(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 292 820 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
09.03.2011 Bulletin 2011/10

(21) Application number: **09773315.8**

(22) Date of filing: **19.06.2009**

(51) Int Cl.:
D04B 35/00 *(2006.01)* ***D04B 15/00*** *(2006.01)*

(86) International application number:
PCT/JP2009/061174

(87) International publication number:
WO 2010/001737 (07.01.2010 Gazette 2010/01)

(84) Designated Contracting States:
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 SE SI SK TR
Designated Extension States:
AL BA RS

(30) Priority: **03.07.2008 JP 2008174547**

(71) Applicant: **Shima Seiki Manufacturing., Ltd.**
Wakayama-shi
Wakayama 641-0003 (JP)

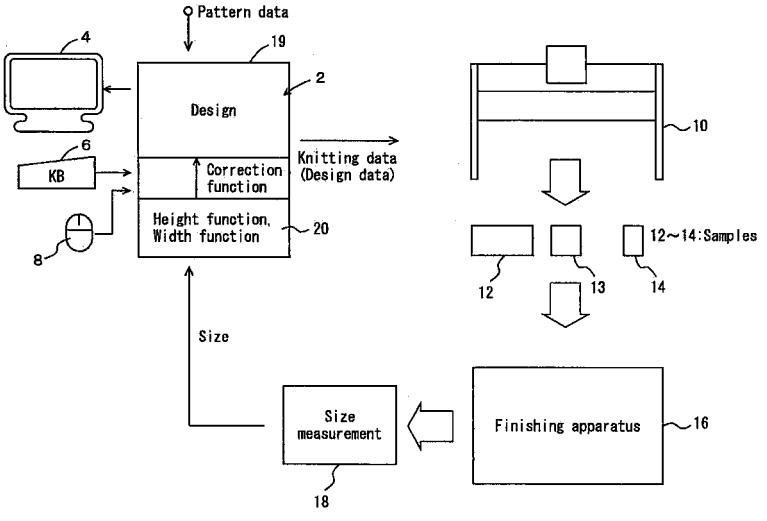
(72) Inventors:
- **SHIMASAKI Yoshinori**
  Wakayama-shi
  Wakayama 641-0003 (JP)
- **YUI Manabu**
  Wakayama-shi
  Wakayama 641-0003 (JP)

(74) Representative: **Wagner, Karl H.**
Wagner & Geyer
Gewürzmühlstrasse 5
80538 Munich (DE)

(54) METHOD, DESIGN SYSTEM AND DESIGN PROGRAM FOR DETERMINING KNITTED ARTICLE GAUGE

(57) In a method for determining the gauge of a knitted article (40) of the present invention, a plurality of samples (12, 13, 14) that are smaller than a knitted article (40) and different in the number of needles are knitted by using a flat knitting machine (10), and the height of each of the samples (12, 13, 14) is measured. A height function for converting the number of needles used for knitting the samples (12, 13, 14) into the size of stitches in a height direction is obtained on the basis of the measured height. Then the number of knitting courses for each part of the knitted article (40) is determined from the obtained height function, a target height and target width of each part of the knitted article (40). Accordingly, the number of knitting courses for a knitted article (40) can be determined easily and reliably.

F I G. 1



EP 2 292 820 A1

Description

[0001] The present invention relates to the determination of the number of stitches for a knitted article. More specifically, the present invention relates to determining the number of stitches in the width direction, in other words, the knitting width or the number of needles, as well as the number of stitches in the height direction, in other words, the number of knitting courses, to produce a knitted article in approximately the target size.

[0002] The applicant of the present invention has proposed a technique for knitting test pieces, or texture samples, that are smaller than an actual knitted article, to determine the gauge of the knitted article (Patent Document 1: JP 2676182). In this specification, the term "gauge" means the number of stitches per width or height of a knitted article, and, "stitches/cm", for example, is used as the unit length thereof. In Patent Document 1, the plurality of texture samples are knitted together under a different knitting condition, to select the optimal texture sample. The knitting width is constant. Then, the number of stitches per width or height of the selected sample is measured to determine the gauges of the knitted fabrics. With the defined gauge, the width and height of the knitted article are specified based on pattern data of the target knitted article. Therefore, the width is multiplied by the gauge in the width direction, to obtain the number of needles. In addition, by multiplying the height by the gauge in the height direction, the number of knitting courses is obtained. These processes can reduce the time required for correcting the gauges while producing the actual knitted article.

