



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
08.04.2015 Bulletin 2015/15

(51) Int Cl.:
D04B 1/12 (2006.01) D04B 37/02 (2006.01)

(21) Application number: **14183157.8**

(22) Date of filing: **02.09.2014**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

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(30) Priority: **17.09.2013 JP 2013191349**
12.06.2014 JP 2014121204

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(54) **Knitted fabric with reduced cracks, knitting method therefor, and design system using the knitting method**

(57) A knitting method for knitting, by a double knit electric jacquard circular knitting machine with needle selection on dial and cylinder, a knitted fabric in which a pattern on a front face of the knitted fabric is knitted by using one of a cylinder and a dial, boundaries between motifs of the pattern in a wale direction being continuous at the same position in the wale direction in a plurality of successive courses, and a pattern on a back face of the

knitted fabric is knitted by using the other of the cylinder and the dial. The knitted fabric is knitted such that knit structures adjacent, on the back face of the knitted fabric, to a border line in the wale direction are successively knitted. The borderline is formed by the boundary between the motifs on the front face of the knitted fabric in at least one course of the number of successive courses.

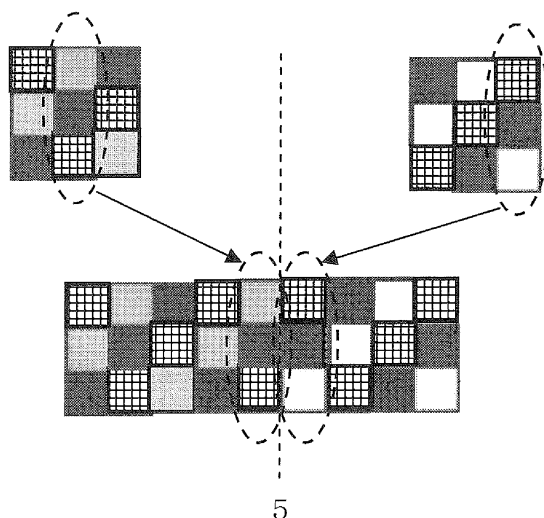


Fig. 13

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a knitted fabric with reduced cracks, a knitting method therefor, and a design system using the knitting method.

2. Description of Related Art

[0002] Conventionally, knitted fabrics in which a space is formed between the front and back faces thereof have been knitted by a double knit circular knitting machine with needle selection on dial and cylinder. In addition to quilted knit fabrics in which inner cotton is interposed between the front and back faces thereof, there have been produced in recent years knitted fabrics in which a plain knitted structure is used in one of the front and back faces of a double knitted fabric, such as blister, ripple, tubular welt, or the like.

[0003] At the production sites of knitted fabrics, the above-described knitted fabrics have experienced "cracks" in which the space between motifs on the front face of the knitted fabric is expanded, and this has led to a significant reduction in the knitted fabric quality.

[0004] In quilt knitting, for example, when a double knit circular knitting machine with needle selection on dial and cylinder is used to perform doubled-faced jacquard knitting and the pattern on the front face of a knitted fabric is knitted by a cylinder and the pattern on the back face of the knitted fabric is knit by a dial, the pattern may be knitted on the dial side so that a yarn that is not used for knitting on the cylinder side will not remain in excess on the dial side. At this time, when several types of yarns are used and a motif having a certain amount of area is alternately and repeatedly knitted on the cylinder side for each yarn, the knitted fabric moves away in the opposite wale direction at the boundary between the motifs on the cylinder side, resulting in the problem of cracks. This problem occurs as a result of cracks becoming prominent at the boundaries between the motifs in the wale direction when the boundaries are continuous at the same position in the wale direction in a plurality of successive courses. This has led to the problem that the inner cotton of a quilted knitted fabric becomes visible or extrudes from the fabric, or the like, resulting in a significant reduction in the quality of knitted fabrics, (see e.g., JP-2008-297657A and JP-H11-158758A).

SUMMARY OF THE INVENTION

[0005] It is an object of the present invention to provide a knitting method for knitting a knitted fabric having a pattern in which boundaries between motifs in the wale direction are continuous at the same position in the wale direction in a plurality of successive courses, without al-

tering the pattern on the front face of the knitted fabric, while reducing cracks, and to provide such knitted fabric.

[0006] A method according to an aspect the present invention is a knitting method for knitting, by a double knit electric jacquard circular knitting machine with needle selection on dial and cylinder, a knitted fabric in which a pattern on a front face of the knitted fabric is knitted by using one of a cylinder and a dial, boundaries between motifs of the pattern in a wale direction being continuous at the same position in the wale direction in a plurality of successive courses, and a pattern on a back face of the knitted fabric is knitted by using the other of the cylinder and the dial, wherein the knitted fabric is knitted such that knit structures adjacent, on the back face of the knitted fabric, to a border line in the wale direction that is formed by the boundary between the motifs on the front face of the knitted fabric in at least one course of the number of successive courses that is fewer by one than the number of types of jacquard knitting yarns used are successively knitted (Claim 1).

[0007] A knitted fabric according an aspect to the present invention is a knitted fabric knitted by a double knit electric jacquard circular knitting machine with needle selection on dial and cylinder, in which a pattern on a front face of the knitted fabric is knitted by using one of a cylinder and a dial, boundaries between motifs of the pattern in a wale direction being continuous at the same position in the wale direction in a plurality of successive courses, and a pattern on a back face of the knitted fabric is knitted by using the other of the cylinder and the dial, wherein the knitted fabric is knitted such that knit structures adjacent, on the back face of the knitted fabric, to a border line in the wale direction that is formed by the boundary between the motifs on the front face of the knitted fabric in at least one course of the number of successive courses that is fewer by one than the number of types of jacquard knitting yarns used are successively knitted (Claim 7).

[0008] In the above-described aspects of the present invention, a portion on the back face of the knitted fabric may include a repetition of a basic pattern, the portion corresponding to the motifs on the front face of the knitted fabric (Claims 2, 8).

[0009] Preferably, the knitted fabric is a quilted knit fabric (Claims 3, 9).

[0010] The pattern on the front face of the knitted fabric can be, for example, a jacquard pattern in which a plurality of plain motifs are combined, the motifs having a certain area and being created with one of a plurality of types of yarns, and the pattern on the back face of the knitted fabric can be an unusual bird's-eye pattern in which the yarns other than the yarn used for the front face of the knitted fabric are alternately knitted and welted for every course and every wale (Claims 4, 10).

[0011] The basic pattern is preferably composed of a plurality of wales and a plurality of courses (Claims 5, 11), preferably 2 wales $\times$ 2 courses, or 3 wales $\times$ 3 courses (Claims 6, 12).

