

METHOD FOR KNITTING MANUFACTURED ARTICLES WITH CIRCULAR KNITTING MACHINES HAVING THE NEEDLE CYLINDER ACTUATABLE FOR ROTATION IN BOTH ROTATION DIRECTIONS

5 **Technical Field**

The present invention relates to a method for knitting manufactured articles with circular knitting machines having the needle cylinder actuatable for rotation in both rotation directions, particularly with high-fineness, high-gauge circular machines.

10 Knitting machines for hosiery or the like capable of transferring a loop of knitting from the needle that formed it to a contiguous needle are known. A machine of this kind is disclosed, for example, in WO-02/070799.

Background art

Up to now, this technique for transferring loops of knitting has been
15 used mainly to obtain openwork in manufactures. Examples of application of this technique for openwork are given in WO2005/080653 by the same Applicant.

Methods for knitting shaped manufactures with circular knitting machines are also known which are based on increasing the number of
20 active needles in certain regions of the manufacture. Techniques of this kind suffer the drawback of allowing only to increase the active needles and therefore require starting the knitting of these regions of the manufacture from their side that must be knitted with a minimum number of needles. This fact limits the knitting processes that are possible and the shapes that
25 can be obtained with this technique.

Circular knitting machines are also known which are provided with a needle cylinder which can be actuated with a rotary motion about its own axis in both directions of rotation. These machines allow to produce, by utilizing the possibility to actuate the needle cylinder in both rotation
30 directions, manufactures with regions, such as for example the shoulder

straps of undershirts, body suits or the like or the crotch region of underpants, body suits or the like, with edges which are already finished, without requiring subsequent cutting and/or finishing operations.

Even with these machines, due to the fact that it is only possible to
5 increase the number of needles active during knitting, it is not always possible to produce manufactures which do not require cutting and/or finishing interventions. For example, if in a manufacture it is necessary to provide regions of knitting composed of a number of stitches that increases gradually and then regions of knitting composed of a number of stitches that
10 decreases gradually, these last regions can be obtained traditionally by cutting after producing the manufacture on the machine in order to be able to obtain the required shape.

Disclosure of the Invention

The aim of the present invention is to provide a method for knitting
15 manufactured articles with circular knitting machines having the needle cylinder actuatable for rotation about its axis in both rotation directions, particularly with high-fineness circular machines, which allows to produce manufactures having shaped regions which do not necessarily require cutting or finishing operations, regardless of the side from which the
20 knitting of the manufacture begins.

Within this aim, an object of the invention is to provide a method which, by allowing to produce manufactures with shaped regions without requiring cutting or finishing operations, also allows to reduce the consumption of thread for producing manufactures.

25 Another object of the invention is to provide a method which can be used to obtain manufactures with shaped regions produced with circular machines having a high fineness, preferably comprised substantially ranging from 16 to 50 needles per inch.

This aim and these and other objects, which will become better
30 apparent hereinafter, are achieved by a method for knitting manufactured

articles with circular knitting machines having the needle cylinder actuatable for rotation in both rotation directions, particularly with high-fineness circular machines, characterized in that at least one region of the article is produced with a group of contiguous needles by reducing at least once the number of active needles in said group of needles by transferring the last loop of knitting formed by certain needles of said group of needles to contiguous needles of said group of needles and thus excluding from knitting said certain needles during the formation of at least one portion of a subsequent row of knitting by the needles that are kept active, and in that said region of the article is produced by providing in succession portions of rows of knitting obtained by actuating the needle cylinder with a rotary motion about its own axis in one direction of rotation alternated with portions of rows of knitting obtained by actuating the needle cylinder with a rotary motion about its own axis in the opposite direction.

Brief description of the drawings

Further characteristics and advantages of the present invention will become better apparent from the description of a preferred but not exclusive embodiment of the method according to the invention, illustrated by way of non-limiting example in the accompanying drawings, wherein:

Figure 1 is a schematic view of a manufactured article such as a body suit which can be obtained with the method according to the invention;

Figure 2 is an enlarged-scale view of a detail of the manufacture shown in Figure 1;

Figure 3 is an enlarged-scale view of another detail of the manufacture shown in Figure 1;

Figure 4 is an enlarged-scale view of another detail of the manufacture shown in Figure 1;

Figure 5 is a fragmentary view of an adjustable cam arrangement, known in the art, wherein a stitch is released from one needle and transferred to an adjacent needle;

Figure 6 is a schematic top plan view of adjacent hooks and sinkers showing the creation of the stitch pattern according to the cam location shown in Figure 5.

