**

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[54] **WARP KNIT ELASTIC FABRIC**

[75] Inventor: **Bettie E. Holliday,** Pickens, S.C.

[73] Assignee: **Deering Milliken Research Corporation,** Spartanburg, S.C.

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[52] **U.S. Cl.** **66/192;** 66/190

[51] **Int. Cl.²** **D04B 23/08**

[58] **Field of Search** 66/190–195, 66/86

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Primary Examiner—Ronald Feldbaum

Attorney, Agent, or Firm—Luke J. Wilburn, Jr.; H. William Petry

[57] **ABSTRACT**

A warp knitted elastic fabric having a ground construction of a pair of sets of relatively inelastic yarns formed into wales and courses of single yarn stitch loops with one set of yarns forming single yarn stitch loops in alternate courses with the stitch loops of each yarn of the one set occurring in the same wale and the other set of yarns forming single yarn stitch loops in the courses intervening between the alternate courses, each yarn of the other set forming single yarn stitch loops alternately in two adjacent wales, and a set of relatively elastic yarns laid into the ground construction between and generally parallel to the wales such that yarns of the one set are folded about the elastic yarns to cover and maintain the elastic yarns in the ground construction.

19 Claims, 6 Drawing Figures

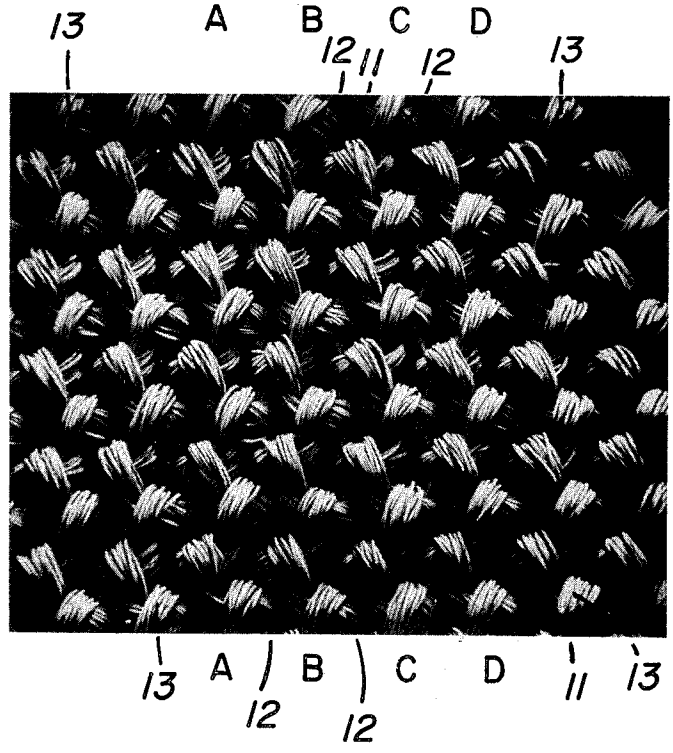


FIG. 3

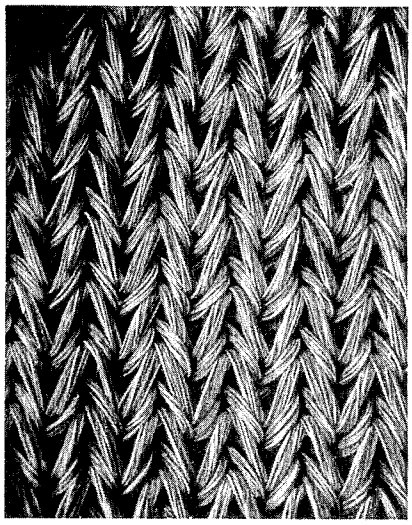
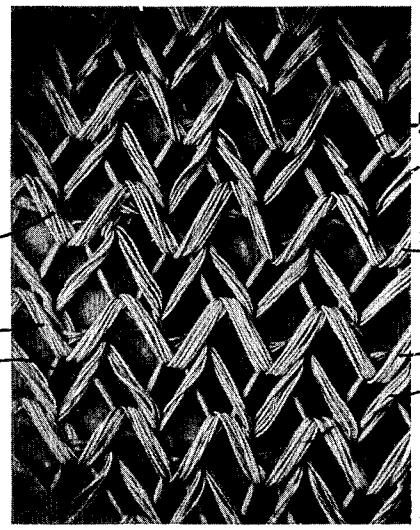


