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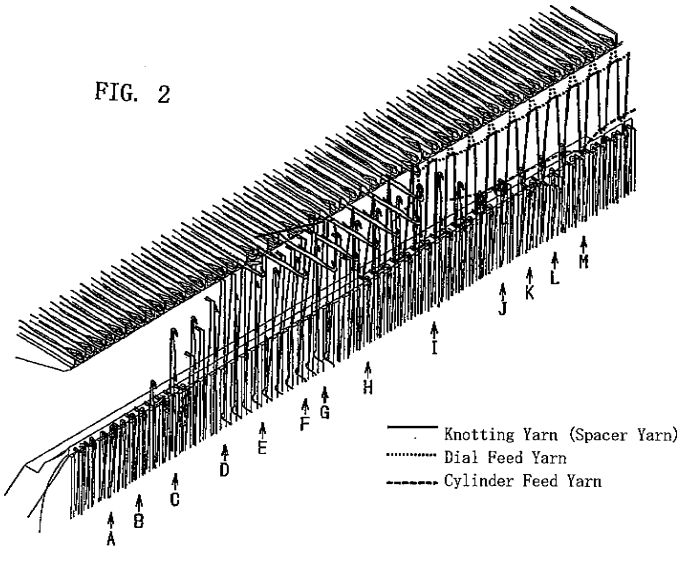
(54) DEVICE AND METHOD FOR KNITTING SPACER FABRIC

(57) [PROBLEMS] To provide an apparatus and a method for obtaining a spacer fabric of a simple structure that can ensure stabilized tuck knotting by reducing the burden on the needle.

[MEANS FOR SOLVING PROBLEMS] The knitting method of spacer fabric comprises a step in which a cylinder needle (5) is used to knit a cylinder knitted fabric (17), a step in which a dial needle (13) is used to knit a dial knitted fabric (16), and a step in which a knotting yarn is used to join the cylinder knitted fabric and the dial knitted fabric. The knotting yarn, which is supplied to either the cylinder needle (5) or the dial needle (13), is caught by a hook portion (73) of a hooked knitting tool (7), which pulls the knotting yarn onto a stem at a position deviated from the tip of the open latch of the other needle, thus securing a knotting yarn length necessary for knotting the dial knitted fabric and the cylinder knitted fabric.

FIG. 2



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Description

Technical Field

[0001] The present invention relates to an apparatus and a method for knitting a spacer fabric using a circular knitting machine. The present invention further relates to a hooked knitting tool used in this method and a spacer fabric obtained by the same method.

Background Art

[0002] A spacer fabric is a fabric made by joining a cylinder knitted fabric knitted by cylinder needles and a dial knitted fabric knitted by dial needles using a knotting yarn, and is also called a "corrugated knit."

[0003] Because spacer fabrics provide excellent cushion and keep and absorb moisture well, they are increasingly used in industrial materials such as vehicle seats, bedding materials such as mattress ticking for beds and chair upholstery as well as in special purpose clothes such as underwear and nursing wear. Under such circumstances, thick spacer fabrics are sought after especially for use in industrial materials.

[0004] The thickness of a spacer fabric is determined by the distance between the needle cylinder and the needle dial. Traditionally, spacer fabrics manufactured on a circular knitting machine are manufactured on a double knit raceway machine, in which a knotting yarn is inserted into both the cylinder needle and the dial needle for tuck connection. At this time, the cylinder needle needs to take in the knotting yarn on the dial needle, but because the cylinder needle can be raised only up to the tuck position, the distance between the needle cylinder and the needle dial necessarily has to be short.

[0005] In order to manufacture a thick spacer fabric in the traditional way, it is necessary to use long needles. But because of the limitation of their strength, the needles cannot be longer than a certain length. Using long needles also requires the use of longer cams, which lowers the productivity.

[0006] In order to solve these problems, Patent Document 1 cited below proposes a spacer fabric that can be tuck connected without being affected by the needle length or needle stroke.

[0007] According to this previously filed application, a pile yarn transfer apparatus is installed between two needle beds of a circular knitting machine. This transfer apparatus has two groups of feeding elements, which can individually move from an idle position to a tuck position. The feeding elements of one group move towards the needle hook of the first needle bed, and the feeding elements of the other group move towards the needle hook of the other needle bed, thus making a spacer fabric on the circular knitting machine. This invention claims that even when a latch needle having a standard needle stroke of less than 14 mm is used, a spacer fabric with a thickness of over 14 mm can be obtained.

Patent Document 1: Japanese Patent Laid-Open No. 2007-169871

Disclosure of the Invention

Problems to be Solved by the Invention

[0008] The previously filed application of Patent Document 1 has drawbacks in that it is mechanically complicated, and stable yarn feeding is difficult because the knotting yarn is supplied from an angled position.

[0009] The object of the present invention is to provide an apparatus and a method for obtaining a spacer fabric that feature a simpler structure, less burden on the needles, and the stable tuck knotting capability.

Means for Solving the Problems

[0010] The apparatus for knitting a spacer fabric of the present invention comprises a cylinder-knitted-fabric-forming means equipped with a needle cylinder, a vertically slidable cylinder needle housed in a groove of said needle cylinder and a cylinder-needle-controlling cam for controlling said cylinder needle, a dial-knitted-fabric-forming means equipped with a dial, a horizontally slidable dial needle housed in a groove of said dial and a dial-needle-controlling cam for controlling said dial needle, and a means for controlling a knotting yarn that knots a cylinder knitted fabric formed by said cylinder-knitted-fabric-forming means and a dial knitted fabric formed by said dial-knitted-fabric-forming means, in which the means for controlling the knotting yarn that knots said cylinder knitted fabric and said dial knitted fabric is a hooked knitting tool arranged between either two cylinder needles or two dial needles and equipped with a hook portion that is swingable towards the center of the knitting machine or away from the center of the knitting machine, and said hook portion can either ascend lengthwise higher than the stem of the other needle i.e. dial needle if the hooked knitting tool is arranged between two cylinder needles or move forward lengthwise inner than the stem of the other needle i.e. cylinder needle if the hooked knitting tool is arranged between two dial needles.

[0011] The method for knitting a spacer fabric of the present invention comprises a step for knitting a cylinder knitted fabric using a cylinder needle, a step for knitting a dial knitted fabric using a dial needle and a step for joining the cylinder knitted fabric and the dial knitted fabric using a knotting yarn, in which the knotting yarn, which is supplied to either the cylinder needle or the dial needle, is caught by a hook portion of a hooked knitting tool, which pulls the knotting yarn onto a stem at a position deviated from the tip of the open latch of the other needle, thus securing a knotting yarn length necessary for knotting the dial knitted fabric and the cylinder knitted fabric.

[0012] The hooked knitting tool used in the present invention has a plate-like overall shape comprising a neck and a trunk, and the tip of said neck is provided with an

L-shaped hook facing towards the center of the knitting machine, while on the trunk, swinging butts facing away from the center of the knitting machine and a vertically moving butt are formed.

Effects of the Invention

[0013] In the apparatus of the present invention, a hooked knitting tool is arranged between either two cylinder needles or two dial needles. The hook portion at the tip of this hooked knitting tool swings towards the center of the knitting machine so that the hook portion holds the knitted fabric formed by the cylinder needles, and swings away from the center of the knitting machine so that the hook portion disengages the knitted fabric that is held by the hook portion. The hook portion at the tip of the hooked knitting tool rises lengthwise higher than the stem of the dial needle. The hooked knitting tool swings so that the hook portion catches the knotting yarn even at the risen position. The needle dial can be raised until the gap between the needle cylinder and the needle dial becomes wide enough to accommodate the thickness of the spacer fabric.

[0014] That is, in the present invention, by providing said hooked knitting tool, it becomes possible to take in the knotting yarn positioned on a dial needle that is set at a high position even when the risen position of the cylinder needle is in a tuck position, because the hooked knitting tool, which can swing back and forth, can rise high.

[0015] As a result, according to the present invention, it is possible to obtain a tuck-knotted thick spacer fabric without being affected by the needle length or stroke.

