March 8, 1960 R. L. T. CONNORS 2,927,448

KNITTED FABRIC

Filed May 7, 1958 2 Sheets-Sheet 1

Fig. 1.



Fig. 2.

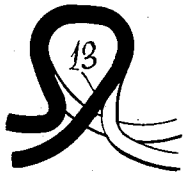


Fig. 3.

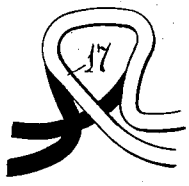


Fig. 4.



Fig. 5.



Fig. 6.



Fig. 7.



Fig. 8.



Fig. 9.



Fig. 10.



Fig. 11.

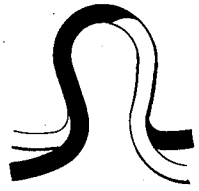
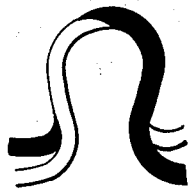


Fig. 12.



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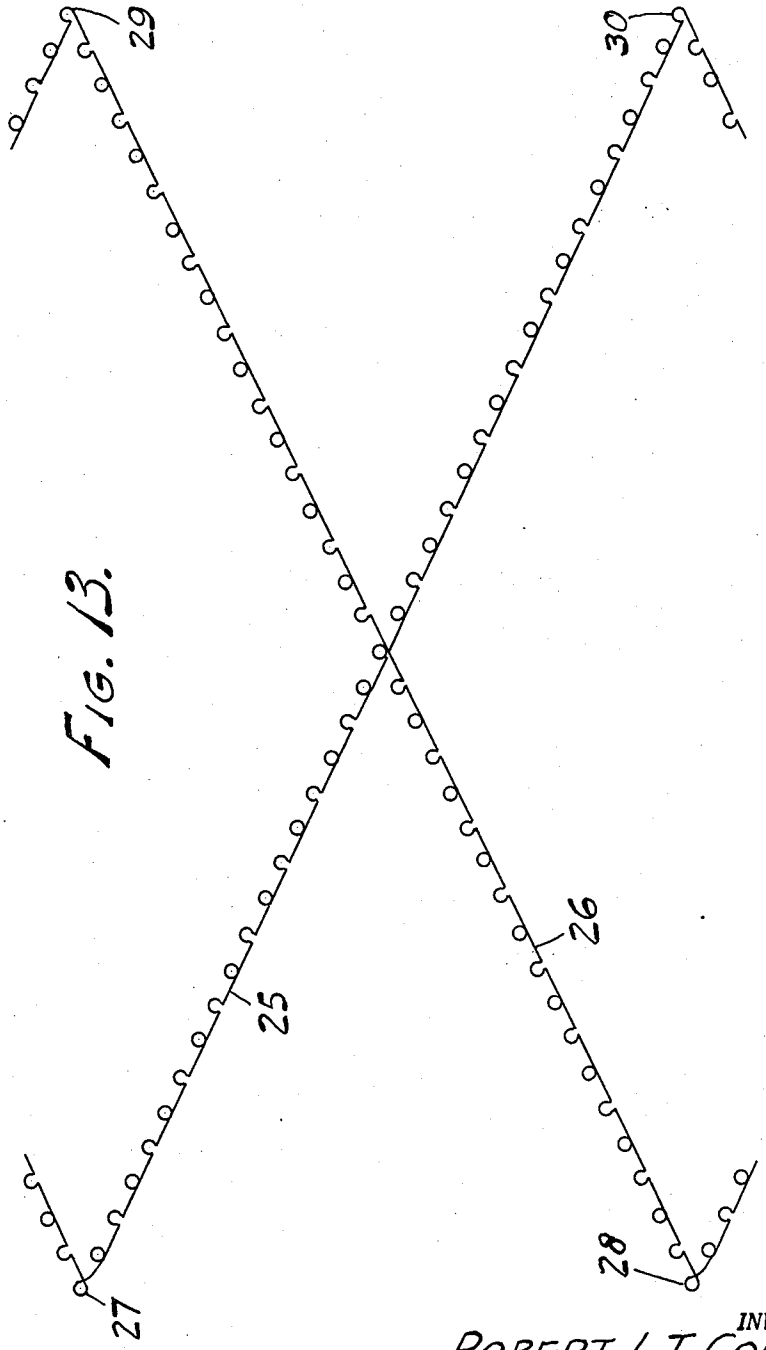


FIG. 13.

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KNITTED FABRIC

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Application May 7, 1958, Serial No. 733,705

4 Claims. (Cl. 66—195)

This invention relates to warp knitted fabrics and more particularly to a novel warp knitting method and to the novel fabrics produced by such method.