FIG. 4



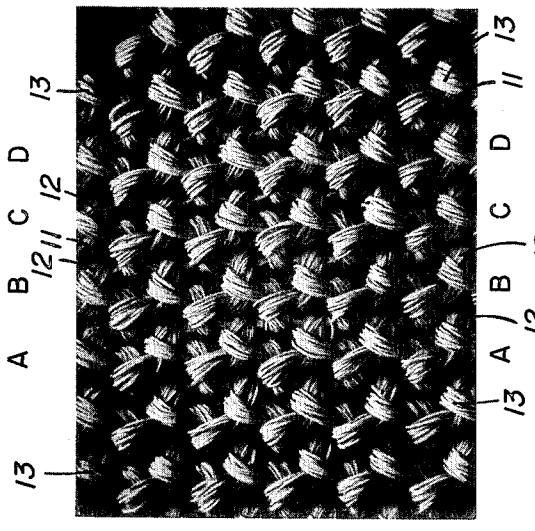


FIG. 1

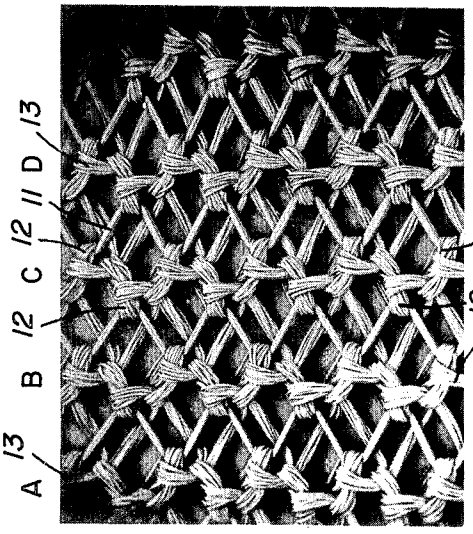
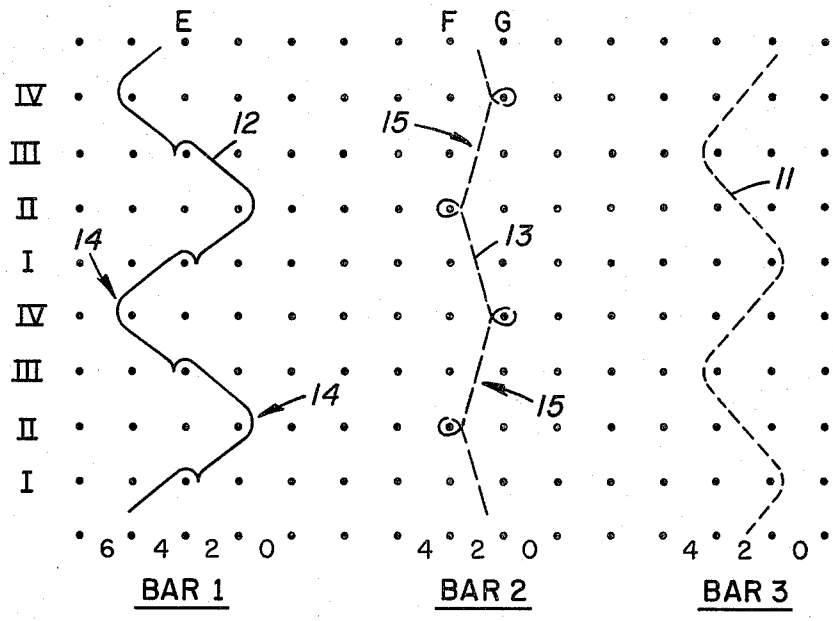


FIG. 2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6 4 2 0
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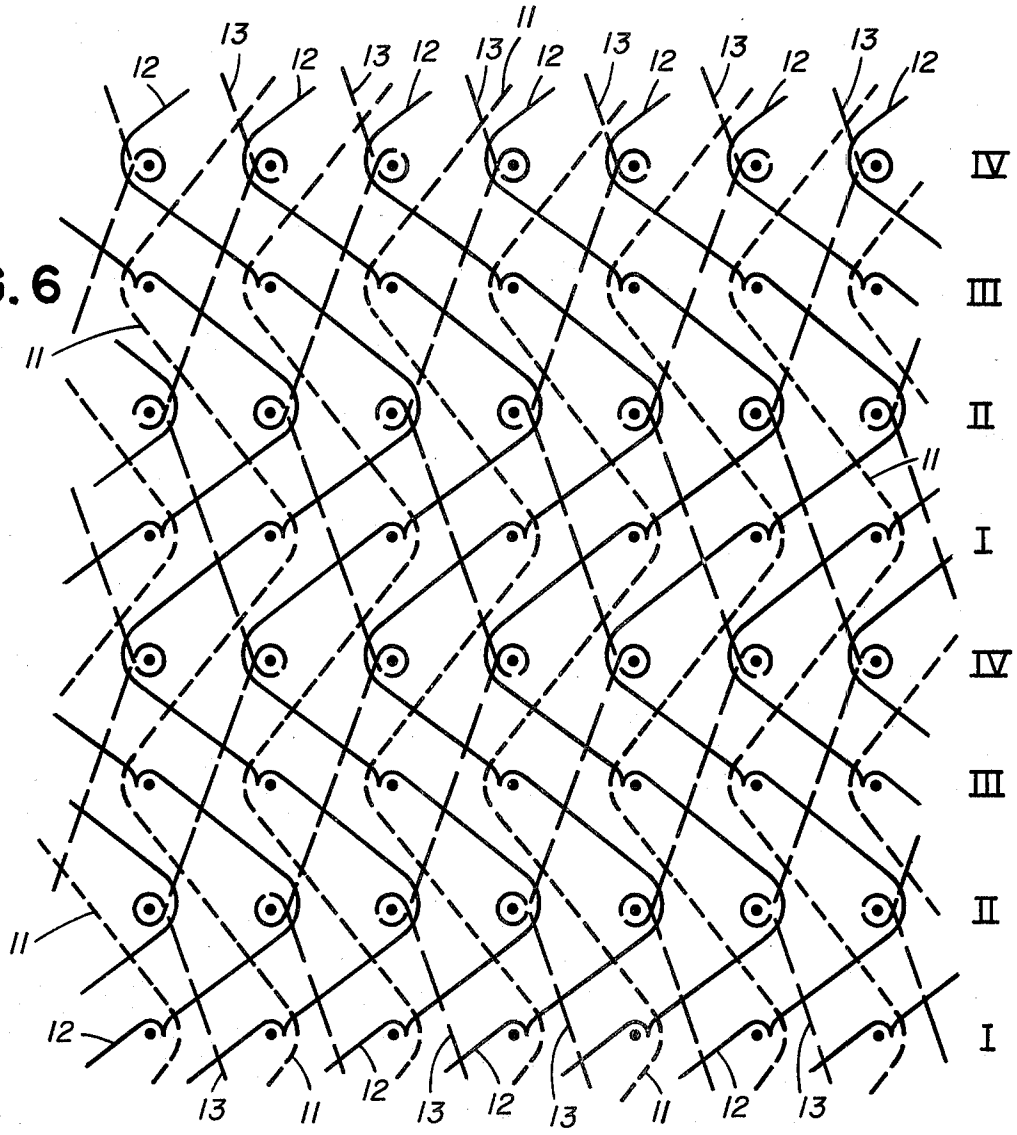
BAR 1
BAR 2
BAR 3

