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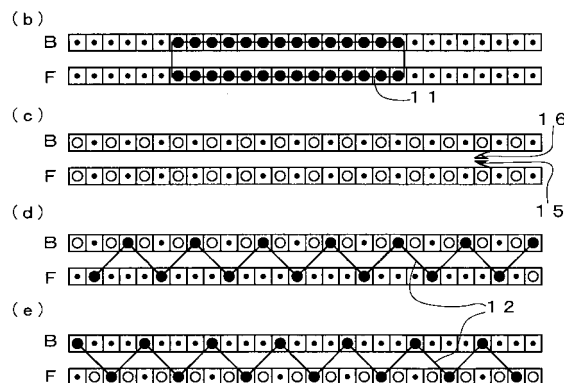
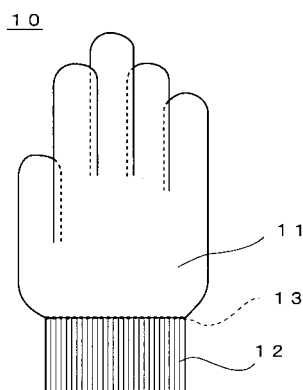
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(54) **CYLINDRICAL FABRIC KNITTING METHOD, AND CYLINDRICAL FABRIC**

(57) The present invention provides a method for knitting a tubular shaped fabric which can smoothly change an all needle arrangement to a half gauge arrangement without causing yarn breakage or change in hand value, and a tubular shaped fabric itself.

A glove 10 shown in (a) is knitted as a tubular shaped fabric by the use of a pair of opposing front and rear needle beds with a needle gap in-between. As shown in (b), a base fabric 11 of the glove 10 is basically knitted by knitting needles in the all needle arrangement on front and rear needle beds. As shown in (c), in the course of knitting a needle arrangement changing portion (13) of (a), yarn feeding ports 15 and 16 are assigned to each needle bed in such a manner as to provide a empty needle between adjacent knitting needles in the all needle arrangement, and the knitting width is successively widened. By keeping the yarn feeding ports 15 and 16 such as yarn feeders, or the like in the vicinity of the place where the stitches are transferred, the knitting width can be smoothly widened and the knitting can be changed from the all needle arrangement to the half gauge arrangement. A wrist portion 12 shown in (a) can be knitted by a rib knitting structure as shown in (d) and (e).

[Fig. 1]
(a)



Description**Technical Field**

5 **[0001]** The present invention relates to a method for knitting a tubular shaped fabric using a flatbed knitting machine, and in particular, to a method for knitting a tubular shaped fabric associated with a change of an all needle arrangement in which all knitting needles within a knitting width are used without any empty needle to a half gauge arrangement in which empty needles are provided between adjoining knitting needles suspending stitches within the knitting width, and to a tubular shaped fabric knitted by the method.

Background Art

15 **[0002]** Conventionally, a base fabric of a glove 1 as shown in Fig. 7 has been able to be basically knitted as a plain knitting structure in an all needle arrangement in which knitting needles within the knitting width are used with no empty needle. The plain knitting structure is knitted with only front stitches using knitting needles of front and rear needle beds opposing each other in a needle bed gap, to which a knitting yarn is supplied on a flatbed knitting machine. Joining the plain knitting structure fabrics, each of which is knitted on each needle bed, at both ends of the knitting width can produce a tubular shaped fabric. In order to knit a stretch wrist portion 2 by the all needle arrangement, a method for inserting an elastic yarn or the like as a sub yarn into a plain-knitted fabric is known (for example, see Patent Citation 1). The wrist portion 2 is desirably knitted by changing the knit fabric itself from the plain knitting structure to a stretch rib knitting structure. However, since the rib knitting structure must be knitted with front stitch and back stitch alternately, the needles of both needle beds opposing each other in a needle bed gap are used. The rib knitting structure fabric, which has front stitches knitted by knitting needles of one needle bed, has back stitches knitted by knitting needles of the other needle bed. In such a case, the fabric of the rib knitting structure in which the front stitches are knitted by the knitting needles of the other needle bed must be saved by transferring the front stitches knitted by knitting needles of the one needle bed to empty needles of the other needle bed. To enable such saving, on each needle bed, between knitting needles used for knitting front stitches, empty needles, for saving the back stitches and for knitting back stitches that follow the front stitches knitted on the opposite needle bed, must be prepared together. Consequently, in order to knit other portions of the glove 1 with the plain knitting structure and to knit the wrist portion 2 with the rib knitting structure, the arrangement of knitting needles used for knitting on each needle bed must be changed from the all needle arrangement to the half gauge arrangement in which empty needles are provided.

30 **[0003]** For a knitting needle of a flatbed knitting machine, a composite needle equipped with a slider to open and close a hook and capable of holding a stitch on a tongue at a head end of the slider may be used. In such a case, changing from the all needle arrangement to the half gauge arrangement while increasing the knitting width and generating empty needles between adjoining knitting needles is enabled by using hold and place to a tongue and further using a transfer jack (for example, see Patent Citation 2). In Patent Citation 2, a procedure to partially obtain the half gauge arrangement at a sweater neckline portion is disclosed. In addition, it is described that change from the all needle arrangement to the half gauge arrangement is able to be achieved via transfer jack only without utilizing the hold and place to the tongue, too. Incidentally, for changing from a rib-knitted hem portion consisting of the 1 x 1 rib knitting structure, which requires change from the half gauge arrangement to the all needle arrangement, to a body portion consisting of a plain knitting structure, back stitches that are knitted by knitting needles of the opposite needle bed might be transferred to the knitting needles of the needle bed on which the front stitches are knitted (for example, see Patent Citation 3).

45 Patent Citation 1 Japanese Examined Utility Model Application Publication No. Sho 33-018528

Patent Citation 2 Japanese Patent No. 3863019

Patent Citation 3 Japanese Patent No. 2946325

Disclosure of Invention**Technical Problem**

50 **[0004]** Change from the all needle arrangement to the half gauge arrangement shown in Patent Citation 2 is achieved by, first, transferring the all stitches temporarily suspended from the knitting needles of one needle bed where empty needles to be generated, to the transfer jack bed or the like. The stitches are transferred to the transfer jack bed and are returned stitch by stitch while the transfer jack bed is shifted stitch by stitch, whereby the knitting width is widened and an empty needle can be generated between adjoining knitting needles. However, even when the knitting width is widened, no new stitch loop is knitted. When the knitting width is widened, the knitting yarn is elongated and contracted. Repeating elongation and contraction of the knitting yarn required for transferring in a range of limited yarn length existing

as stitches which have been already knitted without forming new stitches may result in yarn breakage. Consequently, the number of stitches is restricted for widening the knitting width. Even in Patent Citation 2, the change from the all needle arrangement to the half gauge arrangement is conducted not for the whole tubular fabric but for the neckline portion only, and the remainder of stitches temporarily transferred to the transfer jack bed is returned to the needle bed without forming any empty needle.

[0005] Even in a glove 1 of Fig. 7, by knitting a wrist portion 2 in advance, it is possible to shift from the rib structure to a base fabric of the flat knitting structure as in the case of Patent Citation 3. However, in the glove 1, yarn ends must be treated for each one of the five finger bags, respectively.

[0006] A fabric of the plain knitting structure can be knitted even in the half gauge arrangement, and therefore, knitting the base fabric of the glove 1 in the half gauge arrangement can secure empty needles for knitting the wrist portion 2 with the half gauge structure or the like. However, for the base fabric, only a fabric could be knitted with so coarse hand value that corresponds to a gauge about one half of the gauge corresponding to the arrangement pitch of the knitting needles.

