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

(11) **EP 2 610 381 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
03.07.2013 Bulletin 2013/27

(51) Int Cl.:
D04B 7/26 *(2006.01)*

(21) Application number: **12007872.0**

(22) Date of filing: **22.11.2012**

(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

(30) Priority: **27.12.2011 JP 2011286041**

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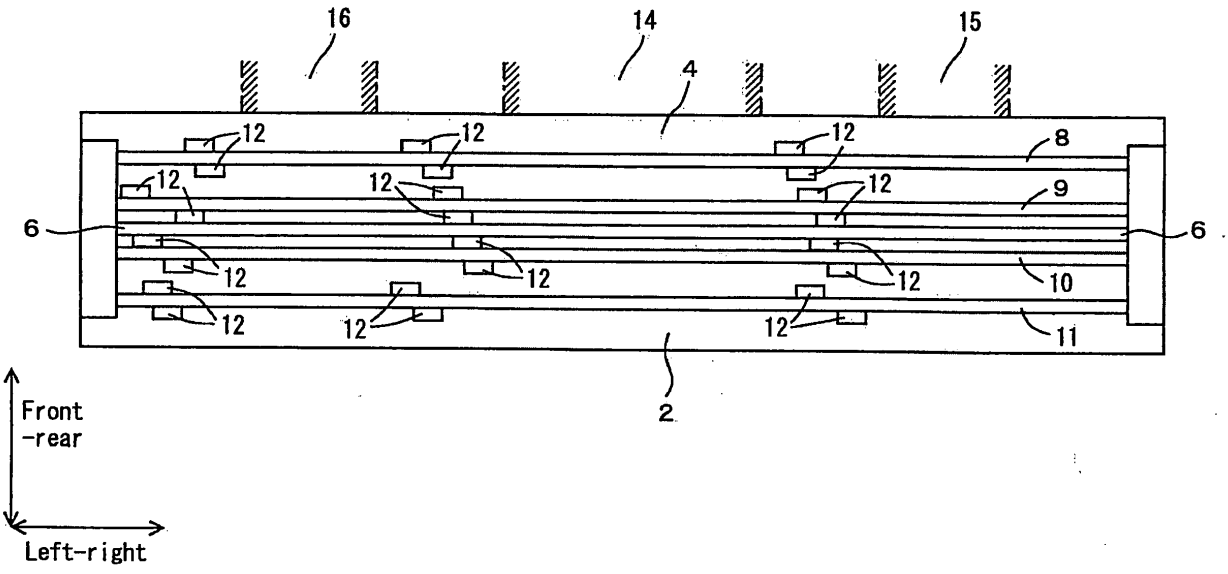
(54) **Method and apparatus for generating knitting data for flat knitting machine**

(57) Knitting data for a flat knitting machine is automatically generated. Data indicating a course of a carriage using carriers (12) and a movement range of the carriers (12) in one part (32-34) of a garment is obtained for each carrier (12) used for knitting, stop positions of the carriers (12) are obtained for each carrier (12), and, when it is detected that the stop positions of the carriers (12) are to overlap each other, the stop positions are changed.

F I G. 1



EP 2 610 381 A1

Description

Technical Field

[0001] The present invention relates to generation of knitting data for a flat knitting machine, and particularly relates to determination of stop positions of carriers in knitting data while preventing interference between the carriers.

Background Art

[0002] A flat knitting machine includes, for example, a pair of elongated needle beds, wherein a knitted fabric is knitted by causing a carriage that travels back and forth on the needle beds to operate needles, and feeding a yarn from carriers to the needles. A plurality of carrier rails are arranged above the needle beds in parallel to the longitudinal direction of the needle beds. The carriers are also referred to as yarn feeders, each having a lower end as a yarn feeding port for feeding a yarn and an upper end supported by the carrier rail. The carriers are elastic such that they may be slightly bent in the front-and-rear direction of the flat knitting machine. The carriers are slidingly moved along the carrier rails when being conveyed by the carriage, and stopped when the conveyance is cancelled.

[0003] Since the yarn feeding ports of the carriers move directly above a gap between the needle beds, when the carriers pass each other, the yarn feeding ports are brought into contact with each other. At that time, the carriers are slightly bent such that the yarn feeding ports are allowed to pass each other. The carriage includes not only cams for operating the needles but also other constituent elements such as stitch pressers, and these constituent elements are positioned above the gap between the needle beds. Accordingly, when a plurality of carriers are stopped at the same position, the yarn feeding ports are brought into contact with these other constituent elements such as stitch pressers. Thus, processing is performed such that carriers are not stopped at the same position, that is, carriers are stopped at positions on the outer side of the knitting width by parameters called reset correction. It is possible to prevent a plurality of carriers from being stopped at the same position, by providing different reset correction values for the respective carriers. However, for this purpose, the reset correction values have to be manually input. Note that the reset correction values are part of the knitting data because they directly affect factors such as movement distance and operation of the carriers.

[0004] Patent Literature 1 (JP H5-93348A) discloses correction of a position at which the conveyance of carriers is cancelled, in consideration of the slippage amount of the carriers. Furthermore, Patent Literature 2 (JP 2011-106059A) describes arrangement of carrier rails and carriers with respect to needle beds. However, automatic generation of data indicating a carrier stop position is not known.