Best Mode for Carrying Out the Invention

[0016] In the apparatus of the present invention, the hooked knitting tool is established inside a groove provided on the needle cylinder or the needle dial. The cylinder needle or the dial needle and the groove for the hooked knitting tool can be arranged as described below.

[0017] (1) The grooves that house the hooked knitting tools are arranged adjacent to each other and interposed by insert pieces on the needle cylinder, and the cylinder needles are arranged on the outer surfaces of said insert pieces with hooked knitting tools arranged adjacent to them on their either side.

[0018] (2) The grooves that house the hooked knitting tools are arranged adjacent to each other and interposed by insert pieces on the needle dial, and the dial needles are arranged on the upper surfaces of said insert pieces with hooked knitting tools arranged adjacent to them on their either side.

[0019] (3) A large number of grooves that house the cylinder needles are established on the needle cylinder interposed by insert pieces, and in each groove, the cylinder needle is arranged together with the hooked knitting tools on its either side.

[0020] (4) A large number of grooves that house the dial needles are established on the needle dial interposed by insert pieces, and in each groove, the dial needle is arranged together with the hooked knitting tools on its either side.

[0021] (5) The needle cylinder grooves that house the hooked knitting tools and the needle cylinder grooves that house the cylinder needles are arranged alternately, and on either side of the hooked knitting tool and the cylinder needle, insert pieces that are long in the radial direction of the needle cylinder are positioned.

[0022] (6) The needle dial grooves that house the hooked knitting tools and the needle dial grooves that house the dial needles are arranged alternately, and on either side of the hooked knitting tool and the dial needle, insert pieces that are long in the vertical direction of the needle dial are positioned.

[0023] (7) The needle cylinder grooves that house the hooked knitting tools are divided in halves by the interposing insert pieces that are short in the radial direction of the needle cylinder. The cylinder needles are arranged on the outer surfaces of the insert pieces with the hooked knitting tools arranged adjacent to them on their either side.

[0024] (8) The needle dial grooves that house the hooked knitting tools are divided in halves by the interposing insert pieces that are short in the vertical direction of the needle dial. The dial needles are arranged on the outer surfaces of the insert pieces with the hooked knitting tools arranged adjacent to them on their either side.

[0025] In the apparatus of the present invention, it is preferable to establish a ring-shaped part in the upper portion of the inner surface of the needle cylinder so as to prevent a loop from falling into the gap between the hooked knitting tool and the groove of the hooked knitting tool.

[0026] In the method of the present invention, the knotting yarn can be fed to either the cylinder needle or the dial needle in two ways: by being fed onto a stem that is deviated from the tip of the open latch, and by being fed into the knit section of the needle. According to the former method, the cylinder knitted fabric and the dial knitted fabric are joined with knotting yarn that joins both knitted fabrics in tuck knotting; according to the latter method, the cylinder knitted fabric and the dial knitted fabric are joined with knotting yarn that joins one fabric in tuck knotting and the other fabric in double loops of a plain jersey loop and knotting yarn.

[0027] In the method of the present invention, one more step can be added as follows. As the cylinder needle and the dial needle, two kinds of needles can be used: a high butt needle (H needle) and a low butt needle (L needle). Using a plurality of color yarns, either the cylinder needles or the dial needles are knit-welted according to the pattern, and the other needles are all welted, to jacquard-knit either the cylinder knitted fabric or the dial knitted fabric. This results in a spacer fabric in which either the cylinder knitted fabric or the dial knitted fabric is

jacquard-knitted.

[0028] Examples of the present invention will now be described by reference to the accompanying drawings.

Brief Description of the Drawings

[0029]

FIG. 1 is a cross sectional view illustrating the essential parts of the knitting head of a double knit circular knitting machine, that is, a spacer-fabric-manufacturing apparatus of the present invention.

FIG. 2 is an enlarged perspective view of the essential parts of the knitting head.

FIG. 3 is an enlarged cross sectional view of the essential parts of the knitting head in a condition illustrated in FIG. 6 (a).

FIG. 4 (a-1) illustrates the shapes of lines along which the tips of cylinder needle 5, dial needle 13 and hooked knitting tool 7 of example 1 move.

FIG. 4 (a-2) illustrates knit textures produced by example 1.

FIG. 4 (b-1) illustrates the shapes of lines along which the tips of cylinder needle 5, dial needle 13 and hooked knitting tool 7 of example 2 move.

FIG. 4 (b-2) illustrates knit textures produced by example 2.

FIG. 4 (c-1) illustrates the shapes of lines along which the tips of cylinder needle 5, dial needle 13 and hooked knitting tool 7 of example 3 move.

FIG. 4 (c-2) illustrates knit textures produced by example 3.

FIG. 4 (d-1) illustrates the shapes of lines along which the tips of cylinder needle 5, dial needle 13 and hooked knitting tool 7 of example 4 move.

FIG. 4 (d-2) illustrates knit textures produced by example 4.

FIG. 5(a) A to M are side views illustrating the relationships between cylinder needle 5, dial needle 13 and hooked knitting tool 7 at coded positions in FIG. 2 according to example 1.

FIG. 5 (b) illustrates changes (F'-I') from example 1 according to example 2.

FIG. 6 (a) is a front view illustrating a condition in which cylinder needles and hooked knitting tools are arranged.

FIG. 6 (b) is a front view illustrating another condition in which cylinder needles and hooked knitting tools are arranged.

FIG. 6 (c) is a plan view of FIG. 6 (a).

FIG. 6 (d) is a plan view of FIG. 6 (b).

FIG. 7 is an enlarged cross sectional view of the essential parts of the knitting head in a condition illustrated in FIG. 6 (b).

FIG. 8 (a) is a plan view illustrating a third condition in which cylinder needles and hooked knitting tools are arranged.

FIG. 8 (b) is a front view illustrating a third condition in which cylinder needles and hooked knitting tools are arranged.

FIG. 9 (a) is a plan view illustrating a fourth condition in which cylinder needles and hooked knitting tools are arranged.

FIG. 9 (b) is a front view illustrating a fourth condition in which cylinder needles and hooked knitting tools are arranged.

Example 1

[0030] FIG. 1 is a cross sectional view illustrating the essential parts of the knitting head of a double knit circular knitting machine, that is, a spacer-fabric-manufacturing apparatus. Knitting head 2 is installed on bed 1, which is supported by a plurality of legs (not illustrated).

[0031] Above needle groove 41, which is formed on the periphery of needle cylinder 3, a vertically slidable cylinder needle 5 is housed. As illustrated in FIG. 3, cylinder needle 5 is a flat plate having a head 51 at its tip and a narrow stem 53 equipped with a butt 52 at its rear. Head 51 is equipped with a hook 54 and a latch 55 that opens and closes. Facing the needle cylinder 3, a cylinder cam holder 6 that controls cylinder needle 5 is arranged. Cylinder needle 5 is moved up and down by a control cam 61 that is housed in cylinder cam holder 6 (See FIGs. 1 and 2). Preferably, in the upper portion of the internal surface of needle cylinder 3, a ring-shaped part 31 is arranged so as to prevent a loop from falling into the gap between a hooked knitting tool 7 and a groove of the hooked knitting tool.

[0032] As illustrated in FIG. 2, in the needle groove 41 of the cylinder, between two adjacent cylinder needles 5, one hooked knitting tool 7 is arranged. This hooked knitting tool 7 is, as illustrated in FIG. 3, shaped like a flat plate overall and has a long and narrow neck 71 and a long and wide trunk 72. At the tip of neck 71, an L-shaped hook 73 facing towards the center of the knitting machine is established. At the front and rear ends of trunk 72, a swinging butt 74 and a vertical motion butt 75 are formed respectively facing away from the center of the knitting machine.

[0033] The cam holder 6 is arranged opposite the trunk 72 of the hooked knitting tool 7. A pressing cam 81 housed in the cam holder 6 and the swinging butt 74 of the hooked knitting tool 7 engage each other and swing the hooked knitting tool 7. A control cam 91 housed in the cam holder 6 and the vertical motion butt 75 of the hooked knitting tool 7 engage each other and swing the hooked knitting tool 7 up and down (See FIGs. 2 and 3).

