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(54) **METHOD FOR KNITTING CABLE PATTERN, DESIGN SYSTEM OF KNITTED FABRIC, AND STORAGE MEDIUM**

(57) There is provided a method for knitting a cable pattern excelling in versatility.

The following processes α to δ are carried out assuming a region where a first stitch row 1 and a second stitch row 2 are lined in an FB is an intersecting region. In the process α , the first stitch row 1 is gradually moved toward an other-side base portion b2, and stitch rows b1, b2, 1 other than the second stitch row 2 are knitted. In the process β , an empty needle is formed within a knitting

width of the first stitch row 1. In the process γ , the stitches of the second stitch row 2 are moved to the empty needles in the intersecting region in the FB, and the stitch rows b1, b2, 2 other than the first stitch row 1 are knitted. In the process δ , the stitch rows b1, b2, 2 other than the first stitch row 1 are knitted while dissolving the coexistence of the stitches of the first stitch row 1 and the stitches of the second stitch row 2.

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Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to a method for knitting a cable pattern, a design system of a knitted fabric for preparing a knitting program for knitting the cable pattern, and a storage medium stored with the knitting program for knitting the cable pattern.

Description of the Related Art

[0002] A method for knitting a cable pattern for knitting the cable pattern within a knitting width of a base knitted fabric portion using a flat knitting machine is known. The cable pattern is a structure pattern knitted by interchanging a position of a first stitch row and a position of a second stitch row lined within the knitting width of the base knitted fabric portion. For example, Patent Document 1 discloses a method for knitting a cable pattern for knitting the cable pattern that bridges across a front side and a back side of a tubular knitted fabric at a side end of the tubular knitted fabric.

[0003] A method for knitting a cable pattern by interchanging the position of the first stitch row and the position of the second stitch row all at once using racking and transfer, and a method for knitting a cable pattern by dividing both stitch rows into a plurality of groups and gradually moving each group to interchange the position of the first stitch row and the position of the second stitch row stepwisely are known when interchanging the position of the first stitch row and the position of the second stitch row from a state lined in an order of a one-side base portion (one part of base knitted fabric portion), first stitch row, second stitch row, and other-side base portion (one part of base knitted fabric portion) in a length direction of a needle bed in the flat knitting machine.

PRIOR ART DOCUMENT

PATENT DOCUMENT

[0004] [Patent Document 1] Japanese Patent Publication No. 3887410

SUMMARY OF THE INVENTION

[0005] However, the conventional method for knitting the cable pattern may not be applicable depending on the number of stitches in the first stitch row and the second stitch row configuring the cable pattern and the structure of the base knitted fabric portion other than the cable pattern. For example, if the number of stitches in each stitch row is four or more, yarn breakage may occur in the method for knitting the cable pattern by interchanging the first stitch row and the second stitch row all at once.

Furthermore, when forming the structure pattern in the base knitted fabric portion, the knitting of the cable pattern and the knitting of the structure pattern of the base knitted fabric portion may not be simultaneously carried out due to the difference in racking, and the like. Thus, the conventional method for knitting the cable pattern has drawbacks and advantages, and the user designing the knitted fabric needs to select the optimum method for knitting the cable pattern as necessary. In order to reduce such burden on the user, a method for knitting the cable pattern that can be used in a versatile manner without being restricted by the structure pattern of the base knitted fabric portion and the number of stitches in the stitch rows to be intersected is desired.

[0006] In light of the foregoing, it is one object of the present invention to provide a method for knitting a cable pattern excelling in versatility. Another object of the present invention is to provide a design system of a knitted fabric for preparing a knitting program for causing a flat knitting machine to execute the method for knitting the cable pattern excelling in versatility, and a storage medium stored with the knitting program.

[0007] The present invention is a method for knitting a cable pattern for knitting a cable pattern in a knitted fabric using a flat knitting machine including at least a first needle bed and a second needle bed disposed opposite to each other in a front and back direction by interchanging a position of a first stitch row and a position of a second stitch row from a state in which a one-side base portion, the first stitch row, the second stitch row and an other-side base portion are lined in order in a length direction of the needle beds. In the method for knitting the cable pattern of the present invention, the processes α to δ are carried out assuming a region where the first stitch row and the second stitch row are lined in the first needle bed as an intersecting region.

[process α] Moving of the first stitch row toward the other-side base portion in the intersecting region with the second stitch row temporarily moved to the second needle bed, and knitting of the one-side base portion, the first stitch row, and the other-side base portion without knitting the second stitch row are carried out for at least one or more times.

[process β] Dividing a plurality of stitches configuring the first stitch row to a one-side group closer to the one-side base portion and an other-side group closer to the other-side base portion, moving the other-side group to an end on the other-side base portion in the intersecting region, and moving at least some stitches of the one-side group toward the other-side base portion, forming an empty needle between the other-side group and the one-side group and within a knitting width of the one-side group.