Citation List

Patent Literature

[0005]

[Patent Literature 1] JP H5-93348A
[Patent Literature 2] JP 2011-106059A

Summary of the Invention

Technical Problem

[0006] It is an object of the present invention to automatically generate knitting data including data indicating stop positions of carriers while preventing the carriers from interfering with each other.

Means for Solving Problem

[0007] The present invention is directed to method for automatically generating knitting data for a flat knitting machine including at least a pair of front and rear needle beds, a carriage that operates needles on the needle beds, a plurality of carrier rails, and a plurality of carriers that are conveyed by the carriage along the respective carrier rails and feed at least a yarn to the needles on the needle beds, characterized by including:

a step of obtaining, for each carrier used for knitting, data indicating at least a course of the carriage using the carrier and a movement range of the carrier in one part of a garment;
a step of determining, for each carrier, a stop position of the carrier based on the data; and
a step of, when it is detected that the stop positions of the carriers are to overlap each other in a direction that is at a right angle to a longitudinal direction of the needle beds in a horizontal plane, changing the stop positions such that the stop positions do not overlap each other.

[0008] Furthermore, the present invention is directed to an apparatus for automatically generating knitting data for a flat knitting machine including at least a pair of front and rear needle beds, a carriage that operates needles on the needle beds, a plurality of carrier rails, and a plurality of carriers that are conveyed by the carriage along the respective carrier rails and feed at least a yarn to the needles on the needle beds, characterized by including:

an analysis means for obtaining, for each carrier used for knitting, data indicating at least a course of the carriage using the carrier and a movement range of the carrier in one part of a garment; and
a stop position determination means for determining,

for each carrier, a stop position of the carrier based on the data, and, when it is detected that the stop positions of the carriers are to overlap each other in a direction that is at a right angle to a longitudinal direction of the needle beds in a horizontal plane, changing the stop positions such that the stop positions do not overlap each other.

[0009] With this configuration, based on data indicating the usage frequency and the movement ranges of the carriers, the stop positions of the carriers are automatically determined. Furthermore, the stop positions of the carriers are prevented from overlapping each other in a direction that is at a right angle to the longitudinal direction of the needle beds in a horizontal plane, and, thus, the carriers are prevented from interfering with each other. The stop positions of the carriers may be positions directly above the edge of the knitting width, as well as positions that is remote to the position directly above the edge of the knitting width obtained by the minimum value in FIG. 4. The analysis means corresponds to, for example, the usage frequency extractor or the block extractor in FIG. 2, and the stop position determination means corresponds to, for example, the reset correction value allocation unit in FIG. 2. In this specification, the description regarding the knitting data generation method is applicable as it concerns the knitting data generation apparatus, and the description regarding the knitting data generation apparatus is applicable as it concerns the knitting data generation method.

[0010] It is preferable that the stop position determination means determines the stop positions such that a carrier having a high usage frequency is stopped at a position close to an edge of a knitting width and a carrier having a low usage frequency is stopped at a position away from the edge of the knitting width. With this configuration, since carriers having a high usage frequency are stopped at positions close to the edge of the knitting width, the distance in which the carriage moves the carriers is short. Accordingly, one part is knitted in a shorter period of time. Note that the usage frequency level may be obtained with an appropriate level of precision, and, for example, if the level of resolution is set to "three times", the numbers of times used of 51 and 49 are classified into the same usage frequency. Regarding the stop positions of carriers, what matters are values of carriers having high usage frequencies, and the stop positions of carriers having, for example, the two lowest usage frequencies do not have to follow the order of usage frequency.

[0011] It is preferable that the stop position determination means determines the stop positions based on the usage frequency in each part. With this configuration, the stop positions are easily determined.

Furthermore, it is preferable that the analysis means divides one part into a plurality of blocks in a wale direction, and in that the stop position determination means determines the stop positions based on the usage frequency in each block. With this configuration, for example, when carriers that are to be used are changed along the wale direction, the stop positions are determined such that the total distance in which the carriers are conveyed is short.

Brief Description of the Drawings

[0012]

FIG. 1 is a plan view of needle beds and carrier rails.
FIG. 2 is a block diagram of a knitting data generation apparatus according to an embodiment.
FIG. 3 is a flowchart showing an algorithm for determining a carrier stop value according to the embodiment.
FIG. 4 is a diagram showing a relationship between the knitting width of one part, the minimum value, and the reset correction value.
FIG. 5 is a diagram schematically showing the stop positions of carriers a, b, and c with respect to one part.
FIG. 6 is a flowchart showing an algorithm for determining a carrier stop value according to a modified example.
FIG. 7 is a diagram schematically showing the stop positions of the carriers a, b, and c with respect to one part according to the modified example.
FIG. 8 is a diagram schematically showing the stop positions of carriers a to d with respect to one part in intarsia knitting according to the modified example.

Description of Embodiment

[0013] Hereinafter, an optimal embodiment for carrying out the present invention will be described.