[0034] To carry out the present invention, a number of structures can be conceived. In a first structure, as illustrated in FIG. 6 (a) and FIG. 6 (c), the needle cylinder groove 42 that houses the hooked knitting tool 7 has insert pieces 44b that are short in the radial direction of the cylinder arranged on its either side. FIG. 3 illustrates a cross sectional view of FIG. 6 (a). The groove 42 of needle cylinder 3 needs to be formed deeper than the groove

41 for the cylinder needle so as to allow the hooked knitting tool 7 to swing. The bottom of the groove of cylinder needle 5 is the outer surface of the insert piece 44b.

[0035] In a second structure, as illustrated in FIG. 6 (b) and FIG. 6 (d), no special needle cylinder groove 42 is provided in order to house the hooked knitting tool 7. In this case, a large number of cylinder needle grooves 41 are provided on the needle cylinder interposed by insert pieces 44a that are long in the radial direction of the needle cylinder, and a cylinder needle 5 is provided in each groove 41 together with hooked knitting tools 7 on its either side. FIG. 7 illustrates a cross sectional view of FIG. 6 (b). The depthwise sizes of the cylinder needle 5 and the hooked knitting tool 7 are decided so that they are the same as the depth of needle cylinder grooves 41 that house cylinder needles 5 and hooked knitting tools 7.

[0036] In a third structure, as illustrated in FIG. 8 (a) and FIG. 8 (b), needle cylinder grooves 42 that house hooked knitting tools 7 and needle cylinder grooves 41 that house cylinder needles 5 are arranged alternately, and on either side of these grooves insert pieces 44a that are long in the radial direction of the needle cylinder are positioned. The depthwise sizes of the cylinder needle 5 and the hooked knitting tool 7 are decided so that the depths of needle cylinder grooves 41 that house cylinder needles 5 and hooked knitting tools 7 and the depths of grooves 42 that house hooked knitting tools 7 are the same.

[0037] In a fourth structure, as illustrated in FIG. 9 (a) and FIG. 9 (b), needle cylinder grooves 42 that house hooked knitting tools 7 are divided into two by insert pieces 44a and 44b. The bottom of the groove of cylinder needle 5 is the outer surface of the insert piece 44b that is short in the radial direction of the needle cylinder. On either side of the cylinder needle 5 is an insert piece 44a that is long in the radial direction of the needle cylinder. The groove 42 of needle cylinder 3 needs to be formed deeper than the groove 41 for the cylinder needle so as to allow the hooked knitting tool 7 to swing.

[0038] Referring back to FIG. 1, the double knit circular knitting machine of the present invention further has a needle dial 10 and a dial cam holder 11. In a needle groove 12 formed on the upper surface of needle dial 10, a dial needle 13 is housed in such a way that it is horizontally slidable (See FIG. 2). As illustrated in FIG. 3, dial needle 13 is a flat plate having a head 131 at its tip and a narrow stem 133 equipped with a butt 132 (See FIG. 1) at its rear. Head 131 is equipped with a hook 134 and a latch 135 that opens and closes. Cam 111 housed in dial cam holder 11 acts on dial needle 13 to move it back and forth horizontally. On the dial cam holder 11, a yarn carrier 14 (FIG. 1) is installed, feeding knitting yarn to knitting needles.

[0039] Below the needle cylinder 3 is an integrally mounted driving gear 15, which is driven by a power unit installed on the knitting machine and rotates at the same speed as the needle cylinder 3.

[0040] Example 1, in which the cylinder knitted fabric and the dial knitted fabric are tuck-knotted on both sides with knotting yarn, will now be explained.

[0041] FIG. 4 (a-2) illustrates textures of a fabric knitted by example 1, At the first feeder, the cylinder knitted fabric and the dial knitted fabric are tuck-knotted using low-butt needles (L needles) of the cylinder needle and the dial needle; at the second feeder, the cylinder knitted fabric and the dial knitted fabric are tuck-knotted using high-butt needles (H needles) of the cylinder needle and the dial needle. FIG. 4 (a-1) illustrates the shapes of lines along which the tips of cylinder needle 5, dial needle 13 and hooked knitting needle 7 for knitting the fabrics move.

[0042] The movement of each part will now be explained referring to drawings A to M of FIG. 5 (a). A to M of FIG. 5 (a). A to M are side views illustrating the relationships between cylinder needle 5, dial needle 13 and hooked knitting tool 7 at coded positions in FIG. 2, and these views correspond to descriptions A to M in the following paragraphs. In the paragraphs where no explanation is given with regard to the movement of the corresponding part, that part maintains the position described in the previous paragraph.

[0043] A. Cylinder needle 5 maintains a welt position where its tip more or less coincides with the top of needle cylinder 3. Hooked knitting tool 7 swings away from the center of the knitting machine so that the hook portion 73 of the hooked knitting tool 7 comes at a position where it does not engage knitted fabric 17 formed by cylinder 5. Dial needle 13 maintains a welt position where its tip more or less coincides with the outside of needle dial 10.

[0044] B. Hook portion 73 of hooked knitting tool 7 swings towards the center of the knitting machine so that the old loop of a rising cylinder needle 5 does not rise together with the cylinder needle 5 that rises and that the hook portion 73 holds knitted fabric 17 (old loop) formed by cylinder needle 5. Dial needle 13 maintains a welt position where its tip more or less coincides with the outside of needle dial 10.

[0045] C. Cylinder needle 5 rises to a knit position where the old loop is cleared from latch 55.

[0046] D. Hooked knitting tool 7 rises to the height where its tip more or less coincides with dial needle 13. Dial needle 13 begins to move forward.

[0047] E. Hooked knitting tool 7 rises to a position where hook portion 73 at its tip is higher than the stem of dial needle 13. Dial needle 13 continues to move forward.

[0048] F. The tip of hooked knitting tool 7 swings away from the center of the knitting machine. Dial needle 13 moves forward to a knit position where the old loop is cleared from latch 135.

[0049] G. When the tip of hooked knitting tool 7 swings towards the center of the knitting machine, hook portion 73 of the hooked knitting tool catches the knotting yarn 18 that is fed in such a way that it sits astride the stem part 133 of dial needle 13.

[0050] H. In the condition that knotting yarn 18 is caught by hook portion 73, hooked knitting tool 7 de-

scends until its tip more or less coincides with the top of needle cylinder 3. Knotting yarn 18 that is necessary for joining dial knitted fabric 16 and cylinder knitted fabric 17 that make up a spacer fabric is secured here (See FIG. 1). Knotting yarn 18 that is supplied to cylinder needle 5 is supplied onto the stem, which is deviated from the tip of the open latch 55 of the cylinder needle 5, in a tuck position. Knotting yarn 18 that is supplied to the dial needle 13 is supplied to the stem, which is deviated from the tip of the open latch 135 of the dial needle 13, in a tuck position.

[0051] I. Yarn for the dial knitted fabric is supplied to hook 134 of dial needle 13 that has descended, and latch 135 of dial needle 13 is closed by the knotting yarn supplied in H and a dial old loop that is not illustrated. The knotting yarn and the old loop knock over at the stitch part of the dial needle 13 between this step and J. After this, dial needle 13 moves forward until its tip more or less coincides with the outside of needle dial 10. Cylinder needle 5 begins to descend.

[0052] J. Yarn for cylinder knitted fabric is supplied to hook 54 of cylinder needle 5 that has descended, and latch 55 of cylinder needle 5 is closed by the knotting yarn supplied in H and a cylinder old loop that is not illustrated. Before the old loop knocks over from cylinder needle 5, hooked knitting tool 7 ascends so as to relax the tension of knotting yarn 18.

[0053] K. Hooked knitting tool 7 swings away from the center of the knitting machine so that hook portion 73 does not prevent the formation of cylinder knitted fabric 17.

[0054] L. Hooked knitting tool 7 descends until its tip is at a position slightly lower than needle cylinder 3. After that, hooked knitting tool 7 of hooked knitting tool 7 swings towards the center of the knitting machine so that the hook portion 73 is positioned below cylinder knitted fabric 17 formed by cylinder needle 5.