[0007] It is an object of the present invention to provide a method for knitting a tubular shaped fabric which can smoothly change an all needle arrangement to a half gauge arrangement without causing yarn breakage or change in hand value, and to provide a tubular shaped fabric.

Technical Solution

[0008] The present invention is a method for knitting a tubular shaped fabric, by using a flatbed knitting machine, which has at least one pair of needle beds disposed in an opposing relationship to each other over a needle bed gap, is capable of racking and stitch transferring between the opposing needle beds, and is capable of transferring stitches suspended from knitting needles on one of the opposing needle beds to the other knitting needles of the one needle bed by moving the stitches back and forth in the needle bed gap without causing any effect on stitches suspended from hooks of knitting needles on the other needle bed while knitting the tubular shaped fabric by using the both needle beds, and by knitting fabrics on both of the opposing needle beds and joining both fabrics to each other at the opposite ends of the knitting width:

wherein when knitting on each needle bed is changed from an all needle arrangement in which no empty needle is generated between knitting needles in the knitting width to a half gauge arrangement in which an empty needle is generated between knitting needles in the knitting width;
 assigning a yarn feeding port to each fabric suspended from needles of each needle bed; and
 repeating to form stitches in part on each needle bed, to keep the yarn feeding port in the vicinity of the formed stitches, and to move all stitches within a range from the formed stitch or the adjacent stitch thereof to an end stitch of one side of the knitting width, back and forth in the needle bed gap under a state without causing any effect on stitches suspended from hooks of knitting needles on the opposing needle bed so as to move each stitch from a needle on which the stitch suspending to a needle adjacent in the one side, and then to generate an empty needle adjacent to the formed stitch, while changing a position where the stitches are formed in part;
 thus generating empty needles between needles suspend stitches.

[0009] In addition, the method for knitting a tubular shaped fabric according to the present invention is **characterized in that**

the change from said all needle arrangement to said half gauge arrangement is conducted within a single knitting course.

[0010] In addition, the method for knitting a tubular shaped fabric according to the present invention is **characterized in that**

the change from said all needle arrangement to said half gauge arrangement is conducted within a plurality of knitting courses.

[0011] In addition, the method for knitting a tubular shaped fabric according to the present invention is **characterized in that**

the direction in which said empty needle adjacent to said formed stitch is evenly changed over between one side and the other side of the knitting width.

[0012] In addition, the method for knitting a tubular shaped fabric according to the present invention is **characterized in that**

said repeating to form stitches in part is executed stitch by stitch, and to move each stitch for generating each empty needle is executed every time one stitch is formed.

[0013] Furthermore, the present invention provides a tubular shaped fabric knitted by any one of the preceding methods for knitting a tubular shaped fabric.

Advantageous Effects

[0014] According to the present invention, while knitting a tubular shaped fabric with use of one pair of needle beds opposing each other over a needle bed gap in-between, a yarn feeding port is assigned to each fabric suspended from needles of each needle bed, respectively, when the all needle arrangement is changed to the half gauge arrangement in which empty needles are generated between knitting needles in the knitting width. In each needle bed, stitches are formed in part and the yarn feeding port is kept in the vicinity of the formed stitches. All stitches within a range from the formed stitch or the adjacent stitch thereof to an end stitch of one side of the knitting width, are transferred from knitting needles which suspend the stitches to adjacent knitting needles on the one end side, by moving back and forth in the needle bed gap under a state without causing any effect on stitches suspended from hooks of knitting needles of the opposing needle bed, so that it is possible to generate empty needles adjacent to the formed stitches. When the empty needles adjacent to the formed stitches are generated, the knitting yarn elongates and contracts not only within a range of a limited yarn length existing as already knitted stitches but also including knitting yarn supplied from the yarn feeding port kept in the vicinity of the formed stitches, and therefore, likelihood of yarn break is reduced. Transfer of stitches would be conducted so as not to cause any effect on stitches suspended from hooks of knitting needles of opposing needle bed by use of holding stitches to tongues of compound needles, by the use of transfer jack bed, or the like. Accordingly, knitting can be smoothly changed from the all needle arrangement to the half gauge arrangement without yarn breakage or changes in hand value.

[0015] In addition, according to the present invention, the change from the all needle arrangement to the half gauge arrangement is conducted in a single knitting course, so that it is possible to change knitting from plain knitting structure to rib knitting structure without scarcely causing effect on external appearance of knitted fabric.

[0016] In addition, according to the present invention, the change from the all needle arrangement to the half gauge arrangement is conducted in a plurality of knitting courses, so that it is possible to, for example, restrict the number of stitch transfers or change the knitting width. In case that the upper limit of the number of the stitch transfers would be fixed in a range in which there is no likelihood of yarn break, and knitting courses are added when the number of transfers exceeds the upper limit, the change from the all needle arrangement to the half gauge arrangement might be conducted with no likelihood of any yarn break.

[0017] In addition, according to the present invention, the direction to transfer a stitch to other knitting needle and generate an empty needle between knitting needles is evenly changed over between the one direction and the other direction of the needle row direction of knitting needles. Since the knitting width is widened bringing a balance on both sides of the formed knitted loop, it is possible to widen the knitting width with reducing the number of transferring stitches and without biasing direction of stitches.

[0018] In addition, according to the present invention, stitches formed in part are knitted stitch by stitch, and every time one stitch is formed, the stitch is transferred to the other knitting needle to generate an empty knitting needle, and then the knitting width can be widened. The knitting yarn required for generating empty needles is fed from the yarn feeding port kept in the vicinity of the formed stitches, so that empty needles can be generated stably.

[0019] Furthermore, according to the present invention, it is possible that a tubular shaped fabric formed by front and rear needle beds includes a fabric knitted by knitting needles in the all needle arrangement, a fabric knitted by knitting needles in the half gauge arrangement, and a portion where knitting needle arrangement is changed while stitches are knitted in part with different knitting yarns in respective needle beds.

Brief Description of Drawings

[0020]

[Fig. 1] Fig. 1 shows a plan view showing a schematic structure of a glove 10 which can be knitted by the use of a method of knitting a tubular shaped fabric according to one embodiment of the present invention, and a knitting state of the front and rear needle beds.

[Fig. 2] Fig. 2 is a diagram showing a first third of a schematic procedure of one example in which a needle arrangement changing portion 13 as shown in Fig. 1(a) is formed within a single knitting course.

[Fig. 3] Fig. 3 is a diagram showing a second third of the schematic procedure of the one example in which the needle arrangement changing portion 13 as shown in Fig. 1(a) is formed within the single knitting course.

[Fig. 4] Fig. 4 is a diagram showing a last third of the schematic procedure of the one example in which the needle arrangement changing portion 13 as shown in Fig. 1(a) is formed within the single knitting course.

[Fig. 5] Fig. 5 is a diagram showing a main portion of a schematic procedure of another example in which the needle arrangement changing portion 13 as shown in Fig. 1(a) is formed within a plurality of knitting courses.

[Fig. 6] Fig. 6 is a diagram showing a last part of the schematic procedure of the another example in which the needle arrangement changing portion 13 as shown in Fig. 1(a) is formed within the plurality of knitting courses.

[Fig. 7] Fig. 7 is a plan view showing a schematic structure of a conventional glove 1.