Embodiment

[0014] FIGS. 1 to 8 show an embodiment and its modified example. FIG. 1 schematically shows carrier rails above needle beds, wherein reference numeral 2 denotes a front bed, 4 denotes a rear bed, and 6 denotes a gap between the beds. A plurality of carrier rails 8 to 11 are present above the beds 2 and 4, and carriers 12 are slidingly moved along the carrier rails 8 to 11 when being conveyed by a carriage (not shown). In this drawing, it is assumed that shaped knitting is performed, wherein 14 reference numeral denotes a knitting width of a front body or the like, 15 denotes a knitting width of a left sleeve or the like, and 16 denotes a knitting width of a right sleeve or the like. One garment is configured by a plurality of parts, and the knitting width of each part may be changed during knitting. A garment may have a fixed knitting width, and, furthermore, one garment may be configured by one part as in the case of non-sewing knitting. In this specification below, in a horizontal plane, a direction that is parallel to the longitudinal direction of the beds 2 and 4 is referred to as a left-and-right direction,

and a direction that is orthogonal to the longitudinal direction of the beds 2 and 4 is referred to as a front-and-rear direction.

[0015] Reference numeral 20 denotes a knitting data generation apparatus, 21 denotes a user interface that is configured by an input means such as a mouse, a track ball, a digitizer, and a keyboard, together with a color monitor, and 22 denotes a network interface that exchanges data and programs with a network. Furthermore, reference numeral 23 denotes a disc driver that exchanges data, programs, and the like with a disc (not shown), 24 denotes a memory that stores various type of data, in particular, knitting data, and 25 denotes a program memory that stores programs for the knitting data generation apparatus 20.

[0016] A converter 26 converts knitted fabric design data input from the user interface 21, the network interface 22, the disc driver 23, or the like, to knitting data. In this conversion, data indicating stop positions of the carriers is not generated, or is allocated to an appropriate default value. A usage frequency extractor 27 extracts a usage frequency and a movement range in each course of each carrier used in knitting data. A block extractor 28 is used to execute the algorithm in FIG. 6, and divides one part into a plurality of blocks based on which carrier to use. In the case where the algorithm in FIG. 3 is executed, the block extractor 28 is not necessary. One part is divided into blocks along the wale direction of the part, the block length along the wale direction is provided with a minimum value, and a block having a length less than the minimum value is merged into either its upper or lower block.

[0017] A reset correction value allocation unit 29 allocates reset correction values to the carriers. The reset correction value may be fixed throughout knitting of one part, or may be changed during knitting of one part. An interference check unit 30 checks interference between the carriers, the interference being an event in which a plurality of carriers are stopped at positions that overlap each other in the front-and-rear direction of the flat knitting machine. When carriers interfere with each other, that is, when a plurality of carriers have been stopped in an overlapped manner in the front-and-rear direction, if the carriage (not shown) moves so as to cross the carriers, the stitch pressers and the like on the carriage may be damaged by interference with the carriers.

[0018] The reset correction value allocation unit 29 initially allocates, for example, a reset correction value of 0 to each carrier. Then, when the interference check unit 30 detects that the carriers are to interfere with each other, the interference is eliminated, for example, by increasing a reset correction value for a carrier having a low usage frequency so as to avoid the interference. Note that the knitting data generation apparatus 20 may be disposed inside a flat knitting machine, or may be disposed inside a design apparatus that generates design data of a garment or the like and converts it to knitting data.

[0019] FIGS. 3 to 5 show a method for determining carrier stop positions. When a design of one part is determined and then converted to knitting data, the knitting width, the stitch types, the number of courses, and which carrier is to be moved in which course over which range, and other types of data are determined. Thus, in Step 1, for each carrier, courses using the carrier and a movement range in each course in one part are obtained. This processing is performed at least on carriers that are to be actually used. The usage frequency of the carriers in one part is determined for each carrier, and the stop position of each carrier is set to a minimum value. In other words, the reset correction value for each carrier is set at 0 (Step 2). Carriers that are not to be used are, for example, withdrawn to an end of the needle beds or the like.

[0020] FIG. 4 illustrates the reset correction values. The carriers are moved back and forth along the left and the right of the knitting width, and the carrier stop position is a position that is away from an edge of the knitting width by a distance of a minimum value corresponding to approximately zero to three needles. For example, the minimum value is 0 in the case of intarsia knitting, and is a value corresponding to two or three needles in the case of other types of knitting. The carrier movement range in the knitting data is obtained by adding the knitting width and the minimum values. The reset correction value is 0 at a position shifted from an edge of the knitting width by the minimum value to the outer side, which corresponds to a minimum reset correction value. The reset correction value increases toward the outer side of the knitting width. Furthermore, the reset correction value is expressed by, for example, a width of one yarn feeding port. In the reset correction value, "reset" means cancellation of the conveyance of the carrier by the carriage, and "correction value" means the amount of shift from the minimum value. When the reset correction value is minimum, the carrier is stopped at a position shifted from an edge of the knitting width by the minimum value to the outer side, and, as the reset correction value increases, the carrier is stopped at a position shifted further away from the edge of the knitting width to the outer side.

[0021] Steps 4 to 7 are performed on the carriers, for example, in descending order of the usage frequency (Steps 3 to 7). In Step 4, the position of a carrier when it is stopped in each course is checked, and it is detected whether or not there is interference with any other carrier. If there is interference with any other carrier, the interference is eliminated by shifting the stop position to the outer sides, that is, by increasing the reset correction value (Step 5). If the stop positions of the carriers that are to cause interference are changed, interference with other carriers may occur as a chain reaction, and, thus, the stop positions of the carriers are changed until elimination of interference is completed. After Steps 4 and 5 are performed on all the courses, for example, the same processing is performed on a carrier having the next highest usage frequency. The algorithm in FIG. 3 ends if the

processing is completed for all the carriers that are to be used.