[0055] M. Hooked knitting tool 7 ascends to virtually the same height as needle cylinder 3 at the stitch part of cylinder needle 5, and knotting yarn 18 and the old loop knock over.

Example 2

[0056] Example 2 will now be explained. In this example, the cylinder knitted fabric and the dial knitted fabric are joined with knotting yarn that joins the cylinder knitted fabric in tuck knotting and the dial knitted fabric in double loops of a plain jersey loop and knotting yarn

[0057] FIG. 4 (b-2) illustrates knit structures knitted by example 2. At the first feeder, the cylinder knitted fabric and the dial knitted fabric are knotted using low-butt needles (L needles) of the cylinder needle and the dial needle; at the second feeder, the cylinder knitted fabric and the dial knitted fabric are knotted using high-butt needles (H needles) of the cylinder needle and the dial needle. FIG. 4 (b-1) illustrates the shapes of lines along which the tips of the cylinder needle 5, dial needle 13 and hooked knitting tool 7 for knitting the fabrics move. The movement of each part will now be explained by reference to F'-I' of FIG. 5 (b). The movements illustrated by A-E and J-M of FIG. 5 (a). A to M are the same as those in example 1, therefore the explanation of these will be omitted.

[0058] F'. The tip of hooked knitting tool 7 swings away from the center of the knitting machine. Dial needle 13 descends to the tuck position after the old loop advances to the knit position where it clears from latch 135.

[0059] G'. When the tip of hooked knitting tool 7 swings towards the center of the knitting machine, hook portion 73 of the hooked knitting tool catches the knotting yarn 18 that is fed to the knit section of the dial needle 13.

[0060] H'. In the condition that the knotting yarn 18 is caught by hook portion 73, hooked knitting tool 7 descends until its tip more or less coincides with the top of needle cylinder 3. Knotting yarn 18 that is necessary for joining dial knitted fabric 16 and cylinder knitted fabric 17 that make up a spacer fabric is secured here. Knotting yarn 18 that is supplied to the cylinder needle 5 is supplied to the stem, which is deviated from the tip of the open latch 55 of the cylinder needle 5, in a tuck position. Knotting yarn 18 that is supplied to the hook 134 of the dial needle 13 that descended is supplied in a knit position together with the yarn for dial knitted fabric. Latch 135 of the dial needle 13 is closed by the dial old loop.

[0061] I'. The knotting yarn and the old loop knock over at the stitch part of dial needle 13. After that, the dial needle 13 moves forward until its tip more or less coincides with the outside of needle dial 10. Cylinder 5 begins to descend.

Example 3

[0062] A third example will now be described. In this example, a cylinder knitted fabric of example 1 is deformed into a jacquard fabric. In this example, two kinds of cylinder needles and dial needles are used: high-butt needles (H needles) and low-butt needles (L needles).

[0063] FIG. 4 (c-1) illustrates the shapes of lines along which the tips of the cylinder needle 5, dial needle 13 and hooked knitting tool 7 for knitting the fabric move.

[0064] At the first feeder, as in example 1, a cylinder jacquard fabric and a dial knitted fabric are knotted with knotting yarn using the L needles of the cylinder and dial in a tuck position. The L needles of the dial form a dial knitted fabric in a knit position.

[0065] At the second feeder, first color yarn is used. The cylinder needles are knit-welted according to the pattern, and the dial needles are all welted.

[0066] At the third feeder, second color yarn is used. The cylinder needles are knit-welted according to the pattern, and the dial needles are all welted.

[0067] At the fourth feeder, as at the first feeder, a cylinder knitted fabric and a dial knitted fabric are knotted with knotting yarn using the H needles of the cylinder and dial in a tuck position. The H needles of the dial form a

dial knitted fabric in a knit position.

[0068] The workings of the fifth feeder and the six feeder are the same as those of the second feeder and the third feeder.

[0069] FIG. 4 (c-2) illustrates knit structures knitted by example 3.

Example 4

[0070] A fourth example will now be described. In this example, a cylinder knitted fabric of example 3 is deformed into a jacquard fabric. In this example again, two kinds of cylinder needles and dial needles are used: high-butt needles (H needles) and low-butt needles (L needles).

[0071] FIG. 4 (d-1) illustrates the shapes of lines along which the tips of the cylinder needle 5, dial needle 13 and hooked knitting tool 7 for knitting the fabric move.

[0072] The first feeder to the third feeder and the fifth feeder to the seventh feeder of example 4 are the same as the first feeder to the third feeder and the fourth feeder to the sixth feeder of example 3. The fourth feeder and the eighth feeder are newly added in this example.

[0073] At the fourth feeder, a dial knitted fabric is formed in a knit position using L needles of the dial. At the eighth feeder, a dial knitted fabric is formed in a knit position using H needles of the dial.

[0074] FIG. 4 (d-2) illustrates the structures of the fabrics knitted by example 4.

[0075] Compared with example 3, in example 4, the cylinder side and the dial side have the same number of stitches, resulting in a fabric with an excellent front and back balance.

[0076] Using the above described knitting steps, it is possible to obtain a thick, tuck-knotted spacer fabric that is not influenced by latch lengths. Moreover, compared with the previously filed application in Patent Document 1, the present invention has excellent effects as described below.

[0077] (1) In the present invention, in contrast to the previously filed application in Patent Document 1, a guide plate for guiding knotting yarn is not needed at the knitting head. Namely, the reason a guide plate is necessary in the previously filed application is to suppress the tuck-knotting yarn from the back of the cylinder needle in order to clear the tuck-knotting yarn from the cylinder needle, but in the present invention, a loop is already formed at this point in time (See "I" above).

[0078] (2) In the previously filed application in Patent Document 1, a dial knitted fabric and a cylinder knitted fabric are knitted separately and then joined together using knotting yarn, but in the present invention, knitting of a dial knitted fabric and a cylinder knitted fabric and joining them using knotting yarn can be proceeded more or less simultaneously, therefore the number of yarn feeders can be increased.

[0079] Although not illustrated, by establishing hooked knitting tools on the needle dial side instead of the needle cylinder side, a similar spacer fabric can be obtained. In that case, "needle cylinder" and ""needle dial" in the above examples need to be read as "needle dial" and "needle cylinder" respectively.

Claims

1. An apparatus for knitting a spacer fabric comprising:

a cylinder-knitted-fabric-forming means equipped with a needle cylinder (3), a vertically slidable cylinder needle (5) housed in a groove (41) of said needle cylinder (3) and a cylinder-needle-controlling cam (61) for controlling said cylinder needle (5);

a dial-knitted-fabric-forming means equipped with a needle dial (10), a horizontally slidable dial needle (13) housed in a groove (12) of said needle dial (10) and a dial-needle-controlling cam (111) for controlling said dial needle (13); and

a means for controlling a knotting yarn (18) that knots a cylinder knitted fabric (17) formed by said cylinder-knitted-fabric-forming means and a dial knitted fabric (16) formed by said dial-knitted-fabric-forming means;

in which the means for controlling the knotting yarn (18) that knots said cylinder knitted fabric (17) and said dial knitted fabric (16) is a hooked knitting tool (7) arranged between either two cylinder needles (5) or two dial needles (13) and equipped with a hook portion (73) that is swingable towards the center of the knitting machine or away from the center of the knitting machine, and said hook portion (73) can either ascend lengthwise higher than the stem of the other needle (13), if the hooked knitting tool (7) is arranged between two cylinder needles (5), or move forward lengthwise inner than the stem of the other needle (5), if the hooked knitting tool (7) is arranged between two dial needles (13).

2. An apparatus of Claim 1, in which:

the hooked knitting tool (7) has a plate-like overall shape comprising a neck (71) and a trunk (72);

the tip of said neck is provided with an L-shaped hook facing towards the center of the knitting machine; and

said trunk (72) is provided with swinging butts (74) facing away from the center of the knitting machine and a vertically moving butt (75).