Explanation of Reference

5	[0021]	
	10	Glove
	11	Base fabric
	12	Wrist portion
10	13	Needle arrangement changing portion
	15, 16	Yarn feeding port

Best Modes for Carrying Out the Invention

15 **[0022]** Fig. 1 shows a schematic structure of a glove 10 which can be knitted by use of a method for knitting a tubular shaped fabric according to one embodiment of the present invention, and a knitting state of the front and rear needle beds. Incidentally, in each of the following figures, "F" denotes the front needle bed and "B" denotes the rear needle bed, respectively. In addition, a grid cell in each needle bed shows a knitting needle. A dot inside the grid cell indicates a empty needle. A circular mark in a grid cell indicates that a stitch is suspended. A black circular mark indicates a stitch newly formed as a knit stitch or the like. A triangle mark outside a grid cell indicates a yarn feeding port.

20 **[0023]** A glove 10 which has an external appearance structure shown in Fig. 1(a) is knitted as a tubular shaped fabric using a flatbed knitting machine equipped with a pair of opposing front and rear needle beds with a needle bed gap in-between. In this kind of flatbed knitting machine, racking and stitch transferring are possible between the opposing front and rear needle beds. A base fabric 11 of the glove 10 includes finger bags to which five fingers are inserted, respectively. 25 Knitting of the glove 10 is basically set up from the finger bag side of the base fabric 11 in an all needle arrangement, and is finished at a wrist portion 12 formed in a half gauge arrangement. To the portion shifting from the base fabric 11 to the wrist portion 12, a needle arrangement changing portion 13 is provided.

30 **[0024]** Fig. 1(b) shows a usage state of knitting needles when the base fabric 11 of Fig. 1(a) is knitted into a tubular shape on the front and rear needle beds. A tubular shaped fabric can be produced by joining the fabrics knitted on the front and the rear needle beds on both sides of the knitting width and by rounding the knitting yarn. The base fabric 11 becomes an all needle knitting fabric knitted basically by needles in an all needle arrangement. In the all needle arrangement, no empty needle is provided in the knitting width but stitches are continuously formed by adjacent knitting needles.

35 **[0025]** Fig. 1(c) shows a state in a course of knitting the needle arrangement changing portion 13. The knitting width is successively widened so as that empty needles are provided between adjacent knitting needles in the all needle arrangement. When the needle arrangement changing portion 13 of the present embodiment is knitted, yarn feeding ports 15 and 16, such as yarn feeders, are assigned to each needle bed, respectively, and kept in vicinity of stitches to be transferred.

40 **[0026]** Fig. 1(d) and Fig. 1(e) show states in which the wrist portion 12 of Fig. 1(a) is knitted as 1 x 1 rib knitting structure. The needle arrangement of Fig. 1(d) and Fig. 1(e) can be achieved by shifting, for example, the front needle bed to the right by one pitch in the knitting needle arrangement of Fig. 1(c). By repeating in this kind of half gauge needle arrangement, on one side, a stitch as a back stitch knitted on the opposing needle bed, on the other side, is returned and saved to the needle bed from which a stitch is suspended after knitted as a front stitch, a tubular shaped fabric with half gauge knitting knitted structure could be obtained.

45 **[0027]** Fig. 2 through Fig. 4 show a schematic procedure of one example in which the needle arrangement changing portion 13 as shown in Fig. 1(a) is formed within a single knitting course line. In grid cells of front and rear needle beds, symbols "A" through "T" and "a" through "t" are added to distinguish each knitting needle for expedient purposes. The uppercase letters "A" through "T" denote knitting needles of the front needle bed. The lowercase letters "a" through "t" denote knitting needles of the rear needle bed.

50 **[0028]** An empty needle shown with a dot in a grid cell indicates a case in which a knitting needle becomes an empty needle after a procedure to suspend a stitch. An empty needle which does not suspend stitch in a preceding procedure is shown by a blank grid cell. A stitch with an X-mark added to a circular mark in a grid cell indicates a state, immediately after the stitch is knitted as shown by a black circular mark. The needle arrangement changing portion 13 is knitted by assigning relevant yarn feeding ports to the front and the rear needle beds, respectively. The yarn feeding port to be assigned to the front needle bed is shown by a black coat triangle mark. The yarn feeding port assigned to the rear needle bed is shown by an outline triangle mark. For the knitting needle, the compound needle that can hold and place a stitch on the tongue of the slider is used. A double circle mark in a grid cell shows a state in which a stitch is suspended form the hook and at the same time, a stitch is hold and placed on the slider, too. An arrow mark in a grid cell shows a state in which a stitch suspended form the hook is transferred to a knitting needle of the opposite needle bed. An arrow 55

mark shown in a needle bed gap between needle beds shows a state in which the a stitch held and placed on the tongue of the slider is transferred to a knitting needle of the opposite needle bed. Incidentally, in place of using a compound needle that can hold and place a stitch on a slider, a flatbed knitting machine equipped with a transfer jack bed, or the like may be used, too.

[0029] In the right side of the indication of the needle bed, racking motions between the front and the rear needle beds, or knitting motions are shown. Between the front and the rear needle beds, a racking motion to shift, for example, the rear needle bed to the right or the left in units of a knitting needle arrangement pitch with respect to the front needle bed is possible, and let the "L0.5P" denote the standard state. In addition, in the right and left direction of the front and the rear needle beds, a carriage is installed in such a manner to be able to run, and to the carriage, a cam system that can selectively drive knitting needles is mounted. The carriage can selectively bring yarn feeding ports. In the right side of the indication of the needle bed, carriage travel direction is indicated by a right or left arrow. When "K" is added to the arrow, it is indicated that a yarn feeding port is brought and a stitch is formed. The yarn feeding port is kept in the vicinity of the last-formed stitch. When a short arrow is attached to a right or left arrow, it is indicated that the yarn feeding port is kicked back. A upward or downward arrow attached to a right or left arrow indicate a stitch transfer direction. In case, the upward or downward arrow is an outline arrow, it is indicated that stitches are held and placed on the tongues of the sliders.

[0030] A character "S" of Fig. 2 shows a suspending state in which final course stitches of a fabric knitted by knitting needles in an all needle arrangement like the base fabric 11 shown in Fig. 1(a). However, the knitting width is for expedient purposes only and is chosen in accordance with a size of a fabric actually knitted or a gauge of a flatbed knitting machine used. The range of the knitting width used in the half gauge arrangement is larger than the range of knitting needles "A" through "T" and "a" through "t" as described later.

[0031] Hereinafter, with respect to each step of step a1 to step a19, a plurality of steps may be executed in one stroke if a plurality of cam systems are mounted to a carriage. In addition, even if description is made as a single step, the carriage may need a plurality of strokes.

[0032] In step a1, a knitting yarn is fed to knitting needles "d" and "e" on the left end side of the rear needle bed by a yarn feeding port assigned to the rear needle bed and stitches are formed. In step a2, the knitting yarn is fed to knitting needles "D" and "E" on the left end side of the front needle bed by a yarn feeding port assigned to the front needle bed and stitches are formed. In step a3, both yarn feeding ports are kicked back to move them leftwards, and stitches suspended from hooks of knitting needles "e" through "q" of the rear needle bed are transferred so as to be held and placed on sliders of knitting needles "E" through "Q" of the front needle bed. The kick backs of the yarn feeding ports are carried out to clear out of the way for this transfer. In step a4, the rear needle bed is shifted to the left by 1 pitch by racking with respect to the front needle bed and the "L1.5P" state is obtained. Transferring the stitches held and placed on the sliders of the knitting needles "E" through "Q" of the front needle bed to the knitting needles "f" through "r" of the rear needle bed can make the knitting needle "e" an empty needle.

[0033] That is, in steps a3 through a6, within the knitting needles "D" and "E" as well as "d" and "e" on which stitches were formed in steps a1 and a2, the stitches suspended from the knitting needles "E" and "e" on the right side and from the knitting needles "F" through "Q" as well as "f" through "q" on the further right side are transferred to the rightward, respectively. Such a transfer of these stitches makes the knitting needles "e" and "E" serve as empty needles generated between the knitting needles "D" and "F", and between the knitting needles "d" and "f", respectively.