FIG. 5

FIG. 6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WARP KNIT ELASTIC FABRIC

This invention generally relates to warp knit fabrics, and more specifically relates to warp knit elastic fabrics.

Warp knit elastic textile fabrics are typically composed of both elastic and inelastic thread components, and such fabrics are widely used in the manufacture of support garments such as girdles, corsets, bras, swimsuits, and the like, as well as outer garments, all of which are designed to more closely conform to the body of a wearer. The most common of such warp knit elastic fabrics are the well known "powernet" elastic fabrics which are an open mesh or net fabric having relatively inelastic threads knitted into a ground support construction, with relatively elastic threads inlaid or formed into stitches with the relatively inelastic threads to provide an open net elastic fabric having high elongation and stretch recovery in one or more directions. However such powernet fabrics are typically transparent so that portions of the body or under garmets beneath such fabrics are readily visible therethrough, and significant portions of the elastic threads are visible at the surface of the fabric, giving an undesirable "grin-through" effect.

Among the well known relatively elastic yarns which are typically used in such elastic fabrics are rubber yarns, and more recently, synthetic spandex yarns. While such yarns provide desirable high elastic elongations and stretch recovery, such yarns also have certain undesirable characteristics which typically must be dealt with in producing commercially acceptable elastic fabrics. One of those problems is that bare rubber and bare spandex yarns have an undesirably clammy feeling when brought into contact with human skin. Another undesirable characteristic is that bare rubber and bare spandex yarns are difficult to dye with dyes suitable for use in coloring commonly used textile yarns. Therefore if fabrics incorporating both the common yarns and the bare rubber or spandex yarns are to be dyed after being knit, it is desirable to cover the rubber or spandex yarns with the relatively inelastic yarns. Similarly, it is desirable to cover bare rubber or spandex yarns with the relatively inelastic yarns in order to avoid direct contact between the undesirably clammy rubber or spandex yarns and human skin when garments made from such fabrics are worn next to the skin.

A variety of efforts have been made to avoid undesirable see-through as well as unnecessary exposure of bare elastic yarns in fabrics. One attempt to solve the problems inherent in bare elastic yarns comprised spirally winding a relatively inelastic yarn around each bare rubber yarn before knitting the resultant covered rubber yarns into a fabric. Such yarns are known as wound rubber or covered rubber yarns, and are typically heavy, expensive, and have limited elongation.

Another solution has been to knit bare elastic yarns with relatively inelastic yarns such that the elastic yarn is covered with a pile effect of the relatively inelastic yarn. This fabric structure is described, for example, in Lesley U.S. Pat. No. 3,254,510. The bare elastic and inelastic yarns are knitted together into double yarn stitches to facilitate covering of the bare elastic yarns with the relatively inelastic threads, and to thereby obtain opaqueness to avoid undesirable see-through in garments made from such fabrics. However, it will be

appreciated that where the yarns which comprise the fabric are knit into double yarn stitches and are more tightly pulled together to obtain desired opaqueness, greater amounts of yarn will be will be employed in such fabrics than in fabrics such as the aforementioned powernet type elastic fabrics, and increased yarn consumption per fabric area increases the unit fabric cost.

A more economical solution to the problem encountered in the production of warp knit elastic fabrics has been provided by fabrics having a plurality of pairs of relatively inelastic yarns forming a ground construction wherein the relatively inelastic yarns are knit together in single yarn stitches, while the relatively elastic spandex yarn is laid into the ground construction in such a way that the lap portions of stitches of one of the yarns of the ground construction are wrapped about the relatively elastic yarn to substantially cover the inlaid relatively elastic yarn. That fabric is described in Lesley U.S. Pat. No. 3,552,154. Furthermore, in that fabric, the pairs of relatively inelastic yarns which are knit together in single yarn stitches are knit in such a way that one yarn of each of said pairs forms stitches in adjacent wales and alternate courses, and the other yarn of each of said pairs forms stitches in non-adjacent wales and alternate courses. It will be appreciated that this fabric may be made lighter in weight than the aforementioned fabrics wherein the yarns were knit together in double yarn stitches, while still having the advantage of substantially covering the bare elastic yarn.