[0022] FIG. 5 shows reset correction values (dashed dotted lines) and actual stop positions (dashed double dotted lines) of carriers a, b, and c during knitting of one part 32, wherein the reference symbols a, b, and c in the part 32 each indicate a carrier that is to be used. Furthermore, in this specification, a course direction refers to a direction that is parallel to a direction in which a carriage travels back and forth, and a wale direction is a direction that is at a right angle to the course direction. In the part 32, the usage frequency of the carriers is in order of c > a > b, so that a smallest reset correction value is allocated to the carrier c, a second smallest reset correction value is allocated to the carrier a, and a largest reset correction value is allocated to the carrier b. If the knitting width of the part 32 does not increase or decrease, there is no interference between the carriers when the reset correction values are determined as above. The dashed dotted lines in FIG. 5 indicate the carrier stop positions following the reset correction values.

[0023] If the knitting width of the part 32 increases or decreases, the carrier stop positions may be the same even when the reset correction values are different from each other. For example, in the block using the carrier c, the knitting width increases to the right side, but the carriers a and b are not used and are kept stationary in this block, and, thus, the carrier c interferes with the carriers a and b. Thus, the stop positions of the carriers a and b are automatically changed in Step 5 in FIG. 3 to positions as indicated by the dashed double dotted lines in FIG. 5, or manually changed. In the last block using the carrier a, the knitting width gradually decreases, and the carrier a interferes with the carrier c, and, thus, the stop position of the carrier c is changed, for example, to a position as indicated by the dashed double dotted line in FIG. 5. Note that, although FIG. 5 shows a case in which the carrier stop positions are shifted from the trajectories indicated by the dashed dotted lines to the trajectories indicated by the dashed double dotted lines in one pass of the carriage, the carrier stop positions may be gradually shifted between courses to avoid interference. Furthermore, it is sufficient that the carrier stop positions are shifted before a course where interference occurs. When it is assumed that the reset correction values are variables that are allowed to change during knitting of one part, the reset correction values may be determined such that the trajectories are as indicated by the dashed double dotted lines on the right side in FIG. 5.

[0024] According to the above-described processing, it is possible to:

- automatically generate data indicating the stop positions of the carriers a, b, and c;
- shorten the carrier conveyance distance, thereby shortening the carriage travelling distance, and improving the productivity; and
- eliminate interference between the carriers.

[0025] FIGS. 6 to 8 show a modified example that is the same as the embodiment in FIGS. 1 to 5 unless otherwise specified. First, Step 1 in FIG. 3 is performed, and the procedure advances to Step 11 where one part is divided into a plurality of blocks along the wale direction based on which carrier to use. At that time, it is preferable that a small block having a number of courses of a predetermined value or less is prevented from being formed, by setting a minimum value for the block length along the wale direction, for example. Furthermore, in Step 11, the usage frequency of the carriers is obtained for each block. The following process is performed in each block, and, in Step 12, the stop position of each carrier is set to a minimum value. Then, interference in the block is eliminated, for example, as in Steps 4 to 7 in FIG. 3 (Step 13).

[0026] FIG. 7 shows reset correction values for one part 33 as dashed dotted lines, wherein X marks indicate switching of the reset correction values. In the part 33, the small block shown at the lowermost position using the carrier a and the following small block using the carriers a and b are merged into one block, and, thus, for example, four blocks are formed in total. Then, the reset correction values are switched for the unit of each block. In the first block, the carrier a is mainly used, and the carrier b is also used, so that the reset correction value for the carrier a is set at 0, which is the minimum value, the reset correction value for the carrier b is set at 1, and the reset correction value for the carrier c is set at 2. In the next block using the carrier b, the carrier a is not used, so that, for example, the reset correction values are switched between the carriers a and b. In a similar manner, in the next block using the carrier c, the carrier b is not used, so that the reset correction values are switched between the carriers b and c. In the last block using the carrier a, the carrier c is not used, so that the reset correction values are switched between the carriers c and a. Furthermore, in the block using the carrier b and the block using the carrier c, interference occurs, for example, between the carrier a whose stop position is fixed because it is not used, and the carriers b and c whose stop positions are shifted to the right side as the knitting width increases. Thus, as in FIG. 5, interference is avoided by shifting the stop positions of the carriers that are to cause interference to a side away from the knitting width.

[0027] FIG. 8 shows reset correction values in intarsia knitting according to the modified example, wherein carriers for intarsia knitting are allowed to be stopped at positions directly above an edge of the knitting width and directly above a yarn change point such that a yarn is oriented downward in the vertical direction. In this case, the area knitted by one carrier is taken as one knitting width, and one part 34 is processed as having two knitting widths in the course direction. Since the minimum value is 0, the stop positions with a reset correction value of 0 match the boundaries between both edges of the part 34 and the areas. The part 34 is divided into two upper and lower blocks. In the first block, the carriers a and b are

used, so that small reset correction values are allocated to the carriers a and b. In the next block, the carriers c and d are used, so that small reset correction values are allocated to the carriers c and d. If the fact that the block using the carriers a and b is larger than the block using the carriers c and d is focused, and the reset correction values for the lower block are taken as being effective also for the upper block, this processing is the same as that in the embodiment in FIGS. 1 to 5.

[0028] According to the embodiment, the following effects are obtained, that is, it is possible to:

(1) automatically generate data indicating the stop positions of the carriers;
(2) eliminate interference between the carriers; and
(3) determine the reset correction value according to the carrier usage frequency, thereby shortening the carriage travelling distance, and reducing the time necessary to perform knitting.

List of Reference Numerals

[0029]

2	Front bed
4	Rear bed
6	Gap
8 to 11	Carrier rails
12	Carrier
14 to 16	Knitting width
20	Knitting data generation apparatus
21	User interface
22	Network interface
23	Disc driver
24	Memory
25	Program memory
26	Converter
27	Usage frequency extractor
28	Block extractor
29	Reset correction value allocation unit
30	Interference check unit
32 to 34	Part

Claims

1. A method for automatically generating knitting data for a flat knitting machine including at least a pair of front and rear needle beds (2, 4), a carriage that operates needles on the needle beds (2, 4), a plurality of carrier rails (8-11), and a plurality of carriers (12) that are conveyed by the carriage along the respective carrier rails (8-11) and feed at least a yarn to the needles on the needle beds (2, 4), **characterized by**:

   a step of obtaining, for each carrier (12) used for knitting, data indicating at least a course of the carriage using the carrier (12) and a movement range of the carrier (12) in one part (32-34) of a garment;
   a step of determining, for each carrier (12), a stop position of the carrier (12) based on the data; and
   a step of, when it is detected that the stop positions of the carriers (12) are to overlap each other in a direction that is at a right angle to a longitudinal direction of the needle beds (2, 4) in a horizontal plane, changing the stop positions such that the stop positions do not overlap each other.

2. An apparatus (20) for automatically generating knitting data for a flat knitting machine including at least a pair of front and rear needle beds (2, 4), a carriage that operates needles on the needle beds (2, 4), a plurality of carrier rails (8-11), and a plurality of carriers (12) that are conveyed by the carriage along the respective carrier rails (8-11) and feed at least a yarn to the needles on the needle beds (2, 4), **characterized by**:

   an analysis means (27, 28) for obtaining, for each carrier (12) used for knitting, data indicating at least a course of the carriage using the carrier (12) and a movement range of the carrier (12) in one part (32-34) of a garment; and
   a stop position determination means (29) for determining, for each carrier (12), a stop position of the carrier (12) based on the data, and, when it is detected that the stop positions of the carriers (12) are to overlap each other in a direction that is at a right angle to a longitudinal direction of the needle beds (2, 4) in a horizontal plane, changing the stop positions such that the stop positions do not overlap each other.

3. The apparatus (20) for generating knitting data for a flat knitting machine according to claim 2, **characterized in that** the stop position determination

means (29) determines the stop positions such that a carrier (12) having a high usage frequency is stopped at a position close to an edge of a knitting width (14-16) and a carrier (12) having a low usage frequency is stopped at a position away from the edge of the knitting width (14-16).

4. The apparatus (20) for generating knitting data for a flat knitting machine according to claim 3, **characterized in that** the stop position determination means (29) determines the stop positions based on the usage frequency in each part (32-34).

5. The apparatus (20) for generating knitting data for a flat knitting machine according to claim 3, **characterized in that** the analysis means (28) divides one part (32-34) into a plurality of blocks in a wale direction, and **in that** the stop position determination means (29) determines the stop positions based on the usage frequency in each block.