[process γ] Moving each stitch of the second stitch row to the empty needle of the intersecting region, and knitting the one-side base portion, the second stitch row, and the other-side base portion without knitting the first stitch row.

[process δ] Repeating moving the stitches of the first stitch row in a mixed region, where the stitches of the

first stitch row and the stitches of the second stitch row coexist, toward the other-side base portion, moving the stitches of the second stitch row in the mixed region toward the one-side base portion, and knitting the one-side base portion, the second stitch row, and the other-side base portion without knitting the first stitch row, until the coexistence of the stitches of the first stitch row and the stitches of the second stitch row is dissolved. The mixed region is a region where the first stitch row and the second stitch row overlap in the length direction of the needle beds, and is a region from the end closer to the other-side base portion of the second stitch row to the end closer to the one-side base portion of the first stitch row (see S7, S9 of Fig. 2 to be described later).

[0008] In the method for knitting the cable pattern according to the present invention, a process ε of knitting the one-side base portion, the second stitch row, and the other-side base portion without knitting the first stitch row to disconnect a connection of the first stitch row and the second stitch row may be carried out before the process α .

[0009] In the method for knitting the cable pattern according to the present invention, a grouping of the process β may be carried out so that a moving distance of an end stitch closer to the other-side base portion of the second stitch row is greater than or equal to two needles and smaller than or equal to four needles when moving the second stitch row toward the one-side base portion in the process γ . This configuration is similar to when the number of stitches of the other-side group of the process β is two to four in the case of the all-needle knitting.

[0010] The present invention is a design system of a knitted fabric including an input unit for a user to input knitting information related to a knitting of a knitted fabric, and a knitting program preparing portion for preparing a knitting program readable with a computer arranged in a flat knitting machine including a first needle bed and a second needle bed disposed opposite to each other in a front and back direction based on the knitting information. The design system of the knitted fabric according to the present invention includes a knitting condition determining portion for determining a knitting condition for performing the method for knitting the cable pattern according to the present invention based on cable pattern related information related to the knitting of the cable pattern among the knitting information. The knitting program preparing portion arranged in the design system of the knitted fabric of the present invention prepares a knitting program for causing the computer to control the flat knitting machine to execute the method for knitting the cable pattern based on the knitting condition determined by the knitting condition determining portion.

[0011] The present invention is a storage medium for storing a knitting program readable with a computer arranged in a flat knitting machine including a first needle bed and a second needle bed disposed opposite to each other in a front and back direction. The knitting program stored in the storage medium of the present invention is

a knitting program for causing the computer to control the flat knitting machine to execute the method for knitting the cable pattern according to the present invention.

[0012] According to the method for knitting the cable pattern according to the present invention, yarn breakage is less likely to occur when interchanging the position of the first stitch row and the position of the second stitch row. This is because the stitches are to be gradually moved in a range the yarn breakage does not occur when moving the stitches of the first stitch row and also when moving the stitches of the second stitch row. The details will be described in the embodiment.

[0013] The method for knitting the cable pattern according to the present invention can be used in a versatile manner irrespective of the structure pattern of the base knitted fabric portion. Since the knitting of the first stitch row and the knitting of the second stitch row are carried out only within the intersecting region of the first needle bed until the knitting of the cable pattern is finished, the stitches configuring the cable pattern can be knitted with the first needle bed irrespective of the racking state of the second needle bed even when forming the structure pattern, that can be knitted only in a state the second needle bed is racked with respect to the first needle bed, in the base knitted fabric portion.

[0014] According to the method for knitting the cable pattern of the present invention of further carrying out the process ε , the connection of the first stitch row and the second stitch row, and the connection of the first stitch row and the one-side base portion can be disconnected, so that the yarn breakage of when moving the first stitch row can be suppressed.

[0015] If the moving distance of the end stitch closer to the other-side base portion of the second stitch row is greater than or equal to two needles and smaller than or equal to four needles, the yarn breakage of a cross-over yarn connecting the second stitch row and the other-side base portion can be suppressed when moving the stitches of the second stitch row in the process γ .

[0016] According to the design system of the knitted fabric of the present invention, the knitting program capable of knitting a cable pattern, which is not restricted by the structure pattern of the base knitted fabric portion, in the knitted fabric can be prepared. As mentioned in the embodiment described below, the user merely needs to specify the position to knit the cable pattern on the design system of the knitted fabric, and the design system of the knitted fabric automatically prepares the knitting program based on the specification of the user.