3. An apparatus of Claim 1 or 2, in which grooves (42) that house the hooked knitting tools (7) are arranged adjacent to each other on the needle cylinder (3)

interposed by insert pieces (44b), and the cylinder needles are arranged on the outer surfaces of said insert pieces with the hooked knitting tools (7) arranged adjacent to them on their either side.

4. An apparatus described in Claim 1 or 2, in which the grooves (12) that house the hooked knitting tools (7) are arranged adjacent to each other on the needle dial (10) interposed by insert pieces (44b), and the dial needles (13) are arranged on the upper surfaces of said insert pieces with the hooked knitting tools (7) arranged adjacent to them on their either side.

5. An apparatus described in Claim 1 or 2, in which a large number of grooves (41) that house the cylinder needles (5) are established on the needle cylinder (3) interposed by insert pieces (44a), and in each groove (41), the cylinder needle (5) is arranged together with the hooked knitting tools (7) on its either side.

6. An apparatus described in Claim 1 or 2, in which a large number of grooves (12) that house the dial needles are established on the needle dial (10) interposed by insert pieces (44a), and in each groove (12), the dial needle (13) is arranged together with the hooked knitting tools (7) on its either side.

7. An apparatus described in Claim 1 or 2, in which the needle cylinder grooves (42) that house the hooked knitting tools (7) and the needle cylinder grooves (41) that house the cylinder needles (5) are arranged alternately, and on either side of the hooked knitting tool (7) and the cylinder needle (5), insert pieces (44a) that are long in the radial direction of the needle cylinder are positioned.

8. An apparatus described in Claim 1 or 2, in which the needle dial grooves (12) that house the hooked knitting tools (7) and the needle dial grooves (12) that house the dial needles (13) are arranged alternately, and on either side of the hooked knitting tool (7) and the dial needle (13), insert pieces (44a) that are long in the vertical direction of the needle dial are positioned.

9. An apparatus described in Claim 1 or 2, in which the needle cylinder grooves (42) that house the hooked knitting tools (7) are divided in halves by insert pieces (44a, 44b), and the cylinder needles (5) are arranged on the outer surfaces of the insert pieces (44b), which are short in the radial direction of the needle cylinder, with the hooked knitting tools (7) arranged adjacent to them on their either side.

10. An apparatus described in Claim 1 or 2, in which the needle dial grooves (12) that house the hooked knitting tools (7) are divided in halves by insert pieces (44a, 44b), and the dial needles (13) are arranged on the outer surfaces of the insert pieces (44b), which are short in the vertical direction of the needle dial, with the hooked knitting tools (7) arranged adjacent to them on their either side.

11. An apparatus described in any of Claims 1 to 10, in which a ring-shaped part (31) is established in the upper portion of the inner surface of the needle cylinder (3) or the needle dial (10) so as to prevent a loop from falling into the gap between the hooked knitting tool (7) and the groove (42) of the hooked knitting tool.

12. A method for knitting a spacer fabric, comprising a step for knitting a cylinder knitted fabric (17) using a cylinder needle (5), a step for knitting a dial knitted fabric (16) using a dial needle (13) and a step for joining the cylinder knitted fabric (17) and the dial knitted fabric (16) using a knotting yarn (18), in which the knotting yarn, which is supplied to either the cylinder needle (5) or the dial needle (13), is caught by a hook portion (73) of a hooked knitting tool (7), which pulls the knotting yarn (18) onto a stem at a position deviated from the tip of the open latch of the other needle, thus securing a length of the knotting yarn (18) that is necessary for knotting the dial knitted fabric (16) and the cylinder knitted fabric (17).

13. A method for knitting a spacer fabric described in Claim 12, in which the knotting yarn that is supplied to either the cylinder needle (5) or the dial needle (13) is supplied onto the stem that is at a position deviated from the tip of the open latch.

14. A method for knitting a spacer fabric described in Claim 12, in which the knotting yarn supplied to either the cylinder needle (5) or the dial needle (13) is supplied to the knit section of the needle.

15. A method for knitting a spacer fabric described in Claim 12, in which two kinds of needles, high butt needle (H needle) and low butt needle (L needle), are used as the cylinder needle (5) and the dial needle (13); and
using a plurality of color yarns, either the cylinder needles (5) or the dial needles (13) are knit-welted according to the pattern, and the other needles are all welted, to jacquard-knit either the cylinder knitted fabric (17) or the dial knitted fabric (16).

16. A spacer fabric that is obtained in the method described in Claim 14, **characterized in that** the knotting yarn (18) that joins the cylinder knitted fabric (17) and the dial knitted fabric (18) is tuck-knotted to one fabric and joined in double loops of a plain jersey loop and knotting yarn with the other fabric.

17. A spacer fabric obtained by the method described in Claim 15, **characterized in that** either the cylinder knitted fabric (17) or the dial knitted fabric (16) is jacquard knitted.

18. A hooked knitting tool (7) used in a method for knitting a spacer fabric described in any of Claims 12 to 15, **characterized in that**:

said hooked knitting tool has a plate-like overall shape comprising a neck (71) and a trunk (72); the tip of said neck (72) is provided with an L-shaped hook (73) facing towards the center of the knitting machine; and
said trunk (72) is provided with swinging butts (74) facing away from the center of the knitting machine and a vertically moving butt (75).

