METHOD OF MAKING KNITTED FABRICS

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The present invention relates to methods of knitting and to the resulting products.

It is the object of the present invention to provide knitting methods whereby very extensive variety in design and pattern of knitted fabrics may be obtained.

It is also the object of this invention to provide knitting methods capable of simulating in the fabric produced designs and patterns of woven fabrics of the most complex nature.

It is an object of the present invention to provide knitting methods whereby a great multiplicity of individual yarns may be knitted into a fabric by arranging one or more yarns to be each exclusively knitted by an individual needle, throughout the knitting process, to form a series of walewise extending stitches from each of such yarns, in either a continuous or intermittent order, as desired.

It is also an object of the present invention to provide a knitting method wherein the yarns forming the series of wale-wise running stitches are supplied from stations that are fixed in position relative the needle cylinder, and are each wrapped around an individual needle by a wrap finger which is fixed in position relative the feeding station and the needle cylinder.

It is another object of the present invention to provide methods for combining such wrap-fed wale-wise stitch forming yarns with a plurality of yarns fed laterally to a multiplicity of the needles, in a normal manner, and forming series of course-wise stitches, to produce plaid and other designs of greater variety and complexity than hitherto possible.

It is a further object of the present invention to provide methods whereby the various yarns incorporated into the fabric, both in a walewise and a course-wise direction are knitted in a pre-determined arrangement of stitches in the various knitted courses of each knitting revolution, as in diagonal or zig-zag arrangement, to produce fabrics having characteristics simulating twill and herringbone, heretofore possible only in woven fabrics.

It is a still further object of the present invention to provide knitting methods which will most economically produce fabrics having the characteristics specified, utilizing a minimum amount of yarn, and which will produce fabrics of a minimum elasticity and stretchability, both in course-wise and wale-wise direction.

The accompanying drawings illustrate one embodiment of a fabric produced by the methods of the present invention and of a knitting machine on which the methods may be practiced; it being understood that the embodiments shown are intended as illustrative only, to make the principles and practice of the invention more readily comprehensible, and not as limiting the spirit and scope of the invention, in any way, to their specific details.

In the drawings:

Fig. 1 is a plan view of the outer face of a knitted fabric formed in accordance with the methods of the present invention.

Fig. 2 is a diagrammatic, enlarged, detail view of a portion of the said fabric outlined by the square in Fig. 1, with the stitches shown in greatly extended form.

Fig. 3 is a schematic view of one of several sets of pattern wheels and needle separating cams which control the needles that knit the various course-wise and wale-wise stitches of one of the knit courses of the fabric during one knitting revolution of the machine.

Fig. 4 is a fragmentary, schematic, top plan view, of a knitting machine for the practice of the present invention, illustrating the relative arrangement of pattern wheels, cams and striper, and feeding stations for knitting and course-wise stitches, and the pattern wheel, wrap fingers and feeding stations for forming the wale-wise, wrap stitches of the fabric.

Fig. 5 is a cross sectional view of the needles and associated wrap fingers, showing their relative position prior to the commencement of the formation of wrap stitches.

Fig. 6 is a similar view of the same showing their position in the first step in the formation of a wrap stitch, and illustrating the manner in which the diagonally off-set end of a wrap finger wipes a yarn along one side of a knitting needle.

Fig. 7 is a view similar to Figs. 5 and 6 illustrating the second step in the formation of a wrap stitch with the wrap finger shown as having passed the needle and assuming a position directly forward of it.

Fig. 8 is a view similar to that of Figs. 5, 6 and 7, illustrating the third step in the formation of a wrap stitch with the other face of the diagonally off-set end of the wrap finger wiping the yarn along the second side of the knitting needle, on its way to return to the initial position shown in Fig. 5.

Fig. 9 is a diagrammatic view of a fabric illustrating a method of inlaying a thread fed from a feeding station which is stationary relative the needle cylinder, without its paraking in the formation of stitches.
The present invention may best be illustrated and understood by means of Figs. 2 and 3, respectively, illustrating a detailed enlargement of a fabric produced by the methods of the present invention and one arrangement of the elements of a knitting machine for practicing such methods.