[0034] In step a5, under the "L1.5P" state, the stitches suspended from the hooks of the knitting needles "E" through "Q" of the front needle bed are transferred in such a manner that they are held and placed on the sliders of the knitting needles "f" through "r" of the rear needle bed. In step a6, the rear needle bed is returned to the right by one pitch to achieve the "L0.5P" state, and the stitches held and placed on the sliders of the knitting needles "f" through "r" of the rear needle bed are transferred to the hooks of the knitting needles "F" through "R" of the front needle bed, respectively. The knitting needle "E" of the front needle bed becomes an empty needle.

[0035] In step a7 of Fig. 3, a stitch is newly formed on the knitting needle "G" of the front needle bed, and only the yarn feeding port is kicked back to move rightward in the rear needle bed. In step a8, the stitches suspended from the hooks of the knitting needles "F" and "D" on the left side of the knitting needle "G" on which the new knitted stitch was formed are transferred to the sliders of the knitting needles "f" and "d" of the rear needle bed, respectively, so as to be held and placed on the sliders. In step a9, the rear needle bed is racked by only one pitch leftward with respect to the front needle bed to have the "L1.5P" state, and the stitches are transferred from the sliders of the knitting needles "f" and "d" of the rear needle bed to the hooks of the knitting needles "E" and "C" of the front needle bed. The knitting needle "F" becomes an empty needle. In step a10, with the "L1.5P" state continued, the yarn feeding port assigned to the rear needle bed is kicked back to move leftward temporarily, and then, the yarn feeding port is further moved rightward to form a stitch on a knitting needle "g". The kick back in such event is conducted for the purpose of forming the stitch on the knitting needle "g" while the yarn feeding port is moving rightward. In step a11, the stitches suspended from the hooks of the knitting needles "f" and "d" on the left side of the knitting needle "g" of the rear needle bed on which the new knitted stitch was formed are moved to be held and placed on the sliders of the knitting needles "E" and "C" of the

front needle bed. In step a12, the rear needle bed is returned rightward by 1 pitch to have the "L0.5P" state, and the stitches are transferred from the sliders of the knitting needles "E" and "C" of the front needle bed to the hooks of the knitting needles "e" and "c" of the rear needle bed. Accordingly, in the rear needle bed, too, the knitting needle "f" is made into an empty needle.

[0036] That is, in steps a7 through a12, the knitting yarn is fed to the knitting needles "G" and "g" from the left to the right so as to form stitches, and stitches on the left side of the formed stitches are transferred to the left side. By transfer of the knitted stitches in the direction reversal to the yarn feeding direction, the knitting needles "F" and "f" adjacent to the left side of the knitting needles "G" and "g" on which the stitches were formed can be made into empty needles.

[0037] Same as above, in step a13 of Fig. 3 to step a15 of Fig. 4, by the transfer of a newly knitted stitch to the right side on the knitting needle "H" of the front needle bed, the knitting needle "H" can be made into an empty needle. In step a16 to step a18, by the transfer of a newly knitted stitch to the right side on the knitting needle "h" of the rear needle bed, the knitting needle "h" can be made into an empty needle. That is, in step a13 to step a18, the knitting yarn is fed to the knitting needles "H" and "h" from the left to the right, to form stitches, and the formed stitches and the stitches on the right side thereof are transferred to the right side. By the transfer of stitches in the direction same as such yarn feeding direction, the knitting needles "H" and "h", on which stitches are formed, can be made into empty needles.

[0038] Incidentally, one of the two yarn feeding ports assigned to the front needle bed and the rear needle bed, respectively, may be used for knitting the base fabric 11 as it is. In such event, the needle arrangement changing portion 13 is knitted with the knitting yarn linked to the base fabric 11 and with a knitting yarn newly added.

[0039] Description on the procedure between step a18 and step a19 of Fig. 4 is omitted, but all we have to do is to generate empty needles on the right and the left of a position where a stitch is formed while moving a newly knitted stitch forming position successively to the right. Step a19 is a state in which formation of an empty needle is practically finished and practically shows the state equivalent to that of Fig. 1(c).

[0040] It is possible to change the all needle arrangement to the half gauge arrangement within the same knitting course by the procedure from state S of Fig. 2 to step a19 of Fig. 4. In the arrangement shown in step a19, the empty needles are provided between adjacent knitting needles on the front and the rear needle beds, and then the knitting needles which suspend stitches themselves are faced to one another, the empty needles themselves are faced to one another. From this state, shifting rightward or leftward by one pitch can easily change the needle arrangement to an arrangement in which a knitting needle that suspend a stitch and an empty needle are faced to each other as shown in Fig. 1(c). Incidentally, an empty needle is provided by widening the knitting width alternately to the right and the left while a newly knitted stitch is formed one by one from one end to the other end in the knitting width in the same knitting course, but it is possible to repeat the procedure of widening the knitting width in multiple times with respect to the formation of multiple stitches. Forming newly knitted stitches and keeping a yarn feeding port close to the newly formed stitches can help prevent yarn breakage even when the stitches are transferred and the knitting width is widened in multiple times. The stitches formed at a time may be, for example, about 5 stitches. By forming multiple stitches and transferring the knitted stitches in multiple times, the all needle arrangement can be efficiently changed to the half gauge arrangement. The direction to form empty needles to widen the knitting width may not only be repeatedly changed between rightward and leftward evenly, but also may be repeatedly changed after widening the knitting width in one direction in multiple times and then in the other direction in multiple times. By changing the direction to form empty needles between rightward and leftward evenly, the needle arrangement can be changed in a well-balanced manner.

[0041] Fig. 5 and Fig. 6 show a schematic procedure of one example for forming the needle arrangement changing portion 13 as shown in Fig. 1(a) within a plurality of knitting courses. In Fig. 2 through Fig. 4, single stitches are formed, but in Fig. 5 and Fig. 6, plural stitches are formed. A character "S" of Fig. 5 is basically equivalent to "S" of Fig. 2 and shows the state in which the final course stitches of a fabric, such as the base fabric 11 shown in Fig. 1(a), knitted by knitting needles in the all needle arrangement are suspended. In steps between steps b1 and b7, there included steps which show a procedure to change the needle arrangement still more collectively than in steps between steps a1 and a19 of Fig. 2 through Fig. 4. For example, in step b2, the transfer of stitches for generating empty needles on one needle bed as shown in Steps a2 through a4 and steps a5 through a6 of Fig. 2 is shown by one step as though transferring on both sides. In addition, the display of the yarn feeding port is omitted.