[0012] Furthermore, a design system according to an aspect of the present invention automatically creates the patterns in the knitting method according to the above-described aspects of the present invention (Claim 13). It is preferable that the design system automatically creates a pattern on the back face of the knitted fabric by creating a pattern on the front face of knitted fabric, the pattern on the back face of the knitted fabric corresponding to the pattern on the front face of the knitted fabric (Claim 14).

[0013] According to the present invention, in a pattern in which the boundaries between motifs in the wale direction are continuous at the same position in the wale direction in a plurality of successive courses, knit structures that are successively knitted with the boundary interposed therebetween are always present in one every several courses. Accordingly, it is possible to obtain a knitted fabric with reduced cracks, without altering the pattern on the front face of the knitted fabric. Furthermore, by setting the basic pattern so as to achieve this effect, it is possible to provide the above-described successively knitted structures by forming the pattern only by the basic pattern. Thus, it is possible to save the time and effort needed to create the pattern so as to form the knit structures around the boundary as the successively knitted knit structures, which are different from the pattern.

[0014] Moreover, with the use of the design system according to the present invention, it is possible, by inputting a pattern on the front face of knitted fabric, to automatically create a pattern on the back face of the knitted fabric with a consideration given to the successively knitted knit structures. Accordingly, the time required to create the pattern can be further shortened.

[0015] A knitted fabric in which cracks have occurred (a conventional knitted fabric) and a normal knitted fabric (a knitted fabric according to the present invention) are shown in (1) and (2), respectively, of FIG. 11. In (1) of FIG. 11, significant cracks have occurred at boundaries between motifs, and inner cotton extrudes. In contrast, in (2) of FIG. 11, substantially no inner cotton is seen, and the front face of the knitted fabric is maintained in a neat condition. Note that the knitted fabrics shown in (1) and (2) of FIG. 11 are knitted by using a red yarn and a blue yarn for the front face of the knitted fabric, without using a white yarn, in order to facilitate recognition of the state of the inner cotton caused by cracks. However, the present invention is not limited thereto.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016]

FIG. 1 shows a feeder configuration of Embodiment 1.

FIG. 2 is a diagram showing knit structures at boundaries between motifs according to a conventional example, under the same conditions as those in Embodiment 1.

FIG. 3 is a diagram showing knit structures at the boundary between motifs according to Embodiment 1.

FIG. 4 shows a cylinder pattern of Embodiment 1.

FIG. 5 shows a conventional dial pattern.

FIG. 6 shows a dial pattern of Embodiment 1.

FIG. 7 shows dial basic patterns of Embodiment 1.

FIG. 8 shows all combinations of the dial basic patterns at the boundary between the motifs according to Embodiment 1.

FIG. 9 shows dial basic patterns of Embodiment 2.

FIG. 10 shows all combinations of the dial basic patterns at the boundary between motifs according to Embodiment 2.

FIG. 11 shows: (1) a photograph of a knitted fabric with significant cracks (a conventional knitted fabric); and (2) a photograph of a normal knitted fabric (a knitted fabric according to the present invention).

FIG. 12 shows dial basic patterns of Embodiment 3.

FIG. 13 shows one of combinations of the dial basic patterns at the boundary between motifs according to Embodiment 3.

DETAILED DESCRIPTION OF THE INVENTION

Embodiment 1

[0017] In the production of a knitted fabric described in the following, a double knit circular knitting machine with needle selection on dial and cylinder (model: V-LEC6DSIB, 38-inch, 20-gauge) manufactured by Precision Fukuhara Works, Ltd. was used.

[0018] As shown in FIG. 1, a three-color jacquard pattern was knitted by rib knitting using a six-feeder configuration in which three feeders are used to knit one course. Three types of yarns, namely, a white yarn 2, a blue yarn 3, and a red yarn 4 made of a polyester processed yarn of 167 decitexes/48 filaments were used, and two strings of a polyester processed yarn of 330 decitexes 2 were inserted as an inlay yarn (inner cotton) 1.

[0019] A cylinder pattern that will constitute the pattern on the front face of the knitted fabric is a jacquard pattern in which a plurality of plain motifs are combined, the motifs having a certain area and being created with one of the plurality of types of yarns, and a dial pattern that will constitute the pattern on the back face of the knitted fabric is an unusual bird's-eye pattern in which the yarns other than the yarn used for the cylinder pattern are alternately knitted and welted for every course and every wale.

[0020] FIG. 2 shows a conventional example in which the dial pattern is a conventional bird's-eye pattern. The knit structures on the dial are shown on the upper side, and the knit structures on the cylinder are shown on the lower side. The yarn that has been knitted with the cylinder needle until the motif in the cylinder pattern changed is transferred from the cylinder needle to the dial needle, and at the same time, the yarn that is to be knitted with the cylinder needle after the motif has changed is trans-

ferred from the dial needle to the cylinder needle.

[0021] At this time, the yarns fed from a first feeder (F1), a second feeder (F2), a fourth feeder (F4), and a fifth feeder (F5) are transferred from the cylinder needle to the dial needle, or from the dial needle to the cylinder needle at the same position. This results in boundaries between motifs, and thereby, a border line 5 is formed. At this time, as indicated by the arrows in FIG. 2, in a third feeder (F3) and a sixth feeder (F6), the knit structures that are adjacent to the border line 5 on the dial side are formed by a knit and a welt, and an interval corresponding to one needle stitch is formed between the knits in each of these feeders. As a result, a space is created, and thus significant cracks tend to occur.

[0022] With the knitting method of FIG. 3, which shows the dial pattern according to Embodiment 1 of the present invention, the yarns fed from a first feeder (F1), a second feeder (F2), a fourth feeder (F4), and a fifth feeder (F5) are also transferred from the cylinder needle to the dial needle, or from the dial needle to the cylinder needle at the same position, and boundaries between motifs are created. However, as indicated by the dashed circle, the knit structures that are adjacent to a border line 5 formed by the boundary between motifs are successively knitted in a third feeder (F3), and the space is thus narrowed, making it possible to reduce cracks.

[0023] FIG. 4 shows a cylinder pattern, FIG. 5 shows a conventional dial pattern, and FIG. 6 shows a dial pattern according to Embodiment 1 of the present invention. In these drawings, one knit structure is present in one box, in which a yarn of the displayed color is knitted and yarns of other colors are welted. For the sake of convenience, all of FIGS. 4, 5, and 6 are diagrams of the knitted fabrics as viewed from the outside of the knitting machine.