While the present invention may be practiced on any suitable type of knitting machine, it may most conveniently be practiced on a circular knitting machine, especially one in which the needle cylinder is stationary and the pattern wheels, cams, striper and their associated yarn feed stations are movable relative to and around the needle cylinder, such as the machine illustrated in the drawings. Such knitting machines require only the addition of stationary, cam actuated wrap fingers of conventional construction and a plurality of associated stationary feed stations to function in a manner which will hereinafter be explained, and for which purpose I have devised apparatus which may supply as many as 300 or 400 individual stationary yarn feed stations.

The knitting machine is provided with uniform conventional needles, preferably of uniform type throughout and having latches, and needles mounted on a needle cylinder of the conventional type. A rotary annular table or ring, is provided around the needle cylinder, so as to be capable of producing one knitted course during each knitting revolution of the cylinder. In the drawings, the number of wheels to each set is shown to be three and the wheels are designated, respectively, as A, B and C in the order in which they are knitted on the machine.

As the fabric illustrated in Figs. 1 and 2 is formed of knitted units of four courses each, designated as W, X, Y and Z, the knitting machine must be provided with four sets of pattern wheels, A, B and C, and associated structures.

One or more of the pattern wheels such as A and B, are each associated with an individual striping, A' and B', of the conventional type having, in the illustrated embodiment, 4 stripper arms, &, and with needle positioning cams, 5% preferably of the type disclosed in my U. S. Patent No. 1,970,238. One or more of the pattern wheels in each of the four sets, such as pattern wheels C, in the illustration, is unassociated with any striping.

Each of the pattern wheels A and B is also associated with a yarn feed station A' and B', respectively, supporting a plurality of yarn spools, 51, one of each of which supplies yarn to one of the needles A, 55, in their associated striping, in the conventional manner, and feeding stations being arranged to rotate synchronously with the annular table, 53, in a manner well known to those skilled in the art, and not thought necessary to be here shown.

Pattern wheel A and its associated cam, 56, control the yarn supplied from station A', through one of the arms of the striping, A'.

Pattern wheel B and associated cam, 56, is set to control the needles which knit yarn from station B', fed by one of the arms of striping, B'.

Pattern wheel C is set to control the needles, which knit yarn supplied from stationary feeds D and E and others similar to them, arranged, preferably, above the interior of the needle cylinder, on a fixed structure designed to support as many as 300 or 400 such individual feeds, if desired. The yarn from each of such feeds is engaged in guiding apertures, 58 (Fig. 4), in the diagonally offset ends, 59, of wrap fingers, 50, a plurality of which fingers, at least one for each needle controlled by wheel C, being pivoted in annular arrangement above the needle cylinder in position to have each wrap finger wrap yarn around an individual needle raised to latch clearing position by pattern wheel C, when the finger is moved outwardly past such needle and returned by conventional cams synchronized with pattern wheel C.

As shown in Figs. 3, 4 and 5, pattern wheel C raises needles d' and e', while simultaneously wrap fingers d' and e' are actuated by their respective cams to have their ends, 59, carrying yarns d and e, respectively, moved outwardly in the direction of needles d' and e', respectively. On the outward movement of wrap fingers d' and e', for example, the outer faces of their diagonally offset ends, 59, will strike against the needles d' and e', at an angle. Fingers d' and e' and needles d' and e' being flexible, they will bend in opposite directions to permit fingers d' and e' to pass the needle cylinders of d and e' on one side thereof, and bring threads, d and e, passing to one side of the respective needle.

On the return movement of the wrap finger d' and e', the opposite faces of their diagonal ends, 59, will strike the needles, and the wrap fingers will, therefore, pass on the opposite sides of the needles, to wrap yarn d and e, completely around the respective needles so that they will be engaged by the needles and be knitted into the fabric to form loop stitches when the needles are drawn below the sinker line, by the cam associated with pattern wheel C after being released by pattern wheel C.

It will be readily apparent that the stitches formed by yarns d and e, and others knitted by pattern wheel C, will consist solely of loop stitches, having no wales and which are held in the fabric by previously knit stitches, and by floated wale portions of the yarns knitted by pattern wheels A and B, as the case may be. The floated wales pass intermediate the sides of the loop stitch and the continuation of the yarn forming it which interlocks with the stitch previously cast off from the particular needle and is folded over to form a succeeding stitch.