A conventional class of warp knitting is that which is performed on so-called Simplex knitting machines. As is well known in the art, Simplex machines employ two sets of needles and produce double faced fabric. Two sets of warp threads are involved in the knitting process and guide bars move the threads of each set laterally with respect to the needles. In knitting multi-waled fabrics the guide bars move laterally in step by step fashion so that a given warp thread is passed from needle to needle in a transverse direction for a given number of stitches depending on the pattern wheel of the machine.

During this phase of operation the two guide bars move in generally opposite lateral directions and after the aforesaid given number of stitches the two guide bars reverse their relative lateral step by step movement so that, in effect, a given warp thread is passed back along the needle bars from needle to needle. When this reverse movement of the guide bars equals the first range of movement the guide bars again reverse and the cycle is continuously repeated.

This point of reversal of movement of the guide bars and the consequent reversal of a given warp thread in the resultant fabric is known as the changeover. For the purpose of this specification we shall refer to the stitches produced at the time of the reversal of the guide bars as "changeover" stitches and other stitches, produced while the guide bars are moving generally laterally between changeovers, shall be referred to as "intermediate" stitches.

Present Simplex warp knitting machines and methods are such that the type of stitch inherent in the "changeover" differs from the intermediate stitches produced as the guide bars move laterally between changeovers. This inherent stitch difference produces a discernible line across the fabric in a lateral direction at each changeover course. Thus, if the guide bars move laterally for eighteen stitches between reversals or "changeovers," this objectionable changeover line will appear every eighteen courses along the fabric.

These "changeover" lines and the "mirror" effects of the panels of fabric between the changeovers are well recognized defects and objections in warp knit fabrics produced on Simplex machines by conventional methods but have heretofore been considered as necessary evils which could not be avoided within practical limitations. Various extraneous steps have been taken to render these defects less apparent by various after treatments of the fabric.

As is well known in the knitting art, fabrics produced on Simplex machines are inherently double faced fabric and the foregoing phenomena are most noticeable at the side of the fabric at which the changeover stitches occur, although it is well known that the changeover

lines are also discernible at the side of the fabric which is opposite to the changeover side.

Despite the vexatiousness of the above condition and its long standing, no satisfactory method has been evolved for eliminating these changeover lines. Many proposals and attempts have been made to hide these lines or reduce their visibility, but these proposals have been mere makeshifts such as finish treatment of the fabric by brushing or the like to hide the lines. No prior knitting procedure of which I am aware has been proposed which deals directly with the circumstances which produce the above defects, namely, the stitch forms employed in the changeover stitches and the intermediate stitches as compared with each other.

The present invention recognizes the fact that the appearance of the changeover lines in the fabric are due to differences in the stitch forms employed in the changeover stitches and the intermediate stitches, respectively. The present invention provides a warp knitting method and a resultant fabric wherein the respective stitch forms and stitch arrangements are such that differences in the stitches along the changeover lines are practically indiscernible. Speaking generally, this is accomplished by employing changeover and intermediate stitch forms which are of sufficiently the same type and character as to result in fabric wherein the changeover and intermediate stitches are visually indistinguishable.

Still speaking generally, and by way of illustrating the basic principles of the invention, a common warp knitting method practiced on Simplex machines comprises a stitch sequence wherein the stitches between changeovers, that is the intermediate stitches, comprise pairs of open loops, whereas the changeover stitches consist generally of pairs of open and closed loops. Even when the changeover stitches consist of pairs of open loops they produce changeover lines since the manner in which the open changeover loops cross over each other at the changeover apparently produces about the same visual effect as in the case of the more common combined open and closed loop changeover stitches.

In its broadest aspect the present invention comprises the employment of combinations of open and closed loop stitches in the intermediate stitches instead of the usual paired open loops, and it is found that this relatively simple and practical expedient produces a warp knitted fabric which is free of changeover lines and mirror effects for all practical purposes. Theoretically this might be achieved by forming all closed loops in the intermediate stitches of one warp during a complete lateral traversal of one of the guide bars and all open loops in the intermediate stitches of the other warp during the accompanying traversal of the other guide bar. This would produce a fabric wherein each intermediate stitch consists of an open and a closed loop. However, this introduces problems of yarn tension and non-uniform yarn consumption and related complexities due to the greater amount of yarn or thread required for forming closed loops. It is accordingly preferable to form alternate closed and open loops in the thread of each warp, with such loops staggered so that each intermediate stitch at a given side of the fabric consists of a closed loop and an open loop.

It may be stated here that this specification is directed to those skilled in the knitting art and that, in the interests of simplicity, the present invention and its variations and combinations are described and defined in terms of the stitch forms that are or may be employed. The required contour of pattern wheels for producing a desired sequence of open and closed loop stitches can be determined readily by one skilled in the warp knitting art and particularly by those familiar with Simplex

knitting machine or knitting machines employing the same or similar knitting principles and procedures.