[0003] However, the inventors have discovered that the technique of Patent Document 1 alone does not always determine optimal gauges. Without the optimal gauges, the knitted article cannot fit into a predetermined size, and consequently, the number of knitting courses needs to be increased or decreased in accordance with the knitting data after knitting the actual article. Especially when obtaining a sweater by joining tubular knitted fabrics together seamlessly, the sleeves, bodies, and other parts with different knitting widths are knitted simultaneously. For this reason, the knitting widths of the texture samples are significantly different from the knitting widths of these parts, and, consequently, the optimal gauge of each part cannot be established. What was discovered by the inventors is that the gauges of the knitted fabrics in the height direction change depending on the knitting widths, even if the other conditions stay the same. In addition, the gauges of the knitted fabrics in the width direction also change depending on the knitting width, although the impact of the knitting width is small.

[0004] Patent Document 1: JP 2676182

[0005] An object of the present invention is to be able to determine the number of knitting courses, and the number of needles, in other words, the knitting width, in order to produce a knitted article in approximately the target size.

[0006] The present invention is a method for converting pattern data of a knitted article into the number of stitches to be knitted using a flat knitting machine, the method having: a knitting step of knitting a plurality of samples, which are different in the number of needles, by using the flat knitting machine; a measuring step of measuring the size of stitches of each sample in at least a height direction; a step of obtaining a relationship between the number of needles of each sample and the size of the stitches thereof in the height direction; and a stitch number determination step of determining the number of knitting courses for a target height in the pattern data, on the basis of the obtained relationship between the number of needles of each sample and the size of the stitches thereof in the height direction, as well as a target width in the pattern data.

[0007] Moreover, the present invention is a system for converting pattern data of a knitted article into the number of stitches to be knitted using a flat knitting machine, the system having: means for obtaining a relationship between the number of needles and the size of stitches in a height direction of each of a plurality of samples, which are different in the number of needles, on the basis of an input value of the number of needles and an input value of at least the size of the stitches in the height direction; means for storing the obtained relationship; and stitch number determination means for determining the number of knitting courses for a target height in the pattern data, on the basis of the stored relationship and a target width in the pattern data.

[0008] Moreover, the present invention is a program for converting pattern data of a knitted article into the number of stitches to be knitted using a flat knitting machine, the program causing a computer to function as: means for obtaining a relationship between the number of needles and the size of stitches in a height direction of each of a plurality of samples, which are different in the number of needles, on the basis of an input value of the number of needles and an input value of at least the size of the stitches in the height direction; means for storing the obtained relationship; and stitch number determination means for determining the number of knitting courses for a target height in the pattern data, on the basis of the stored relationship and a target width in the pattern data.

[0009] In this specification, the descriptions of the method for determining the number of stitches apply directly to the design system and the design program, and the descriptions of the design system apply directly to the method for determining the number of stitches and the design program.

As shown in Fig. 2, the size of the stitches in the height direction is dependent upon the number of needles, in other words, the knitting width. For this reason, the relationship between the size of the stitches in the height direction and the number of needles (knitting width) can be obtained by knitting the plurality of samples that are different in the number of needles. The pattern data is

used for specifying the target height and target width for each of the parts of the knitted article, and the impact of the number of needles on the size of stitches in the width direction (width size) is smaller than its impact on the size in the height direction (height size). Therefore, the target width is converted into the number of needles by means of an appropriate technique. Subsequently, the number of knitting courses necessary is defined based on the target height for each part of the knitted article and the relationship between the size of the stitches in the height direction and the number of needles. As a result, the impact of the number of needles on the size of the stitches in the height direction can be corrected, and consequently parts in a desired height can be knitted.

[0010] The plurality of samples may be connected to one another by excess yarn. The size of the stitches in the height direction may be obtained by, for example, measuring the number of stitches per predetermined height length or by measuring the total height of a predetermined number of stitches. Since a known method is used as the method for knitting the samples, the design device and the design program may not be involved in creating the knitting data of the samples. The pattern data is used for specifying the shape and size of the knitted article, the size being the height and the width.

[0011] The present invention can correct the impact of the number of needles on the size of the stitches in the height direction and knit a knitted article with a height according to approximate pattern data.

It is preferred that the step of obtaining a relationship obtain the relationship between the number of needles of each sample and the size of the stitches thereof in the height direction, as a height function expressing the dependence of the size of the stitches in the height direction upon the number of needles.