Viewing Fig. 2, we see, for example, that in the first or lowermost course designated as W, needle d', knitted yarn, a, to form wale stitch 2W. In the second course, X, needle d' knitted yarn d, to form stitch 2X, by passing a loop thereof through the loop portion of stitch 2W.

The continuation of yarn d passing to the rear of the loop 2X, and enclosing between itself and the loop wales, 52 and 54. In course Y, needle d', knitted yarn d, by looping yarn 46, back through its own preceding stitch 2X, to form loop stitch 2Y, enclosing between such loop and the looped over continuation of yarn d, floated wale 63, from course wise stitch 2Z. In the fourth course, Z, needle d' again knits thread 4, to form wale stitch 2Z, casting off stitch 2Y, and floating others Wale-wise across stitch 2Z, and enclosing yarn 66 from stitch 4W of the next succeeding set of courses.

Each of pattern wheels A, B and C has a combination of jacks adjusted to raise certain of the needles in a continuous group of needles to knitting or latch opening position, and to skip the
other needles in the group, in accordance with a pre-determined design; the combination of the set of three pattern wheels A, B, and C, complementing one another to raise all of the needles in the group, and in the entire machine, as they move around the machine. Thus, by way of example, Fig. 2, illustrates a portion of fabric having a unit of design or pattern knit by twenty contiguous needles forming 20 stitches, designated I to 20, respectively. Each of wheels A, B, and C is arranged to knit some of the stitches and to skip others, but wheels A, B and C, combined are set to knit all of the 20 stitches.

Cams of the conventional type, which are not thought necessary to be here shown, may be provided on the machine for throwing the stripper arms SS, as they complete a knitting revolution around the needle cylinder, to change, when desired, the thread fed the needles controlled by the associated pattern wheel during the following revolution around the needle cylinder.

While, as has been stated, each set of pattern wheels, A, B, and C, forms a combination which must knit all of a group of contiguous needles forming a design portion or unit, the various sets of wheels need not knit the needle group according to the same combination. Thus, while in courses W needle d', knits yarn a, the same needle knits yarn d, in the following courses X and Y, and then repeats yarn a, in course Z. This is accomplished by varying the combinations of needles raising jacks in the pattern wheels of each set so that the same needle is actuated by wheel A of the first and last sets of pattern wheels, and by wheels C of the two intermediate sets of pattern wheels.

It will be readily apparent to those skilled in the art that by the methods of the present invention infinite variety in fabric design may be obtained. The method of knitting by wrap-feeding, as described, together with the stripper feeding, combined with the variation in the knitting combinations of the several sets of pattern wheels, make possible the introduction of numerous individual yarns of different characteristics into a fabric.

Thus, into a twenty stitch fabric segment, such as illustrated, it is theoretically possible to introduce as integral, stitch forming elements, as many as twenty-eight individual yarns. As a result, the most involved, complex and colorful plaited and other patterns may be produced by the methods of the present invention.

In addition, variation in the locus of introduction or stitching of the individual threads in the several courses of each knitting revolution may be obtained according to a regularly repeated design, whereby simulation of woven fabric structures, such as twill or herringbone may be obtained.

These possible variations may best be comprehended by reference to Fig. 2 of the drawings. It will be observed that the fabric fragment illustrated is composed of eleven individual yarns; namely, a, a', and b, which are supplied from the revolving feeds and are knitted into the fabric by pattern wheels, A and B; and yarns d, e, f, g, h, i, and j, which are wrap-fed wale-wise into the fabric and knitted through by pattern wheel C.

Yarns a and b may be considered as the background yarns and may be of the same or different colors, their different identification merely indicating that the needles stitching such yarns are controlled by different pattern wheels. Each of yarns a and b may be substituted in successive knitting revolutions by any one of three other yarns by the shifting of the feeding arms, SS, of the associated strippers A' and B'.
The remaining yarns appear as follows:

Knit 2
Welt 1 7 11

It will be observed that throughout the several courses the yarns knit by wheels A and C which do not form any substantial wales, are welted when not knitted; but that the yarn knit
ted by pattern wheel B, which is floated, frequently, in relatively long wales, is twisted, when not knitted, so as to hold such yarn between the need
dles not knitted, to retain such yarn in position to be caught and interlocked between the wale-wise floats of the loop stitches knitted by pattern wheel C and the loops of such stitches. By this means a compact, reinforced fabric is produced.