[0017] The cable pattern, which is not restricted by the structure pattern of the base knitted fabric portion, can be knitted in the knitted fabric by knitting the knitted fabric with the flat knitting machine using the knitting program stored in the storage medium of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018]

Fig. 1 a knitting process diagram showing a first half of a knitting process of a cable pattern shown in an embodiment;

Fig. 2 is a knitting process diagram showing a second half of the knitting process of the cable pattern shown in the embodiment; and

Fig. 3 is a function block diagram of a design system of a knitted fabric shown in the embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0019] A knitting example using a two-bed flat knitting machine including a front needle bed (hereinafter referred to as FB) and a back needle bed (hereinafter referred to as BB) extending in a traverse direction and disposed opposite to each other in a front and back direction, and a yarn feeder for feeding a knitting yarn, the BB capable of racking in the traverse direction and the stitches being transferable, will be described. The flat knitting machine to be used is not, of course, limited to the two-bed flat knitting machine, and may be, for example, a four-bed flat knitting machine.

<Method for knitting cable pattern>

[0020] In the embodiment, an example of knitting a cable pattern (cable pattern of 6 x 6) in which a first stitch row and a second stitch row, whose left and right positions in the knitted fabric are to be interchanged, each includes six stitches will now be described based on Figs. 1 and 2 as an example of the method for knitting the cable pattern. The number of stitches in each stitch row is not particularly limited, and for example, may be a cable pattern of 4 x 4 to 12 x 12. The number of stitches in the first stitch row and the number of stitches in the second stitch row may be different (e.g., cable pattern of 4 x 6). Furthermore, the method for knitting the cable pattern according to the present example may be applied to a tubular knitted fabric.

[0021] "Alphabet + number" in the left column of Figs. 1 and 2 indicates the number of the knitting process, and the right column shows a knitting state in the needle beds. The upper case alphabet in the figure indicates the position of the knitting needle, the arrow indicates the direction of transfer, and the triangular mark indicates a yarn feeder 8. Furthermore, the stitches of a one-side base portion b1 and an other-side base portion b2, which are base knitted fabric portions other than the cable pattern, are indicated with a circular mark, the stitch of a first stitch row 1 is indicated with a diamond mark, and the stitch of a second stitch row 2 is indicated with a pentagonal mark. The operation actually carried out in each process is indicated with a thick line/filled area. In Figs. 1 and 2, the racking operation of the BB is omitted.

[0022] S0 shows a state in which the yarn feeder 8 is moved toward a rightward direction in a plane of drawing, and the one-side base portion b1, the first stitch row 1,

the second stitch row 2, and the other-side base portion b2 lined in a length direction of the FB and the BB are knitted (base portions b1, b2 are also stitch rows including a plurality of stitches). The one-side base portion b1 is held on the knitting needle Q, R of the BB, and the knitting needles S, T of the FB. The first stitch row 1 is held on the knitting needles K to P of the FB, and the second stitch row 2 is held on the knitting needles E to J of the FB. The other-side base portion b2 is held on the knitting needles A, B of the FB and the knitting needles C, D of the BB.

[0023] The stitches on a cable pattern forming region side in the base portions b1, b2 are knitted with the BB and formed as back stitches so that the cable pattern stands out from the base knitted fabric portion. Moreover, because of this formation of the back stitches, a cross-over yarn connecting each base portion b1, b2 and the stitch rows 1, 2 configuring the cable pattern becomes long, and thus the yarn breakage of the cross-over yarn of when moving the stitch rows 1, 2 configuring the cable pattern is suppressed.

[0024] From the state shown in S0, the position of the first stitch row 1 and the position of the second stitch row 2 on the knitting needles E to P are interchanged to form the cable pattern within the knitting width of the base knitted fabric portion configured by the one-side base portion b1 and the other-side base portion b2. When forming the cable pattern, the stitch rows 1, 2 are intersected so that the first stitch row 1 is on the front side of the second stitch row 2.

[0025] In the knitting processes described below, the knitting of the first stitch row 1 and the knitting of the second stitch row 2 are carried out only within a region in which the first stitch row 1 and the second stitch row 2 are lined in the FB (i.e., region of knitting needles E to P of FB). This region is referred to as an intersecting region, and is shown by being surrounded with a broken line in the figure.

[0026] In S1, the yarn feeder 8 is moved toward the leftward direction, and the one-side base portion b1, the second stitch row 2, and the other-side base portion b2 are knitted without knitting the first stitch row 1 (corresponds to process ε). According to S1, the first stitch row 1 and the second stitch row 2, as well as, the first stitch row 1 and the one-side base portion b1 are disconnected, and the yarn breakage of when moving the first stitch row 1 in the subsequent processes can be prevented. S1 also has an effect of preventing the yarn breakage of when moving the second stitch row 2 in the post-process.

[0027] In S2, the first stitch row 1 held on the knitting needles K to P of the FB is moved to the knitting needles K to P of the BB, and the second stitch row 2 held on the knitting needles E to J of the FB is moved to the knitting needles E to J of the BB. S2 is a preparation for interchanging the position of the first stitch row 1 and the position of the second stitch row 2.