While there has been progress in producing warp knit elastic fabrics which attempt to overcome the undesirable physical characteristics of bare elastic yarns, as well as attempt to overcome the economic difficulties inherent in attempting to deal with those characteristics, it will be appreciated that there is a continuing need for warp knit elastic fabric structures wherein the desirable elasticity characteristics of highly elastic bare rubber and spandex yarns may be used, while minimizing yarn consumption of both elastic and inelastic yarns per unit fabric area.

BRIEF SUMMARY OF THE INVENTION

It is, therefore, an object of the present invention to provide a warp knit elastic fabric of relatively elastic and relatively inelastic yarns, which fabric may be made opaque, lightweight, and more economically than previous warp knit elastic fabrics.

It is another object of this invention to provide a novel warp knit fabric structure.

The foregoing objects and others are provided in accordance with the present invention which is a warp knit elastic fabric comprising a ground construction of a pair of sets of relatively inelastic yarns formed into wales and courses of single yarn stitch loops with one set of yarns forming single yarn stitch loops in alternate courses with the stitch loops of each yarn of the one set occurring in the same wale, and the other set of yarns forming single yarn stitch loops in the courses intervening between the alternate courses, each yarn of the other set forming single yarn stitch loops alternately in two adjacent wales, and a set of relatively elastic yarns laid into the ground construction between and generally parallel to the wales such that yarns of the one set are folded about the elastic yarns to cover and maintain the elastic yarns in the ground construction.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the invention as well as other objects and further features thereof, reference is made to the following detailed disclosure of preferred embodiments of the invention taken in conjunction with the accompanying drawings thereof, wherein:

FIG. 1 is an about 18X scanning electron photomicrograph of the technical face side of a relexed fabric of the present invention.

FIG. 2 is an about 18X scanning electron photomicrograph of the technical face side of the fabric of FIG. 1, said fabric being extended in both the course and wale directions.

FIG. 3 is an about 18X scanning electron photomicrograph of the technical back side of a relaxed fabric of the present invention.

FIG. 4 is an about 18X scanning electron photomicrograph of the technical back side of the fabric of FIG. 3, said fabric being extended in both course and wale directions.

FIG. 5 is a point diagram schematically illustrating the bar movement patterns by which each of three yarn sets are knit into a fabric of the present invention.

FIG. 6 is a point diagram schematically illustrating in superimposed form, the stitch pattern, or combination of bar movement patterns, by which three sets of yarn are knit together, using the patterns shown in FIG. 5, to form a fabric of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The appearance of the technical face side and technical back side of the fabric of the present invention is depicted in FIGS. 1 and 3, respectively. FIG. 3 shows how completely the laps of the relatively inelastic yarns cover the inlaid relatively elastic yarns, which are virtually invisible on the back side of the fabric shown in FIG. 3. FIG. 1 shows how the relatively elastic yarn is laid-in between and substantially parallel to the wales of the fabric, and how it is substantially covered by the bases of the loop portions of the single yarn stitches of one of the relatively inelastic yarns. More specifically, FIG. 1 shows relatively elastic yarns 11 extending generally parallel between the wales, a number of which are labelled A, B, C, D. FIG. 1 also shows the base portions of stitch loops of a relatively inelastic yarn 12 substantially covering the laid in relatively elastic yarn 11 on the technical face side of the fabric. FIG. 1 also depicts the loop portions of relatively inelastic yarns 12 lying in a direction approximately parallel to the courses of the fabric, each course comprising a row of stitch loops across the width of the fabric, horizontally as shown in FIG. 1. FIG. 1 further depicts the single yarn loop portions of another relatively inelastic yarn 13, extending in a direction substantially parallel to the wales of the fabric, the wales comprising rows of stitch loops extending lengthwise in the direction in which the fabric is knit, vertically as illustrated in FIG. 1.

The photomicrographic views of the face and the back of the fabric as shown in FIGS. 1 and 3, respectively, illustrate how the fabric of the present invention achieves covering of the undesirable characteristics of the relatively elastic yarns in an opaque, warp knit elastic fabric. While the relatively elastic yarns are apparently more fully covered on the technical backside of the fabric shown in FIG. 3, and the back side may therefore be preferable for use as the desired exterior face when garments are made of such fabric, FIG. 1 shows that the relatively elastic yarn is substantially covered even on the technical face side of the fabric, and that the relatively elastic yarns are so deeply inlaid between the wales of the fabric, and that the relatively inelastic yarns are typically bulkier than the relatively elastic yarn, so that there is very little opportunity for the elastic yarns to come into contact with the human skin if the face side of the fabric is worn next to the skin. Indeed, if desired, the face side itself may be used as the exterior face in garments made of the inventive fabric.