[0012] It is more preferred that the measuring step measure the size of the stitches in the height direction and the size thereof in a width direction in each of the plurality of samples, that the step of obtaining the relationship obtain the height function and a width function expressing the dependence of the size of the stitches in the width direction upon the number of needles, and that the stitch number determination step determine, from the height function and the width function, the number of knitting courses for the target height, as well as the number of needles for the target width in the pattern data.

Accordingly, parts with the target height and width can be knitted.

[0013]

Fig. 1 is a block diagram showing how a knitted article is produced in an embodiment;

Fig. 2 is a diagram showing an example of a correction curve of gauges based on the number of needles (knitting width);

Fig. 3 is a flowchart showing a determination algorithm for the number of stitches according to the embodiment; and

Fig. 4 is a diagram showing the width and height of each part according to the embodiment.

[0014] The best mode for implementing the present invention is described below.

[0015] Figs. 1 to 4 show an embodiment. In these diagrams, reference numeral 2 represents a design system that has a color monitor 4, input keyboard 6, and a mouse 8, and is connected to the internet by a LAN, which is not shown. The design system 2 is also provided with a disc driver that can be read from a CD-ROM or other storage medium, and comprises an appropriate computer. Reference numeral 10 represents a flat knitting machine having two or four needle beds. Reference numeral 16 represents a finishing apparatus that carries out, for example, cleaning, fulling, or steam processing. A size measuring step 18 measures the width and height, or the width and length, of test samples 12 to 14 knitted using the flat knitting machine 10.

[0016] The measured width and height of each of the plurality of samples are input to a correction function generating unit 20 of the design system 2. The correction function generating unit 20 generates and stores therein a height function expressing the size of the stitches in a height direction as a function of the number of needles, as well as a width function expressing the size of stitches in a width direction as a function of the number of needles, the functions being obtained based on the height and width of each of the plurality of samples. Each of these functions expresses a combination of knitting conditions, such as a target loop length per stitch, the type of yarn including the material and thickness of the yarn, and the finished style. Note that, instead of inputting the width and height of each sample into the correction function generating unit, a height direction gauge and width direction gauge of a knitted fabric of each sample may be input. In other words, whether to use the width or height of each sample or whether to use a gauge indicating the reciprocal of the size of stitches in order to express the size of the stitches is arbitrary. Furthermore, in the embodiment, the size in the height direction and the size in the width direction are input in order to generate the height function and the width function. However, because the size in the height direction changes significantly depending upon the number of needles, it is not necessary to generate the width function.

[0017] A design unit 19 of the design system 2 designs a knitted article based on the inputs from the keyboard 6, mouse 8 or LAN that is not shown. There are two stages in designing the knitted article. In the first stage, the size of each part is input in the form of the height and width. The sizes input in this stage are specified by unit length in cm or inch, and the data obtained in this stage is called "pattern data". The design unit 19 then converts the pattern data into design data of the knitted article, or converts the design data into knitting data that can be processed immediately by the flat knitting machine 10. In this process, the width and height of each part are converted into

the knitting width of each part, in other words, the number of needles to be used in knitting, and into the number of knitting courses of each part, based on the height function and the width function.

[0018] The design unit 19 also outputs the knitting data on the test samples 12 to 14 to the flat knitting machine 10 and knit these samples 12 to 14. The test samples 12 to 14 are common in, for example, the number of knitting courses and different in the number of needles. Each of the test samples 12 to 14 is in the shape of, for example, a rectangle but may be in a different shape. The same type of yarn is used in the test samples 12 to 14 under the same knitting conditions. The target loop length per stitch in the test samples 12 to 14 is also the same, as well as the finishing conditions obtained by the finishing apparatus 16. When the type of yarn, the finished style, and the knitting conditions are changed, the design unit 19 outputs new knitting data on the test samples 12 to 14. Note that the design system 2 and the flat knitting machine 10 may be connected by the LAN, or may be connected manually by using a floppy disk (registered trademark) or the like.

[0019] Fig. 2 shows an example of the height function and the width function, wherein the horizontal axis represents the number of needles and the vertical axis represents a height gauge X and horizontal gauge Y, both of which represent the number of stitches per centimeter. Although the height function is shown by a curve and the width function by a straight line in Fig. 2, either function may be shown by a curve or straight line. These functions may be stored as functions expressing the number of needles as variables, or may be stored in the form of a table having the number of needles as the heading.