[0028] In the following S3 to S5 shown in Fig. 2, the moving of the first stitch row 1 by one needle toward the

other-side base b2 and the knitting of the stitch rows b1, 1, b2 other than the second stitch row 2 are repeated three times (corresponds to process α). The movement and the knitting of the first stitch row 1 are preferably repeated until an end stitch (stitch of knitting needle J of FB in S3) closer to the other-side base portion b2 of the first stitch row 1 is moved to the position (positions of knitting needles G to I of FB) spaced apart by two to four needles from the final moving position (position of knitting needle E of FB) of the first stitch row. The moving distance of the first stitch row 1 at one time is not limited to the distance of one needle, as described above, and can be an extent the knitting yarn connecting the first stitch row 1 and the one-side base portion b1 does not break. For example, when the knitting yarn used in the knitting is a normal knitting yarn (non-elastic knitting yarn), the moving distance of the first stitch row 1 may be a distance of about two to three needles. When the knitting yarn used in the knitting is an elastic knitting yarn, the moving distance of the first stitch row 1 may be a distance of four or more needles.

[0029] In S3, which is a part of the process α , the first stitch row 1 held on the knitting needles K to P of the BB is moved to the knitting needles J to O of the FB using racking and transfer with the second stitch row 2 temporarily moved to the BB. That is, the first stitch row 1 is moved by one needle toward the other-side base portion b2 from the state of S1 of Fig. 1. Furthermore, in S3, the yarn feeder 8 is moved toward the rightward direction, and the one-side base portion b1, the first stitch row 1, and the other-side base portion b2 are continuously knitted without knitting the second stitch row 2. According to such moving and knitting, a cross-over yarn 3 connecting the first stitch row 1 and the one-side base portion b1 becomes long, and the next S4 can be easily carried out.

[0030] After S3, the stitch rows b1, 1, b2 may be knitted for at least one course without moving the first stitch row 1. The shape of the cable pattern is better regulated if the number of courses (number of tiers in the wale direction) of the first stitch row 1 is greater than the number of courses of the second stitch row 2, to be described later.

[0031] In S4 and S5, similar to S3 described above, the first stitch row 1 is moved by one stitch toward the other-side base portion b2, and the one-side base portion b1, the first stitch row 1, and the other-side base portion b2 are knitted without knitting the second stitch row 2.

[0032] In S6, the first stitch row 1 in S5 is divided to a one-side group g1 closer to the one-side base portion b1 and an other-side group g2 closer to the other-side base portion b2, and each group g1, g2 is moved to the knitting needles closer to the other-side base portion b2 of the FB (corresponds to process β). In this case, the other-side group g2 is moved to the left end of the intersecting region, and the stitches configuring the one-side group g1 are moved to the knitting needles closer to the one-side base portion b1 than the other-side group g2. When moving the one-side group g1, an empty needle is to be

formed between the other-side group g2 and the one-side group g1, and within the knitting width of the one-side group g1 (see knitting needle H of FB for the former case, and knitting needles J, L of FB for the latter case).

[0033] How many stitches to assign to each group g1, g2 is determined within a range the cross-over yarn 3 connecting the second stitch row 2 and the other-side base portion b2 does not break when moving the second stitch row 2 in the next S7. Specifically, among the stitches configuring the first stitch row 1, one to three stitches closer to the other-side base portion b2 are the other-side group g2, and the remaining stitches are the one-side group g1. For example, if the first stitch row 1 is configured by 12 stitches, two to four stitches are the other-side group g2, and ten to eight stitches are the one-side group g1. When knitting the knitted fabric with an elastic knitting yarn, however, the number of stitches in the other-side group g2 may be four or more.

[0034] When moving the stitches in S6, the BB is racked toward the leftward direction so that the empty needle of the BB is arranged at a position facing the first stitch row 1. Then, the stitches of the first stitch row 1 held on the knitting needles H to M of the FB in S5 are temporarily moved to the BB. The stitches temporarily moved to the BB may be sequentially returned to the FB while racking the BB toward the leftward direction.

[0035] In S7, each stitch configuring the second stitch row 2 is moved to the empty needle of the intersecting region of the FB surrounded with a broken line and the stitch rows b2, 2, b1 other than the first stitch row 1 are knitted (corresponds to process γ). The empty needle of the intersecting region is an empty needle formed on the FB by performing the process α and the process β , where in the case of the present example, the knitting needles N, O, P of the FB are empty needles formed in the process α , and the knitting needles H, J, L of the FB are the empty needles formed in the process β . When moving the second stitch row 2, the lined order of the stitches in the second stitch row 2 in the length direction of the needle bed is not to be changed. In the present example, among the stitches of the second stitch row 2 held on the BB, the stitch on the knitting needle E, the stitch on the knitting needle F, and the stitch on the knitting needle G of the BB are respectively moved to the knitting needle H, the knitting needle J, and the knitting needle L of the FB, and each of the stitches on the knitting needles H, I, J of the BB are moved to the knitting needles N, O, P of the FB.