[0024] As shown in FIG. 5, the conventional dial pattern is formed by the yarns other than the yarn used for the cylinder pattern, and each of the yarns are set to be alternately knitted and welted. However, the most of the knit structures adjacent, on the back face of the knitted fabric, to all border lines formed by the boundaries between motifs on the front face of the knitted fabric in the wale direction are knitted with yarns of different colors. Thus, a space is created, and significant cracks tend to occur.

[0025] On the other hand, in the case of the dial pattern according to Embodiment 1 of the present invention, as shown in FIG. 6, the knit structures that are adjacent, on the back face of the knitted fabric, to all border lines formed by boundaries between the motifs of the cylinder pattern in the wale direction, the same yarns are always successively knitted for one of two successive courses. Thus, not so much space is created, and cracks are reduced.

[0026] FIG. 7 shows dial basic patterns of Embodiment 1 of the present invention. The portion of the dial pattern that corresponds to the motifs of the cylinder pattern is formed by a repetition of the basic patterns. In the dial pattern according to Embodiment 1 of the present inven-

tion, (a) shows a dial basic pattern corresponding to a portion of the motif for which the white yarn is used in the cylinder pattern, (b) shows a dial basic pattern corresponding to a portion of the motif for which the blue yarn is used in the cylinder pattern, and (c) shows a dial basic pattern corresponding to a portion of the motif for which the red yarn is used in the cylinder pattern. As shown in FIG. 8, a setting is made such that structures that are successively knitted in the wale direction are always provided when any of the dial basic patterns shown in (a), (b), and (c) is changed to any different one of the dial basic patterns. Accordingly, the space of the boundary between motifs is narrowed, and cracks are reduced.

[0027] To create the patterns according to the present embodiment, a design system is used in which the dial pattern is automatically created by creating the cylinder pattern. With the design system, the yarn used for a motif of the cylinder pattern determines the dial pattern of a portion corresponding to the motif, and therefore this is performed automatically. The use of the design system can shorten the time required to create a knitted fabric pattern that reduces cracks.

Embodiment 2

[0028] FIG. 9 shows dial basic patterns of Embodiment 2 used for knitting a knitted fabric of a four-color jacquard pattern created by a twelve-feeder repeating configuration in which four feeders are used to knit one course.

(a) shows a dial basic pattern corresponding to a portion of a motif for which a white yarn is used in the cylinder pattern, (b) shows a dial basic pattern corresponding to a portion of the motif for which a blue yarn is used in the cylinder pattern, (c) shows a dial basic pattern corresponding to a portion of the motif for which a red yarn is used in the cylinder pattern, and (d) shows a dial basic pattern corresponding to a portion of the motif for which a green yarn is used in the cylinder pattern.

[0029] In the case of using yarns of four colors as well, as shown in FIG. 10, it is possible to reduce cracks by making a setting such that knit structures that are adjacent to the boundary of the dial basic pattern are always successively knitted for one of three successive courses when any of the dial basic patterns is changed to a different one of the dial basic patterns.

Embodiment 3

[0030] FIG. 12 shows dial basic patterns of Embodiment 3 used for knitting a knitted fabric of a four-color jacquard pattern by using a twelve-feeder repeating configuration in which four feeders are used to knit one course. As with Embodiment 2, (a) shows a dial basic pattern corresponding to a portion of a motif for which a white yarn is used in the cylinder pattern, (b) shows a dial basic pattern corresponding to a portion of the motif for which a blue yarn is used in the cylinder pattern, (c) shows a dial basic pattern corresponding to a portion of

the motif for which a red yarn is used in the cylinder pattern, (d) shows a dial basic pattern corresponding to a portion of the motif for which a green yarn is used in the cylinder pattern.

[0031] In the case of the basic patterns according to Embodiment 3, as shown in FIG. 13, even if a border line 5 is located in the middle of the basic pattern, the knit structures adjacent to the boundary between the dial basic patterns can be always successively knitted for one of three successive courses by setting the order of wales in the basic pattern before being changed so as to correspond to that in the changed basic pattern, when any of the dial basic patterns is changed to any different one of the dial basic patterns. Note that FIG. 13 shows the case where the motif ends at the second wale from the left of the basic pattern before being changed. Since the third wale from the left was supposed to follow the second wale, the corresponding third wale from the left of the changed basic pattern is located at that position.

[0032] The present invention is not limited to the above-described embodiments. For example, the cylinder pattern and the dial pattern may be interchanged with each other. Any pattern other than the patterns described in the embodiments can be used as long as the knitted fabric is knitted such that knit structures adjacent to a border line that is formed by the boundary between the motifs in at least one course of the number of successive courses that is fewer by one than the number of types of jacquard knitting yarns used are successively knitted. It is also possible to use a pattern in which no basic pattern is used. The basic pattern may have any other configuration as long as at least one course of knit structures adjacent to the boundary with another basic pattern are successively knitted. Although the above embodiments use yarns of several different colors, it is also possible to use yarns that are different in the material or the thickness rather than the color. It is also possible to create the patterns by increasing the number of yarns used to 5 or 6, for example. In addition, the knitted fabric is not limited to a quilted knit fabric, and the present invention is applicable to a knitted fabric in which a space is formed between the front and back faces of the knitted fabric, including, for example, a knitted fabric in which a plain knitted structure is used for one of a double knitted fabric, such as blister, ripple, tubular welt, or the like, without the insertion of inner cotton.

[0033] Furthermore, the design system is not limited to a repetition of basic patterns as described in the embodiments, as long as the design system creates the patterns such that, around the border line between the motifs, knit structures adjacent, on the back face of the knitted fabric, to a border line in the wale direction that is formed by the boundary between the motifs on the front face of the knitted fabric in at least one course of the number of successive courses that is fewer by one than the number of types of jacquard knitting yarns used are successively knitted.

[0034] The invention may be embodied in other forms

without departing from the spirit or essential characteristics thereof. The embodiments disclosed in this application are to be considered in all respects as illustrative and not limiting. The scope of the invention is indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are intended to be embraced therein.

Claims

1. A knitting method for knitting, by a double knit electric jacquard circular knitting machine with needle selection on dial and cylinder, a knitted fabric in which a pattern on a front face of the knitted fabric is knitted by using one of a cylinder and a dial, boundaries between motifs of the pattern in a wale direction being continuous at the same position in the wale direction in a plurality of successive courses, and a pattern on a back face of the knitted fabric is knitted by using the other of the cylinder and the dial, wherein the knitted fabric is knitted such that knit structures adjacent, on the back face of the knitted fabric, to a border line in the wale direction that is formed by the boundary between the motifs on the front face of the knitted fabric in at least one course of the number of successive courses that is fewer by one than the number of types of jacquard knitting yarns used are successively knitted.
2. The knitting method according to claim 1, wherein a portion on the back face of the knitted fabric comprises a repetition of a basic pattern, the portion corresponding to the motifs on the front face of the knitted fabric.
3. The knitting method according to claim 1 or 2, wherein the knitted fabric is a quilted knit fabric.
4. The knitting method according to any one of claims 1 to 3, wherein the pattern on the front face of the knitted fabric is a jacquard pattern in which a plurality of plain motifs are combined, the motifs having a certain area and being created with one of a plurality of types of yarns, and the pattern on the back face of the knitted fabric is an unusual bird's-eye pattern in which the yarns other than the yarn used for the front face of the knitted fabric are alternately knitted and welted for every course and every wale.
5. The knitting method according to any one of claims 2 to 4, wherein the basic pattern is composed of a plurality of wales and a plurality of courses.
6. The knitting method according to any one of claims 2 to 4, wherein the basic pattern is composed of 2

wales $\times$ 2 courses, or 3 wales $\times$ 3 courses.

7. A knitted fabric knitted by a double knit electric jacquard circular knitting machine with needle selection on dial and cylinder, in which a pattern on a front face of the knitted fabric is knitted by using one of a cylinder and a dial, boundaries between motifs of the pattern in a wale direction being continuous at the same position in the wale direction in a plurality of successive courses, and a pattern on a back face of the knitted fabric is knitted by using the other of the cylinder and the dial, wherein the knitted fabric is knitted such that knit structures adjacent, on the back face of the knitted fabric, to a border line in the wale direction that is formed by the boundary between the motifs on the front face of the knitted fabric in at least one course of the number of successive courses that is fewer by one than the number of types of jacquard knitting yarns used are successively knitted.

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8. The knitted fabric according to claim 6, wherein a portion on the back face of the knitted fabric comprises a repetition of a basic pattern, the portion corresponding to the motifs on the front face of the knitted fabric.

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9. The knitted fabric according to claim 6 or 7, wherein the knitted fabric is a quilted knit fabric.

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10. The knitted fabric according to any one of claims 6 to 8, wherein the pattern on the front face of the knitted fabric is a jacquard pattern in which a plurality of plain motifs are combined, the motifs having a certain area and being created with one of a plurality of types of yarns, and the pattern on the back face of the knitted fabric is an unusual bird's-eye pattern in which the yarns other than the yarn used for the front face of the knitted fabric are alternately knitted and welted for every course and every wale.

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11. The knitted fabric according to any one of claims 7 to 9, wherein the basic pattern is composed of a plurality of wales and a plurality of courses.

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12. The knitted fabric according to any one of claims 7 to 9, wherein the basic pattern is composed of 2 wales $\times$ 2 courses, or 3 wales $\times$ 3 courses.

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13. A design system that automatically creates the patterns in the knitting method according to any one of claims 1 to 6.
14. The design system according to claim 13, wherein the design system automatically creates a pattern on the back face of the knitted fabric by creating a pattern on the front face of knitted fabric, the

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pattern on the back face of the knitted fabric corresponding to the pattern on the front face of the knitted fabric.

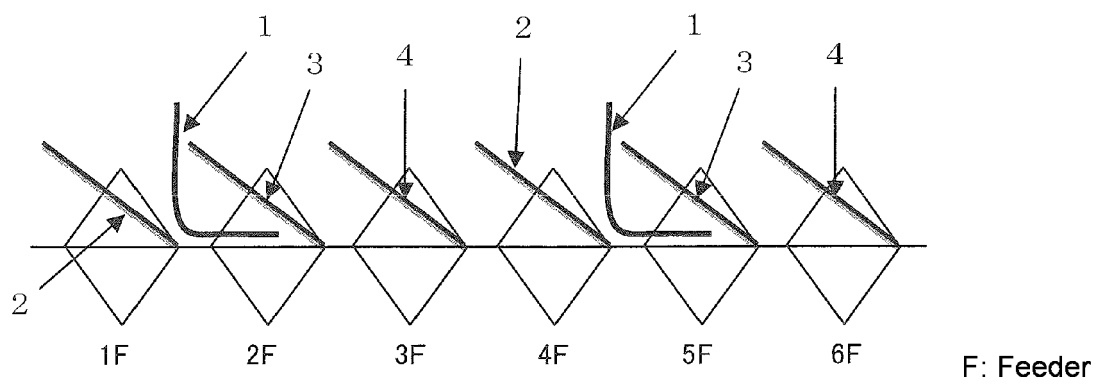


Fig. 1

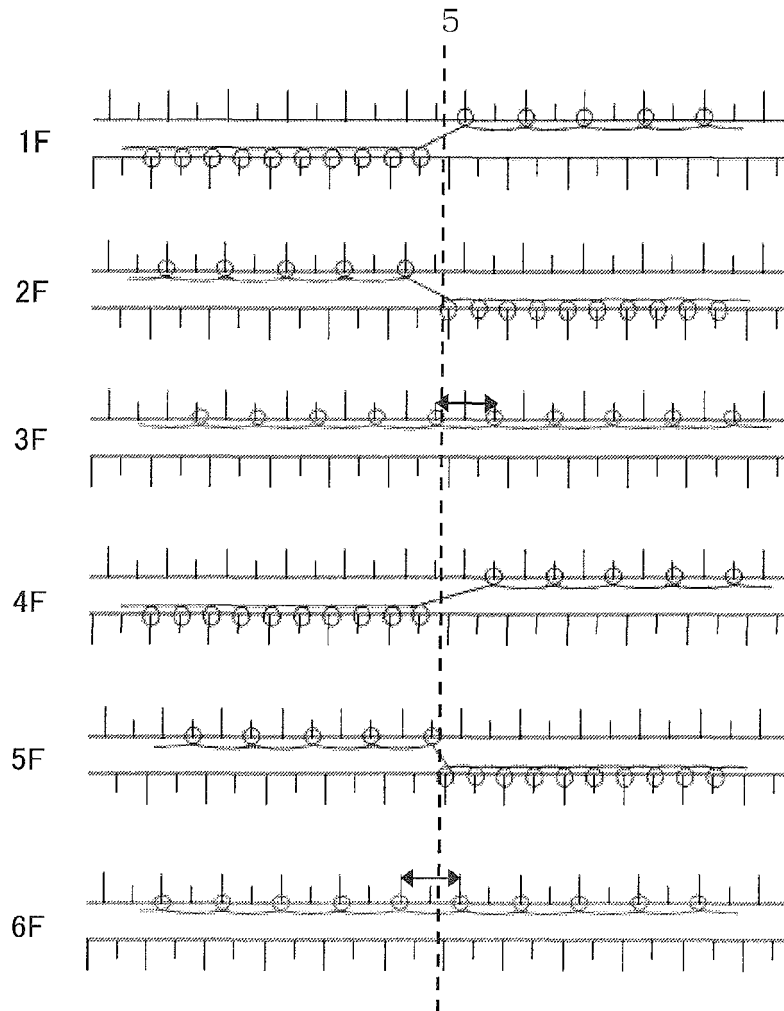


Fig. 2

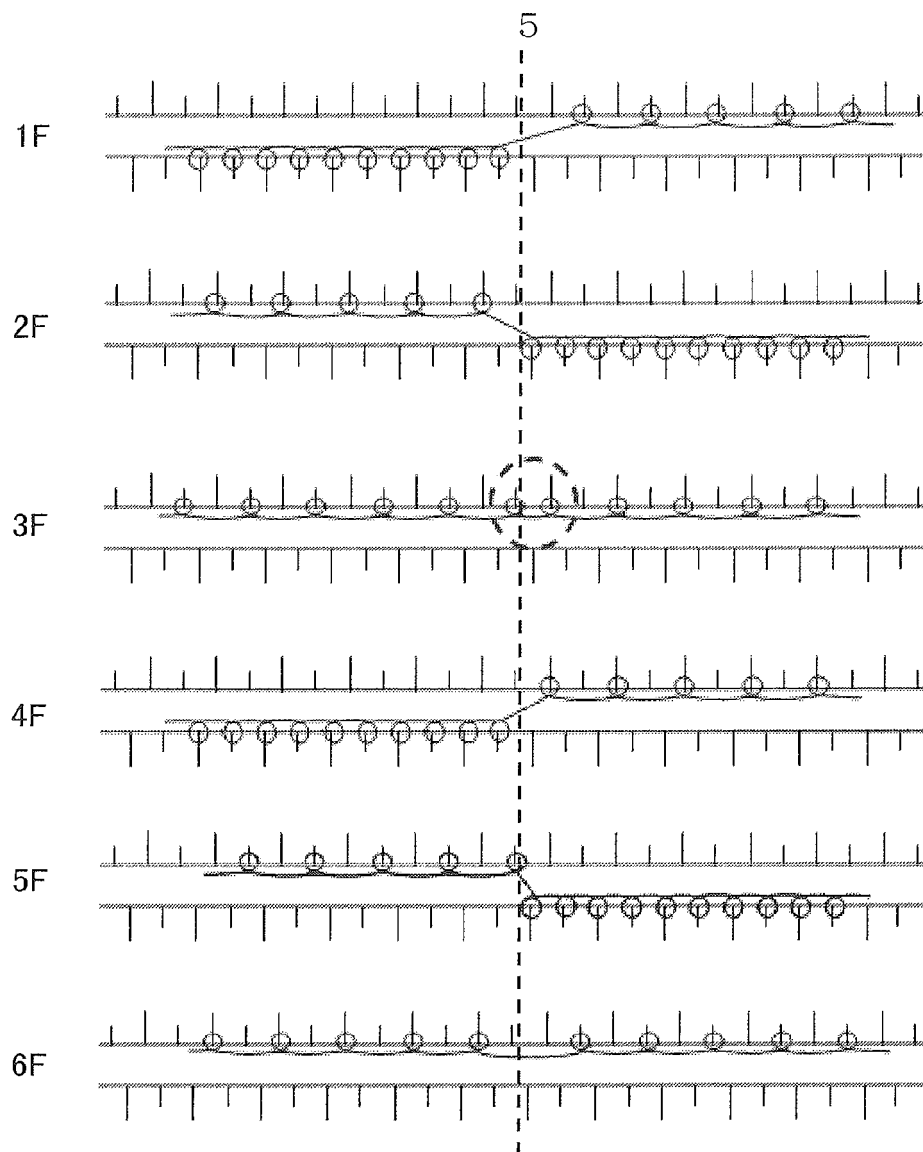


Fig. 3

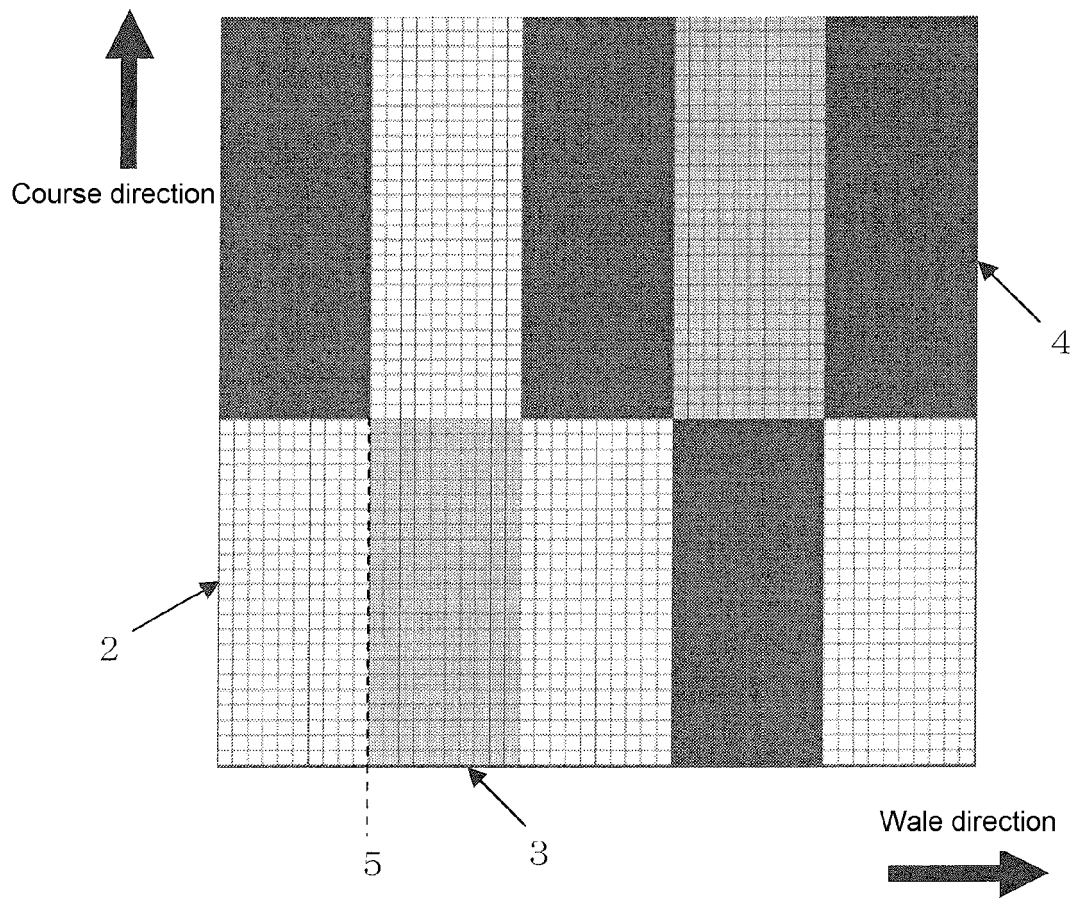


Fig. 4

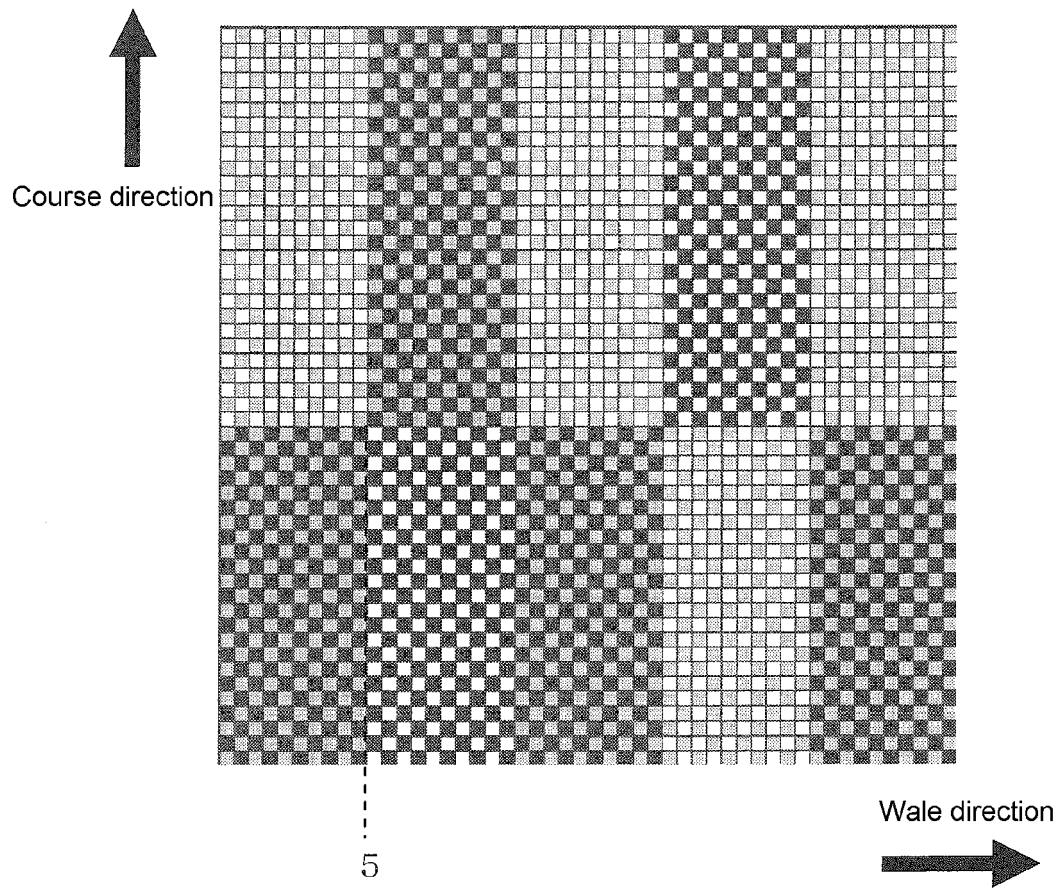


Fig. 5

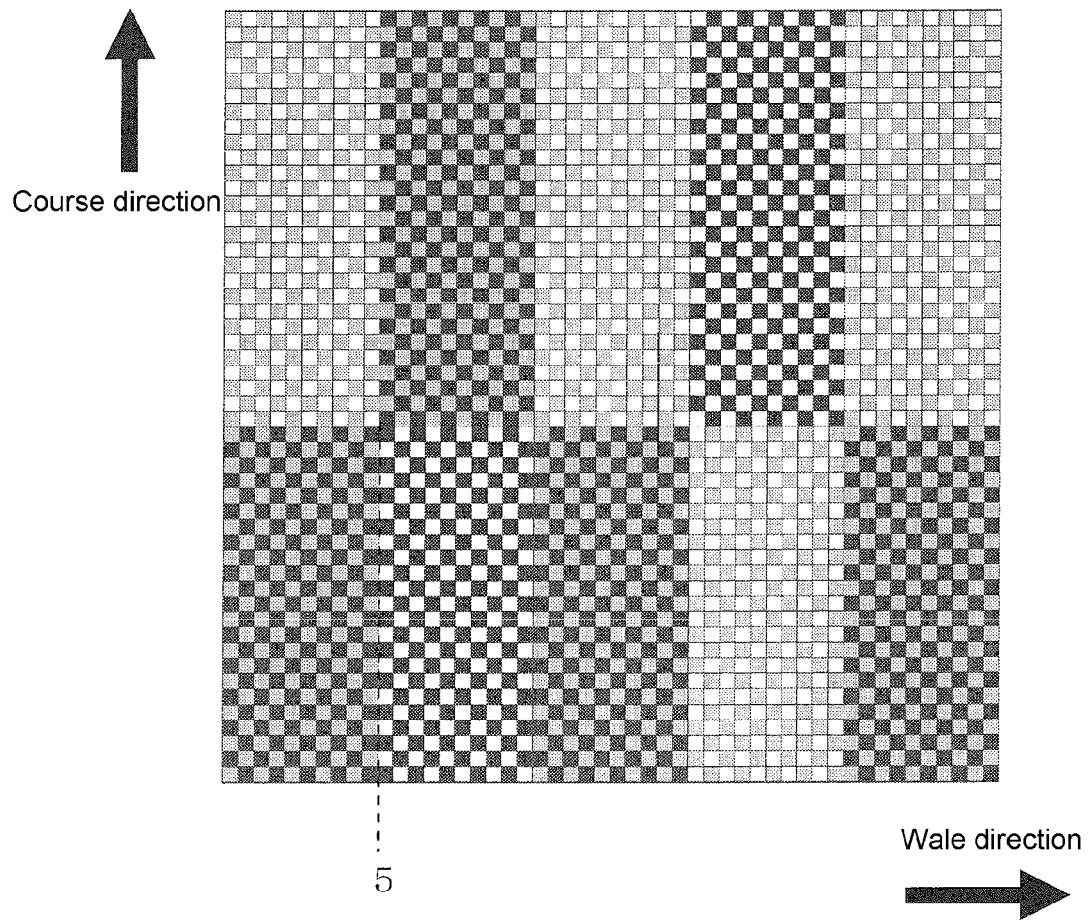


Fig. 6

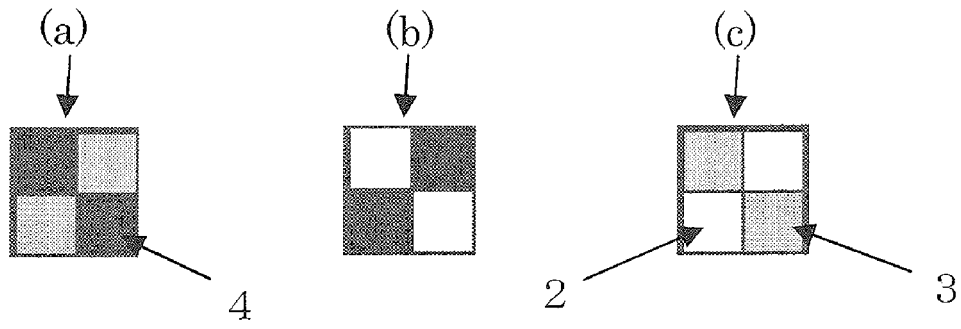