[0042] In step b1 of Fig. 5, same as step a1 and step a2 of Fig. 2, newly knitted stitches are formed on two adjacent knitting needles "D" and "E" as well as "d" and "e" on each needle bed. In step b2, the knitted stitches suspended from the knitting needles "E" and "e" just after newly knitted stitches were formed and knitted stitches suspended from the knitting needles "F" through "Q" and "f" through "q" on the right side of the knitting needles "E" and "e" are moved rightward by one stitch only. Accordingly, the knitting needles "E" and "e" can be made into empty needles. The stitches moved to the knitting needles "G" through "R" as well as "g" through "r" have made a first time transfer after the stitch knitting included in the initial state "S". In step b3, stitches are newly formed on the knitting needles "G", "H", and "I" as well as "g", "h", and "i". On the knitting needles "G", "H", and "I" as well as "g", "h", and "i", the stitches suspended from the knitting needles "F", "G" and "H" as well as "f", "g", and "h" in the initial state "S" are knocked over. In step b4, the stitches suspended from the knitting needles "F" and "D" as well as "f" and "d" on the left side of the knitting needles

"G", "H", and "I" as well as "g", "h", and "i" just after new stitches were formed are moved leftward by one stitch only. Accordingly, the knitting needles "F" and "f" can be made into empty needles. The stitches transferred to the knitting needles "C" and "E" as well as "c" and "e" have made a first transfer after the stitches were formed in step b1. In step b5, the stitches suspended from the knitting needles "H" and "I" as well as "h" and "i" in which the stitches have already been formed and the knitting needles "J" through "R" as well as "j" through "r" on the right side of the knitting needles "H", "I", "h", and "i" are moved rightward by one stitch only. Accordingly, the knitting needles "H" and "h" can be made into empty needles. In step b6, the stitches suspended from the knitting needles "J" and "j" on which the stitches have already been formed and in the knitting needles "K" through "S" as well as "k" through "s" on the right side of the knitting needles "J" and "j" are moved rightward by one stitch only. Accordingly, the knitting needles "J" and "j" can be made into empty needles. The stitches moved to the knitting needles "K" through "T" as well as "k" through "t" have made a second transfer after the stitches were formed.

[0043] Step b7 of Fig. 6 shows a state in which the change to the half gauge arrangement has been finished by repeating stitch formation and stitch transfer as shown in Fig. 5. Repeating transfer after stitches are formed causes the knitting yarn to elongate, and as the number of transfer increases, likelihood of broken yarn increases. As in the steps b1 through b7, the procedure of shift the stitch forming position from the left end side to the right end side of the knitting width, and the generation of empty needles adjacent to the formed stitches, the number of shifts of the stitches on the left end or the right end increases.

[0044] Depending on the conditions of knitting yarn used for knitting, repeating transfer may cause yarn breakage. When the upper limit is set for the number of transfers of stitches after formation of the stitches, and the number of transfers exceeds the upper limit, if the stitches are newly formed on the whole course, the transfer of the following stitches becomes the initial transfer and likelihood of yarn breakage caused by increased number of transfers can be eliminated. For example, when the number of stitch transfers at the knitting end reaches the upper limit under the condition in which the stitch forming position for changing the needle arrangement is on the way of the knitting width, the stitches are knitted, respectively, on the front and the rear needle beds so that the stitches reciprocate with the stitch forming position set as a starting point. The stitches are desirably knitted with the interlock knitting in which stitches are alternately knitted on one way so that the stitches of the whole course may be formed in outward and homeward strokes. The yarn feeding port assigned to each needle bed, feeds a knitting yarn to the knitting end of the opposing needle bed, and at the front and the rear needle beds, the courses knitted by the knitting yarn fed from different yarn feeding ports are joined by tuck joints. By adding knitting courses and knitting the needle arrangement changing portion 13 by a plurality of knitting courses, the number of transfers of stitches can be restricted below the upper limit. The upper limit of the number of transfers may be set to, for example, about 5 times.

[0045] Increasing the number of knitting courses can set the upper limit of the number of transfers to a small number, thereby eliminating likelihood of yarn breakage. However, when the number of knitting courses of the needle arrangement changing portion 13 is increased, the appearance of the fabric may be impaired. It is therefore desirable to restrict the number of knitting courses to about 5 courses. In addition, in the event that the needle arrangement changing portion 13 is knitted by one or a plurality of courses, the knitting width may be varied to change the number of stitches in the all needle arrangement and in the half gauge arrangement. In particular, changing the arrangement when the number of stitches is reduced can be conducted by combining a technique to generate the empty needles by overlapping part of stitches suspended from the knitting needles in the all needle arrangement. That is, when the needle arrangement is changed, empty needles are generated by combining the partial knitted stitch formation with the stitch transfer for increasing the knitting width and at the same time by partially overlapping the stitches. Changing the ratio of the technique of generating empty needles can adjust the degree of reducing the number of stitches in the half gauge arrangement from the number of stitches in the all needle arrangement.

[0046] Applying the present invention can change the knitting in the all needle arrangement to the knitting in the half gauge arrangement by providing empty needles in various tubular shaped fabrics in addition to a glove 10 as shown in Fig. 1(a). Consequently, knitting from plain knitting structures to rib structures, links structures, fringes, and other structures, which has been limited, can be enabled, and knitting and knit fabric designs which have never existed before can be formed.

Claims

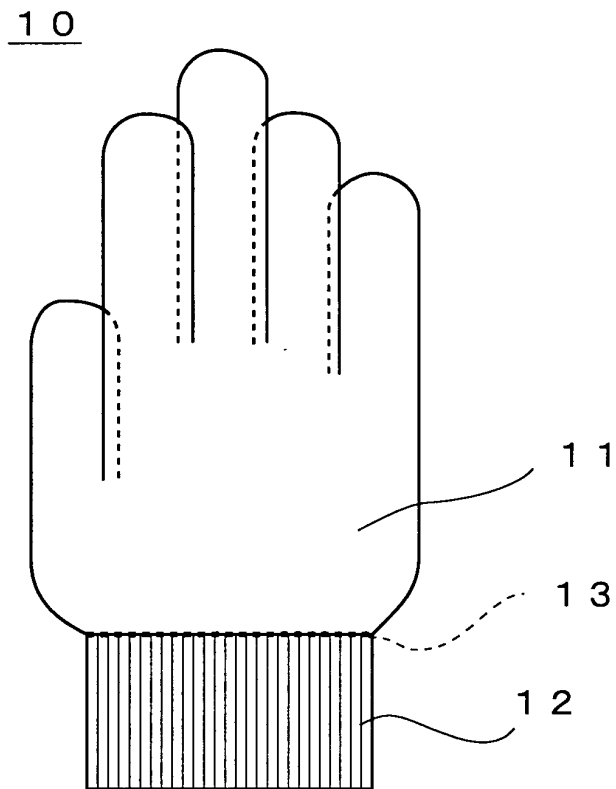
1. A method for knitting a tubular shaped fabric, by using a flatbed knitting machine, which has at least one pair of needle beds disposed in an opposing relationship to each other over a needle bed gap, is capable of racking and stitch transferring between the opposing needle beds, and is capable of transferring stitches suspended from knitting needles on one of the opposing needle beds to the other knitting needles of the one needle bed by moving the stitches back and forth in the needle bed gap without causing any effect on stitches suspended from hooks of knitting needles on the other needle bed while knitting the tubular shaped fabric by using the both needle beds, and by

knitting fabrics on both of the opposing needle beds and joining both fabrics to each other at the opposite ends of the knitting width:

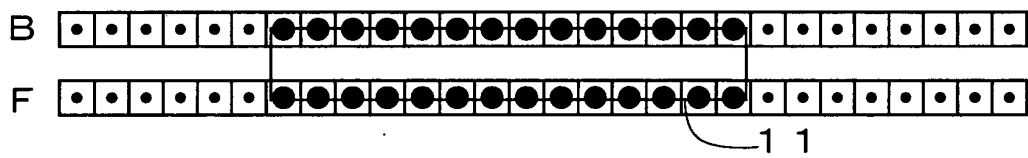
wherein when knitting on each needle bed is changed from an all needle arrangement in which no empty needle is generated between knitting needles in the knitting width to a half gauge arrangement in which an empty needle is generated between knitting needles in the knitting width;
 assigning a yarn feeding port to each fabric suspended from needles of each needle bed; and
 repeating to form stitches in part on each needle bed, to keep the yarn feeding port in the vicinity of the formed stitches, and to move all stitches within a range from the formed stitch or the adjacent stitch thereof to an end stitch of one side of the knitting width, back and forth in the needle bed gap under a state without causing any effect on stitches suspended from hooks of knitting needles on the opposing needle bed so as to move each stitch from a needle on which the stitch suspending to a needle adjacent in the one side, and then to generate an empty needle adjacent to the formed stitch, while changing a position where the stitches are formed in part; thus generating empty needles between needles suspend stitches.