[0036] Among the second stitch row 2, the end stitch closer to the other-side base portion b2 is moved by three stitches in the length direction of the needle bed from the knitting needle E of the BB to the knitting needle H of the FB (empty needle between the one-side group g1 and the other-side group g2). If the movement is in the distance of about three needles, the possibility the cross-over yarn 3 connecting the second stitch row 2 and the other-side base portion b2 will break is low. Furthermore, among the stitches of the second stitch row 2, the end stitch closer to the one-side base portion b1 is moved by

six stitches in the length direction of the needle bed from the knitting needle J of the BB to the knitting needle P of the FB. As shown in S1 of Fig. 1, this end stitch is connected to the one-side base portion b1, and the cross-over yarn connecting the end stitch and the one-side base portion b1 is very long. The moving direction of the end stitch is the direction of reducing the distance between the end stitch and the one-side base portion b1, and thus the yarn breakage is not a concern.

[0037] In S8 to S11, the moving of the stitches of the first stitch row 1 and the stitches of the second stitch row 2 in a mixed region, where the stitches of the first stitch row 1 and the stitches of the second stitch row 2 coexist, toward the side of the other-side base portion b2 and the side of the one-side base portion b1, and the knitting of the second stitch row 2 are repeated until the coexistence of the stitches of the stitch rows 1, 2 is dissolved (corresponds to process δ). When knitting the second stitch row 2, the stitch rows b1, 2, b2 other than the first stitch row 1 are knitted.

[0038] In S8, which is part of the process δ , the stitches on the knitting needles H to M of the FB in the mixed region 4 shown in S7 are moved to the knitting needles H to M of the BB. The mixed region 4 is a region from the end (see knitting needle H) closer to the other-side base portion b2 of the second stitch row 2 to the end (see knitting needle M) closer to the one-side base portion b1 of the first stitch row 1 after S7 is finished.

[0039] In S9, the stitches of the first stitch row 1 held on the knitting needles I, K, M of the BB are moved to the knitting needles H, J, L of the FB, and the stitches of the second stitch row 2 held on the knitting needles H, J, L of the BB are moved to the knitting needles I, K, M of the FB using racking and transfer. Furthermore, in S9, the yarn feeder 8 is moved toward the rightward direction, and the other-side base portion b2, the second stitch row 2, and the one-side base portion b1 are continuously knitted without knitting the first stitch row 1.

[0040] According to S8 and S9, the coexistence of the stitches of the first stitch row 1 and the stitches of the second stitch row 2 is partially dissolved, and the knitting needles I to L of the FB become a new mixed region 5. In S10, the stitches on the knitting needles I to L of the FB in the mixed region 5 are moved to the knitting needles I to L of the BB.

[0041] In S11, the stitches of the first stitch row 1 held on the knitting needles J, L of the BB are moved to the knitting needles I, J of the FB, and the stitches of the second stitch row 2 held on the knitting needles I, K of the BB are moved to the knitting needles K, L of the FB. Furthermore, in S11, the yarn feeder 8 is moved toward the leftward direction, and the other-side base portion b2, the second stitch row 2, and the one-side base portion b1 are knitted without knitting the first stitch row 1. According to S10 and S11, the coexistence of the stitches of the stitch rows 1, 2 is dissolved, and a state in which the position of the first stitch row 1 and the position of the second stitch row 2 are interchanged, that is, a state in

which the cable pattern having the first stitch row 1 intersecting on the front side of the second stitch row 2 is obtained.

[0042] Thereafter, when further knitting the cable pattern, S1 to S11 of Figs. 1 and 2 are to be repeated. The one-side base portion b1, the first stitch row 1, the second stitch row 2, and the other-side base portion b2 may be defined in order from the left side in the plane of drawing, and the knitting similar to S1 to S11 may be carried out. In this case, the cable pattern in which the stitch row of the knitting needles E to J of the FB in S0 of Fig. 1 is arranged on the surface side of the knitted fabric can be formed.

[0043] According to the knitting processes described above, the yarn breakage can be avoided from occurring when interchanging the position of the first stitch row 1 and the position of the second stitch row 2. This is because when moving one of the two stitches connected with the cross-over yarn in a direction of stretching the cross-over yarn, the moving distance is smaller than or equal to the distance of four needles at the most.

[0044] In the knitting processes described above, since the first stitch row 1 and the second stitch row 2 are knitted only within the intersecting region of the FB surrounded with the broken line until the knitting of the cable pattern is finished, even when forming the structure pattern that can be knitted only in a state the BB is racked with respect to the FB in the base knitted fabric portion (base portions b1, b2), the stitches configuring the cable pattern can be knitted with the FB regardless of the racking state of the BB. That is, the method for knitting the cable pattern described in the embodiment has versatility capable of forming the cable pattern regardless of what structure pattern is provided in the base knitted fabric portion outside the intersecting region.

[0045] Furthermore, in the knitting processes described above, the second stitch row hidden on the back side of the first stitch row comprising the front stitches also comprises the front stitches, so that the structure in the portion of the first stitch row and the portion of the second stitch row in the cable pattern has a sense of unity, and the appearance of the cable pattern can be improved.