In a preferred form of the present invention the pattern wheel of the knitting machine is so formed that successive intermediate stitches between changeovers consist of combinations of open and closed loops, with the changeover stitches fitting into this alternate pattern so that there is no visual difference whatever along the changeover lines in the resultant fabric.

While numerous stitch pattern modifications and sequences and combinations may be employed to accomplish the basic aim and purpose of the present invention in greater or less degree, the foregoing relatively simple example will serve to illustrate the broad underlying principles of the invention. However, it is to be understood that the present invention is not limited to or by the illustrated instance, nor otherwise than as defined in the appended claims.

The following specification outlines more fully the teachings of the invention and the governing considerations which dictate the choice of various stitch combinations, as between the changeover and intermediate stitches, which give the novel and highly beneficial and useful results attendant upon a practice of the teachings of the present invention. Here again, while the specification delineates exemplary embodiments of the invention and sets forth specific examples thereof, neither such specification nor the accompanying schematic drawings are intended to limit the scope of the present invention excepting insofar as such limitations are expressed in the claims.

In the drawings:

Figs. 1 through 4 illustrate four variations of more or less conventional changeover stitches each comprising an open loop and a closed loop;

Figs. 5 and 6 illustrate two further forms of changeover stitches each embodying two open loops;

Figs. 7 through 10 illustrate the novel intermediate stitches which, in accordance with the teachings of the present invention, are used in certain prescribed combinations with the conventional changeover stitches of Figs. 1 through 6, as specified more fully hereinafter;

Figs. 11 and 12 illustrate conventional intermediate stitches, each comprising two open loops, such stitches being for illustration of conventional practices only and not as forming a part of the stitch combinations of the present invention; and

Fig. 13 is a stitch diagram of a representative fabric knit in accordance with the principles of the present invention.

In the schematic illustrations comprising Figs. 1 through 12 the black or solid line threads represent threads of the No. 1 warp of a Simplex machine and the white or double line threads represent the threads of the No. 2 warp, the fabric being viewed from the No. 1 warp side in the drawings. It will be understood by those skilled in the knitting art that the several loops illustrated are directional, that is, they run in a given direction or lay in a given orientation. This direction or orientation is determined by the direction in which the thread is laid under the beard of the needle in forming the loop. As used herein, the foregoing expressions are synonymous; that is to say, a loop is said to be made in one direction or to lay in one direction when the same is formed by laying the thread under the beard of the needle in that direction.

In knitting fabric according to the present invention the changeover stitches may be of any of the conventional forms illustrated in Figs. 1 through 4 or of the less conventional but usable form illustrated in Figs. 5 and 6. It will be noted that each stitch in Figs. 1 through 4 comprises an open and a closed loop with the two loops of each stitch oriented in opposite directions. In Figs. 5 and 6 the two open loops of each stitch are likewise oriented in opposite directions. This orientation refers to the direction in which the loop is inclined and has no reference to the direction in which it is laid under the beard of the needle.

It will be noted that, in Figs. 1 through 4, the open loop is in each case the uppermost loop, that is, the loop which is at the outer face of the cloth. In Figs. 5 and 6 the loops illustrated in solid lines are uppermost and correspond to the uppermost open loops of Figs. 1 through 4 in determining the direction in which the loops of intermediate stitches should be oriented to come within and give the results desired in following the teachings of the present invention.

Depending on yarn tension machine adjustments and other factors the bright portions of the pairs of loops (the top portions of the loop as shown in the drawing) may be the reverse of that illustrated in the drawings. This does not affect the general scheme of the loop arrangements of the present invention, the critical thing being the relative positions of the lower or crossing portions of the loops of each pair.

In addition to the changeover stitch combinations of Figs. 1 through 6, it is theoretically possible to employ changeover stitches comprising two closed loops. In such case the uppermost or outer loop would correspond to the uppermost open loops of Figs. 1 through 4 in determining intermediate stitch orientation. However, the two closed loop changeover stitch variations is of little practical importance for other reasons.

We come now to the extremely important consideration of the choice of the correct intermediate stitch form to be employed with the foregoing variety of changeover stitches in proceeding in accordance with the present invention. It will be noted that each of the novel intermediate stitches of Figs. 7 through 10 comprises an open and a closed loop. However, the intermediate stitches of Figs. 7 through 10 cannot be combined indiscriminately with the changeover stitches of Figs. 1 through 6 although certain variations may be tolerated if only one side of the fabric is to be a "finished" side.