2. The method for knitting a tubular shaped fabric according to claim 1, wherein the change from said all needle arrangement to said half gauge arrangement is conducted within a single knitting course.
3. The method for knitting a tubular shaped fabric according to claim 1, wherein the change from said all needle arrangement to said half gauge arrangement is conducted within a plurality of knitting courses.
4. The method for knitting a tubular shaped fabric according to any one of claims 1 - 3, wherein the direction in which said empty needle adjacent to said formed stitch is evenly changed over between one side and the other side of the knitting width.
5. The method for knitting a tubular shaped fabric according to any one of claims 1 - 4, wherein said repeating to form stitches in part is executed stitch by stitch, and to move each stitch for generating each empty needle is executed every time one stitch is formed.
6. A tubular shaped fabric knitted by the method for knitting a tubular shaped fabric according to any one of claims 1 - 5.

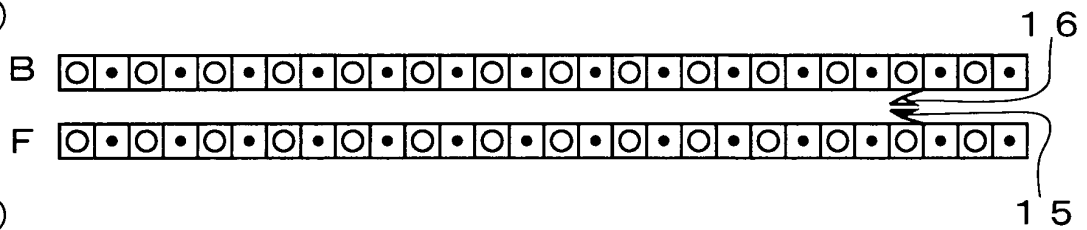
[Fig. 1]
(a)



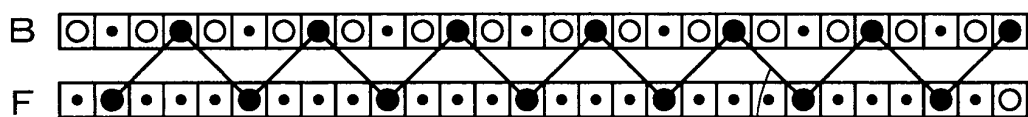
(b)



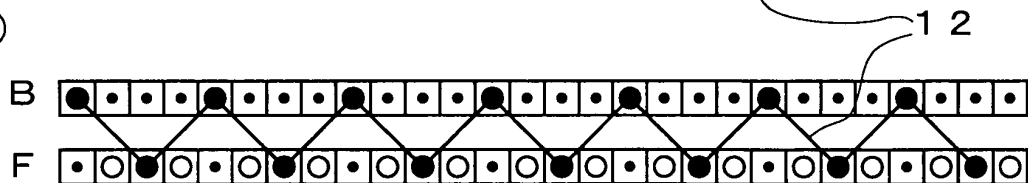
(c)



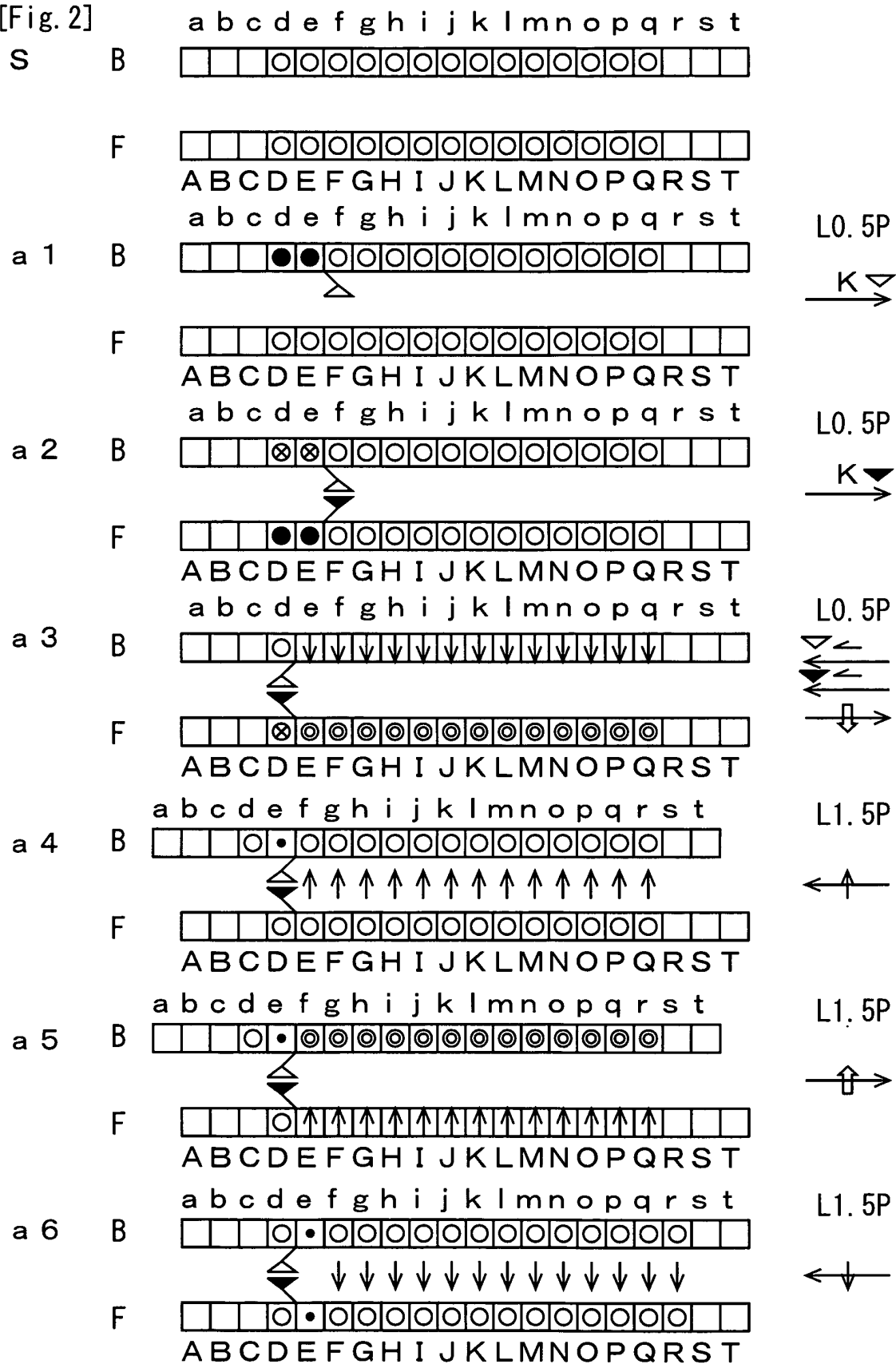
(d)