Fig. 7

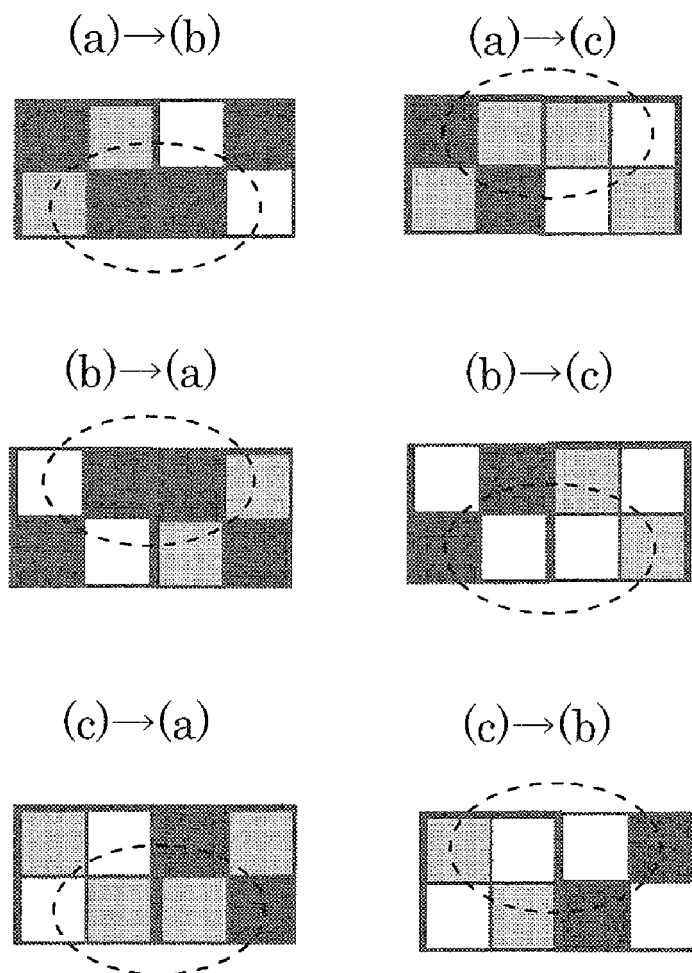


Fig. 8

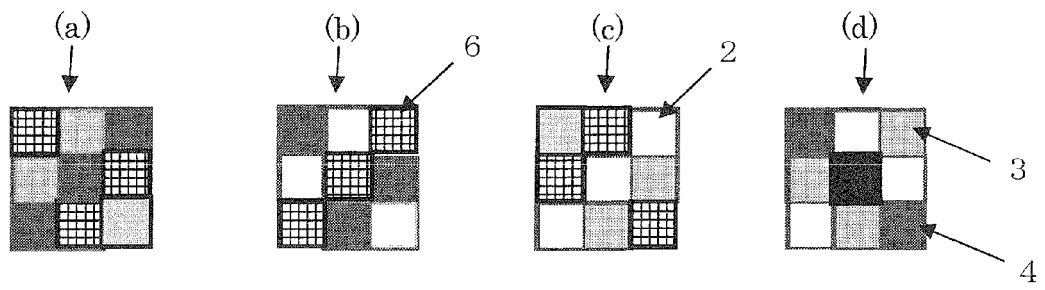


Fig. 9

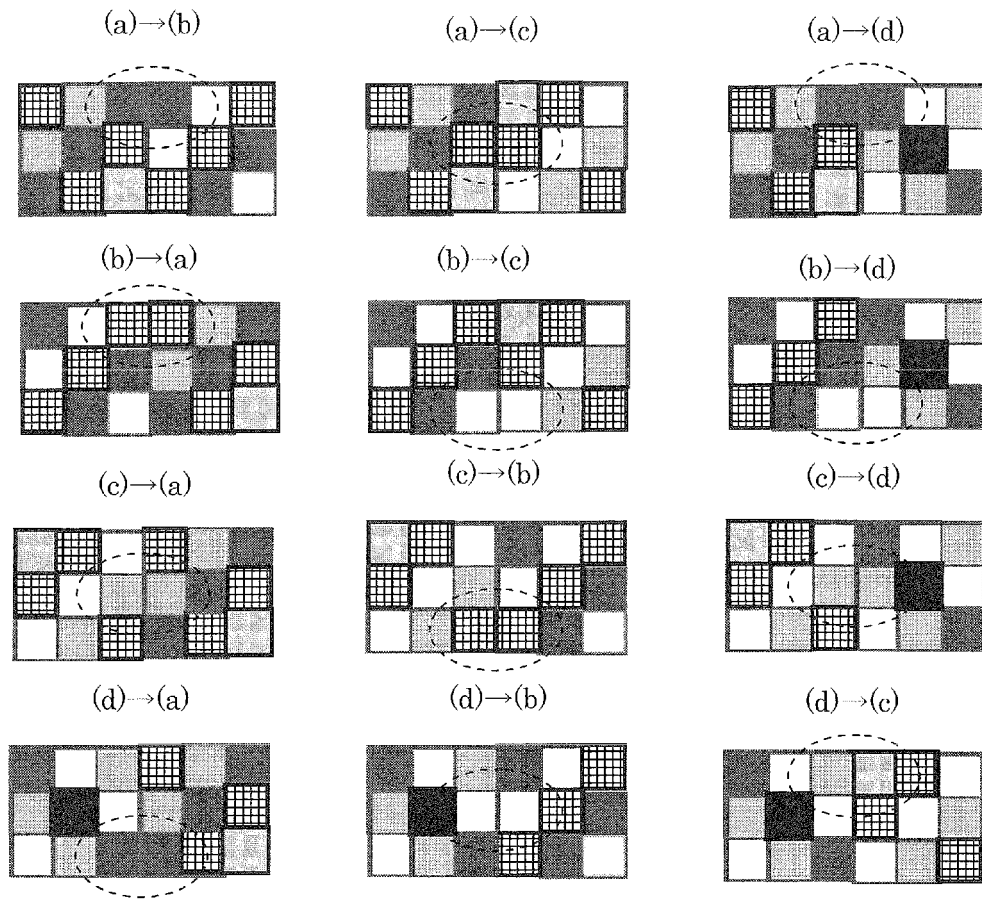


Fig. 10

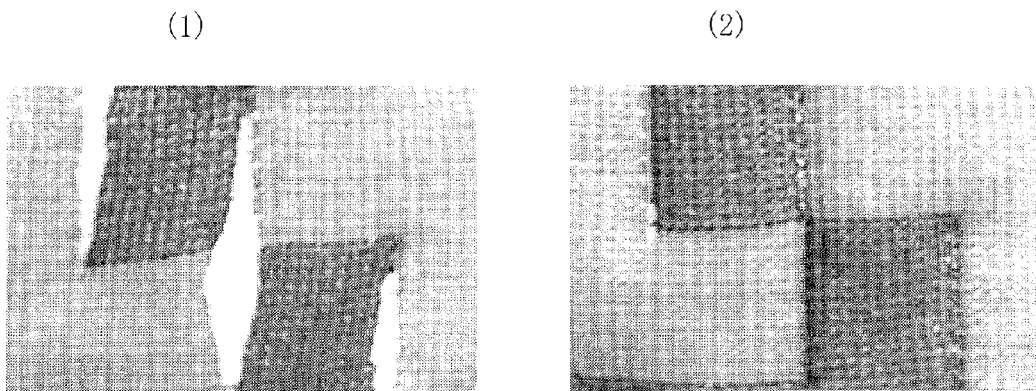


Fig. 11

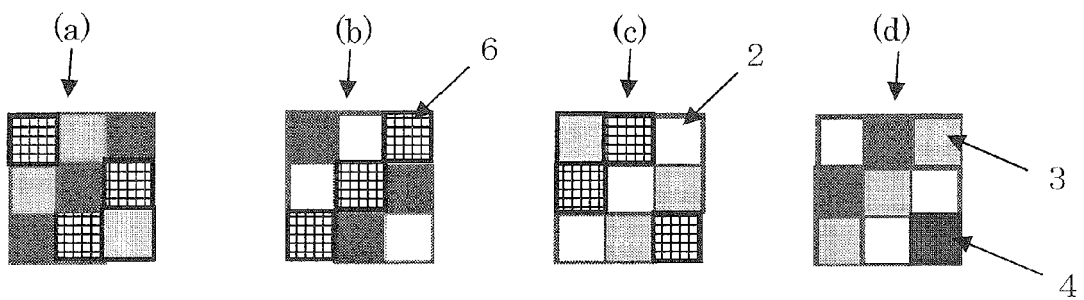


Fig. 12

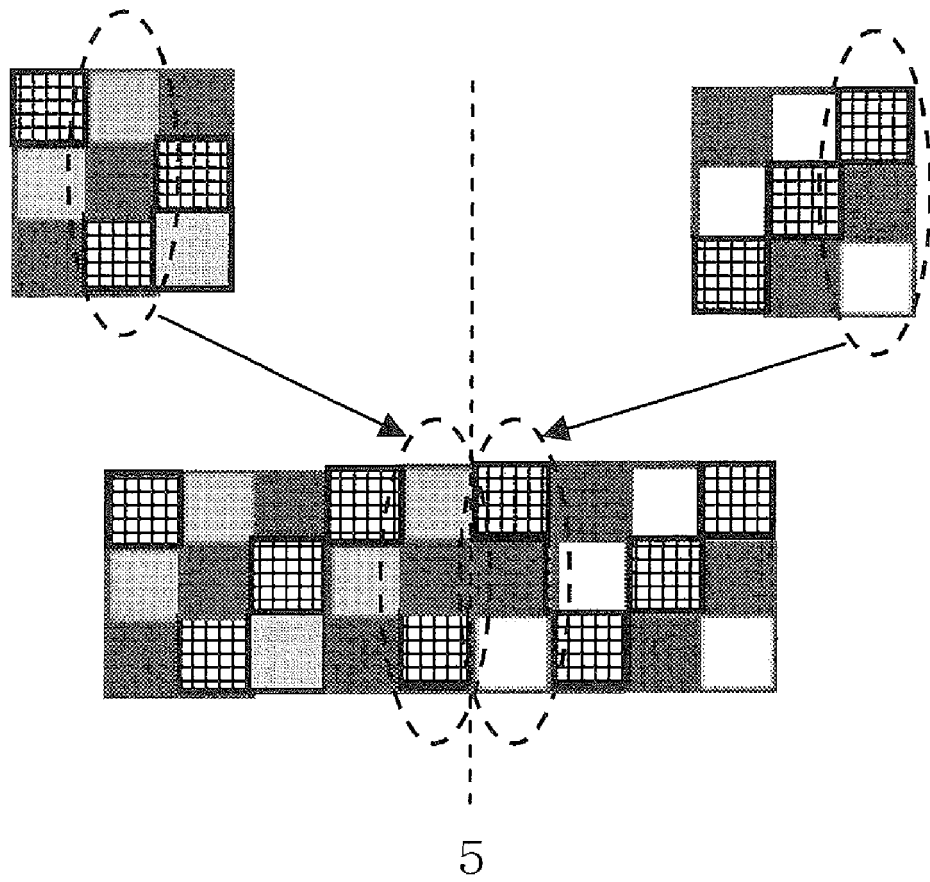


Fig. 13



EUROPEAN SEARCH REPORT

Application Number
EP 14 18 3157

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	EP 2 042 629 A1 (BODET & HORST GMBH & CO KG [DE]) 1 April 2009 (2009-04-01) * paragraphs [0004] - [0010], [0021] - [0023]; claims 1, 4, 10; figures 2, 3 *	1-3,5, 7-9,11, 13	INV. D04B1/12 D04B37/02
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			TECHNICAL FIELDS SEARCHED (IPC)
			D04B
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 26 February 2015	Examiner Sterle, Dieter
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03/82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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26-02-2015

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