The novel warp knit fabric structure of the present invention is more clearly illustrated in FIGS. 2, 4, 5 and 6. A preferred way of making the warp knit elastic fabrics of the present invention is to knit at least two sets of relatively inelastic yarns together while laying-in a third set of relatively inelastic yarns, using the stitch pattern:

Bar 1: 4–2, 0—0, 2–4, 6—6, (fully threaded to approximate fabric width)

Bar 2: 2—2, 2–4, 2—2, 2–0 (fully threaded to approximate fabric width)

Bar 3: 0—0, 2—2, 4—4, 2—2 (fully threaded to approximate fabric width),

the stitch pattern being given in Raschel designations. Those skilled in the art will appreciate that such a stitch pattern or combination of bar movement patterns conventionally defines the coordinated movement by which the guide bars feed yarns to the knitting needles during knitting. The inventive fabric is preferably achieved by knitting three sets of yarns into fabric on a warp knitting machine having at least three guide bars and one needle bar (such as tricot or Raschel machines) with each of three guide bars, or their equivalents, fully threaded with a set of yarns to the approximate width of the desired fabric. Such warp knitting machines are typically provided with appropriate pattern chains or cams to operate the guide bars in accordance with a desired stitch pattern.

The relationships of the patterns by which the yarns are placed in the inventive fabric are illustrated in FIGS. 5 and 6. FIG. 5 indicates separately the movement of each of three guide bars. During knitting, a first set of relatively inelastic yarns 12 is presented to the needles through a front guide bar (Bar 1), a second set of relatively inelastic yarns 13 is presented to the needles through a middle guide bar (Bar 2), and a set of relatively elastic yarns 11 is presented to the needles through a back guide bar (Bar 3) which inlays the relatively elastic yarns 11 into the relatively inelastic yarns 12 and 13 which are knitted into a ground construction. FIG. 6 shows the three bar movement patterns of FIG. 5 in a combined stitch pattern which is schematically representative of a section of the inventive fabric. The stitch pattern, or combination of bar movement patterns, are representative not only of the way in which the guide bars feed yarns to the needles during knitting, but also define the way in which the yarns lie in relationship to each other in the resultant fabric. FIG. 6 also more clearly indicates that each one of the guide bars, Bar 1 (front bar), Bar 2 (middle bar), and Bar 3 (back bar) feeds an entire set, or warp, of yarns to the needles of the knitting machine in accordance with the patterns illustrated in FIG. 5.

As shown in FIG. 6, each of the yarn sets 12 and 13 alternately knits, forming single yarn loops in one course of the fabric, and then lays-in the lap portion of the stitches on the succeeding course, this alternate repetition of knitting and laying-in repeatedly occuring throughout the length of the fabric. Since the stitch pattern repeats itself every four courses of the inventive fabric, the courses schematically represented by the horizontal rows of dots in FIGS. 5 and 6 have been numbered with Roman numberals I, II, III, IV, and a greater length of the pattern of each yarn has been illustrated for greater clarity. As shown in FIGS. 5 and 6, the set or warp of yarns 12 which on the machine are fed to the knitting needles by guide Bar 1, knit single yarn stitch loops in courses I and III, and lay-in the lap portions of the stitches on courses II and IV. Each one of the yarns of the set of relatively inelastic yarns 13 which is fed to the needles by guide Bar 2 alternately knits single yarn stitch loops in courses II and IV while the lap portions of the stitches of yarn 13 are laid-in on courses I and III. It may then be said that yarns 12 knit on alternate courses, and that the yarns 13 knit on the courses which intervene between the alternate courses upon which yarns 12 are knitted.

FIGS. 5 and 6 also schematically illustrate that each yarn 12 is always knit, or formed into a loop, in the same wale, which is schematically illustrated as the vertical row of dots designated E in FIG. 5. However, each yarn 13 is knit or formed into a loop alternately on two adjacent wales designated F and G in FIG. 5. The relatively elastic yarns 11 which are laid-into the ground structure formed of yarns 12 and 13 are laid-in on the machine around two adjacent needles on the needle bar, but in alternate courses I and III of the fabric, in which the Bar 1 yarns 12 are also knit.

It is the fabric stitch pattern, or combination of bar movement patterns illustrated in FIGS. 5 and 6, and particularly the combination and coordination of the Bar 1 yarn 12 with the Bar 3 yarn 11, which provide the advantageous fabric of the present invention. While the laid-in lap portion of a stitch of yarn 12, which is between stitch loops in alternate courses I and III, is laid-in outside of a needle adjacent the needle on which the yarn 12 is always knit, such laid-in lap portions being indicated at reference numeral 14 in FIG. 5, the stitch pattern of the present invention surprisingly causes that laid-in lap portion 14 to assume, on the technical back side of the fabric, a diagonal path crossing the line of the wale in which the yarn 12 is always knit, when the fabric comes off the knitting elements of the knitting machine. FIG. 4 shows these diagonal lap portions 14 of yarn 12 crossing the line of the wales of the fabric, which have been designated A,B,C,D. Considering the Bar 1 pattern alone, or knit in conjunction with another yarn to form a fabric, it is quite unexpected that the laid-in lap portions 14 of Bar 1 yarn 12 would finally assume a position diagonally across the very wale in which the Bar 1 yarn 12 is knit. This resultant arrangement of the lap portions 14 compliments the lap portions 15 of the stitches of the Bar 2 yarn 13, which lap portions 15 extend diagonally between adjacent wales as also shown in FIG. 4. The combination of the complimentary lap portions 14 and 15 of relatively inelastic yarns 12 and 13, both of which are exposed on the technical back side of the fabric, is what provides the excellent cover of the relatively elastic yarn 11 on the technical back side of the fabric, as best illustrated by the photomicrographic view of FIG. 3.