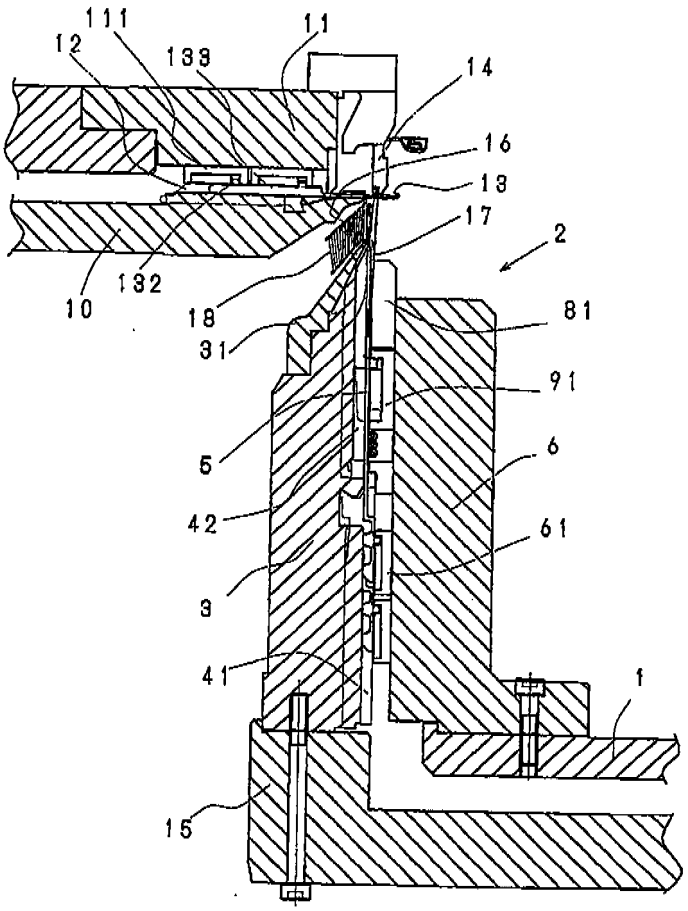


FIG. 1

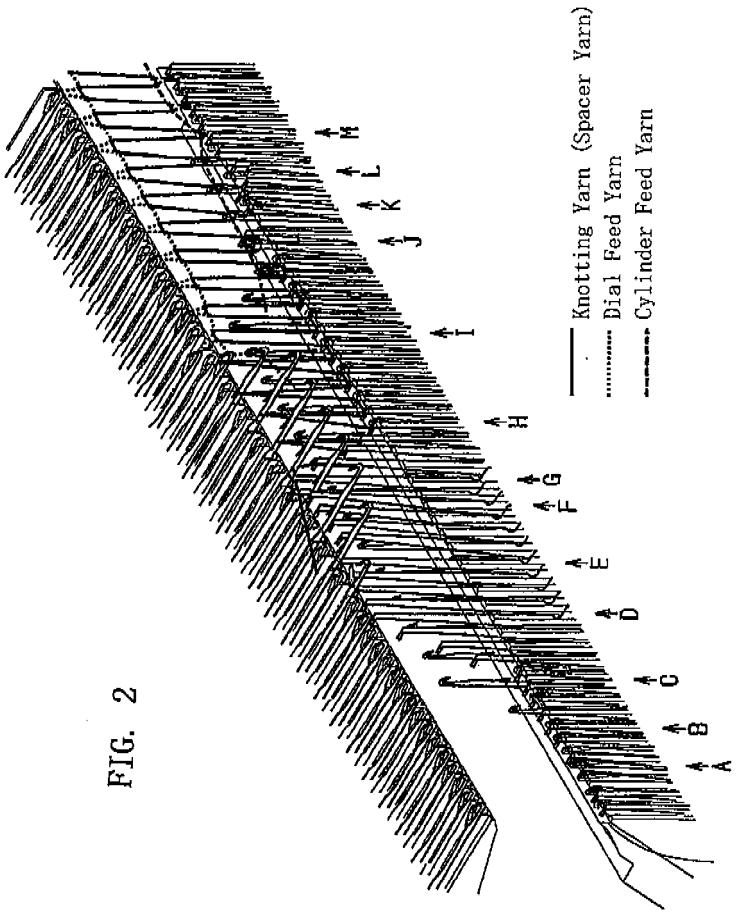

Knotting Yarn (Spacer Yarn)
Dial Feed Yarn
Cylinder Feed Yarn
A
B
C
D
E
F
G
H
I
J
K
L
M

FIG. 2

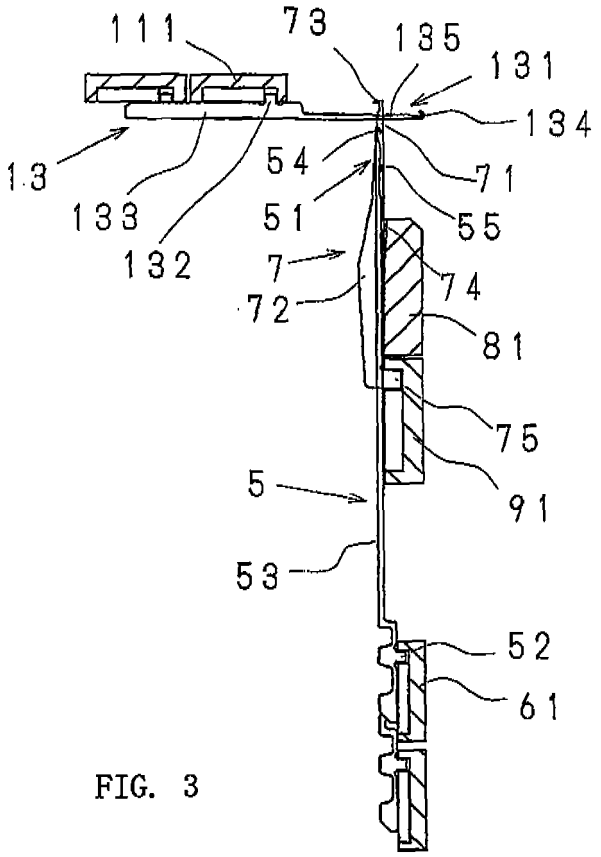


FIG. 3

FIG. 4(a-1)

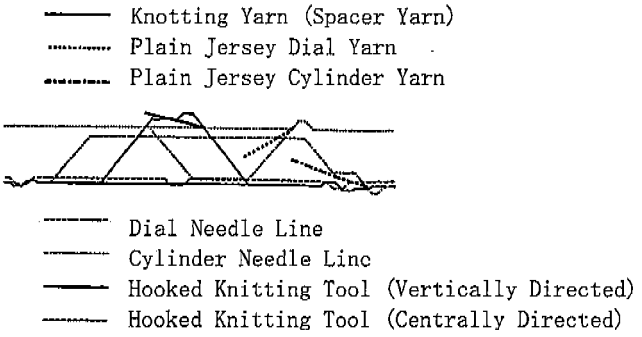


FIG. 4(a-2)

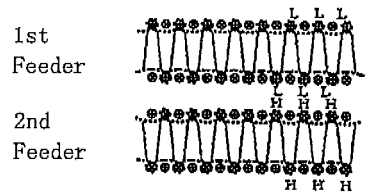


FIG. 4(b-1)

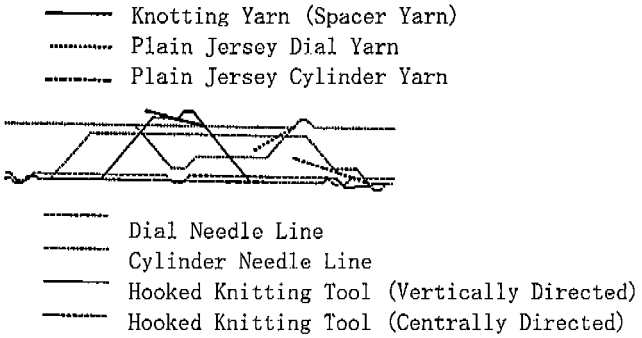


FIG. 4(b-2)

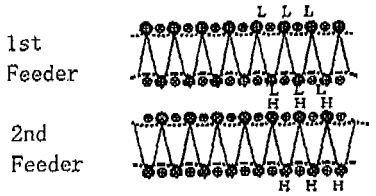


FIG. 4(c-1)

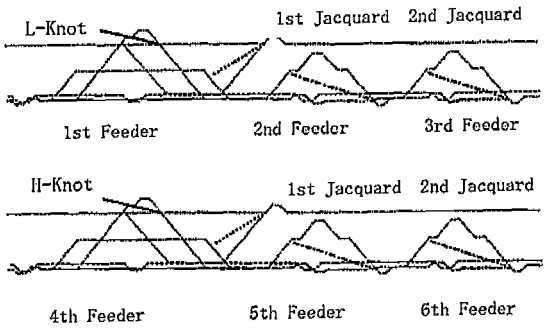


FIG. 4(c-2)

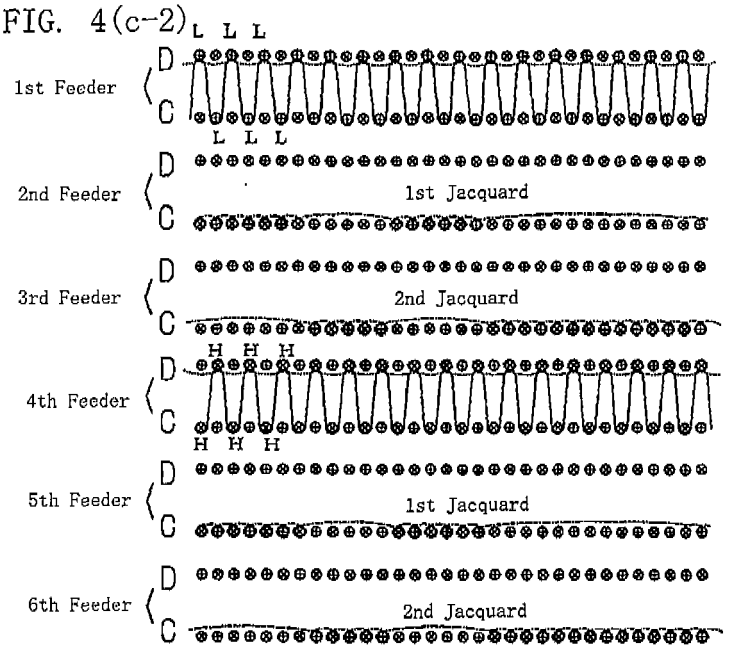
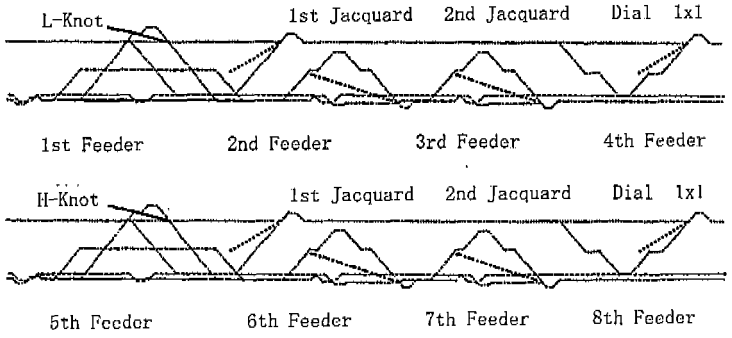