<Knitting program and storage medium>

[0046] The knitting program for causing the flat knitting machine to execute the method for knitting the cable pattern is a knitting program for causing a computer arranged in the flat knitting machine to control the flat knitting machine to execute the following steps. When the following steps are executed, the cable pattern in which the position of the first stitch row 1 and the position of the second stitch row 2 arranged between the one-side base portion b1 and the other-side base portion b2 shown in S0 of Fig. 1 are interchanged can be formed in the knitted fabric.

[0047] In the flat knitting machine, a cam arranged in

a carriage travelling on the needle beds acts on a bat arranged in the knitting needles, and the knitting needles move forward and backward along the needle grooves of the needle beds to form the stitches. The flat knitting machine includes a needle selecting mechanism for determining which knitting needle to perform what kind of movement, a carriage control mechanism that controls the travelling of the carriage and the appearance/disappearance of the cam, and a racking control mechanism that controls the racking of the needle bed. The knitting program realizes the knitting of the following steps by issuing a command to such mechanisms and controlling the racking position of the needle bed and the movement of each knitting needle.

[0048] Step 1 in which a region where the first stitch row 1 and the second stitch row 2 are lined in the FB is assumed as the intersecting region, and with the second stitch row 2 temporarily moved to the BB, the moving of the first stitch row 1 toward the side of the other-side base portion b2 in the intersecting region and the knitting of the one-side base portion b1, the first stitch row 1, and the other-side base portion b2 without knitting the second stitch row 2 are repeated at least one or more times.

[0049] Step 2 of dividing a plurality of stitches configuring the first stitch row 1 to the one-side group g1 closer to the one-side base portion b1 and the other-side group g2 closer to the other-side base portion b2, moving the other-side group g2 to the end of the intersecting region and moving some stitches of the one-side group g1 to the side of the other-side base portion b2, forming an empty needle between the other-side group g2 and the one-side group g1 and within the knitting width of the one-side group g1.

[0050] Step 3 of moving each stitch of the second stitch row 2 to the empty needle of the intersecting region, and knitting the one-side base portion b1, the second stitch row 2, and the other-side base portion b2 without knitting the first stitch row 1.

[0051] Step 4 in which the moving of the stitches of the first stitch row 1 in the mixed regions 4, 5 where the stitches of the first stitch row 1 and the stitches of the second stitch row 2 coexist toward the side of the other-side base portion b2, moving of the stitches of the second stitch row 2 in the mixed regions 4, 5 toward the side of the one-side base portion b1, and the knitting of the one-side base portion b1, the second stitch row 2, and the other-side base portion b2 without knitting the first stitch row 1 are repeated until the coexistence of the stitches of the first stitch row 1 and the stitches of the second stitch row 2 is dissolved.

[0052] The storage medium for storing the knitting program may be in a form of being mounted on a design system of a knitted fabric, may be in a form of being mounted on the flat knitting machine, or may be in a form of a portable storage medium such as a CD-ROM, a USB memory, a magnetic disc, and the like that transitions the knitting program prepared with the design system of the knitted fabric to the flat knitting machine. The design sys-

tem of the knitted fabric is a system for the user to design the knitted fabric on a screen to prepare the knitting program for operating the flat knitting machine based on the design of the user (see e.g., Japanese Patent Publication No. 2916990).

<Design system of knitted fabric>

[0053] As shown in the function block diagram of Fig. 3, the design system 100 of the knitted fabric for preparing the knitting program based on the design of the user includes an input unit 10, an automatic processing unit 20, a memory 30, and a display unit 40. The design system 100 of the knitted fabric is configured to automatically prepare the knitting program when the user specifies a position to knit the cable pattern (e.g., position to start the knitting of the cable pattern) and the width of the cable pattern in some part of the knitted fabric. The configurations of each unit 10, 20, 30, 40 will be briefly described below, and then the procedure for the design system 100 of the knitted fabric to prepare the knitting program based on the information input by the user will be described.

«Input unit»

[0054] The input unit 10 is used when the user edits the design data, and is configured in a form of a keyboard, a mouse, a scanner, a digitizer, and the like. The information input by the user includes information (information of pattern paper) on what shape and size knitted fabric to knit, information on a type of knitting yarn, information on a knitting unit configuring the knitted fabric, information on a knitting code assigned to each knitting unit (information on position of knitting unit and knitting code arranged at the position), and the like. Hereinafter, the information related to the knitting of the knitted fabric is referred to as knitting information.