It is the same coordination of the bar movement patterns illustrated in FIGS. 5 and 6, which causes the relatively inelastic yarns 12 to be folded about the elastic yarns 11 to thereby cover the relatively elastic yarns and maintain them in the ground formed of the sets of yarns 12 and 13. As schematically illustrated in FIGS. 5 and 6, laid-in yarn 11 is placed in the fabric so that it avoids being knit at the time yarns 12 are being knit. From FIGS. 5 and 6, it would at first appear that the elastic yarn 11 is trapped within or around the wale in which the yarn 12 is knit. However, due to the fact that a relatively short length of yarn 11 is typically fed to the knitting elements on the knitting machine while greater lengths of knitted yarns 12 and 13 are fed thereto, and because those shorter lengths of yarn 11 may be elastically elongated as a set of yarns 11 are laid into the fabric from Bar 3, when the knitted fabric comes off of the knitting elements, there is a tendency for yarn 11 to retract into its shortest configuration, which is theoretically a straight line parallel to the wales and lying between the two wales around which it would at first appear that the inlaid yarns 11 are trapped, as schematically illustrated in FIG. 6. However, since the things that would apparently trap the inlaid yarns 11 in those two wales are the single yarn loop portions of the stitches of yarn 12, the force created by the short length of relatively elastic yarn 11 in the fabric pulls the bases of the loop portions of the stitches of yarn 12 toward the straight line in which yarn 11 seeks to lie, thereby orienting the loop portions of the stitches in yarn 12 in a direction more nearly parallel to the courses of the fabric, at the same time relocating the bases of the loops of yarn 12 which are joined by the laid-in portions 14 of yarn 12. It is this dislocation of the bases of the loop portions of the stitches of yarn 12, and the fact that the coordination of yarns 11 and 12 are such that each alternate loop in each yarn 12 has its base distended in a different direction from the wale in which the yarn 12 is knitted, that causes the lap portions 14 of the yarn 12 on the technical back of the fabric to assume a diagonal path crossing the wale in which the yarn 12 is knitted, when one might originally have assumed that the laid-in portions 14 of yarn 12 might themselves be trapped in a wale adjacent to the wale in which the yarn 12 is knit. Furthermore, since the loop portions of yarns 13 are alternately pulled through the loop portions of the yarn 12, in order to form the fabric of the present invention, it becomes clear that it is the loop portions of the yarn 13 which extend substantially parallel to the wales as also illustrated in FIGS. 1 and 2.

The way in which the bases of the loops of yarn 12 are alternately pulled toward the two opposite wales adjacent to the wale in which yarn 12 is knitted is most distinctly depicted in FIG. 2 where the fabric of FIG. 1 has been stretched in both the wale and course directions. For example, the bases of the loop portions of the loops of yarn 12 in wale C alternately extend toward adjacent wales B and D. FIG. 2 also more clearly illustrates the position of relatively elastic yarn 11 which alternately passes behind the bases of the loop portions of yarns 12, first in wale C, and then in wale D. When the inventive fabric is in an extended position as shown in FIG. 2, the relatively elastic yarns 11 assume a zigzag path between the wales, but it is still clear that their

location in the fabric is between and extending generally parallel to the wales. The elastic yarns **11** are even visible in FIG. **4** where the fabric is seen from its technical back side, the elastic yarns passing under the ends of the lap portions **14** of yarn **12** first in wale D, and then in wale C, alternately throughout the length of the fabric. FIGS. **2** and **4** therefore even more clearly then FIG. **1** illustrate that in the fabric of the present invention, the relatively inelastic yarns **12** are folded about the laid-in elastic yarns **11** so that an elastic yarn lies between the base portion of each of the loops, and the laps which are connected to each such loop, of the relatively inelastic yarn **12.** In this way the inlaid elastic yarns are substantially covered, even on the technical face side of a fabric having single yarn stitch loops, and thereby maintained in the ground construction formed by the relatively inelastic yarns **12** and **13.** FIGS. **2** and **4** also illustrate the advantageous two way stretch characteristics of the inventive fabric.

By virtue of the fact that the yarns are knit according to the aforementioned stitch pattern, a fabric structure is provided in which significantly less relatively inelastic yarn, and somewhat less relatively elastic yarn, are used to provide an opaque, warp knitted elastic fabric whose characteristics, and particularly whose ability to make the best use of a bare elastic yarn while compensating for the undesirable characteristics of that bare elastic yarn, are comparable to fabrics known in the prior art.

The relatively inelastic yarns suitable for use in the present invention may include any textile yarns capable of being knitted on a warp knitting machine. Such yarns may comprise cotton, nylon, polyester, acetate, rayon, silk, and/or any other suitable material. The relatively elastic yarns suitable for use in the present invention may comprise any textile material having significant elastic elongation and stretch recovery, and those yarns impart good elastic elongation and stretch recovery characteristics to the inventive fabric. Such relatively elastic yarns may comprise natural or synthetic rubbers, or may be the more recently developed spandex yarns such as DuPont's Lycra yarn. The relatively elastic yarn of the present invention is usually used in its bare condition, without covering such as a spiral winding. The word "yarn" is used herein in the generic sense to include any sort of elongate flexible member which may be knit on a warp knitting machine, and may include threads, filaments, strands, or yarns, whether they be monofilament, multifilament, continuous filament, or comprise spun shorter fibers.