Ways of carrying out the Invention

5 With reference to the figures, the method according to the invention is meant to be performed on circular knitting machines, preferably on circular machines having a fineness or gauge substantially ranging from 16 to 50 needles per inch, provided with a needle cylinder which can be actuated with a rotary motion about its own axis in both rotation directions, for
10 example of the type disclosed in WO 2004/097092 by the same Applicant, and equipped with needles and/or other elements for transferring the loop of knitting formed by one needle to a contiguous needle located laterally on one side or on the other side of the needle that must release the loop of knitting, as disclosed for example in Italian patent application
15 MI2004A-001146 by the same Applicant.

 The method consists in producing at least one region A, B, C, D of the manufactured article or manufacture 1 by means of a group of contiguous needles, reducing at least once the number of active needles of the group of needles by transferring the last loop of knitting formed by
20 certain needles of the group of needles to contiguous needles of the group of needles and thus excluding from knitting the needles that have released the loop of knitting, during the formation of at least one portion of a subsequent row of knitting by the needles that are kept active. The region A, B, C, D of the manufacture 1 is produced by providing in succession portions of rows
25 of knitting produced by actuating the needle cylinder with a rotary motion about its own axis in one direction of rotation, alternated with portions of rows of knitting produced by actuating the needle cylinder with a rotary motion about its own axis in the opposite direction.

 Preferably, the number of active needles of the group of needles that
30 knits the region A, B, C, D of the manufacture 1 is reduced by transferring

the last loop of knitting formed by certain needles of the group of needles located at at least one end of the group of needles to contiguous needles of the group of needles.

The method according to the invention is now described, with
5 reference to the figures, in an embodiment thereof for producing a manufactured article such as a body suit or the like, it being understood that the method according to the invention can also be used to produce other types of manufactures.

The manufacture of Figure 1 is provided by starting the knitting from
10 the lower side, i.e., from the crotch region of the body suit.

Initially, the needles that belong to two groups of contiguous needles located in two sectors of the needle cylinder which are angularly spaced from each other around the axis of the needle cylinder are made to knit in order to provide the regions E, F of the manufacture that constitute the front
15 and rear regions of the lower part of the body suit.

The number of needles made to knit of the two groups of needles is gradually increased so as to obtain a shape with a gradually increasing width of the front region E and of the rear region F. The increase of the number of needles made to knit of the two groups of needles is performed in a per se
20 known manner, for example by using the needle selection devices with which modern circular knitting machines are usually provided.

Preferably, the regions E, F are produced by actuating the needle cylinder with an alternating rotary motion about its own axis, producing in succession portions of rows of knitting of the region E and of the region F,
25 which are provided by actuating the needle cylinder with a rotary motion about its own axis in one direction of rotation and by making the needles of the two groups of needles knit at one or more separate feeds or drops of the machine, alternated with portions of rows of knitting of the region E and of the region F provided by actuating the needle cylinder with a rotary motion
30 about its own axis in the opposite direction and by making the needles of

the two groups of needles knit respectively at the same feed(s) or drop(s) of the machine. The direction of rotation of the needle cylinder is reversed after the last needle that has been moved to knit of the two groups of needles has passed through the feed or drop being used, at which the thread
5 for forming the portion E and/or F is dispensed.

In this manner, the ends of the portions E, F do not require cutting and/or finishing operations after the manufacture has been unloaded from the machine.

A detail of the knitting proximate to one end of the portion F is
10 shown in Figure 4.

Subsequently, a tubular portion G of the manufacture 1 is produced which can be obtained, in a per se known manner, by actuating the needle cylinder with a continuous rotary motion about its own axis and by making substantially all the needles of the needle cylinder knit at one or more feeds
15 or drops of the machine. In this step, some of the needles of the needle cylinder can be excluded from knitting in order to obtain particular pattern effects or shapes in this region of the manufacture.

Moreover, during the production of the portion G it is possible to provide the cups H, I of the bra region of the body suit, in a per se known
20 manner.

After the portion G, the regions A, B, C, D, which are the appendages of the manufacture that constitute the shoulder straps of the body suit, are produced.