[0055] The knitting unit of the knitted fabric corresponds to one stitch in the knitted fabric. The knitting code assigned to each knitting unit represents the knitting operation to be carried out by the flat knitting machine in, for example, color, number, figure, or a combination thereof. For example, the knitting code represented in red (green) is defined as the knitting code for causing the flat knitting machine to knit a front stitch (back stitch). Of course, a plurality of knitting operations may be defined with one knitting code, and the knitting code related to the knitting of the cable pattern is a typical example thereof. For example, the knitting codes represented in purplish red and purplish blue may be knitting codes for causing the flat knitting machine to knit a portion (first stitch row 1 of Figs. 1 and 2) arranged on the front side of the cable pattern and a portion (second stitch row 2) arranged on the back side of the cable pattern. The knitting code (hereinafter referred to as first knitting code) defining the first stitch row 1 and the knitting code (hereinafter referred to as second knitting code) defining the second stitch row 2 are always used in pairs. Such knitting codes are stored

in the memory 30, to be described later.

«Automatic processing unit»

[0056] The automatic processing unit 20 prepares the knitting program of the knitted fabric, and for example, can be configured with a computer. The automatic processing unit 20 includes a knitting condition determining portion 21 for determining the knitting condition of the cable pattern based on the cable pattern related information related to the knitting of the cable pattern among the knitting information input by the user, and a knitting program preparing portion 29 for preparing the knitting program based on the knitting condition determined by the knitting condition determining portion 21. The cable pattern related information used by the knitting condition determining portion 21 to determine the knitting condition includes information on the knitting code defining the knitting of the cable pattern, information on the position where the knitting code is arranged, information on the type of knitting yarn configuring the cable pattern, and the like.

[Knitting condition determining portion]

[0057] The knitting condition determining portion 21 determines the knitting condition for performing the method for knitting the cable pattern of the present invention, that is, the knitting condition of each step of the knitting program described above based on the cable pattern related information. The knitting condition to be determined includes, for example, the following five conditions.

- (1) Moving distance of the first stitch row 1 at one time in step 1.
- (2) Number of times to repeat moving and knitting of the first stitch row 1 in step 1.
- (3) Manner of grouping the first stitch row 1 in step 2 (how many stitches to be included in the one-side group g1 and the other-side group g2).
- (4) Area to form the empty needle in step 2.
- (5) Moving pattern of the first stitch row 1 and the second stitch row 2 to dissolve coexistence of the stitches of the first stitch row 1 and the second stitch row 2 in step 4.

[0058] In the design system 100 of the knitted fabric of the present example, a plurality of the respective knitting conditions (1) to (5) are prepared, and such knitting conditions are stored in the memory 30, to be described later. Each knitting condition is set in advance according to the type of knitting yarn, and the number of stitches configuring the first stitch row 1 and the second stitch row 2 (i.e., cable pattern related information). For example, a plurality of knitting conditions corresponding to the change in the cable pattern related information is set in advance such that the knitting condition of when the number of stitches of the stitch rows 1, 2 is four each is

"X", and the knitting condition of when the number of stitches of the stitch rows 1, 2 is five each is "Y". That is, the knitting condition determining portion 21 of the present example is configured to reference the cable pattern related information, and select the knitting condition corresponding to the cable pattern related information from the plurality of knitting conditions.

[Knitting program preparing portion]

[0059] The knitting program preparing portion 29 prepares the knitting program set with the actual operation of the knitting needle, the procedure of reeling out the knitting yarn, and the like based on the knitting information input by the user. The knitting program prepared by the knitting program preparing portion 29 is transmitted to the flat knitting machine through the recording medium such as the magnetic disc, and the like, or in a wired or a wireless manner.

«Memory»

[0060] The memory 30 is a storage medium such as a hard disc, and the like that stores the knitting information (including cable pattern related information) input by the user, and the knitting condition referenced by the knitting condition determining portion 21. The memory 30 can, of course, store other information related to the design of the knitted fabric, for example, the knitting code to be assigned to the knitting unit by the user.

«Display unit»

[0061] The display unit 40 is provided to visually grasp the information related to the design of the knitted fabric, and is not particularly limited. The display unit 40 includes, for example, a liquid crystal display. If a touch panel is used for the display unit 40, the display unit 40 may partially covers the function of the input unit 10.

«Procedure for preparing knitting program of cable pattern»

[0062] The procedure for preparing the knitting program by the design system 100 of the knitted fabric having the above configuration will now be described. First, the user arranges the knitting code on the pattern paper including a plurality of knitting units through the input unit 10. In this case, when the knitting code related to the knitting of the cable pattern is arranged in the knitting unit of the knitted fabric, the design system 100 of the knitted fabric prepares the knitting program of the cable pattern based on the position where the knitting code related to the cable pattern is arranged.

[0063] The automatic processing unit 20 first determines whether or not the larger one of the number of the first knitting codes lined continuously in the knitting width direction and the number of the second knitting codes

lined continuously in the knitting width direction is smaller than or equal to three. If the larger one of the numbers is smaller than or equal to three, the knitting program preparing portion 29 of the automatic processing unit 20 prepares the knitting program including the conventional method for knitting the cable pattern of interchanging the position of the first stitch row 1 and the position of the second stitch row 2 all at once.