In other embodiments, the bar movement pattern of Bar **2,** by which relatively inelastic yarns **13** are knitted into the fabric may be a pattern by which open stitch loops rather than closed stitch loops are produced. Or the bar movement pattern of Bar **1** by which relatively inelastic yarns **12** are knitted into the fabric may be a pattern by which closed stitch loops rather than open stitch loops are produced.

During knitting of the fabric of the present invention, the length of each set of yarns **11,** yarns **12,** and yarns **13,** fed to the knitting machine (i.e. the runner length of each warp) need only be sufficient to accommodate the movements of the knitting elements of the machine without breaking yarn or breaking knitting elements. However, the runner length of the relatively elastic yarns **11** is sufficiently short to cause the relatively elastic yarns **11** to attain their desired position between and substantially parallel to the wales in the resultant knit fabric. Any combination of runner lengths and resultant tensions which provides the desired result may be used. After the fabric is removed from the knitting machine, it may be dyed and finished by any means which the user may desire.

The following specific example is intended to further illustrate a preferred embodiment of the present invention.

EXAMPLE

A fabric according to the present invention is produced on a 50'' Mayer Raschel warp knitting machine wherein the first guide bar is fully threaded across the approximate desired fabric width with 40 denier 13 filament Antron Nylon yarn available from DuPont, one yarn and through each guide blade, the second guide bar is also fully threaded across the approximate desired fabric width with 40 denier, 13 filament Antron Nylon, one yarn end through each guide blade, and a third guide bar is fully threaded across the approximate desired fabric width with 140 denier coalsced filament Lycra spandex yarn available from DuPont, and stretched about 104% as warped on the beam for feeding the third guide bar. Those three sets of yarns are knitted together according to the stitch pattern.

First Bar: 4–2, 0—0, 2–4, 6—6
Second Bar: 2—2, 2–4, 2—2, 2–0
Third Bar: 0—0, 2—2, 4—4, 2—2

the amounts of each set of yarns being fed to the knitting needles being about 23 inches per rack of the first bar yarn, about 20 inches per rack of the second bar yarn, and about 4 inches per rack of the third bar spandex yarn, one rack being conventionally defined as 480 courses of resultant knit fabric. The resultant fabric is a light weight, fairly opaque, warp knit elastic fabric having good elastic elongation and stretch recovery.

While the greige fabric embodies the present invention, after knitting the fabric may be finished by any desired technique, specific finishing techniques not being a part of the claimed invention. For example, the griege fabric taken from the knitting machine may then be run into a scray to relax the dry fabric. The fabric may then be removed from the scray and run through a wash box containing water at about 200°F with a small amount of detergent therein. The tension settings are set to run the fabric through the wash box in a relaxed condition. The fabric may be taken from the wash box and framed on a small tenterette, with overfeeds and tension controls set to wind the fabric onto a Burlington beam in a relaxed condition. The fabric may be Burlington beam machine dyed under atmospheric pressure, by steps which may include chemically scouring, rinsing, dying, heat fixation of the dye, and further rinsing. The fabric may then be extracted on a beam extractor, and heat set at a desired wale and course count.

Although specific components, proportions, and arrangements of elements have been stated in the above description of preferred embodiments of this invention, other equivalent components and arrangements of elements may be used with satisfactory results and various degrees of quality, or other modifications may be made herein to enhance the appearance of the fabric. For example, the patterns stated herein have been given in Raschel designations, but those skilled in the art can readily translate those patterns into tricot designations. However, it will be understood that such changes in de-

tails, materials, arrangements of parts, and uses of the invention described and illustrated herein, are intended to be included within the principles and scope of the claimed invention. Any greige or finished fabric meeting the limitations of the appended claims is intended to be within the scope of the present invention.

What is claimed is:

1. A warp knitted elastic fabric, comprising: a knitted ground construction comprising a pair of sets of relatively inelastic warp yarns formed into a plurality of wales and courses of single yarn stitch loops, one set of relatively inelastic warp yarns formed into single yarn stitch loops in alternate courses with each yarn of said one set formed into stitch loops in only one wale, and the other set of relatively inelastic warp yarns formed into single yarn stitch loops in the courses intervening between said alternate courses with each yarn of said other set formed into stitch loops alternately in two adjacent wales; and a set of relatively elastic threads laid-into the ground construction generally parallel to and between the wales with the yarns of said one set of relatively inelastic yarns extending about the laid-in relatively elastic yarns so that a relatively elastic yarn lies between the base portion of each of the stitch loops and the laps which are connected to each stitch loop of the yarns of said one set of relatively inelastic yarns, so that the inlaid relatively elastic yarns are substantially covered and maintained in the ground construction.

2. The elastic fabric of claim **1** wherein the stitch loops of the yarns of said other set of warp yarns are displaced generally parallel to the wales throughout the fabric, and the stitch loops of the yarn of said one set of warp yarns are disposed more nearly parallel to the courses throughout the fabric.