[0020] The data shown in Fig. 2 are obtained when a group of 200 knitting courses was knitted with wool yarn with a loop length per loop of 6.0 mm by a flat knitting method using a flat knitting machine having twelve needles per inch. The data are also based on measurement values obtained when the steam processing and cleaning/drying are carried out as the finishing processing. There are four different numbers of needles in the test samples: fifty, a hundred, two hundred and three hundred. It is clear that the vertical gauge changes significantly depending on the number of needles but the horizontal gauge does not change much. It is expected that the vertical gauge and the horizontal gauge are not dependent upon the number of needles when the number of needles is more than three hundred. Therefore, for example, in a region that has more than three hundred needles, [the data] may be corrected such that the vertical gauge and the horizontal gauge are kept constant. Moreover, three types of test samples may be used in place of the four types of test samples.

[0021] One of the reasons that the data shown in Fig. 2 are obtained is because the quality of the knitted fabrics sometimes changes intrinsically according to the knitting widths thereof. In other words, an elongated knitted fabric stretches easily in a vertical direction, while a wide knitted fabric does not easily stretch in the vertical direction. In Patent Document 1 described above, the gauges are obtained based on the knitting widths, or, in other words, the number of stitches per predetermined length is obtained, and the obtained gauge is applied to the entire knitted fabrics. The optimal gauges are not always obtained if the knitting widths change. However, one of the characteristics of the present invention is to obtain the relationship between the knitting width of each knitted fabric and the gauge or the size of the stitches, to establish the optimal gauges that correct the impact of the knitting widths. In Fig. 2, although the number of knitting courses of each test sample is constantly two hundred, the same result as that shown in Fig. 2 was obtained with a hundred knitting courses or three hundred knitting courses, for example. Specifically, the number of needles is the factor for determining the actual gauge, or the size of the stitches.

[0022] Fig. 3 shows a gauge correction algorithm. Correction here means to correct the impact of the number of needles during the step of converting the size in the pattern data into the number of knitting courses or the number of needles in each part of each knitted fabric. The design system 2 stores the data, such as the knitting conditions of each knitted fabric, the type of yarn including the thickness and material of the yarn, and the finishing conditions. The design system 2 also stores the height function and the width function with respect to a combination of these data items. In other words, the height function or width function is the function that expresses a combination of the knitting conditions, the type of yarn, and the finishing conditions. However, more approximate functions may be used.

[0023] When the thickness or material of the yarn, the knitting conditions, and the finishing conditions change, the stored height function or width function cannot be applied. Thus, the correction function generating unit 20 outputs, to the design unit 19, information indicating that a new test sample is required, and then the design unit 19 generates the knitting data on the test samples 12 to 14. The knitting conditions, the finishing conditions, and the type of yarn are used in the actual production of a knitted article. The flat knitting machine 10 uses these conditions to knit, for example, the three types of test samples 12 to 14 that are different in the number of needles. These samples 12 to 14 are subjected to the same finishing as the actual knitted article by using the finishing apparatus 16, to manually measure the width and the height of each test sample. The obtained measurement results are input to the correction function generating unit 20. The width and the height of each knitted fabric may be input directly or may be input after converting them into the number of stitches per length, or the gauge.

[0024] The correction function generating unit 20 generates the height function and the width function shown in Fig. 2 on the basis of the input data, and stores these functions along with the type of yarn, the knitting conditions and the finishing conditions. On the basis of the

generated height function and width function, the design unit 19 obtains the number of knitting courses and needles required in the height and width of each part in the pattern data. Subsequently, the actual knitted article is knitted based on the obtained number of knitting courses and needles. In this manner, a knitted article in approximately the target size can be produced. The program with which the design system 2 executes the processes shown in Fig. 3 is the knit design program of the embodiment, which is supplied to the design system 2 via a storage medium such as a CD-ROM, or via a carrier wave.

[0025] Fig. 4 shows how the height and width of each part are determined. A knitted article 40 shown in Fig. 4 is constituted by a front body 41, rear body that is not shown, and sleeves 44, 45. Reference numeral 42 represents a rib hem and reference numeral 46 a cuff, which are both subjected to rib knitting. The front body 41 has therein a pattern 43 having different colors, which is knitted by the same type of yarn. Knitting width X1 and height Y1 of the front body are defined as shown in Fig. 4, for example. Width X2 and height Y2 of each of the sleeves 44, 45 are defined as shown in Fig. 4. Because the width on the armhole side generally increases in relation to each cuff 46, the knitting width X2 is the intermediate value between the value of the armhole and the value of the cuff 46. In Fig. 4, because the knitted article 40 is knitted tubularly, tubular knitted fabrics with different knitting widths are knitted as the test samples.

[0026] Although Fig. 4 illustrates an example of tubular knitting, the total of four parts of the front body, the rear body, and the right and left sleeves of the knitted article 40 can be knitted integrally. In this case, the test samples are knitted into a flat knitted fabric instead of a tube, many times with different knitting widths.

[0027] In the present embodiment, the number of knitting courses and the number of needles of a knitted article can be determined by correcting the impact of the number of needles on the size of stitches. Therefore, a knitted article in the size in the pattern data can be knitted more easily.

[0028]

2	Design system
4	Monitor
6	Keyboard
8	Mouse
10	Flat knitting machine
12 to 14	Test samples
16	Finishing apparatus
18	Size measuring step
19	Design unit
20	Correction function generating unit
40	Knitted article
41	Front body
42	Rib hem
43	Pattern
44, 45	Sleeves
46	Cuff
X1, X2	Knitting width
Y1, Y2	Knitting height

Claims

1. A method for determining the number of stitches for a knitted article (40) when converting pattern data of the knitted article (40) into the number of stitches to be knitted using a flat knitting machine (10), the method being **characterized by** comprising:

   a knitting step of knitting a plurality of samples (12, 13, 14), being different in the number of needles, by using the flat knitting machine (10);
   a measuring step of measuring the size of stitches of each sample (12, 13, 14) in at least a height direction;
   a step of obtaining a relationship between the number of needles of each sample (12, 13, 14) and the size of the stitches thereof in the height direction; and
   a stitch number determination step of determining the number of knitting courses for a target height in the pattern data, on the basis of the obtained relationship between the number of needles of each sample (12, 13, 14) and the size of the stitches thereof in the height direction, as well as a target width in the pattern data.

2. The method for determining the number of stitches for a knitted article (40) according to claim 1, **characterized in that** the step of obtaining a relationship obtains the relationship between the number of needles of each sample (12, 13, 14) and the size of the stitches thereof in the height direction, as a height function expressing the dependence of the size of the stitches in the height direction upon the number of needles.

3. The method for determining the number of stitches for a knitted article (40) according to claim 2, **characterized in that** the measuring step measures the size of the stitches in the height direction and the size thereof in a width direction in each of the plurality of samples (12, 13, 14),
   that the step of obtaining the relationship obtains the height function and a width function expressing the dependence of the size of the stitches in the width direction upon the number of needles, and
   that the stitch number determination step determines, from the height function and the width function, the number of knitting courses for the target height, as well as the number of needles for the target width in the pattern data.

4. A design system for a knitted article (40) for convert-

ing pattern data of the knitted article (40) into the number of stitches to be knitted using a flat knitting machine (10), the design system being **characterized by** comprising:

means for obtaining a relationship between the number of needles and the size of stitches in a height direction of each of a plurality of samples (12, 13, 14), being different in the number of needles, on the basis of an input value of the number of needles and an input value of at least the size of the stitches in the height direction;
means for storing the obtained relationship; and
stitch number determination means for determining the number of knitting courses for a target height in the pattern data, on the basis of the stored relationship and a target width in the pattern data.

5. A design program for a knitted article (40) for converting pattern data of the knitted article (40) into the number of stitches to be knitted using a flat knitting machine (10), the design program being **characterized by** causing a computer to function as:

means for obtaining a relationship between the number of needles and the size of stitches in a height direction of each of a plurality of samples (12, 13, 14), being different in the number of needles, on the basis of an input value of the number of needles and an input value of at least the size of the stitches in the height direction;
means for storing the obtained relationship; and
stitch number determination means for determining the number of knitting courses for a target height in the pattern data, on the basis of the stored relationship and a target width in the pattern data.