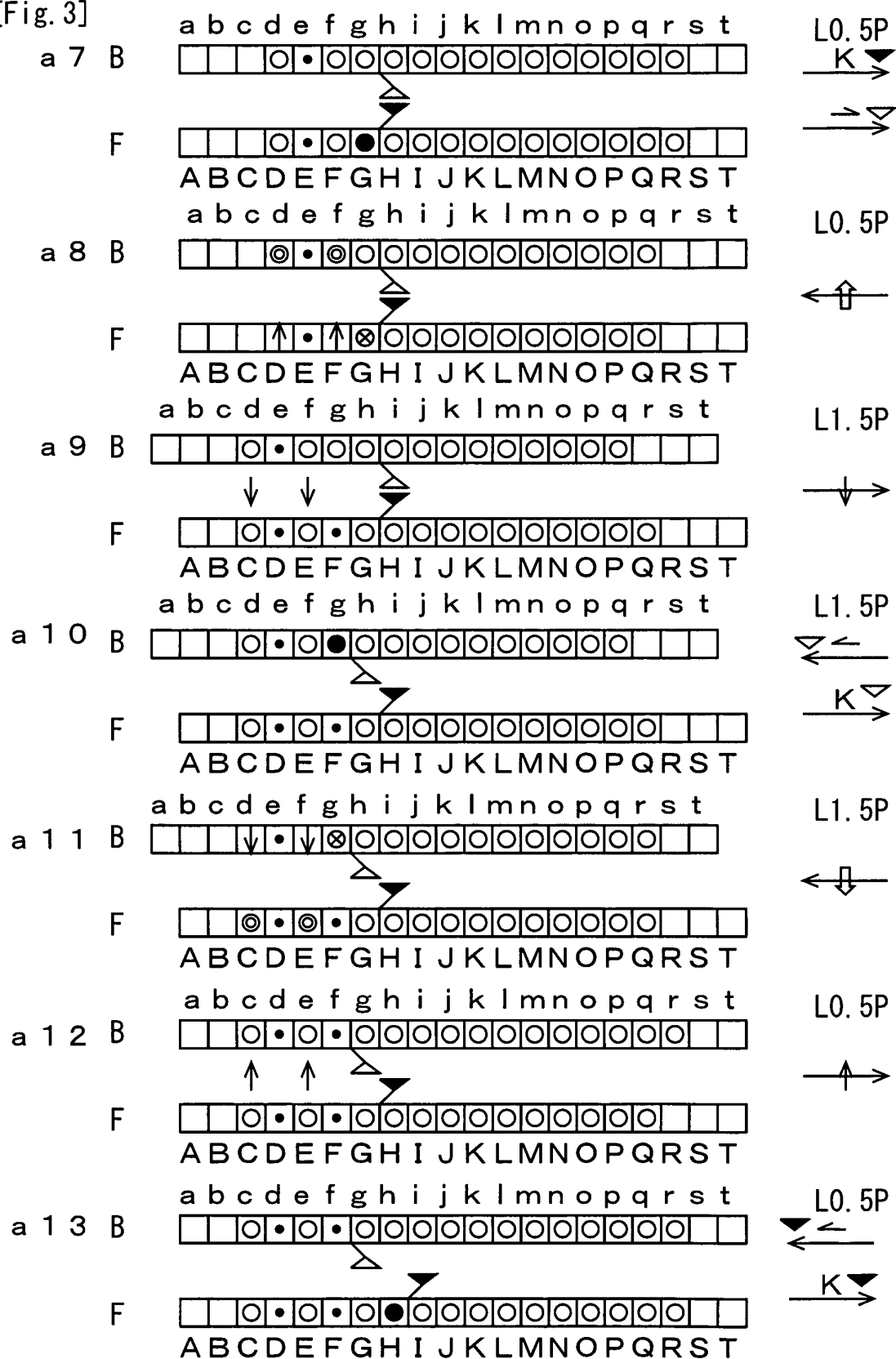
(e)



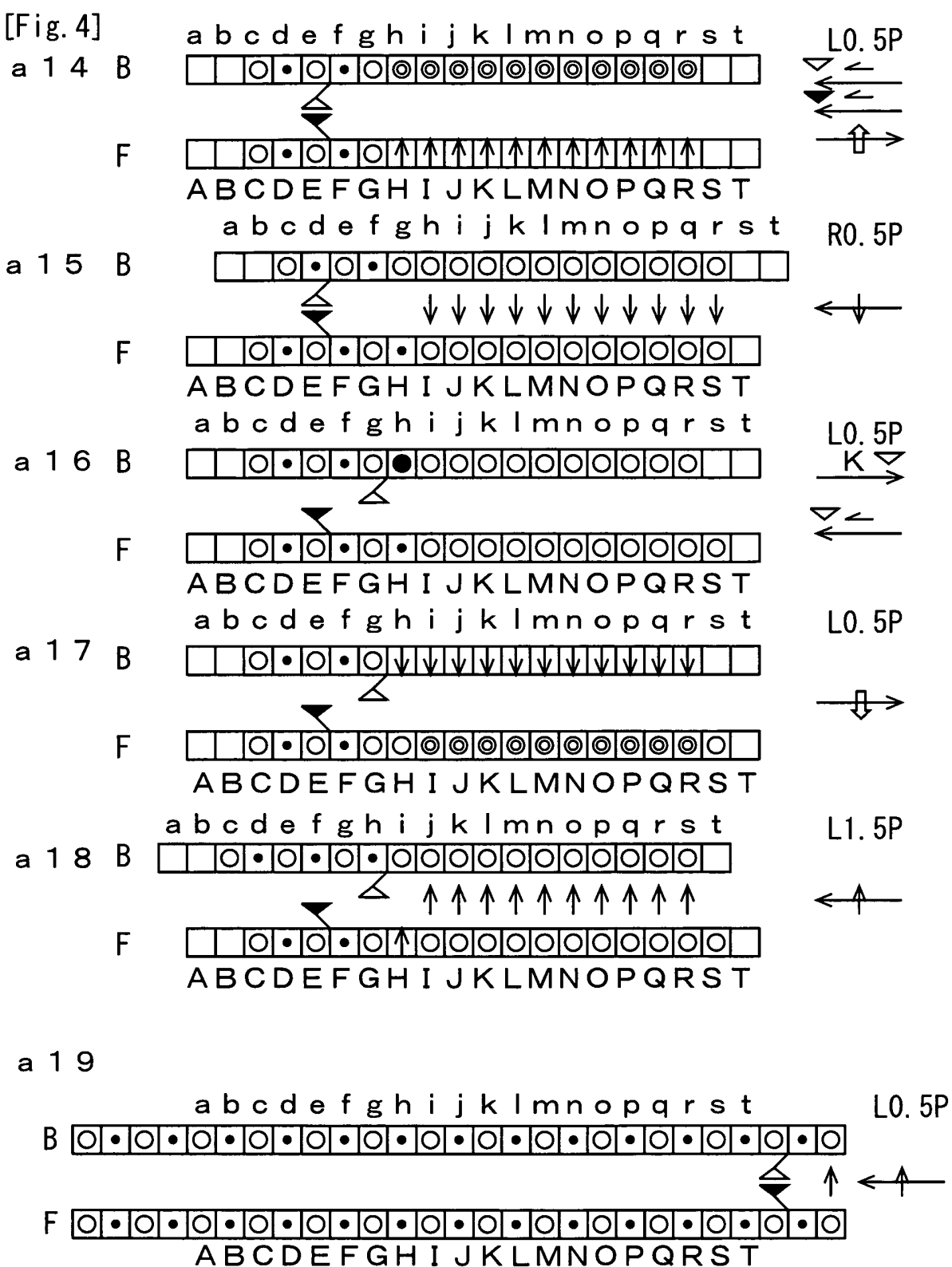
[Fig. 2]