Each one of these regions A, B, C, D is produced, according to the
25 invention, with a group of contiguous needles, by reducing progressively the number of active needles of such group of needles. The reduction of the active needles is performed by transferring the last loop of knitting formed by certain needles of such group of needles to contiguous needles of the same group of needles and therefore excluding from knitting the needles
30 that have given up or transferred the loop of knitting during the formation of

a portion of a subsequent row of knitting by the needles that are kept active.

The regions A, B, C, D of the manufacture are produced by providing in succession portions of rows of knitting produced by actuating the needle cylinder with a rotary motion about its own axis in one direction of rotation, alternated with portions of rows of knitting produced by actuating the
5 needle cylinder with a rotary motion about its own axis in the opposite direction.

Figure 2 is an enlarged-scale view of a detail of the region C proximate to one of its sides (the left side in Figure 1), and Figure 3 is an enlarged-scale view of a detail of the region C proximate to the opposite
10 side (the right side in Figure 1).

In Figures 2 and 3, the representation of the region C has been limited, for the sake of simplicity, to the knitting of eight needles, the rows of knitting whereof have been designated by the reference numerals 1 to 6 in Figure 2 and by the reference numerals 11 to 16 in Figure 3. The formation
15 of the region of knitting C proceeds from the bottom upwardly in Figures 2 and 3.

With reference to Figure 2, the reduction of the active needles is obtained by producing, in a per se known manner, for example as provided
20 in WO-02/070799 (see Figures 5 and 6), the transfer of the last loop of knitting 211 of the portion of row of knitting 21 formed by the needle N that forms the row 1 to the needle N that forms the row 2 before starting the formation of the subsequent portion of row of knitting 22.

In this manner, during the formation of the portion of row of knitting
25 22, the needle N that forms the row 1 is excluded from knitting, while the needle N that forms the row 2 is made to knit, and so are other needles N of the needle group, forming a new loop of knitting 222, which is knitted in with the two loops of knitting 211 and 212 carried by such needle, which are cast off.

30 Before beginning the next portion of row of knitting 23, the loop of

knitting 222 is given up or transferred from the needle N that forms the row 2 to the contiguous needle N that forms the row 3.

During the formation of the portion of row of knitting 23, the needle that forms the row 2 is also excluded from knitting, while the contiguous
5 needle that forms the row 3 is made to knit, and so are other needles of the group of needles, forming a new loop of knitting 233, which is knitted in with the two loops of knitting 222 and 223 carried by such needle, which are cast off.

It should be noted that the portions of row of knitting 21 and 23 are
10 produced by actuating the needle cylinder Cy with a rotary motion about its own axis in one direction of rotation, while the portion of row of knitting 22 is produced by actuating the needle cylinder Cy with a rotary motion about its own axis in the opposite direction.

With reference to Figure 3, the reduction of the active needles is
15 obtained by causing, in a manner which is per se known, for example as provided in WO-02/070799 (see Figures 5 and 6), the transfer of the last loop of knitting 3116 of the portion of row of knitting 31 formed by the needle that forms the row 16 to the needle that forms the row 15 before starting the formation of the next portion of row of knitting 32.

20 In this manner, during the formation of the portion of row of knitting 32, the needle that forms the row 16 is excluded from knitting, while the needle that forms the row 15 is made to knit, and so are other needles of the group of needles, forming a new loop of knitting 3215, which is knitted in with the two loops of knitting 3116 and 3115 carried by such needle, which
25 are cast off.

Before beginning the next portion of row of knitting 33, the loop of knitting 3215 is transferred from the needle that forms the row 15 to the contiguous needle that forms the row 14.

During the formation of the portion of row of knitting 33, the needle
30 that forms the row 15 is also excluded from knitting, while the contiguous

needle that forms the row 14 is made to knit, and so are other needles of the group of needles, forming a new loop of knitting 3314, which is knitted in with the two loops of knitting 3215 and 3214 carried by such needle, which are cast off.

5 It should be noted that the portions of row of knitting 31 and 33 are produced by actuating the needle cylinder with a rotary motion about its own axis in one direction of rotation, while the portion of the row of knitting 32 is produced by actuating the needle cylinder with a rotary motion about its own axis in the opposite direction.

10 The knitting of the region C proceeds in this manner, by actuating the needle cylinder with an alternating motion about its own axis and reducing, until required and depending on the shape to be provided on such portion, the number of the active needles of the group of needles that produces the region C.