FIG. 1

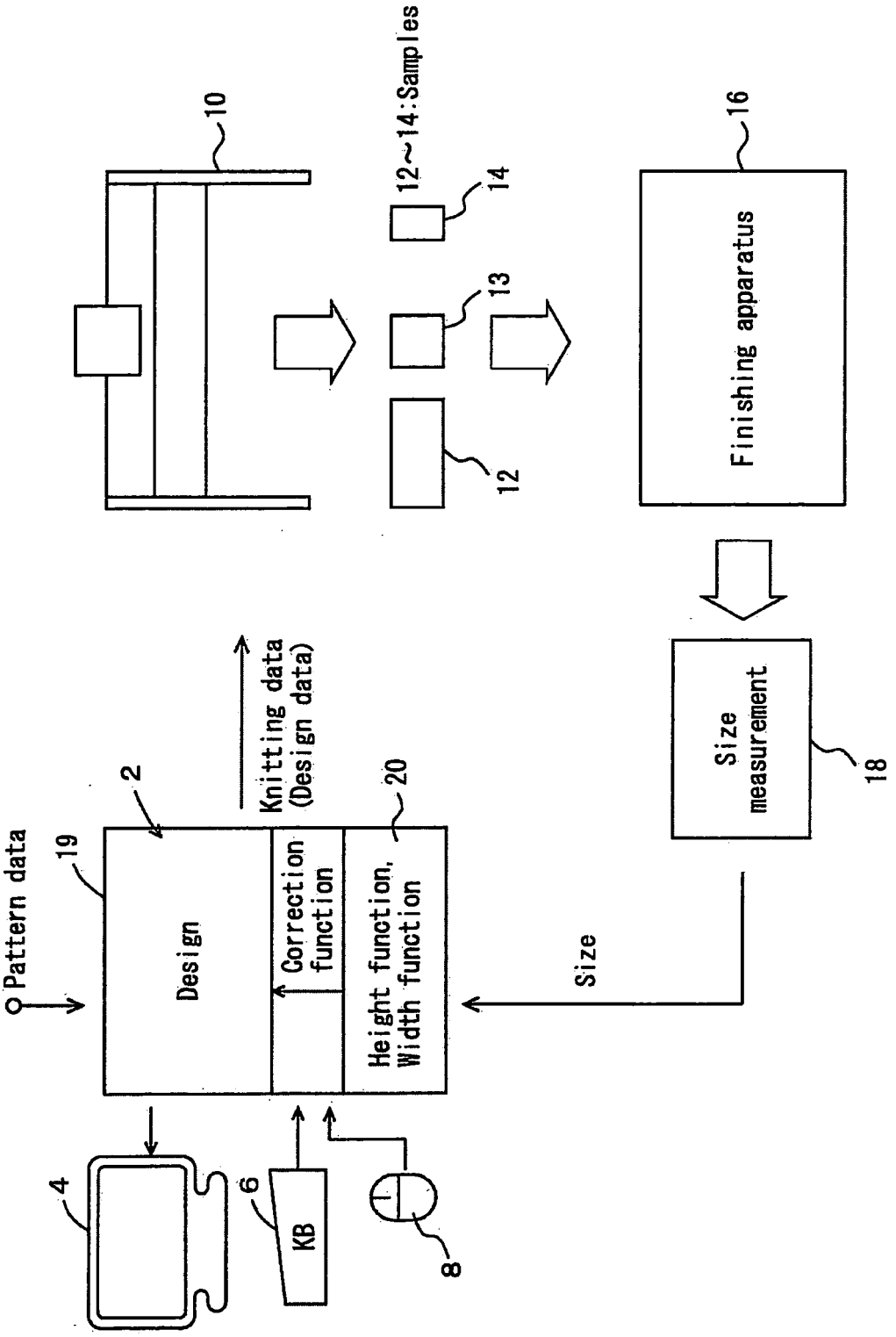

10
12~14:Samples
14
13
12
16
Finishing apparatus
Size measurement
18
Knitting data (Design data)
2
20
Pattern data
19
Design
Correction function
Height function, Width function
Size
4
6
KB
8