If we regard the second group of four courses we see that the knitting combinations of the pattern wheels are a repetition of the first group of four courses with the exception that in the first of the two courses, X and W, yarn a has been substituted for yarn c, which indicates that the arms of the stripes, A1; associated with pattern wheel A, and A2; associated with pattern wheel B, in the first two contiguous sets of pattern wheels have been thrown by a cam
to feed yarn from a different spindle.

Looking at the fabric from another angle, we see that in course W of the first group, the yarn a appears in the following numbered stitches:

1, 2, 5, 6, 9, 10, 13, 14, 17, 19

In course X, of group 1, it appears as stitches

1, 2, 5, 6, 9, 12, 13, 16, 17, 20

In course Y of group 1, it appears as stitches

1, 2, 5, 6, 9, 12, 15, 16, 19, 20

In course Z, it appears as

2, 3, 6, 7, 10, 11, 14, 15, 18, 19

Yarn b, appears in course W of group 1, as stitches

1, 4, 12, 15, 16 and 20

In course X, yarn b appears as stitches 1, 4, 15, 18.

In course Z, yarn b appears as stitches 1, 4, 5, 12, 13, 16, 17 and 20.

As to the wale-wise loops stitches from the stationary yarn feeders, in course W, they appear as stitches 3, 4, 5, 6, 9 and 18; in course X, as stitches 2, 3, 7, 10, 11 and 19; in course Y as stitches 2, 3, 7, 10, 11 and 19.

It will be apparent that all the course-wise stitch forming yarns and wale-wise stitch forming yarns are so embodied in the fabric that each of the course-wise stitch yarns and the course-wise wale forming yarns are arranged in parallel lines of two stitches each extending diagonally across the fabric from course to course in each group; continuing in the same direction across the entire fabric and providing a plaid pattern having the appearance of a woven twill.

It may also be here stated that if the lines of stitches are arranged in opposed diagonal relation or zig-zag fashion, the effect of herringbone may be obtained.

This completes the description of the methods of the present invention and of an embodiment of a fabric produced thereby.

It will be obvious to those skilled in the art that the methods described are economical to practice for the reason that each stitch of the fabric produced, consists of a single yarn, thereby reducing the amount of material heretofore found necessary to use to produce in a fabric any effect remotely resembling that described.

It will be further obvious that the fabrics produced have relatively short floats of yarn and that these floats are interlocked at frequent intervals and that, further, these floats extend both wale-wise and course-wise of the fabric thereby reducing to a minimum the elasticity and stretchability of the fabric in both of said directions.

It will also be apparent that the methods of the present invention may be easily and conveniently practiced on relatively simple knitting machines of the character described requiring fewer additional cam arrangements than might be necessary in methods utilizing platting and reverse platting or pile stitching, and which were heretofore used to provide a multi-color effect; and that the possibility of variation in color or color ar
gangement of the resulting fabric of the present invention is far greater than that which may be obtained by the practice of the other methods heretofore in use. In addition, further variations may be effected by differences in yarn texture and, as described above, by the pattern accord

What I claim is:

1. The method of knitting a multi-yarn fabric comprising the steps of knitting each one of a plurality of yarns, each yarn being individual to a needle and being fed exclusively to one of the needles of a multi-feed knitting machine in intermittent courses to form an intermittent series of individual loop stitches from a single yarn throughout the stitch formation, said stitches ex
tending wale-wise of the fabric, from each of said yarns, knitting a plurality of other yarns on a plurality of needles to form a series of course-wise stitches, floating the said course-wise stitch forming yarns across the wrap stitches and float

2. The method of knitting a multi-yarn fabric of a variegated colored pattern comprising the steps of knitting each one of a plurality of yarns, each yarn being individual to a needle and being fed exclusively to one of the needles of a multi-feed knitting machine, in intermittent courses to form an intermittent series of individual loop stitches from a single yarn throughout the stitch formation, said stitches extending wale-wise of the fabric, from each of said yarns, knitting a plu

erality of other yarns, of different color, on a plu

rality of needles to form a series of cross-wise stitches, floating the said course-wise stitch forming yarns across the wrap stitches, and float

3. In the method of knitting as claimed in claim 2, using different colored yarns for different needles to produce a variegated colored pattern fabric.

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