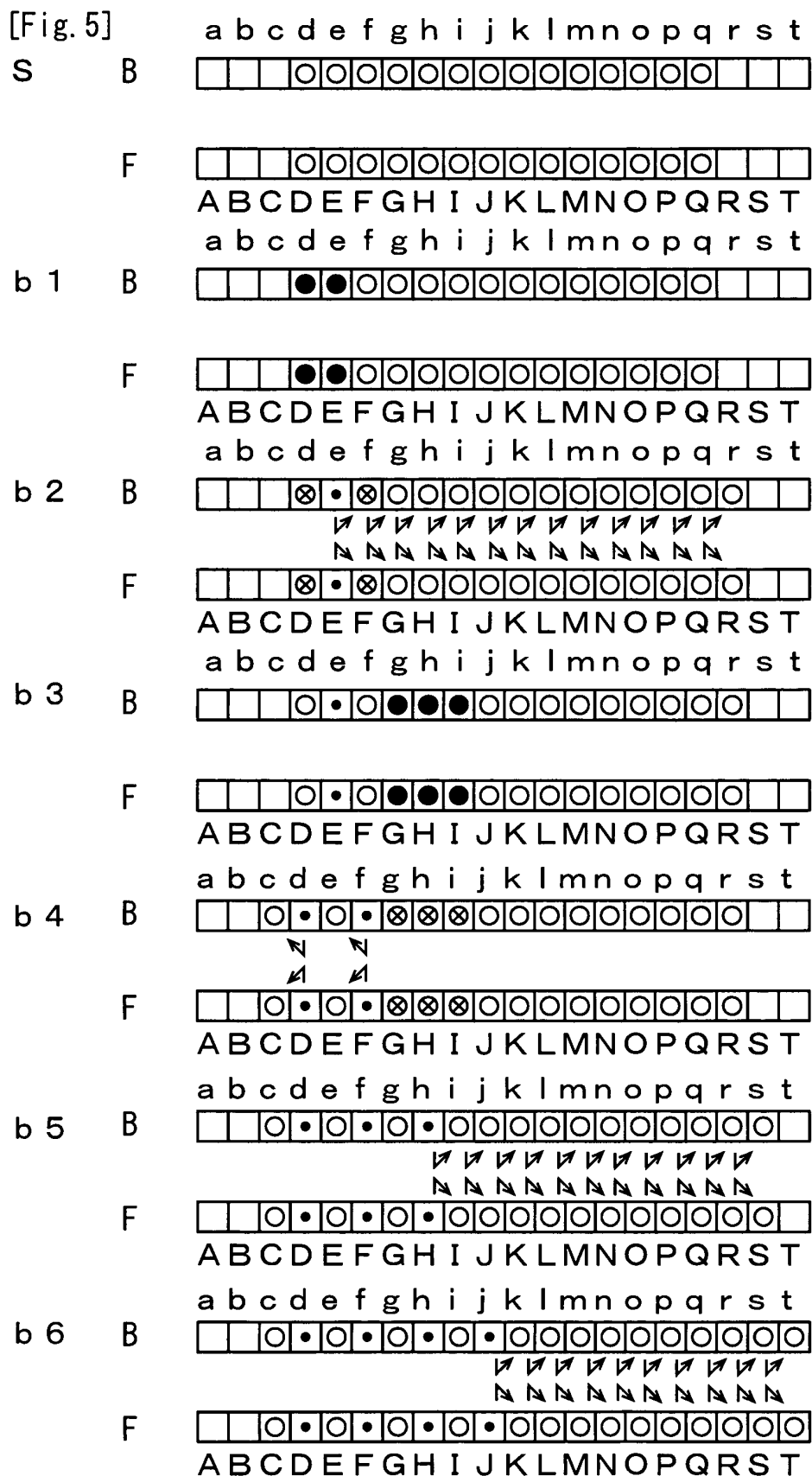


[Fig. 3]

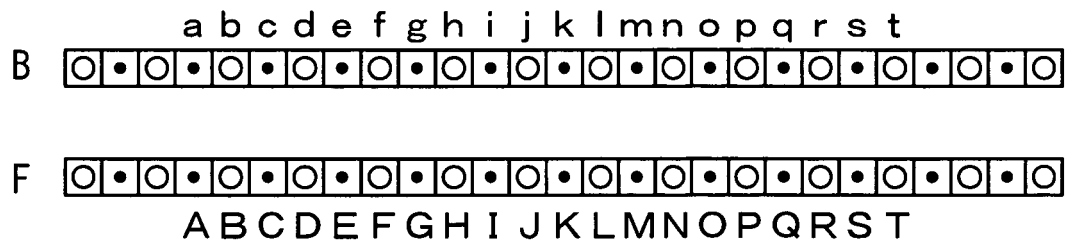


[Fig. 4]

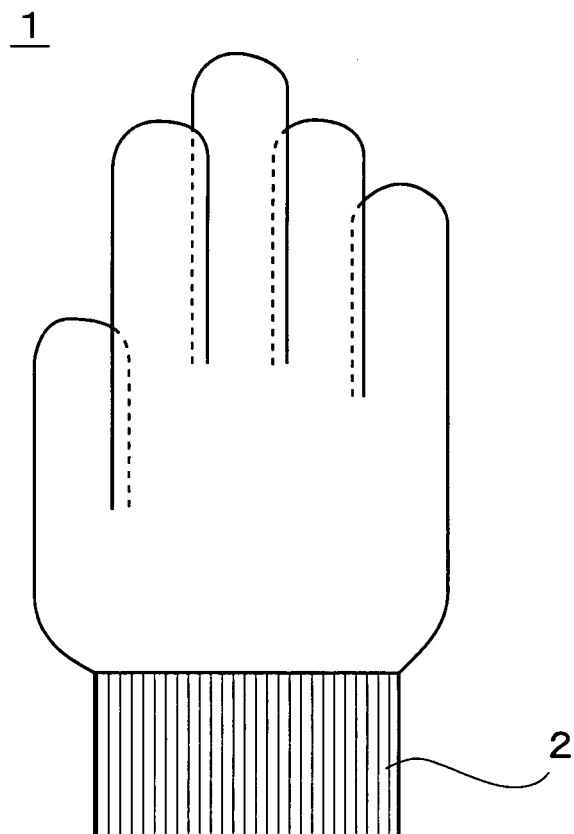




[Fig. 6]
b 7



[Fig. 7]



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2008/001666

A. CLASSIFICATION OF SUBJECT MATTER

D04B1/22(2006.01)i, A41D19/00(2006.01)i, D04B7/00(2006.01)i, D04B7/20
(2006.01)i, D04B7/34(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

D04B1/22, A41D19/00, D04B7/00, D04B7/20, D04B7/34

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

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2008
Kokai Jitsuyo Shinan Koho 1971-2008 Toroku Jitsuyo Shinan Koho 1994-2008

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 11-43849 A (Shima Seiki Mfg., Ltd.), 16 February, 1999 (16.02.99), Full text; all drawings & JP 2946325 B2	1-6
A	JP 8-113853 A (Shima Seiki Mfg., Ltd.), 07 May, 1996 (07.05.96), Claims; Par. No. [0002] (Family: none)	1-6
A	JP 11-323704 A (Shima Seiki Mfg., Ltd.), 26 November, 1999 (26.11.99), Claims; Par. Nos. [0002] to [0007]; drawings & US 6079231 A & EP 959162 A2	1-6

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

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Date of the actual completion of the international search
19 September, 2008 (19.09.08)

Date of mailing of the international search report
07 October, 2008 (07.10.08)

Name and mailing address of the ISA/
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Patent documents cited in the description

- JP SHO33018528 B [0003]
- JP 3863019 B [0003]
- JP 2946325 B [0003]