FIG. 2

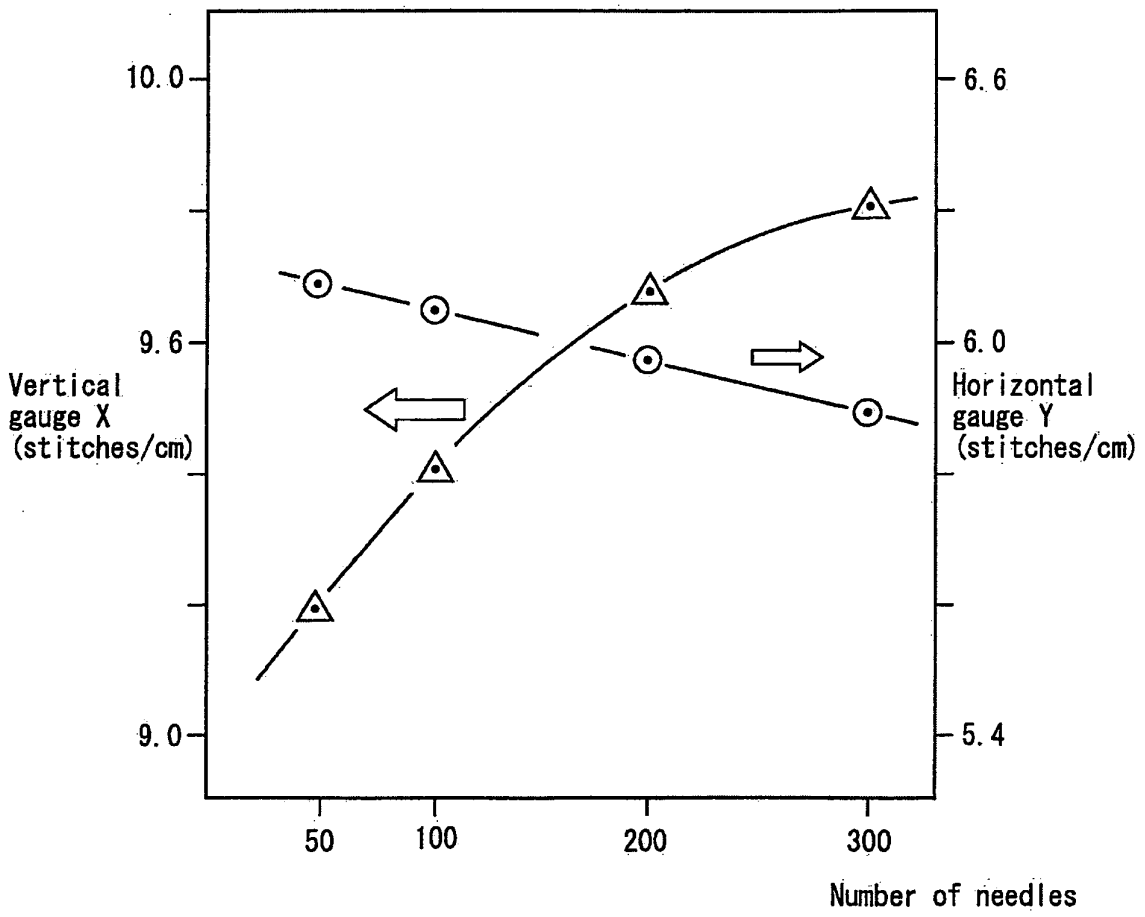

10.0
9.6
9.0
6.6
6.0
5.4
Vertical gauge X (stitches/cm)
Horizontal gauge Y (stitches/cm)
50
100
200
300
Number of needles