FIG. 4(d-1)



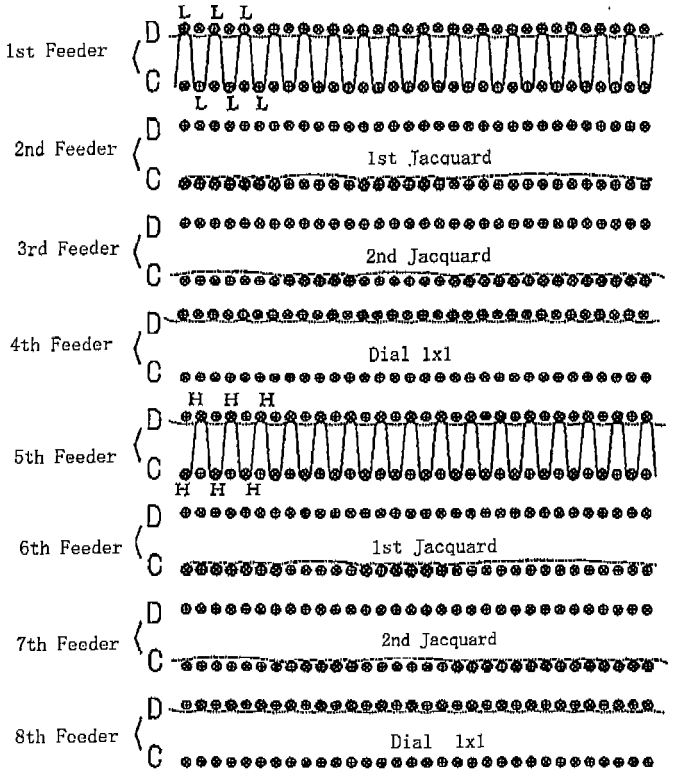

1st Feeder
D
C
L L L
L L L
2nd Feeder
D
C
1st Jacquard
3rd Feeder
D
C
2nd Jacquard
4th Feeder
D
C
Dial 1x1
5th Feeder
D
C
H H H
H H H
6th Feeder
D
C
1st Jacquard
7th Feeder
D
C
2nd Jacquard
8th Feeder
D
C
Dial 1x1

FIG. 4(d-2)

FIG. 5(a)

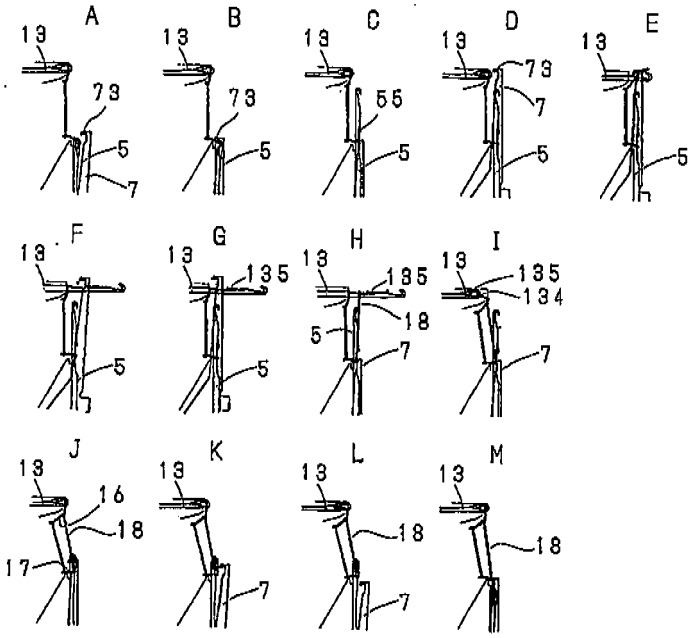


FIG. 5(b) Double Loops of Knotting Yarn and Plain Jersey Yarn

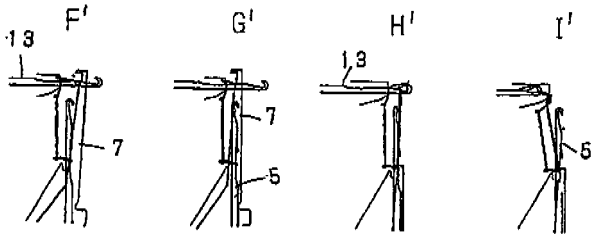


FIG. 6(a)

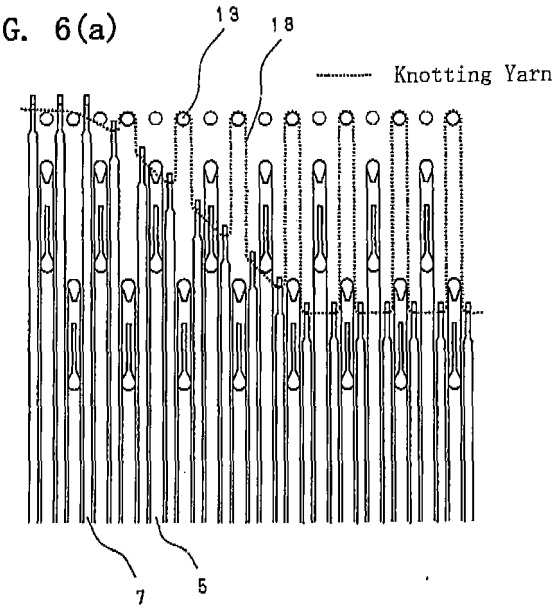


FIG. 6(b)

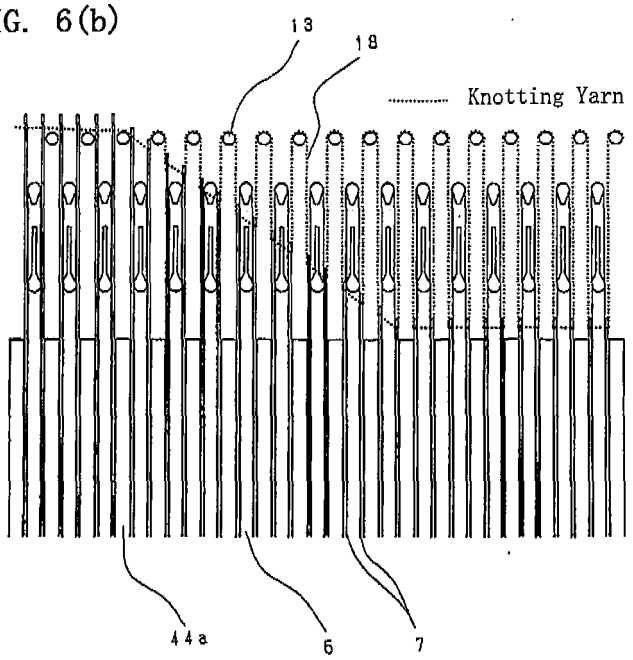
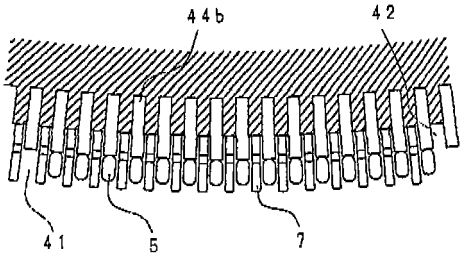


FIG. 6(c)



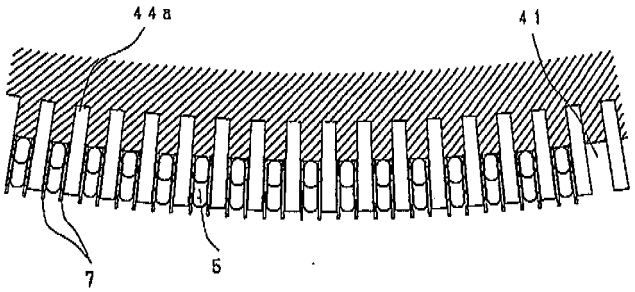


FIG. 6(d)