3. The elastic fabric of claim **1,** wherein lap portions of the yarns of said one set of relatively inelastic warp yarns extend diagonally across each of the wales in which a yarn of said one set of warp yarns is knitted.

4. The elastic fabric of claim **3,** wherein said lap portions of the yarns of said one set extend in a direction approximately parallel to the lap portions of the yarns of said other set, both said lap portions being exposed on the technical back side of said fabric thereby virtually completely covering said relatively elastic yarns on the technical back side of said fabric.

5. The fabric of claim **1** wherein said relatively elastic yarn is bare relatively elastic yarn.

6. The fabric of claim **1** wherein said relatively elastic yarn is bare spandex.

7. The elastic fabric of claim **1** wherein each of the yarns of said one set of relatively inelastic yarns is present in the knitted fabric in the pattern 4–2, 0—0, 2–4, 6—6; each of the yarns of said other set of relatively inelastic yarns is present in the knitted fabric in the pattern 2—2, 2–4, 2—2, 2–0; and each of the set of laid-in relatively elastic yarns is present in the fabric in the pattern 0—0, 2—2, 4—4, 2—2; said patterns being given in Raschel designations.

8. The elastic fabric of claim **7,** wherein at least one of said sets of relatively inelastic yarns comprises nylon yarns, and said set of relatively elastic yarns comprises bare spandex yarns.

9. A method of manufacturing a warp knitted elastic fabric, comprising the steps of:

1. fully threading a front guide bar of a warp knitting machine with a first plurality of relatively inelastic yarns;
2. fully threading a middle guide bar of a warp knitting machine with a second plurality of relatively inelastic yarns;
3. fully threading a back guide bar of a warp knitting machine with a plurality or relatively elastic yarns; and
4. operating said warp knitting machine, said guide bars feeding yarns to the needle bar of said machine according to the combination of bar movement patterns:

front bar: 4–2, 0—0, 2–4, 6—6
middle bar: 2—2, 2–4, 2—2, 2–0
back bar: 0—0, 2—2, 4—4, 2—2

said patterns being given in Raschel designations.

10. The method of claim **9** wherein the back guide bar is threaded with bare spandex yarns.

11. The method of claim **10,** wherein one of the front or middle bars is threaded with nylon yarns.

12. A method of knitting a warp knit elastic fabric, comprising:

knitting a pair of sets of relatively inelastic yarns forming a plurality of courses and wales of single yarn stitch loops in a ground fabric construction by knitting one set of relatively inelastic yarns into single yarn stitch loops in alternate courses, forming each yarn of said one set into said stitch loops in only one wale of the resultant fabric, and by knitting another set of relatively inelastic yarns into single yarn stitch loops in the courses intervening between said alternate courses, forming each yarn of said another set into stitch loops alternately in two adjacent wales,

and simultaneously laying a third set of relatively elastic yarns into the ground construction being formed by said pair of sets of relatively inelastic yarns, laying each of said relatively elastic yarns between two wales of the ground construction; with the yarns of said one set of inelastic yarns being knitted to extend about each relatively elastic yarn so that a relatively elastic yarn passes between the base portion of each of the stitch loops and the laps connected to each said stitch loop of the yarns of said set of relatively elastic yarns, thereby substantially covering and maintaining said relatively elastic yarns in the resultant fabric.

13. The method of claim **11,** wherein said one set of relatively inelastic yarns is knitted so that the laps thereof are exposed on the technical back side of the resultant fabric and extend diagonally across each wale in which one yarn of said one set of yarns is knitted, and laps extending in a direction approximately parallel to the lap portions of the yarns of said another set of relatively inelastic yarns which are also knitted so that its lap portions are exposed on the technical back side of the fabric, thereby virtually completely covering said relatively elastic yarns on the technical back side of the resultant fabric.

14. The method of claim **12,** wherein said set of relatively elastic yarns comprises bare spandex yarns.

15. The method of claim **12,** wherein said relatively elastic yarns are elastically elongated before being laid-into the ground construction.

16. The method of claim **11,** wherein said fabric is knit on a warp knitting machine, and said one set of yarns is supplied to the knitting needles of said machine through a first guide bar fully threaded across an approximate desired fabric width, said another set of

yarns is supplied to said knitting needles through a second guide bar fully threaded across said approximate fabric width, and said third set of yarns is supplied to said knitting needles through a third guide bar fully threaded across said approximate fabric width and said sets are moved with respect to said needles in accordance with the combination of bar movement patterns:

first bar: 4–2, 0—0, 2–4, 6—6
second bar: 2—2, 2–4, 2—2, 2–0
third bar: 0—0, 2—2, 4—4, 2—2

said patterns being given in Raschel designations.

17. The method of claim 16 wherein the yarns supplied through the third guide bar comprise bare spandex yarns.

18. The method of claim 16, wherein the third set of relatively elastic yarns are elastically elongated before being supplied through the third guide bar.

19. The method of claim 17, wherein one of said one set or said another set of relatively inelastic yarns comprises nylon yarns.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,910,075 Dated October 7, 1975

Inventor(s) Bettie E. Holliday

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

Column 10, line 50, the word "and" should read

--said--.

Signed and Sealed this

Third Day of August 1976

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks