



(11) **EP 1 990 451 A1**

(12) **EUROPEAN PATENT APPLICATION**  
published in accordance with Art. 158(3) EPC

(43) Date of publication:  
**12.11.2008 Bulletin 2008/46**

(51) Int Cl.:  
**D04B 7/10 (2006.01) D04B 1/22 (2006.01)**  
**D04B 7/00 (2006.01)**

(21) Application number: **07713519.2**

(86) International application number:  
**PCT/JP2007/000137**

(22) Date of filing: **27.02.2007**

(87) International publication number:  
**WO 2007/099708 (07.09.2007 Gazette 2007/36)**

(84) Designated Contracting States:  
**AT BE BG CH CY CZ DE DK EE ES FI FR GB GR  
HU IE IS IT LI LT LU LV MC NL PL PT RO SE SI  
SK TR**

(72) Inventors:  
• **SHIMASAKI, Yoshinori**  
**Wakayama-shi, Wakayama 6418511 (JP)**  
• **YUI, Manabu**  
**Wakayama-shi, Wakayama 6418511 (JP)**

(30) Priority: **28.02.2006 JP 2006053639**

(71) Applicant: **Shima Seiki Manufacturing., Ltd.**  
**Wakayama 641-8511 (JP)**

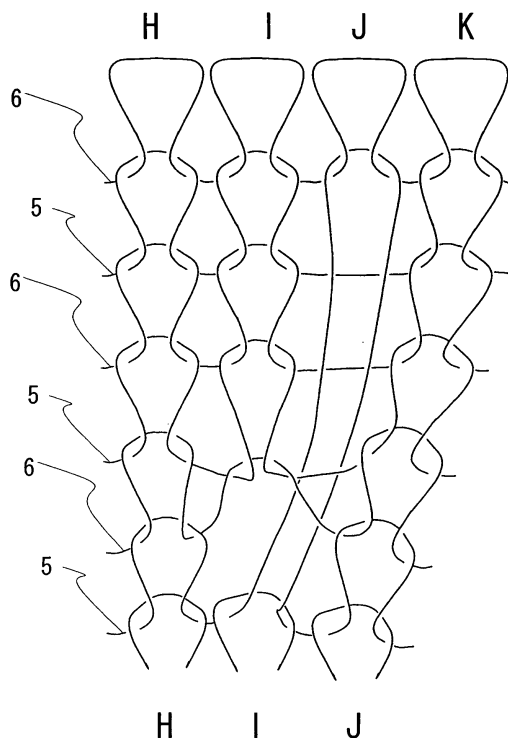
(74) Representative: **Carstens, Dirk Wilhelm et al**  
**Wagner & Geyer**  
**Gewürzmühlstraße 5**  
**D-80538 München (DE)**

(54) **METHOD OF FORMING INCREASE AND KNITTED FABRIC WHERE INCREASES ARE FORMED  
INNER SIDE OF KNITTING WIDTH DIRECTION END OF KNITTED FABRIC**

(57) A method of forming a widening stitch in which knitting is facilitated, the load on a knitting yarn is small, and a hole formed at a location formed with a widening stitch is less likely to stand out, and a knitted fabric including the widening stitch are provided.

The method includes step a of transferring a stitch already held on a knitting needle on which a widening stitch is to be formed to an empty needle of an opposing needle bed to have the knitting needle on which the widening stitch is to be formed as an empty needle; step b of knitting a next course from one end to the other end of a knitting region at the needle bed including the knitting needle on which the widening stitch is to be formed, which is the empty needle, and hooking a loop on the empty needle at the knitting needle on which the widening stitch is to be formed in the relevant knitting; step c of transferring a stitch held on a knitting needle on a knitting needle side adjacent to one side of the knitting needle on which the widening stitch is to be formed of the stitches knitted in step b to an empty needle of the opposing needle bed; and step d of racking the needle bed so that the stitch transferred in step c moves away from the loop hooked on the empty needle, and transferring the stitches transferred in step a and in step c to the empty needles of the opposing needle bed.

Fig. 1



## Description

### TECHNICAL FIELD

**[0001]** The present invention relates to a method of forming a widening stitch on an inner side from the end in a knitting width direction of a knitted fabric when knitting a knitted fabric with a flat knitting machine, and a knitted fabric formed with such widening stitch.

### BACKGROUND ART

**[0002]** In the process of knitting a knitted fabric with a flat knitting machine, widening stitches and narrowing stitches are formed to knit the knitted fabric to a desired shape. Two methods are known for the method of forming the widening stitch. One method is a method of forming a new stitch on an empty needle positioned on the outer side of the stitch at the end of the front knitted fabric part or the back knitted fabric part in the knitting width direction to increase the knitting width (hereinafter referred to as outer widening). The other method is a method of forming a new stitch on an empty needle in a knitting region of the knitted fabric made by moving the stitches of a plurality of wales at the end of the knitted fabric in the knitting width direction to the outer side to increase the knitting width (hereinafter referred to as inner widening).

**[0003]** The knitting method of performing outer widening is disclosed in patent document 1 and the like. In the knitting method disclosed in patent document 1, outer widening is performed while knitting the knitted fabric to a tubular form through a double system knitting in which knitting is carried out by traveling two yarn feeders in a longitudinal direction of a needle bed at shifted time.

**[0004]** Since a new wale is formed at the edge of the knitted fabric in the knitting width direction every time a widening stitch is formed in the outer widening, the edge of the knitted fabric becomes uneven, and the outer appearance becomes unsatisfactory. In the inner widening, on the other hand, a new wale is formed at a location other than at the edge of the knitted fabric, and thus wales formed in a series appear at the edge of the knitted fabric, and the wales with the boundary line of the front and back knitted fabric parts in between are formed in a parallel and even state.

**[0005]** In either method of forming the widening stitch, however, the widening stitch is formed by feeding a knitting yarn to an empty needle on which the stitches of the previous course do not exist. Therefore, a newly formed stitch is pulled up by the stitch of the next course at the location formed with the widening stitch, whereby a large hole forms at the location formed with the widening stitch, and the appearance degrades.

**[0006]** In order to solve the problem of a large hole, the applicant of the invention has proposed a method of forming a widening stitch through inner widening so that the hole formed at the location formed with the widening stitch is less likely to stand out (see patent document 2).

This widening stitch forming method first feeds the knitting yarn to a first needle while transferring the stitch held on the first needle to a second needle where the first needle and the second needle are arranged facing each other on front and back needle beds respectively, and forming a new stitch on the first needle in continuation to the stitch transferred to the second needle. The stitch transferred to the second needle becomes the widening stitch as a result of forming the new stitch on the first needle. After moving the needle beds in a lateral direction by racking and creating an empty needle next to the first needle, the stitch transferred to the second needle is transferred to the relevant empty needle, so that the widening stitch is formed next to the stitches held on the first needle. In this widening stitch forming method, the widening stitch is formed using transfer between the needles arranged on the different front and back needle beds, and the stitch is split into two to form the widening stitch (hereinafter referred to as split knitting).

### [0007]

Patent document 1: Japanese Patent Publication No. 3121283

Patent document 2: Japanese Patent Publication No. 62-52063

## DISCLOSURE OF THE INVENTION

### PROBLEMS TO BE SOLVED BY THE INVENTION

**[0008]** When forming the widening stitch by split knitting, the widening stitch will be held at the stitch of the previous course, and thus will not be pulled up by the stitch of the next course. The knitted fabric having a widening stitch with a very small hole opening is thereby knitted, and the knitted fabric of satisfactory outer appearance is obtained.

**[0009]** However, when forming the widening stitch by split knitting, a new stitch is formed by splitting the already formed stitch into two. Therefore, when knitting at a small mesh using a knitting yarn that easily breaks, the widening stitch becomes smaller than other stitches, and thus knitting including transfer becomes difficult to be performed and drop stitch might occur. Furthermore, the load on the knitting yarn increases if the stitch is extremely small.

**[0010]** It is an object of the present invention to provide a method of forming a widening stitch in which knitting is facilitated, the load on the knitting yarn is small, and the hole formed at the location formed with the widening stitch is less likely to stand out, and a knitted fabric including the widening stitch knitted with the relevant method.

### MEANS FOR SOLVING THE PROBLEMS

**[0011]** A method of knitting a knitted fabric of the present invention is a method of forming a widening stitch

on an inner side from an end of a knitted fabric in a knitting width direction with a flat knitting machine having at least a pair of front and back needle beds, at least either of which is capable of being racked in a transverse direction so that stitches can be transferred between the front and back needle beds, wherein the widening stitch is formed according to the following steps.

**[0012]** The steps include:

step a of transferring a stitch already held on a knitting needle on which a widening stitch is to be formed to an empty needle of the opposing needle bed to make the knitting needle on which the widening stitch is to be formed empty;

step b of knitting a next course from one end to the other end of a knitting region at the needle bed including the knitting needle on which the widening stitch is to be formed, which is empty, and forming a hooked loop by feeding a knitting yarn to a hook of the knitting needle on which the widening stitch is to be formed in the relevant knitting;

step c of transferring, out of the stitches knitted in step b, a stitch held on a knitting needle being adjacent to one side of the knitting needle on which the widening stitch is to be formed to an empty needle of the opposing needle bed; and

step d of racking the needle bed so that the stitch transferred in step c moves away from the hooked loop hooked on the knitting needle on which the widening stitch is to be formed, and then transferring the stitch transferred in step a and the stitch transferred in step c to the empty needles of the opposing needle bed.

**[0013]** In the method of forming the widening stitch of the present invention, the step of knitting a next course from one end to the other end of the knitting region while missing the knitting needle holding the stitch transferred in step a out of the stitches transferred in step d is preferably performed at least once in continuation to step d described above.

**[0014]** Further, the method of forming the widening stitch of the present invention preferably includes, between step b and step c, a step of knitting a next course from one end to the other end of the knitting region on the previous course including the hooked loop hooked by step b on the knitting needle on which the widening stitch is to be formed.

**[0015]** The method of forming the widening stitch of the present invention can be applied to a case where a first yarn feeder and a second yarn feeder are arranged in the flat knitting machine, and the widening stitch is formed on the inner side from the end of the knitted fabric in the knitting width direction by performing a double system knitting using the two yarn feeders. When performing the double system knitting, the knitted fabric is preferably knitted to a tubular form.

**[0016]** When knitting the knitted fabric to a tubular form

through double system knitting, the two knitting yarns tend to cross at one end in the knitting width direction that becomes an inverting position in the traveling direction of the yarn feeders if knitting is performed to a tubular form with the preceding first yarn feeder 6 being arranged on the far side and the following second yarn feeder 5 being arranged on the near side when seen from the front side of the knitting machine, as shown in Fig. 9. At the crossing portion of the knitting yarns, the knitting yarn is pulled by the surrounding stitches, and a hole g as shown in Fig. 10 forms at the boundary X of the front and back knitted fabric parts. In patent document 1, knitting is performed such that the hole at the crossing portion hardly stand out, but a hole still exists in the knitted fabric although the hole is less likely to stand out.

**[0017]** The method of forming the widening stitch of the present invention preferably forms a boundary wale, which serves as a boundary of a front knitted fabric part and a back knitted fabric part when forming the widening stitch while knitting the knitted fabric to a tubular form by double system knitting. The boundary wale is formed by continuously forming stitches by twisting the stitches, and winding a knitting yarn different from the knitting yarn forming the twisted stitch on the twisted stitch, whereby a hole does not form at the crossing portion of the yarns.

**[0018]** The knitted fabric formed with a widening stitch on the inner side from the end of the knitted fabric in the knitting width direction according to the above-described method includes a widening stitch formed by feeding a knitting yarn to a hook of a knitting needle which is empty as a result of transferring the stitch already held on the knitting needle on which a widening stitch is to be formed to the opposing needle bed. In addition, the knitted fabric formed with the above-described method includes a stitch hidden between the widening stitch and a stitch adjacent to the widening stitch, which was transferred to the opposing needle bed, wherein a new stitch is formed on the hidden stitch.

**[0019]** The knitted fabric formed with the widening stitch on the inner side from the end of the knitted fabric in the knitting width direction of the present invention is preferably a tubular knitted fabric.

## EFFECTS OF THE INVENTION

**[0020]** According to the method of knitting the knitted fabric of the present invention, a stitch is formed in advance on the knitting needle on which a widening stitch is to be formed, the stitch is transferred to the opposing needle bed, a widening stitch is formed on the relevant knitting needle which became empty as a result of the transfer, and then the transferred stitch is returned next to the widening stitch. As a result, even if a hole forms by the widening stitch, a part of the hole will be blocked by the stitch returned by transferring, and thus the hole formed at the location formed with the widening stitch is less likely to stand out.

**[0021]** When forming the widening stitch with the meth-

od of the present invention, the widening stitch is not formed by splitting the already formed stitch into two, and thus the widening stitch can be easily knitted and the load on the yarn becomes small even when knitting with a yarn that easily breaks or knitting at a small mesh.

**[0022]** In the knitting following step d, the next course is knitted from one end to the other end of the knitting region while missing the knitting needle holding the stitch transferred in step a, and thus a new stitch on the stitch transferred in step a is formed in the course after the course in which the knitting needle is missed. The stitch transferred in step a is pulled up by the newly formed stitch, and the hole formed at the location formed with the widening stitch becomes more unlikely to stand out.

**[0023]** When the next course is knitted on the hooked loop hooked on the empty needle at between step b and step c, a new stitch is formed on the stitch transferred in step a and the stitch transferred in step a is pulled up. Accordingly, the hole formed at the location formed with the widening stitch becomes more unlikely to stand out.

**[0024]** Furthermore, the method of forming the widening stitch of the present invention enables knitting for two courses as well as transferring of stitches while a carriage mounted with a plurality of knitting systems travels one course when the widening stitches are formed while knitting is performed in a double system. As a result, the productivity enhances while easily forming the widening stitch so as not to form a large hole at the location formed with the widening stitch.

**[0025]** In the case of double system knitting, the productivity enhances by knitting the knitted fabric into a tubular form. Moreover, when knitting to a tubular form through double system knitting, a hole that was formed conventionally does not form if the boundary wale, which serves as the boundary of the front and the back knitted fabric parts, is formed by twisting the stitches and winding a knitting yarn different from the knitting yarn forming the twisted stitch on the twisted stitch. Furthermore, an outer appearance similar to the stitches formed by a sewing machine is obtained by the twisted stitch and the winding of the knitting yarn, and a knitted fabric excelling in design is obtained.

#### BEST MODE FOR CARRYING OUT THE INVENTION

**[0026]** Preferred embodiments of the present invention will now be described in detail below with reference to drawings. In the present embodiment, a knitted fabric is knitted with a four-bed flat knitting machine having a pair of front and back needle beds extending in a transverse direction and disposed opposite to each other in a cross section, the back needle bed is capable of being racked in the transverse direction so that stitches can be transferred between the front and back needle beds.

**[0027]** In knitting the knitted fabric, a two-bed flat knitting machine having a front needle bed and a back needle bed may be used for knitting. When knitting the knitted fabric with the two-bed flat knitting machine, the knitted

fabric is knitted with an empty needle provided alternately. Furthermore, when using the two-bed flat knitting machine, a transfer jack bed having transfer jacks arranged in line and located at an upper level of one or both of the front and back needle beds may be used to knit the knitted fabric.

**[0028]** The four-bed flat knitting machine includes an upper front needle bed and an upper back needle bed arranged in line located at an upper level of the lower front and back needle beds. The upper front and back needle beds are provided with a great number of knitting needles at the same pitch as the lower needle beds. The lower front needle bed is hereinafter simply referred to as FD, the lower back needle bed as BD, the upper front needle bed as FU, and the upper back needle bed as BU.

**[0029]** In the present embodiment, the front body and the front knitted fabric parts of the left and right sleeves are knitted with the FD of the four-bed flat knitting machine, and the back body and the back knitted fabric parts of the left and right sleeves are knitted with the BD. The needles of the BU are used to transfer stitches of the front body and the front knitted fabric parts of the sleeves. The needles of the FU are used to transfer stitches of the back body and the back knitted fabric parts of the sleeves.

**[0030]** Through the use of the FU and the BU, structure patterns of mixed front-and-back stitches, such as links, purls, and ribs can be knitted. Further, stitches can be rotated, and the stitches can be overlapped.

**[0031]** The flat knitting machine used in the present embodiment further includes a second yarn feeder 5 slidably arranged on a guide rail (not shown) positioned on the near side (front side) when seen from the front side of the knitting machine, and a first yarn feeder 6 slidably arranged on a guide rail positioned on the far side (back side).

**[0032]** In the flat knitting machine performing the double system knitting of the present embodiment, a carriage mounted with a cam system S2 and a cam system S3 which move on the needle beds and are used for knitting, and a cam system S1 and a cam system S4 which are used for transferring is arranged. The cam system S1, the cam system S2, the cam system S3, and the cam system S4 are hereinafter simply referred to as S1, S2, S3, and S4. In the knitting process, the cam system from the preceding side of the traveling direction of the carriage is always S1, S2, S3, and S4.

**[0033]** While the carriage makes one forward movement or backward movement, the double system knitting is performed knitting with the knitting yarn fed from the preceding first yarn feeder 6, knitting with the knitting yarn fed from the following second yarn feeder 5 and transferring by such cam system.

**[0034]** As shown in Fig. 8, a sweater 1 knitted in the present embodiment is a round-necked, long-sleeved sweater 1 including a body 2, a right sleeve 3, and a left sleeve 4. Regarding such sweater 1, the body 2 is knitted to a tubular form with the front body and the back body

continuing to each other, the right and left sleeves 3, 4 are also knitted to a tubular form, and thereafter, the body 2 and the sleeves 3, 4 are knitted and joined at the joining portions of the body 2 and the sleeve 3, 4 so as to form one continuing tubular form. In the present embodiment, the terms representing left and right of the body and the sleeves, such as right and left of the right sleeve 3 and the left sleeve 4 are used based on the wearer wearing the sweater 1.

**[0035]** The right and left sleeves 3, 4 are both normally knitted so that the knitting width gradually increases from the cuff side while being knitted to a tubular form. In the present embodiment, widening stitches are formed at the end side of the front knitted fabric part and the back knitted fabric part of the sleeves 3, 4 adjacent to the body 2 in the knitting width direction and at four to five stitches on the inner side from the boundary of the front and back knitted fabric parts, in order to increase the knitting width.

**[0036]** In forming the widening stitch, one widening stitch may be formed for every two-course knitting, one widening stitch may be formed for every four-course knitting, or one widening stitch may be formed for every six-course knitting, according to the shape of the knitted fabric to be knitted.

**[0037]** In the sweater 1 of the present embodiment, the back body of the body 2, and the back knitted fabric parts of the right sleeve 3 and the left sleeve 4 are knitted principally with the BD in an every needle without having an empty needle. The front body of the body 2 and the front knitted fabric parts of the right sleeve 3 and the left sleeve 4 are knitted principally with the FD in an every needle without having an empty needle.

**[0038]** An embodiment of a method of forming a widening stitch of the present invention will be described below based on a loop diagram of Fig. 1 and knitting process diagrams of Fig. 2 and Fig. 3. In the present embodiment, the knitting method itself is the same for the knitting performed in the right and left sleeves 3, 4 except for being in a mirror reversed state, and thus only the knitting for forming the widening stitch in the right sleeve 3 will be described in the following embodiment.

**[0039]** For the sake of convenience of description, the knitting pattern of the body 2, and the sleeves 3, 4 in the sweater 1 is presented in the form of a plain stitch with no pattern, and the knitting pattern of the hem part of the body 2 and the cuff portions of the sleeves 3, 4 are presented in the form of a rib stitch.

**[0040]** The knitted fabric loop diagram shown in Fig. 1 shows a state in which a widening stitch is formed in the front knitted fabric part of the right sleeve 3. Alphabets H to K shown in Fig. 1 represent the needles of the BD. In Fig. 2 and Fig. 3, a process diagram of forming the widening stitch at a certain portion of the right sleeve 3 from a state knitted to a tubular form in a plain stitch is shown.

**[0041]** For the sake of convenience of description, the number of stitches of the right sleeve 3 is shown to be less than the number actually used in knitting in the knit-

ting process diagrams of Fig. 2 and Fig. 3, and a knitting process diagram (Fig. 6) in knitting a boundary wale as hereinafter described. Alphabets A to R shown in Fig. 2 and Fig. 3 represent the needles of FD, BD, and FU, BU, arranged opposite to each other in the cross direction. In the knitting process diagram of Fig. 6, FU and BU are omitted. Furthermore, alphabets in capital letters in the knitting loop diagram and the alphabets shown in the knitting process diagrams are corresponded. In Fig. 2, Fig. 3, and Fig. 6, the numbers on the left end indicate the knitting block number.

**[0042]** In each knitting block of Fig. 2 and Fig. 3, the arrow in the right end column indicates the racking direction of the back needle bed, and the number of pitches is shown under the arrow. The arrow in the column on the immediate left of the right end column indicates the knitting direction. In each knitting block of Fig. 6, the arrow in the right end column indicates the knitting direction.

**[0043]** Step S shown in Fig. 2 shows the state before formation of the widening stitch is started in the middle of knitting of the right sleeve 3. The step S also shows the state in which the stitches are held on the needles C to N of the FD and the BD, and the right sleeve 3 is being knitted to a tubular form.

**[0044]** The stitches held on the FD are stitches of the front knitted fabric part of the right sleeve 3, and the stitches held on the BD are stitches of the back knitted fabric part of the right sleeve 3.

**[0045]** In the knitting block 1 of Fig. 2, the carriage is moved in the left direction, and the knitting yarn is first fed from the first yarn feeder 6 to the FD, and the front knitted fabric part is knitted for one course by the preceding S2. Subsequently, the knitting yarn is fed from the second yarn feeder 5 to the FD, and the next course is knitted by the following S3 on the stitches knitted by S2. Finally, by S4, the stitch held on the needle J of the BD of the stitches of the back knitted fabric part already knitted is transferred to the needle J of the opposing FU. The needle J of the BD then becomes empty as a result of such transfer.

**[0046]** In the next knitting block 2, the knitting yarn is first fed from the first yarn feeder 6 to the BD, and the back knitted fabric part is knitted for one course by the preceding S2. Since the needle J of the BD is empty, the knitting yarn is fed to a hook of the relevant knitting needle. Subsequently, the knitting yarn is fed from the second yarn feeder 5 to the BD, and the next course is knitted by the following S3 on the stitches knitted by S2. Finally, by S4, the four stitches held on the needles K, L, M, and N of the BD of the stitches of the back knitted fabric part knitted by S3 are transferred to the needles K, L, M, and N of the opposing FU.

**[0047]** In the next knitting block 3, the back needle bed is racked by one pitch towards the left, and thereafter, the five stitches held on the needles J, K, L, M, and N of the FU are transferred to the needles K, L, M, N, and O of the opposing BD by the preceding S1. According to such transfer, the stitch transferred to the needle J of the

FU by S4 in the knitting block 1 is held on the needle K, which locates adjacent to the needle J of the BD which hooks the hooked loop. Thereby, the widening stitch is formed in the back knitted fabric part. Furthermore, by S1 in the knitting block 3, the stitch of the front knitted fabric part held on the needle I of the FD is transferred to the needle J of the opposing BU.

**[0048]** Also in the knitting block 3, the knitting yarn is fed from the first yarn feeder 6 to the FD, and the front knitted fabric part is knitted for one course by the next S2. Since the needle I of the FD is empty, the knitting yarn is hooked on the relevant knitting needle. Subsequently, the knitting yarn is fed from the second yarn feeder 5 to the FD, and the next course is knitted by the following S3 on the stitches knitted by S2. Finally, by S4, the four stitches held on the needles J, K, L, M, and N of the FD of the stitches of the front knitted fabric part knitted by S3 are transferred to the needles K, L, M, N, and O of the opposing BU.

**[0049]** In the next knitting block 4 (see Fig. 3), the back needle bed is racked by one pitch towards the right, and thereafter, the six stitches held on the needles J, K, L, M, N, and O of the BU are transferred to the needles J, K, L, M, N, and O of the opposing FD by the preceding S1. According to such transfer, the stitch transferred to the needle J of the BU by S1 in the knitting block 3 is held on the needle J, which locates adjacent to the needle I of the FD which hooks the hooked loop, whereby the widening stitch is formed in the front knitted fabric part.

**[0050]** Also in the knitting block 4, the knitting yarn is fed from the first yarn feeder 6 to the BD, and the back knitted fabric part is knitted for one course by the next S2. The needle K of the BD is missed in this case. Subsequently, the knitting yarn is fed from the second yarn feeder 5 to the BD, and the next course is knitted for one course by the following S3 on the stitches knitted by S2. The needle K of the BD is again missed. The stitch remains held on the needle K of the BD as a result of such missing.

**[0051]** In the next knitting block 5, the knitting yarn is fed from the first yarn feeder 6 to the FD, and the front knitted fabric part is knitted for one course by the preceding S2. The needle J of the FD is missed. Subsequently, the knitting yarn is fed from the second yarn feeder 5 to the FD, and the next course is knitted for one course by the following S3 on the stitches knitted by S2. The needle J of the FD is again missed. The stitch remains held on the needle J of the FD as a result of such missing.

**[0052]** In the next knitting block 6, the knitting yarn is first fed from the first yarn feeder 6 to the BD, and the back knitted fabric part is knitted for one course by the preceding S2. Subsequently, the knitting yarn is fed from the second yarn feeder 5 to the BD, and the next course is knitted by the following S3 on the stitches knitted by S2.

**[0053]** In the next knitting block 7, the knitting yarn is first fed from the first yarn feeder 6 to the FD, and the front knitted fabric part is knitted for one course by the preceding S2. Subsequently, the knitting yarn is fed from

the second yarn feeder 5 to the FD, and the next course is knitted by the following S3 on the stitches knitted by S2.

**[0054]** The widening stitch as shown in Fig. 1 can be formed at a location to which the widening stitch is formed near one end of the tubular knitted fabric in the knitting width direction by knitting the knitted fabric in the above manner. In the present embodiment, the stitch already held on the knitting needle, on which the widening stitch is to be formed, is transferred to the opposing needle bed. Subsequently, the widening stitch is formed by hooking a loop on the knitting needle on which the widening stitch is to be formed. The stitch transferred to the opposing needle bed is returned to the original needle bed so as to be hidden between the relevant widening stitch and the stitch adjacent to the widening stitch. Thereby, even if a hole forms at the location formed with the widening stitch, a part of the hole is blocked by the hidden stitch. A new stitch is then formed on the hidden stitch, whereby the hidden stitch is pulled up by the new stitch, and the hole at the location formed with the widening stitch becomes smaller.

**[0055]** In the present embodiment, after missing the stitch hidden between the widening stitch and the stitch adjacent to the widening stitch twice, a new stitch is formed on the hidden stitch. Thus, a course, which is five courses above a course in which the hidden stitch is knitted, is knitted with the hidden stitch positioned in alignment with the stitches in a course four courses above a course in which the hidden stitch is knitted. As a result, the hidden stitch is strongly pulled up by the new stitch formed in the course which is five courses above the relevant stitch. Thus, the hole at the location formed with the widening stitch becomes less significant. In the loop diagram of Fig. 1, the hidden stitch is formed long to facilitate the understanding of the knitting state, but actually, the hidden stitch is small as in the image of the knitted fabric shown in Fig. 7.

**[0056]** Thus, since the widening stitch is formed while performing the double system knitting in the present embodiment, two courses of knitting and transferring can be performed while the carriage travels one course. As a result, the knitted fabric is formed so that a large hole does not form at the location formed with the widening stitch, and furthermore, the carriage does not need to be traveled merely for transferring, and the productivity of the knitted fabric enhances.

**[0057]** In the present embodiment, knitting is performed using two yarn feeders through double system knitting. However, even when knitting to a tubular form while feeding the knitting yarn only from one yarn feeder, the widening stitch can be similarly formed, and the knitting of missing the stitch to reduce the hole formed by the widening stitch can be performed. Furthermore, such missing is carried out twice in the present embodiment, but the missing may be carried out only once, or the missing may not be carried out. The decision on whether or not to carry out the missing, or on how many missing to carry out when carrying out the missing is made accord-

ing to the type and the raw material of the knitting yarn to be used. For example, the missing does not need to be carried out in the case of a knitting yarn having stretchability. The number of missing is set large in the case of a knitting yarn having small stretchability, so that the stitch is strongly pulled up by the stitch on the upper side far from the hidden stitch.

**[0058]** When knitting the knitted fabric to a tubular form through double system knitting, both yarn feeders feed the knitting yarn annularly to the needles of the front and back needle beds to knit the tubular knitted fabric. As a result, the knitting yarn fed from the preceding yarn feeder and the knitting yarn fed from the following yarn feeder cross at one of the ends in the knitting width direction being an inverting position in the traveling direction of the yarn feeder, and a hole g forms at the boundary portion X of the front and back knitted fabric parts, as shown in Fig. 10.

**[0059]** In the present embodiment, a boundary wale that serves as the boundary formed at the front and back boundary portion of the front knitted fabric part and the back knitted fabric part of the tubular knitted fabric when forming the widening stitch while knitting to a tubular form through the double system knitting. The boundary wale is formed by forming the stitch in a twisted manner, and winding the knitting yarn different from the knitting yarn forming the twisted stitch on the twisted stitch.

**[0060]** The method of knitting the boundary wale will be described based on Fig. 4 to Fig. 6. Fig. 4 shows a knitting loop diagram of the boundary portion between the front knitting fabric part FF and the back knitting fabric part BF of the right sleeve 3 at the body side, that is, the inner side of the sleeve. In the present embodiment, the body side boundary portion of the right sleeve 3 is the side on which the two knitting yarns cross in the double system knitting. Fig. 5 shows a knitting loop diagram of the boundary portion between the front knitting fabric part FF and the back knitting fabric part BF of the right sleeve 3 at the side opposite to the body, that is, the outer side of the sleeve. The knitting process diagram for knitting the boundary wale is shown in Fig. 6.

**[0061]** Alphabets L to N, and B to D shown in Fig. 4 and Fig. 5 indicate the needles of the FD and the BD. A chain dashed line X of Fig. 4 and Fig. 5 shows the boundary line of the front knitted fabric part FF and the back knitted fabric part BF.

**[0062]** Step S shown in Fig. 6 shows the state in which the stitches are held on the needles C to N of the FD and the BD, and the right sleeve 3 is knitted to a tubular form in the middle of knitting of the right sleeve 3. In the knitting process diagram, the formation of the widening stitch is omitted to distinguish the method of forming the widening stitch and the method of forming the boundary wale. The stitches held on the FD are stitches of the front knitted fabric part FF of the right sleeve 3, and the stitches held on the BD are stitches of the back knitted fabric part BF of the right sleeve 3.

**[0063]** In the knitting block 1 of Fig. 6, the carriage is

moved in the left direction, and the knitting yarn is first fed from the first yarn feeder 6 to the FD, and the front knitted fabric part FF is knitted for one course by the preceding S2. Subsequently, the knitting yarn is fed from the second yarn feeder 5 to the FD, and the next course is knitted by the following S3 on the stitches knitted by S2. The number of stitches knitted by S3 is greater than the number of stitches knitted by S2 with the knitting yarn fed from the first yarn feeder 6 by one stitch at both ends in the knitting width direction. That is, a stitch is formed on the needle B and the needle O of the FD. Finally, the stitch held on the needle O of the FD of the stitches knitted by S3 of the front knitted fabric part FF is transferred by S4 to the needle O of the opposing BU, while the stitch held on the needle B of the FD is similarly transferred by S4 to the needle B of the opposing BD. Regarding the stitch at the left side end of Fig. 6, since the first yarn feeder 6 is arranged on the back side of the second yarn feeder 5, the knitting yarn fed from the second yarn feeder 6 crosses over the knitting yarn fed from the first yarn feeder 6 when the stitch held on the needle B of the FD is transferred to the needle B of the opposing BD.

**[0064]** In the next knitting block 2, the knitting yarn is first fed from the first yarn feeder 6 to the BD, and the back knitted fabric part is knitted for one course by the preceding S2. In this case, a stitch is not formed on the needle B of the BD holding the stitch transferred by S4 in the knitting block 1, and a stitch is formed on the needle O of the BD. Due to the knitting by S2, the stitch held on the needle B of the BD is wound with the knitting yarn fed from the first yarn feeder 6 (knitting yarn a shown in the loop diagram of Fig. 5).

**[0065]** In the knitting block 2, the knitting yarn is then fed from the second yarn feeder 5 to the BD, and the next course is knitted by the following S3 on the stitches knitted by S2. A stitch is formed on the needle B of the BD, and a stitch is not formed on the needle O of the BD. The stitch transferred and held on the needle B of the BD by S4 in the knitting block 1 becomes twisted in the knitting by S3 (stitch b shown in the loop diagram of Fig. 5). A stitch (stitch c shown in the loop diagram of Fig. 5) is formed on the needle B with the same knitting yarn (knitting yarn fed from the second yarn feeder 5) on the twisted stitch.

**[0066]** Lastly in the knitting block 2, the stitch of the needle O of the BD knitted by S2 with the knitting yarn fed from the first yarn feeder 6 is transferred by S4 to the needle O of the opposing FD, while the stitch of the needle B of the BD knitted by S3 with the knitting yarn fed from the second yarn feeder 5 is similarly transferred by S4 to the needle B of the opposing FD. The stitch held on the needle B of the FD becomes twisted (stitch c shown in the loop diagram of Fig. 5), and the stitch held on the needle O becomes twisted (stitch e shown in the loop diagram of Fig. 4), according to such transfer.

**[0067]** In the next knitting block 3, knitting same as in the knitting block 1 is performed. The state of the stitch formed at the end in the knitting width direction will be

described from the relationship of the knitting block 2. The knitting yarn is fed from the first yarn feeder 6 to the FD, and the front knitted fabric part FF is knitted for one course by the preceding S2, but a stitch is not formed on the needle O and the needle B of the FD. Thus, a stitch is formed on the needle N in continuation to the stitch held on the needle O formed by S2 in the knitting block 2. In this case, the stitch held on the needle O is wound with the knitting yarn fed from the second yarn feeder 5 (knitting yarn d shown in the loop diagram of Fig. 4).

**[0068]** In the knitting block 3, the stitch knitted with the needle O of the FD at the end in the knitting width direction of the stitches knitted with the knitting yarn fed from the second yarn feeder 5 is formed by S3 on the stitch knitted with the knitting yarn fed from the first yarn feeder 6, and the stitch knitted with the needle B is formed by S3 on the stitch knitted with the knitting yarn fed from the same second yarn feeder 5.

**[0069]** In the knitting block 3, the stitches held on the needle B and the needle O of the FD are transferred by S4 to the needle B and the needle O of the opposing BD. The stitch held on the needle O of the BD is twisted in this case (stitch f shown in the loop diagram of Fig. 4).

**[0070]** The boundary wale is knitted in this manner, the boundary wale is continuously knitted while twisting the stitches, and furthermore, the knitting yarn different from the knitting yarn forming the twisted stitch is wound on the twisted stitch. As a result, a hole formed conventionally by the double system knitting no longer forms due to the boundary wale, an outer appearance similar to the stitches formed by a sewing machine is obtained by the twisted stitch and the winding of the knitting yarn, and a knitted fabric excellent in design is knitted. Furthermore, since the stitches of the boundary wale are twisted and are wound by another knitting yarn, the boundary portion of the knitted fabric is less likely to stretch.

**[0071]** The loop diagrams shown in Fig. 4 and Fig. 5 show the stitches of the boundary wale at the position corresponding to each needle, for the sake of convenience of description, but when the stitches actually become stable, the stitches of the boundary wale are linearly extended in the wale direction as shown in the image of Fig. 7.

**[0072]** In the present embodiment, the right sleeve 3 has two knitting yarns crossing on the inner side of the sleeve. The boundary wale of the present invention may not be formed on the outer side of the sleeve that becomes the side on which the yarns do not cross by a conventional double system knitting, and the boundary wale may only be formed on the inner side of the sleeve.

**[0073]** When performing the double system knitting, the second yarn feeder 5 is arranged on the near side and the first yarn feeder 6 is arranged on the far side as the yarn feeders for feeding two knitting yarns in the present embodiment, and the first yarn feeder 6 is always preceding. However, the knitting method of the present invention can be applied to a case of preceding the second yarn feeder 5 on the near side in the backward path

after preceding the first yarn feeder 6 on the far side in the forward path. Furthermore, the present invention may be applied to a case of arranging four yarn feeders on different guide rails and knitting with two knitting yarns while switching the yarn feeder, and may be applied to a case of knitting with two yarn feeders arranged on the same guide rail. If the yarn feeders are arranged in such manner, the manner of crossing the yarns differs from the present embodiment, there are some cases where the yarns may cross at the end on the opposite side from that of the present embodiment or the yarns may cross at both ends in the knitting width direction, but the method of forming the boundary wale according to the present invention can appropriately respond even if the crossing state of the yarns differs.

**[0074]** Furthermore, when performing the knitting method of the present invention through the double system knitting, it can be applied not only to a case of knitting the knitted fabric to a tubular form but also to a case of knitting the knitted fabric through fashioning knitting. The knitted fabric in which the widening stitch is formed on the inner side from the end in the knitting width direction of the knitted fabric of the present invention is not limited to a fashioning knitted fabric or the tubular knitted fabric knitted through the double system knitting.

**[0075]** The operation of transferring, out of the stitches knitted for one course including the hooked loop hooked on the empty needle, the stitch held on the knitting needle which is adjacent to one side of the knitting needle to be formed with the widening stitch to the empty needle of the opposing needle bed is applicable to a case of increasing the knitting width, and also to a case of widening and narrowing the stitches to knit with a constant knitting width. For instance, when increasing the knitting width, all the stitches held on the knitting needle on one side with respect to the knitting needle to be formed with the widening stitch are transferred to the empty needle of the opposing needle bed. When knitting with a constant knitting width, the widening and narrowing may be carried out within the knitted fabric, and the stitch held between the knitting needle to be formed with the widening stitch and the knitting needle to be formed with the narrowing stitch (overlapping stitch) is transferred to form the overlapping stitch.

## INDUSTRIAL APPLICABILITY

**[0076]** The method of forming a widening stitch of the present invention is suited for a case of knitting a knitted fabric in which a widening stitch is formed while performing a double system knitting of satisfactory productivity.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0077]**

Fig. 1 is a loop diagram of a knitted fabric including a widening stitch knitted with a method of forming a

widening stitch of the present invention.

Fig. 2 is a knitting process diagram for forming the widening stitch.

Fig. 3 is a knitting process diagram for forming the widening stitch.

Fig. 4 is a loop diagram of a knitted fabric showing a state in which a boundary wale is formed at a boundary part of the front and back knitted fabric parts when being knitted to a tubular form through a double system knitting, the loop diagram being of the left side end in the knitting width direction of the tubular part.

Fig. 5 is a loop diagram of a knitted fabric showing a state in which a boundary wale is formed at a boundary part of the front and back knitted fabric parts when being knitted to a tubular form through the double system knitting, the loop diagram being of the right side end in the knitting width direction of the tubular part.

Fig. 6 is a knitting process diagram for forming the boundary wale.

Fig. 7 is an image of the surface of the knitted fabric showing a state in which a boundary wale is formed at a boundary part of the front and back knitted fabric parts when being knitted to a tubular form through the double system knitting, and a widening stitch is formed near the boundary part.

Fig. 8 is a part plane view seen from the front body side of a sweater knitted with the knitting width of the left and right sleeves increased with the method of forming a widening stitch of the present invention.

Fig. 9 is an explanatory view showing a state of two yarn feeders when being knitted to a tubular form through the double system knitting.

Fig. 10 is a loop diagram showing a state of a hole formed at the boundary part of the front and back knitted fabric parts when being knitted to a tubular form through the double system knitting.

#### Description of Symbols

#### [0078]

- 1 sweater
- 2 body
- 3 right sleeve
- 4 left sleeve
- 6 first yarn feeder
- 5 second yarn feeder
- FF front knitted fabric part
- BF back knitted fabric part

#### Claims

1. A method of forming a widening stitch on an inner side from an end in a knitting width direction of a knitted fabric with a flat knitting machine having at

least a pair of front and back needle beds, at least either of which is capable of being racked in a transverse direction so that stitches can be transferred between the front and back needle beds, the method of forming the widening stitch comprising:

step a wherein a stitch already held on a knitting needle on which a widening stitch is to be formed is transferred to an empty needle of the opposing needle bed so that the knitting needle on which the widening stitch is to be formed becomes empty;

step b wherein a knitting yarn is hooked on said knitting needle on which the widening stitch is to be formed, which is temporarily empty, while a next course is knitted from one end to the other end of a knitting region at the needle bed including said knitting needle on which the widening stitch is to be formed, which is temporarily empty;

step c wherein a stitch held on a knitting needle on a knitting needle side adjacent to one side of the knitting needle on which the widening stitch is to be formed of the stitches knitted in step b is transferred to an empty needle of the opposing needle bed; and

step d wherein the needle bed is racked so that the stitch transferred in step c moves away from the loop hooked on the knitting needle, and the stitch transferred in step a and the stitch transferred in step c are transferred respectively to the empty needles of the opposing needle bed.

2. The method of forming the widening stitch according to claim 1, wherein the step of knitting the next course from one end to the other end of the knitting region while missing the knitting needle holding the stitch transferred in step a of the stitches transferred in step d is performed at least once in continuation to step d according to claim 1.

3. The method of forming the widening stitch according to claim 1 or 2, further comprising, between step b and step c, a step of knitting a next course on the hooked loop hooked on the knitting needle knitted in step b from one end to the other end of the knitting region.

4. The method of forming the widening stitch according to any one of claims 1 to 3, wherein a first yarn feeder and a second yarn feeder are arranged in the flat knitting machine, and the widening stitch is formed on the inner side from the end in the knitting width direction of the knitted fabric by performing a double system knitting using the two yarn feeders.

5. The method of forming the widening stitch according to claim 4, wherein the widening stitch is formed while

knitting a tubular knitted fabric.

6. The method of forming the widening stitch according to claim 5, wherein a boundary wale which serves as a boundary of a front knitted fabric part and a back knitted fabric part is formed, and the boundary wale is formed by continuously forming stitches by twisting the stitches and winding a knitting yarn different from the knitting yarn forming the twisted stitch on the twisted stitch. 5 10
7. A knitted fabric formed with a widening stitch on an inner side from an end in a knitting width direction of the knitted fabric with a flat knitting machine having at least a pair of front and back needle beds, at least either of which is capable of being racked in a transverse direction so that stitches can be transferred between the front and back needle beds, the knitted fabric comprising: 15 20
- a widening stitch formed by transferring a stitch already held on a knitting needle on which a widening stitch is to be formed to the opposing needle bed to make the knitting needle on which the widening stitch is to be formed empty and hooking a knitting yarn on the knitting needle; and 25
- a stitch hidden between the widening stitch and a stitch adjacent to the widening stitch, and transferred to said opposing needle bed, a new stitch being formed on the hidden stitch. 30
8. The knitted fabric formed with the widening stitch on the inner side from the end in the knitting width direction of the knitted fabric according to claim 7, wherein the knitted fabric formed with the widening stitch on the inner side from the end in the knitting width direction of the knitted fabric is a tubular knitted fabric. 35 40 45 50 55

Fig. 1

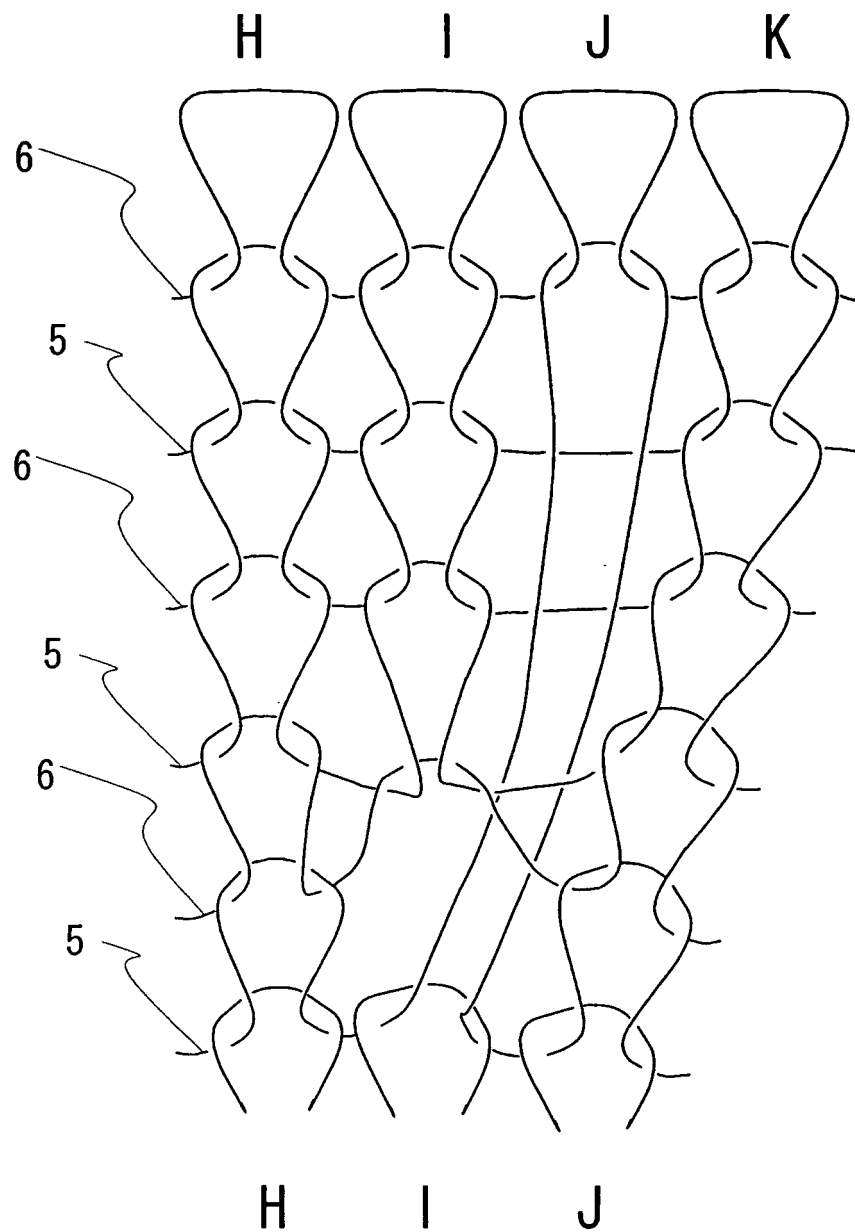


Fig. 2

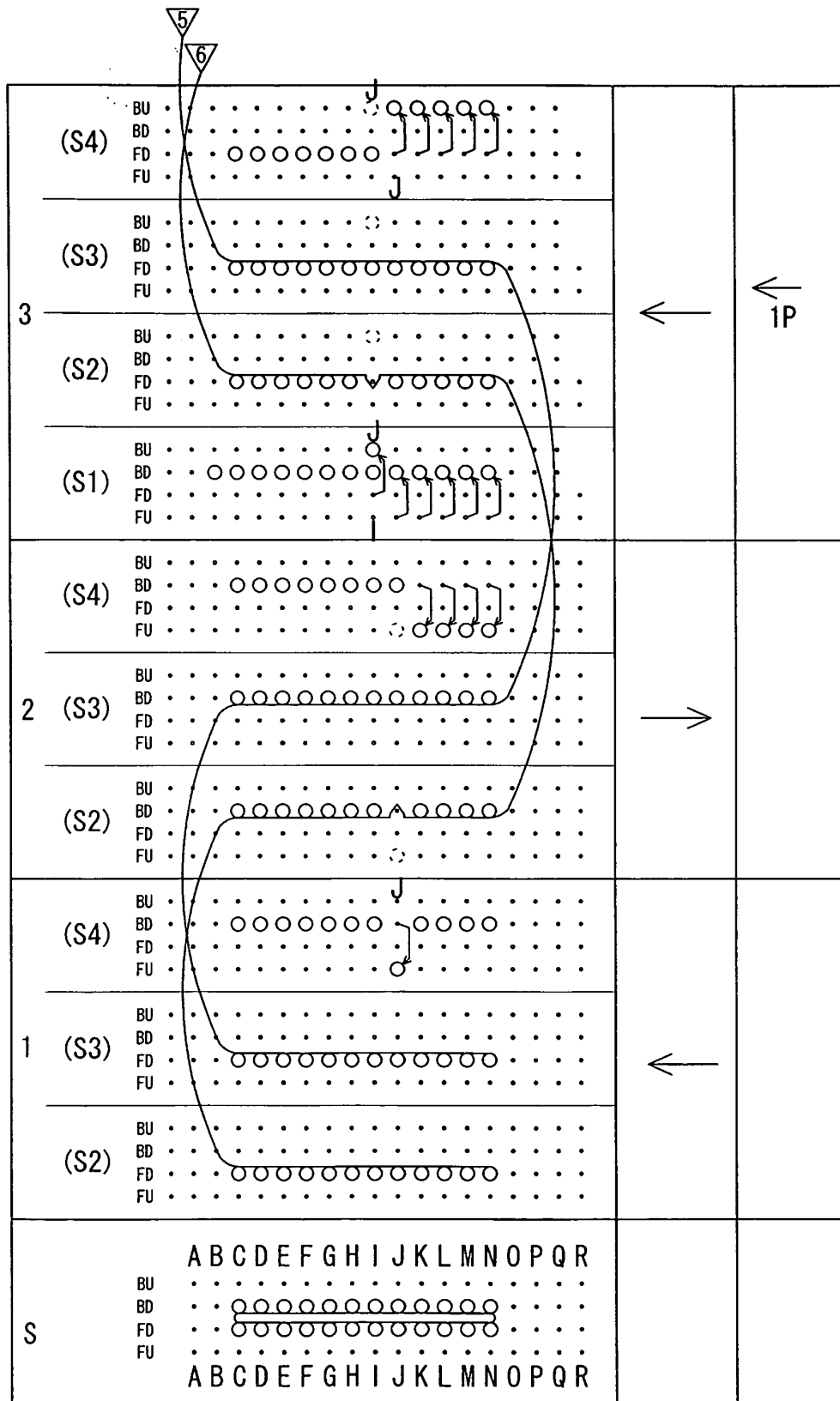


Fig. 3

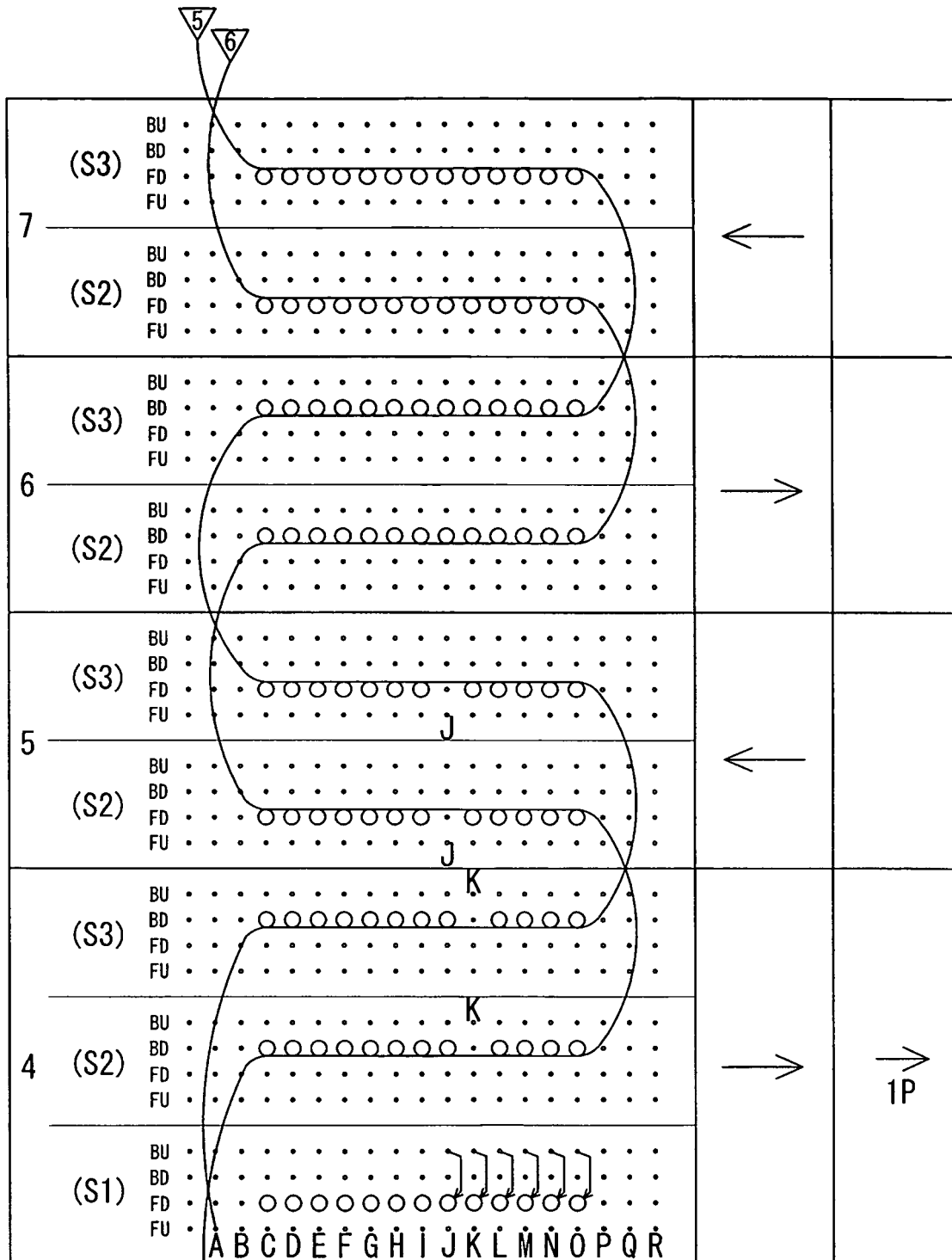


Fig. 4

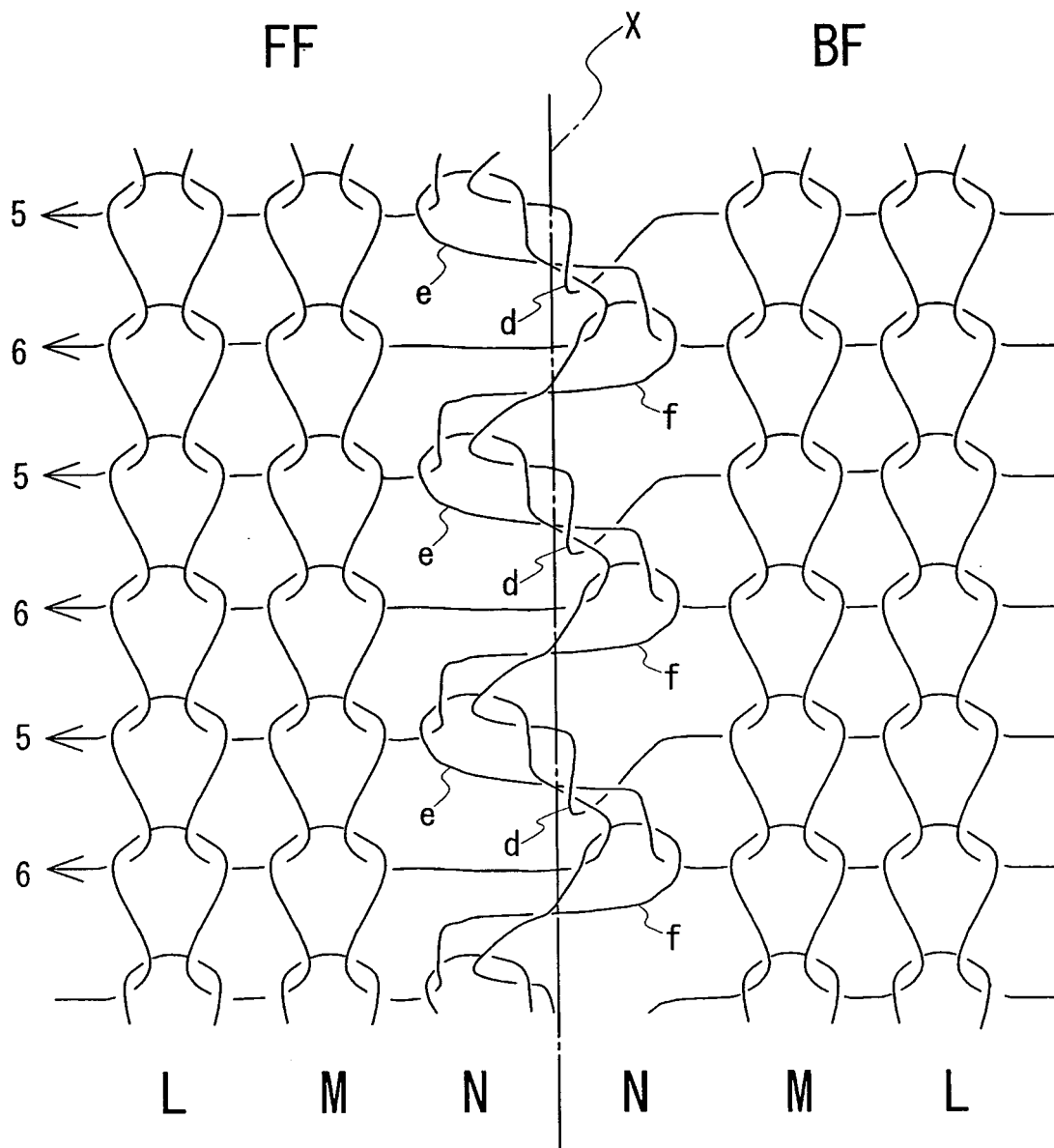


Fig. 5

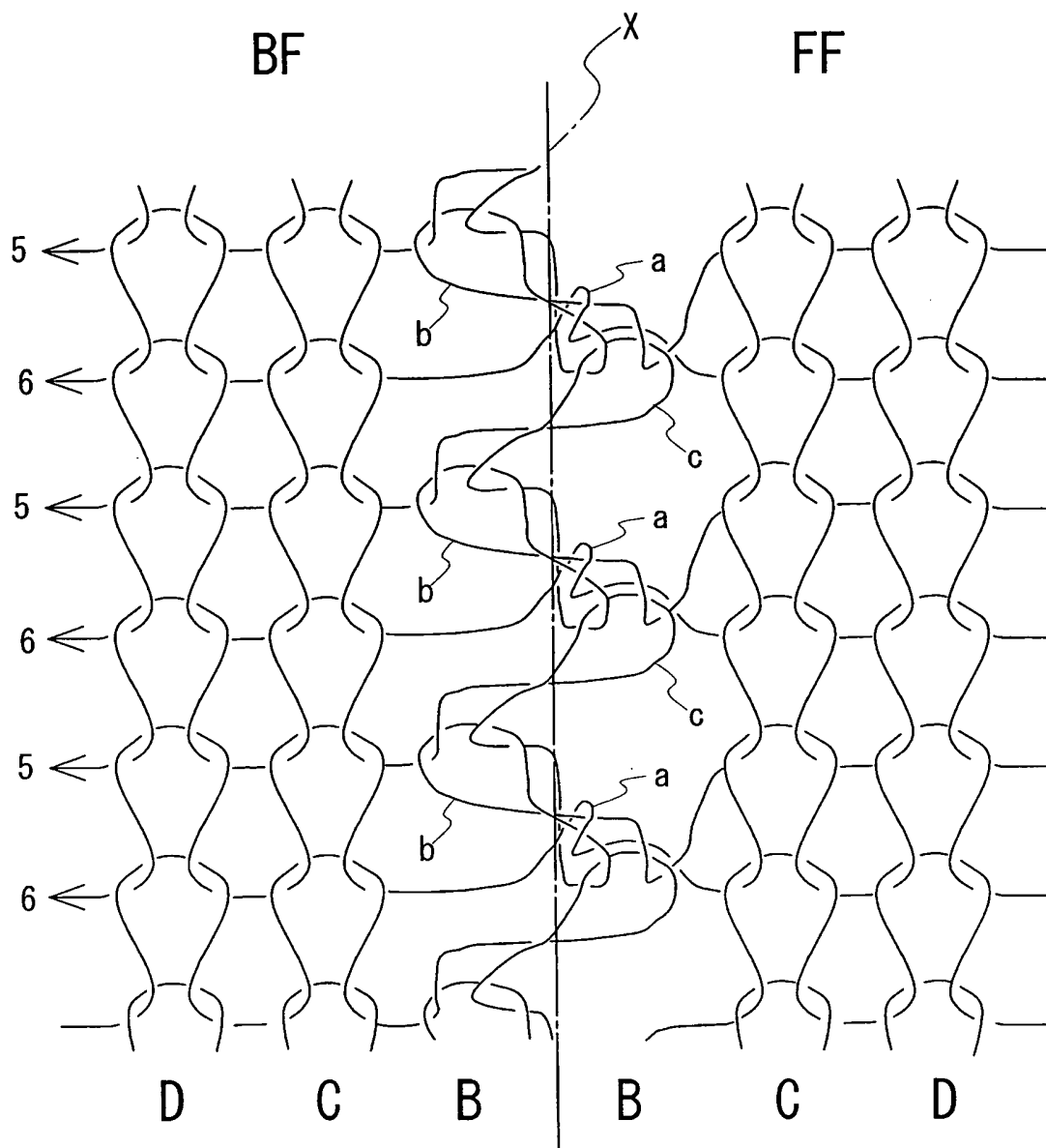


Fig. 6

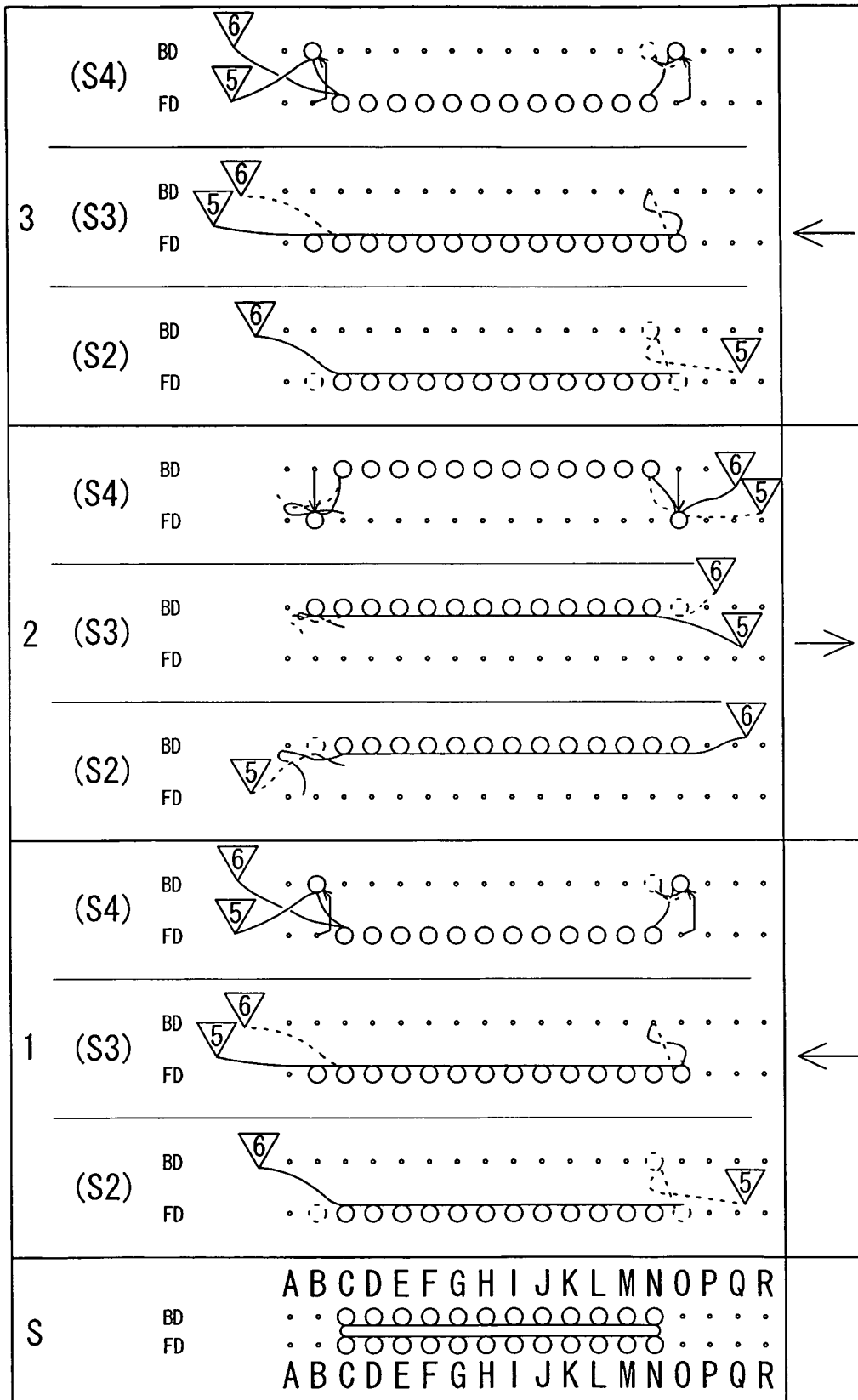


Fig. 7

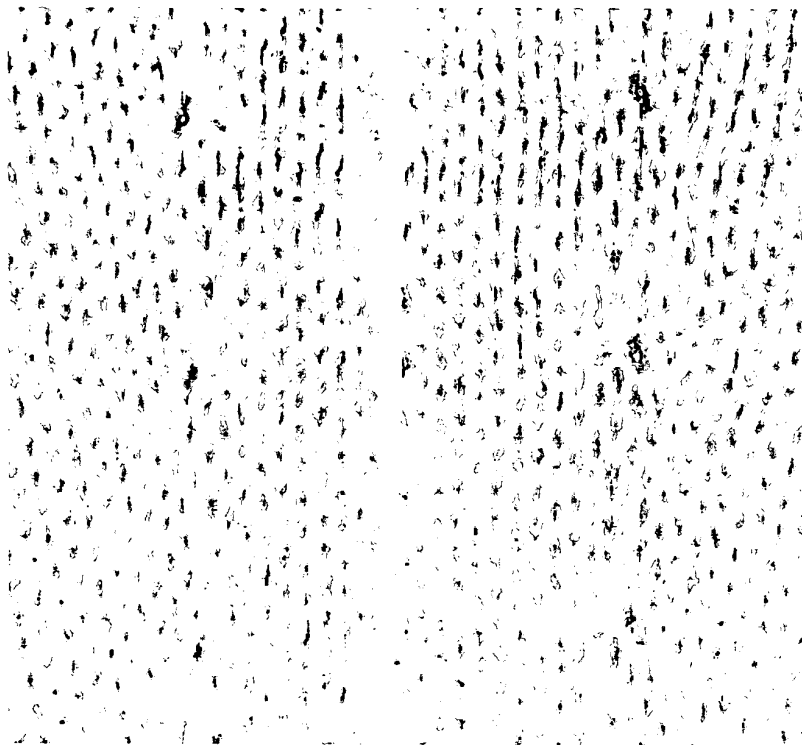


Fig. 8

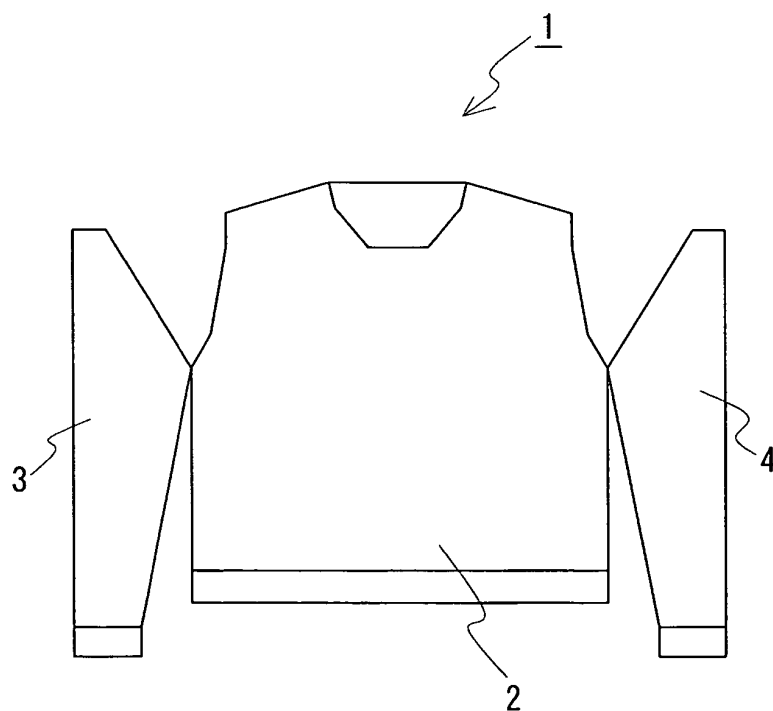


Fig. 9

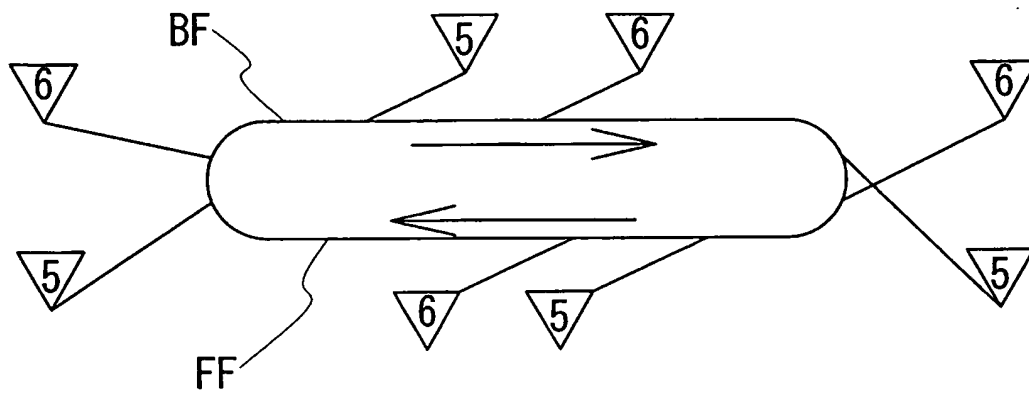
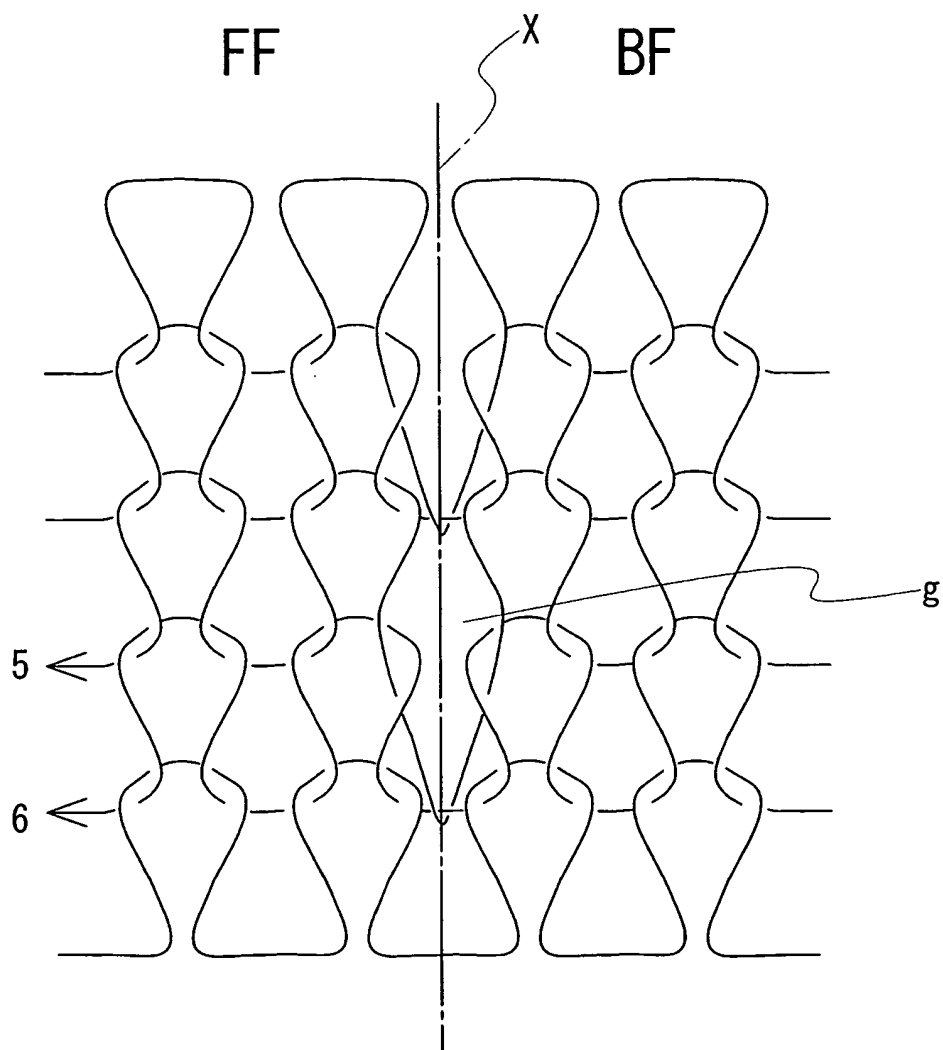


Fig. 10



## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2007/000137

## A. CLASSIFICATION OF SUBJECT MATTER

D04B7/10(2006.01)i, D04B1/22(2006.01)i, D04B7/00(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

D04B1/00-1/28, 7/00-7/34

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2007