Either of the intermediate stitch arrangements illustrated in Figs. 7 and 8 will be employed with any of the changeover stitches of Figs. 1, 2 or 5. The intermediate stitch arrangements illustrated in Figs. 9 and 10 will be employed with any of the changeover stitches of Figs. 3, 4 or 6. The general principle to be adduced from the foregoing permissible combinations may be stated as follows:

As to a given side of the fabric, if the closed loop of the intermediate stitch lays from right to left, as in the so-called white stitch of Fig. 7 or the black stitch of Fig. 8, then the open loop of the compatible changeover stitch likewise lays from right to left, as in the white loop of Fig. 1 and the black loops of Figs. 2 and 5. In other words, the open loop of the changeover stitch will always be in the same direction as the closed loop of the properly combined intermediate stitches. Note here that the black loops of Figs. 5 and 6 are considered to be the open loops of these stitch combinations as noted earlier herein.

As a further generality it may be observed that the open and closed loop combinations of the intermediate stitches are so arranged that the uppermost thread of the combination lays in the same direction as the uppermost thread of the changeover stitch combination. That is, the threads marked **10** and **11** in Figs. 7 and 8, respectively, extend in the same direction as the threads marked **12**, **13** and **14** in Figs. 1, 2 and 5, respectively; and the threads marked **15** and **16** in Figs. 9 and 10, respectively, extend in the same direction as the threads marked **17**, **18** and **19** in Figs. 3, 4 and 6, respectively. It will furthermore be noted by reference to Figs. 7 through 10 that the closed loop of each intermediate stitch combination is oriented oppositely to the open loop of such combination, this being a natural result of the general knitting procedure on Simplex machines. However, when the appearance of only one side of the fabric need be considered, it would be possible to apply the

teachings of the invention as to the stitches at only one side of the fabric, certain permissible stitch variations being indulged as to the other side of the fabric.

While it is believed to be well within the province of those skilled in the knitting machine art to determine the proper guide bar movements and select proper pattern wheels to produce such movements, for the formation of the open and closed loop intermediate stitch combinations of the present invention, the following is included to insure that the present disclosure is complete in every reasonable respect.

To produce intermediate stitches wherein there is one closed loop and one open loop at a given side of the fabric the guide bar movements are modified as follows. In forming intermediate stitches of two open loops each, as is conventionally practiced, both guide bars are traversed under the beard of the needle in opposite directions but each moves continuously in the same direction. To form the open and closed loop intermediate stitch combinations of Figs. 7 through 10, that is, an open loop from one warp and a closed loop from the other warp, the open loop is formed by laying the thread under the beard of the needle in the same direction in which its corresponding guide bar is generally moving. The closed loop, on the other hand, is formed by laying the thread under the beard of the needle in the opposite direction to that in which the corresponding guide bar is generally moving.

A typical and representative fabric according to one form of the present invention is produced by following the stitch diagram depicted in Fig. 13. In Fig. 13 the thread or yarn from the No. 1 warp is designated by the reference numeral **25** and the thread or yarn from the No. 2 warp is designated by the reference numeral **26**. It will be noted that the intermediate stitches consist of alternate open and closed loops and that the changeover loops at the left-hand end of the diagram, designated **27** and **28**, consist of closed loops, while the changeover loops at the right-hand end of the diagram, designated **29** and **30**, comprise open loops. In following this stitch diagram on a Simplex knitting machine the open loop will be the top loop of each changeover and therefore the changeover loops formed at **29**, where the No. 2 warp will be uppermost, would conform with Fig. 1 of the drawing, whereas the changeover loops formed at **30** where the No. 1 warp will be uppermost, will conform with Fig. 2 of the drawings.

In the intermediate stitch combination shown at the center of the stitch diagram, where the threads **25** and **26** are crossing, the closed loop of the No. 2 warp, designated **26**, is uppermost, whereas the open stitch of the No. 1 warp, designated **25**, is below. Accordingly, this intermediate stitch is as depicted diagrammatically and in an enlarged manner in Fig. 7 of the drawings.

I claim:

1. Multi-waled double tricot warp knit fabric comprising successive lateral series of double looped stitches at a face thereof terminating at each end of each series in double looped changeover stitches, each changeover stitch including an open loop and each of said lateral series of stitches comprising an open loop and a closed loop with the closed loop lying in the same direction as said open loops of the changeover stitches at the ends of said series.

2. Multi-waled double tricot warp knit fabric comprising successive lateral series of double looped stitches at a face thereof terminating at each end of each series in double looped changeover stitches, each changeover stitch including an open loop and each of said lateral series of stitches comprising an open loop and a closed loop.

3. Multi-waled warp knit fabric comprising successive lateral series of double looped stitches terminating at each end of each series in double looped changeover stitches, each changeover stitch including an open loop and each of said lateral series of stitches comprising an open loop and a closed loop with the closed loop lying in the same direction as said open loops of the changeover stitches at the ends of said series.

4. Multi-waled warp knit fabric comprising successive lateral series of double looped stitches terminating at each end of each series in double looped changeover stitches, each changeover stitch including an open loop and each of said lateral series of stitches comprising an open loop and a closed loop.

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