15 The regions A, B and D are produced in a manner similar to what has been described with reference to the region C.

 The needles excluded from knitting are kept retracted within the needle cylinder, below the casting off plane formed by the sinkers, so as to not interfere with the work of the other needles or of the other elements of
20 the machine.

 By proceeding in this manner, it is possible to obtain, for the regions A, B, C, D, a width which decreases gradually, with edges which do not require further finishing operations.

 For the sake of simplicity in description, in the examples described
25 above with reference to Figures 2 and 3, it has been assumed that the number of active needles of the group that provides the region C is reduced before the beginning of each portion of row of knitting. In practice, the number of active needles for producing the regions A, B, C, D can be decreased every one or more successive portions of row of knitting,
30 depending on the shape to be obtained for such regions. Moreover, if a

shape with at least one width reduction alternated with a width increase of such regions is to be obtained, the number of needles made to knit of the groups of needles that are used can be decreased in one step of the knitting process and increased in another step of the knitting process, in a per se known manner.

At the end of the production of the regions A, B, C, D, the manufacture is released by the needles and unloaded from the machine. As an alternative, it is possible to perform, on the same circular machine, the joining of two regions that constitute a same shoulder strap or crotch, for example by following the method disclosed in Italian patent application MI2004A-002495 by the same Applicant, thus finishing the manufacture directly on the circular machine used to produce it.

The method according to the invention, although described with reference to the production of shaped regions of a body suit, can be used to obtain shaped regions on other manufactures, such as for example underpants, undershirts, tops or similar articles.

It should be noted that with the method according to the invention the manufacture 1 can also be produced by starting the knitting from the upper end. In this case, the regions A, B, C, D may be provided, in a per se known manner, by increasing gradually the needles of the groups of needles that produce such portions and by instead decreasing gradually, according to the invention, the needles of the two groups of needles that produce the regions E, F by transferring the last loop of knitting formed by the needles that are subsequently excluded from knitting to the contiguous needle.

In practice it has been found that the method according to the invention fully achieves the intended aim, since by using the technique of transferring the loop of knitting from one needle to a contiguous needle to reduce the active needles combined with the actuation of the needle cylinder with a rotary motion about its own axis in both directions of rotation it allows to provide manufactures, even ones having a high fineness, which

have shaped regions which do not necessarily require cutting or finishing operations regardless of the side from which the knitting of the manufacture begins.

The method thus conceived is susceptible of numerous modifications
5 and variations, all of which are within the scope of the appended claims; all the details may further be replaced with other technically equivalent elements.

In practice, the materials used, as well as the dimensions, may be any according to requirements and to the state of the art.

10 The disclosures in Italian Patent Application No. MI2005A001190 from which this application claims priority are incorporated herein by reference.

Where technical features mentioned in any claim are followed by
reference signs, those reference signs have been included for the sole
15 purpose of increasing the intelligibility of the claims and accordingly, such reference signs do not have any limiting effect on the interpretation of each element identified by way of example by such reference signs.

CLAIMS

1. A method for knitting manufactured articles with circular knitting machines having a needle cylinder actuatable for rotation in both rotation directions, particularly with high-fineness circular machines, characterized
5 in that at least one region (A, B, C, D) of the manufactured article (1) is produced with a group of contiguous needles by reducing at least once the number of active needles of said group of needles by transferring the last loop of knitting formed by certain needles of said group of needles to contiguous needles of said group of needles and thus excluding from
10 knitting said certain needles during the formation of at least one portion of a subsequent row of knitting by the needles that are kept active, and in that said region (A, B, C, D) of the manufactured article is produced by providing in succession portions of rows of knitting obtained by actuating the needle cylinder with a rotary motion about its own axis in one direction
15 of rotation alternated with portions of rows of knitting obtained by actuating the needle cylinder with a rotary motion about its own axis in the opposite direction.

2. The method according to claim 1, characterized in that the reduction of the number of active needles of said group of needles is
20 performed by transferring the last loop of knitting formed by certain needles of said group of needles located at at least one end of said group of needles to contiguous needles of said group of needles.

3. The method according to claims 1 and 2, characterized in that it is performed on circular knitting machines which have a fineness
25 substantially ranging from 16 to 50 needles per inch.