Kokai Jitsuyo Shinan Koho 1971-2007 Toroku Jitsuyo Shinan Koho 1994-2007

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                      | Relevant to claim No. |
|-----------|-------------------------------------------------------------------------------------------------------------------------|-----------------------|
| A         | JP 3121283 B2 (Shima Seiki Mfg., Ltd.),<br>25 December, 2000 (25.12.00),<br>& US 6021650 A1 & EP 867547 A2              | 1-8                   |
| A         | JP 62-52063 B2 (Kabushiki Kaisha Shima Idea<br>Center),<br>04 November, 1987 (04.11.87),<br>(Family: none)              | 1-8                   |
| A         | JP 3292836 B2 (Shima Seiki Mfg., Ltd.),<br>17 June, 2002 (17.06.02),<br>& US 6125661 A1 & EP 955401 A2<br>& TW 499520 B | 1-8                   |
| A         | JP 2000-303327 A (Tsudakoma Corp.),<br>31 October, 2000 (31.10.00),<br>(Family: none)                                   | 1-8                   |



Further documents are listed in the continuation of Box C.



See patent family annex.

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"&amp;" document member of the same patent family

Date of the actual completion of the international search  
22 March, 2007 (22.03.07)Date of mailing of the international search report  
03 April, 2007 (03.04.07)Name and mailing address of the ISA/  
Japanese Patent Office

Authorized officer

Facsimile No.

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**REFERENCES CITED IN THE DESCRIPTION**

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**Patent documents cited in the description**

- JP 3121283 B [0007]
- JP 62052063 A [0007]