FIG. 3

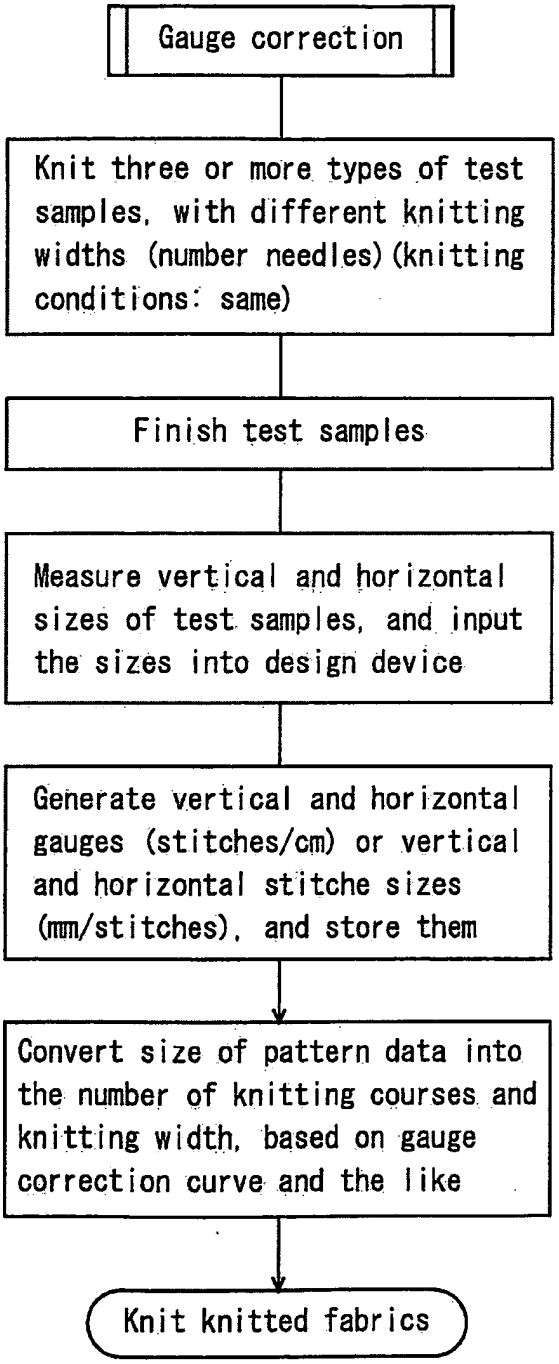
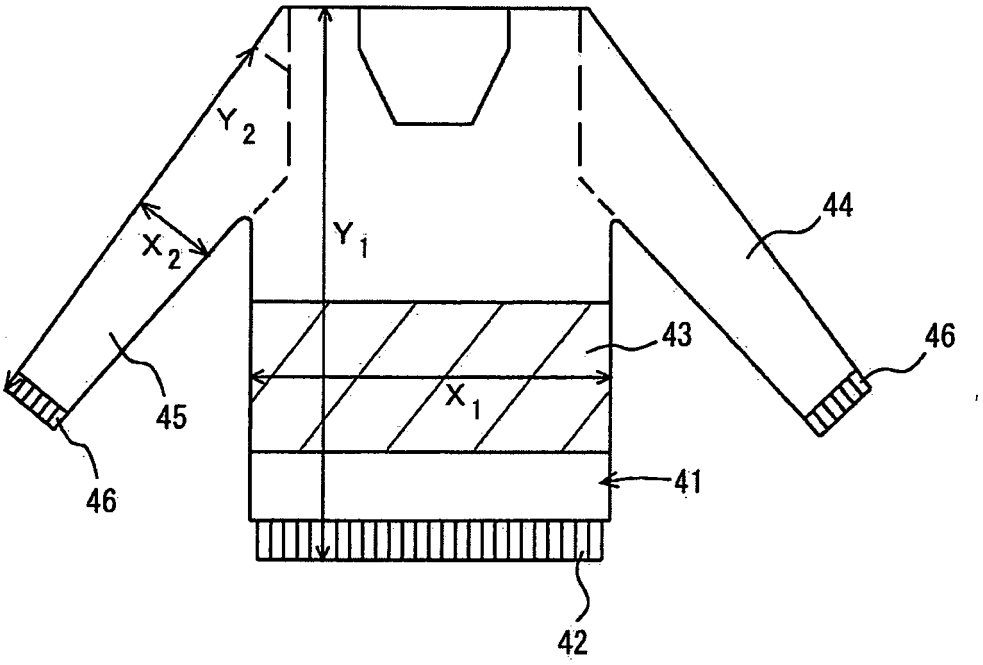

Gauge correction
Knit three or more types of test samples, with different knitting widths (number needles) (knitting conditions: same)
Finish test samples
Measure vertical and horizontal sizes of test samples, and input the sizes into design device
Generate vertical and horizontal gauges (stitches/cm) or vertical and horizontal stitche sizes (mm/stitches), and store them
Convert size of pattern data into the number of knitting courses and knitting width, based on gauge correction curve and the like
Knit knitted fabrics

FIG. 4



40

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2009/061174

A. CLASSIFICATION OF SUBJECT MATTER
D04B35/00(2006.01)i, *D04B15/00*(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)
D04B35/00, D04B15/00

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 1996-2009
Kokai Jitsuyo Shinan Koho 1971-2009 Toroku Jitsuyo Shinan Koho 1994-2009

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 2676182 B2 (Shima Seiki Mfg., Ltd.), 12 November, 1997 (12.11.97), & DE 69410932 C & AU 7745694 A	1-5
A	JP 2005-15958 A (Shima Seiki Mfg., Ltd.), 20 January, 2005 (20.01.05), & WO 2005/001185 A1	1-5
A	JP 55-30477 A (Sharp Corp., Aisin Seiki Co., Ltd.), 04 March, 1980 (04.03.80), (Family: none)	1-5

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
02 July, 2009 (02.07.09)	14 July, 2009 (14.07.09)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (April 2007)

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2676182 B **[0002] [0004]**