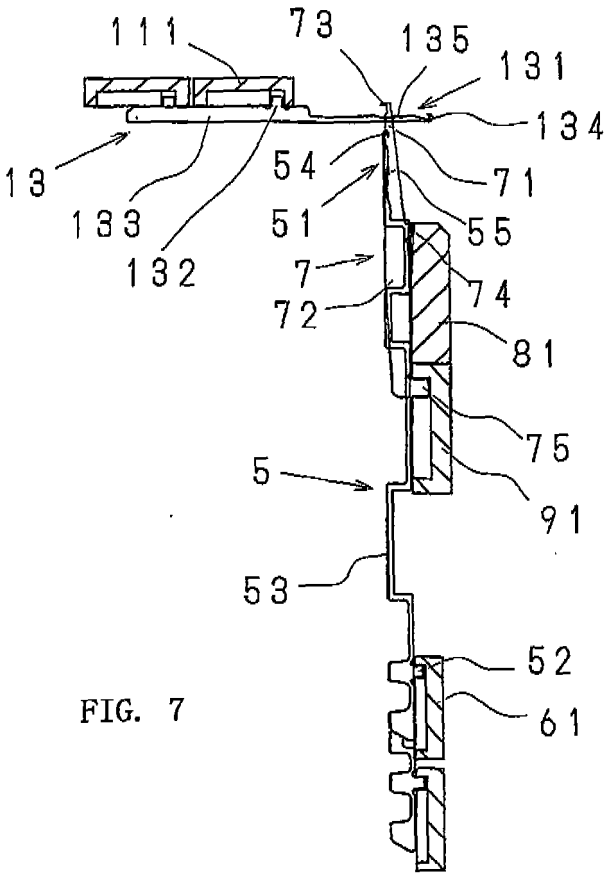


FIG. 7

FIG. 8(a)

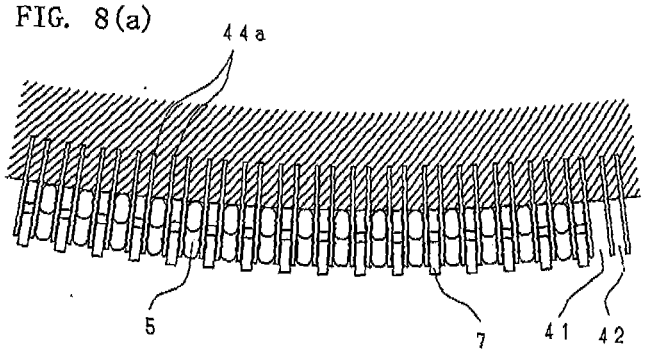


FIG. 8(b)

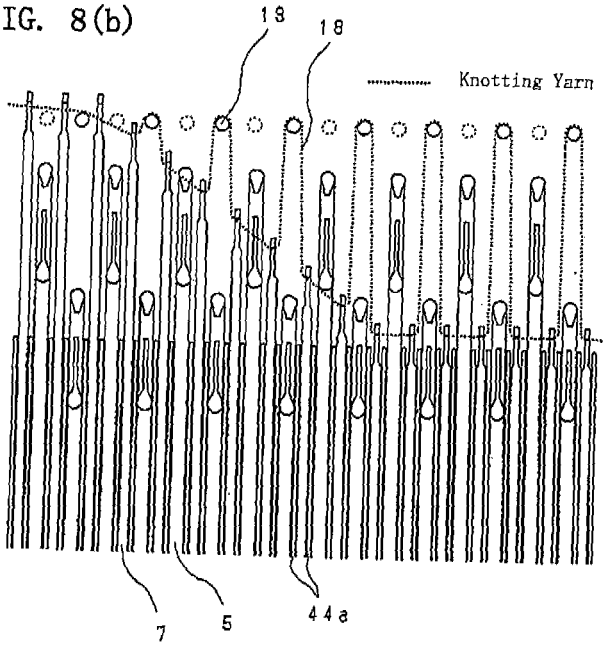


FIG. 9(a)

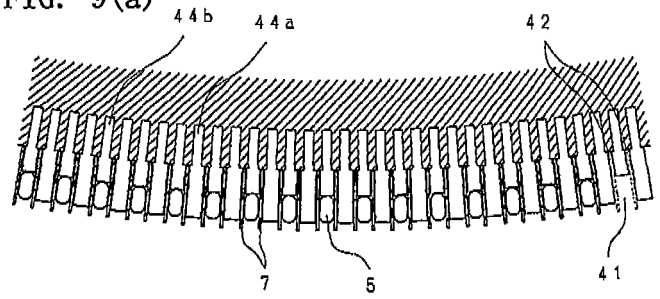
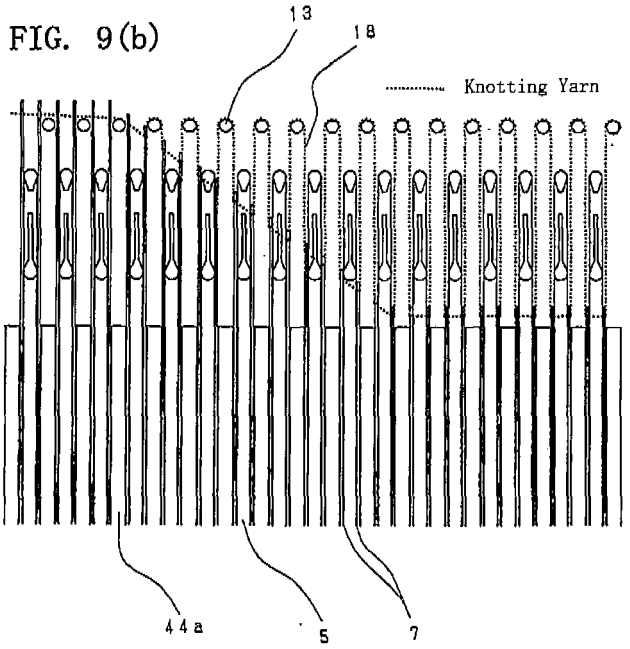


FIG. 9(b)



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2008/002822

A. CLASSIFICATION OF SUBJECT MATTER
D04B9/08(2006.01)i, *D04B1/00*(2006.01)i, *D04B35/02*(2006.01)n

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)
D04B9/08, D04B1/00

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	1996-2008
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.
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A	JP 38-24064 B1 (Kiyotatsu HIGUCHI), 12 November, 1963 (12.11.63), (Family: none)	1-18
A	JP 2909991 B2 (Kabushiki Kaisha Kitahara Sen'i Kogyosho), 23 June, 1999 (23.06.99), (Family: none)	1-18

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Date of the actual completion of the international search	Date of mailing of the international search report
11 December, 2008 (11.12.08)	22 December, 2008 (22.12.08)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2008/002822

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 50-35462 A (Walter Richard Schmidt), 04 April, 1975 (04.04.75), & US 4043151 A & GB 1460867 A & DE 2326235 A & FR 2230769 A & CH 583323 A & ES 426603 A & IT 1012780 B & BR 7404975 A	1-18
A	JP 2006-28727 A (Groz-Beckert KG.), 02 February, 2006 (02.02.06), & US 2006/0010926 A1 & EP 1616982 A1 & KR 10-2006-0050153 A & CN 1727544 A	1-18
A	US 5398526 A (Lin), 21 March, 1995 (21.03.95), & GB 2291656 A	11
A X	JP 2003-286636 A (Precision Fukuhara Works, Ltd.), 10 October, 2003 (10.10.03), & EP 1348788 A1 & CN 1446965 A	1-16,18 17
A	JP 37-16892 B1 (Kiyotatsu HIGUCHI), 19 October, 1962 (19.10.62), (Family: none)	16,17
A	JP 7-18778 Y2 (Unitika Ltd.), 01 May, 1995 (01.05.95), (Family: none)	16,17

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Patent documents cited in the description

- JP 2007169871 A **[0007]**