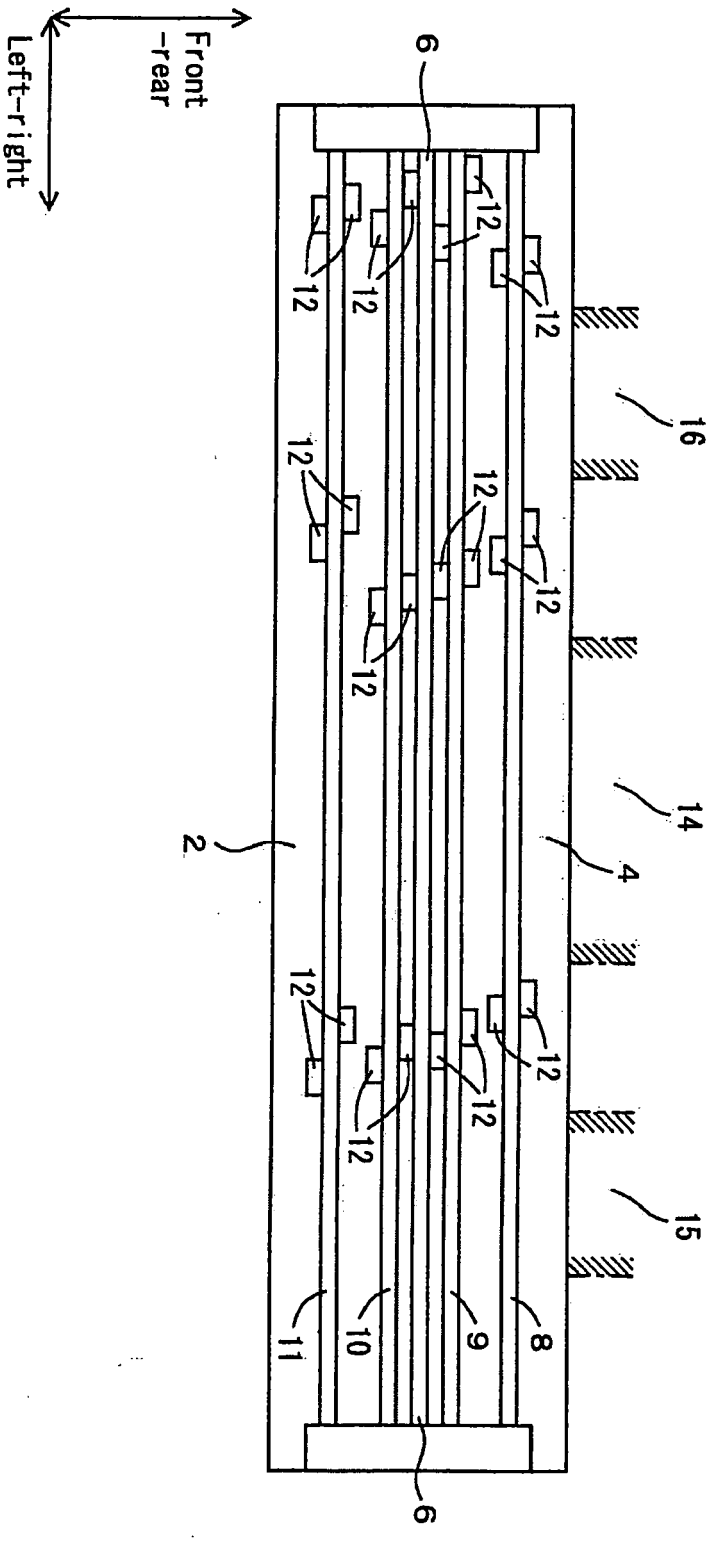


FIG. 1

FIG. 2

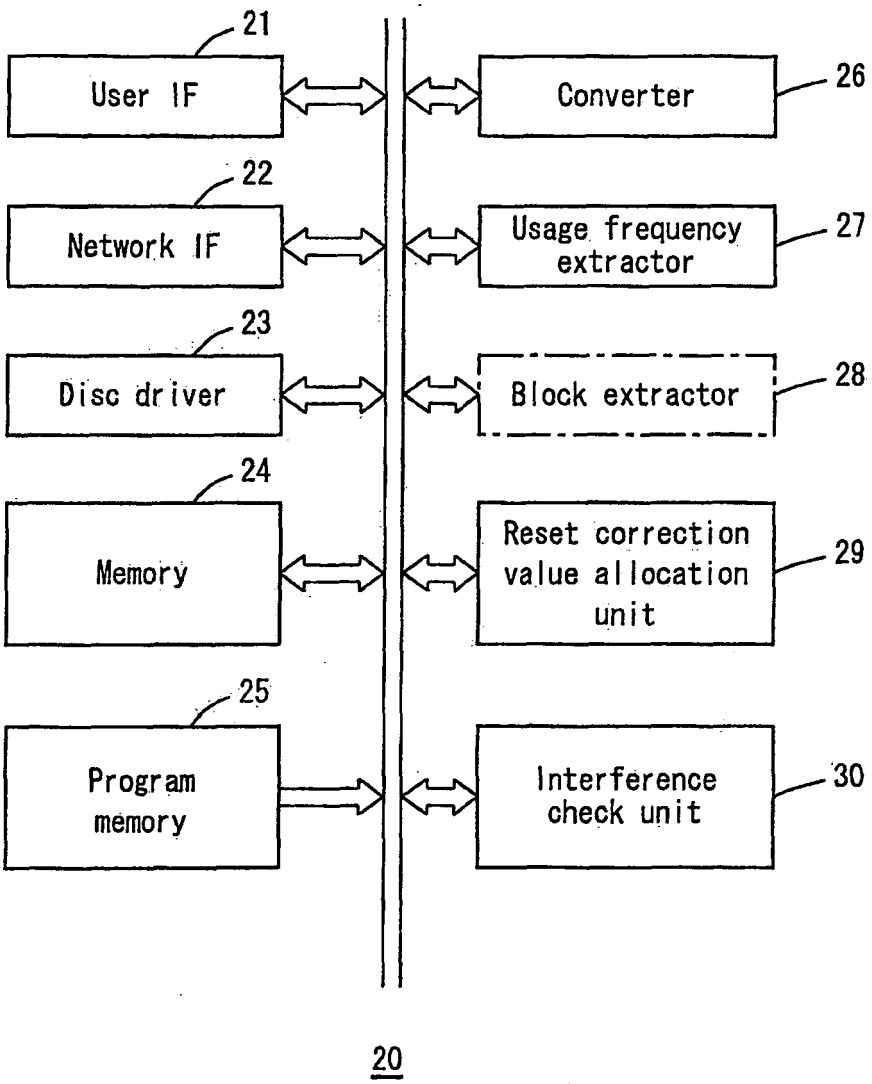

21
User IF
22
Network IF
23
Disc driver
24
Memory
25
Program memory
Converter
26
Usage frequency extractor
27
Block extractor
28
Reset correction value allocation unit
29
Interference check unit
30
20

FIG. 3

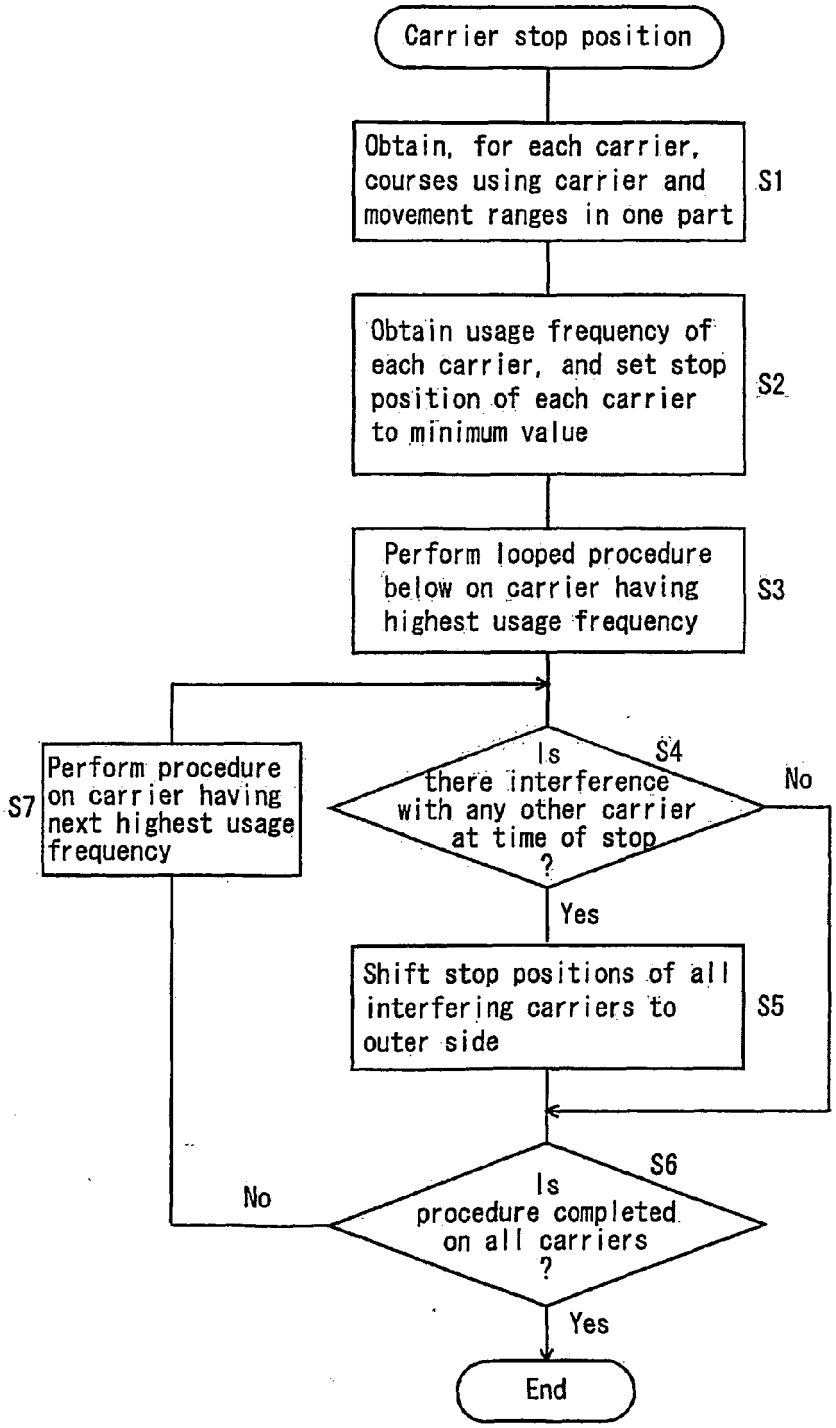

Carrier stop position
Obtain, for each carrier, courses using carrier and movement ranges in one part
S1
Obtain usage frequency of each carrier, and set stop position of each carrier to minimum value
S2
Perform looped procedure below on carrier having highest usage frequency
S3
Is there interference with any other carrier at time of stop ?
S4
No
Yes
Shift stop positions of all interfering carriers to outer side
S5
Perform procedure on carrier having next highest usage frequency
S7
Is procedure completed on all carriers ?
S6
No
Yes
End

FIG. 4

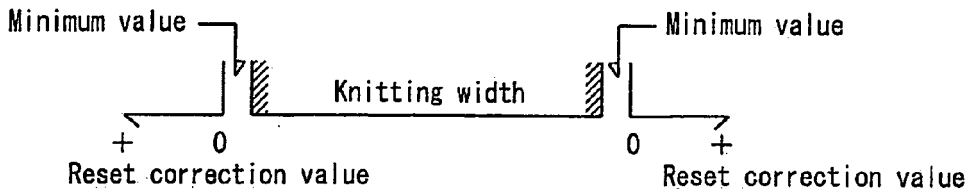

Minimum value
Minimum value
Knitting width
+
0
0
+
Reset correction value
Reset correction value

FIG. 5

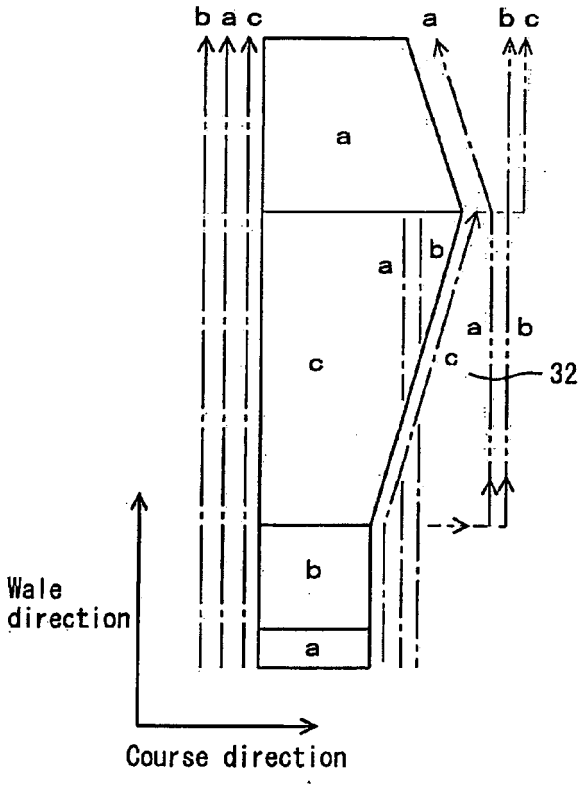

b a c
a
b c
a
b
a
b
c
c
32
b
a
Wale direction
Course direction

FIG. 6

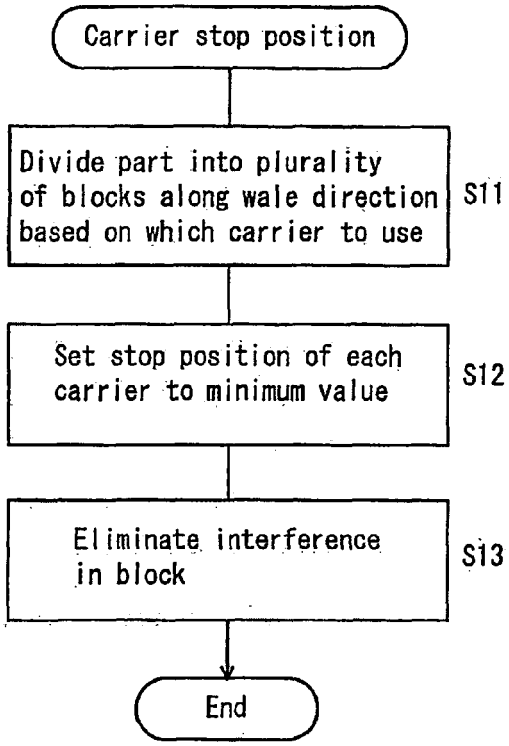

Carrier stop position
Divide part into plurality of blocks along wale direction based on which carrier to use
S11
Set stop position of each carrier to minimum value
S12
Eliminate interference in block
S13
End

FIG. 7

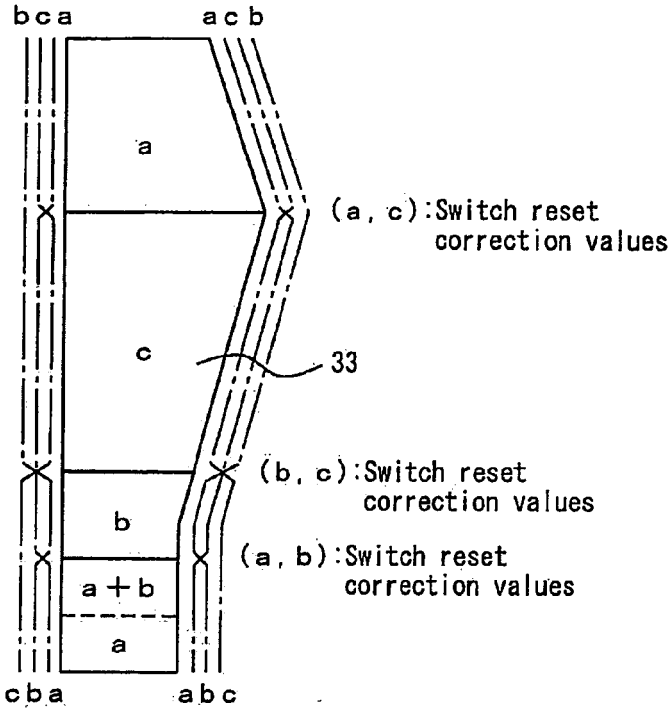
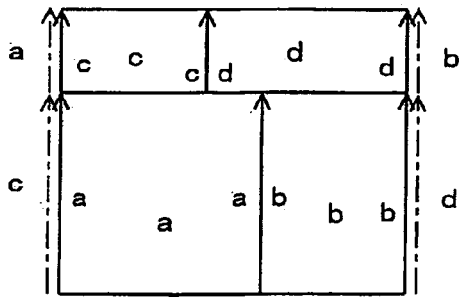

bca
acb
a
(a, c):Switch reset correction values
c
33
(b, c):Switch reset correction values
b
(a, b):Switch reset correction values
a+b
a
cba
abc

FIG. 8


a
c c c d d d b
c
a a a b b b d

34

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 12 00 7872

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X,D	JP H05 93348 A (SHIMA SEIKI MFG) 16 April 1993 (1993-04-16) * abstract; figure 1 * -----	1,2	INV. D04B7/26
A	DE 27 30 306 A1 (H STOLL GMBH & CO FA) 25 January 1979 (1979-01-25) * page 11, line 5 - line 17 * -----	1-5	

TECHNICAL FIELDS SEARCHED (IPC)

D04B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	17 May 2013	Zirkler, Stefanie

CATEGORY OF CITED DOCUMENTS

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP H0593348 A	16-04-1993	NONE	
DE 2730306 A1	25-01-1979	NONE	

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- JP 2011106059 A **[0004] [0005]**