[0064] If the number of continuing first knitting codes (second knitting codes) is greater than or equal to four, the knitting condition determining portion 21 of the automatic processing unit 20 references the cable pattern related information, and determines the knitting conditions (1) to (5) corresponding to the reference result from the plurality of knitting conditions stored in the memory 30. For example, the knitting condition (1) related to the moving distance of the first stitch row 1 at one time may be determined based on the information on whether or not the knitting yarn is an elastic knitting yarn. Furthermore, the knitting conditions (2) to (5) may be determined based on the information on whether or not the knitting yarn is an elastic knitting yarn and how many stitches are in each stitch row 1, 2.

[0065] After the knitting conditions (1) to (5) are determined, the knitting program preparing portion 29 prepares the knitting program for causing the flat knitting machine to perform the method for knitting the cable pattern satisfying the determined knitting conditions (1) to (5).

Claims

1. A method for knitting a cable pattern for knitting a cable pattern in a knitted fabric using a flat knitting machine including at least a first needle bed (FB) and a second needle bed (BB) disposed opposite to each other in a front and back direction by interchanging a position of a first stitch row (1) and a position of a second stitch row (2) from a state in which a one-side base portion (b1), the first stitch row (1), the second stitch row (2), and an other-side base portion (b2) are lined in order in a length direction of the needle beds; assuming a region where the first stitch row (1) and the second stitch row (2) are lined in the first needle bed (FB) as an intersecting region, the method **characterized by:**

process α of carrying out, for at least one or more times, moving of the first stitch row (1) toward the other-side base portion (b2) in the intersecting region with the second stitch row (2) temporarily moved to the second needle bed (BB), and knitting of the one-side base portion (b1), the first stitch row (1), and the other-side base portion (b2) without knitting the second stitch row (2);

process β of dividing a plurality of stitches configuring the first stitch row (1) to a one-side group (g1) closer to the one-side base portion (b1) and an other-side group (g2) closer to the other-side base portion (b2), moving the other-side group (g2) to an end on the other-side base portion (b2) in the intersecting region, and moving at least some stitches of the one-side group (g1) toward the other-side base portion (b2), forming an empty needle between the other-side group (g2) and the one-side group (g1) and within a knitting width of the one-side group (g1); process γ of moving each stitch of the second stitch row (2) to the empty needle of the intersecting region, and knitting the one-side base portion (b1), the second stitch row (2), and the other-side base portion (b2) without knitting the first stitch row (1); and process δ of repeating moving the stitches of the first stitch row (1) in a mixed region (4, 5), where the stitches of the first stitch row (1) and the stitches of the second stitch row (2) coexist, toward the other-side base portion (b2), moving the stitches of the second stitch row (2) in the mixed region (4, 5) toward the one-side base portion (b1), and knitting the one-side base portion (b1), the second stitch row (2), and the other-side base portion (b2) without knitting the first stitch row (1), until the coexistence of the stitches of the first stitch row (1) and the stitches of the second stitch row (2) is dissolved.

2. The method for knitting a cable pattern according to claim 1, wherein a process ε of knitting the one-side base portion (b1), the second stitch row (2), and the other-side base portion (b2) without knitting the first stitch row (1) to disconnect a connection of the first stitch row (1) and the second stitch row (2) is carried out before the process α .
3. The method for knitting a cable pattern according to claim 1 or 2, wherein a grouping of the process β is carried out so that a moving distance of an end stitch closer to the other-side base portion (b2) of the second stitch row (2) is greater than or equal to two needles and smaller than or equal to four needles when moving the second stitch row (2) toward the one-side base portion (b1) in the process γ .
4. A design system (100) of a knitted fabric including an input unit (10) for a user to input knitting information related to a knitting of a knitted fabric, and a knitting program preparing portion (29) for preparing a knitting program readable with a computer arranged in a flat knitting machine including a first needle bed (FB) and a second needle bed (BB) disposed opposite to each other in a front and back direction based on the knitting information; the design system

characterized by:

a knitting condition determining portion (21) for
determining a knitting condition for performing
the method for knitting a cable pattern according
to any one of claims 1 to 3 based on cable pattern
related information related to the knitting of the
cable pattern among the knitting information;
wherein
the knitting program preparing portion (29) pre-
pares a knitting program for causing the com-
puter to control the flat knitting machine to exe-
cute the method for knitting the cable pattern
based on the knitting condition determined by
the knitting condition determining portion (21).

5. A storage medium for storing a knitting program
readable with a computer arranged in a flat knitting
machine including a first needle bed (FB) and a sec-
ond needle bed (BB) disposed opposite to each other
in a front and back direction, **characterized in that:**

the knitting program is a knitting program for
causing the computer to control the flat knitting
machine to execute the method for knitting a ca-
ble pattern according to any one of claims 1 to 3.

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Fig. 1

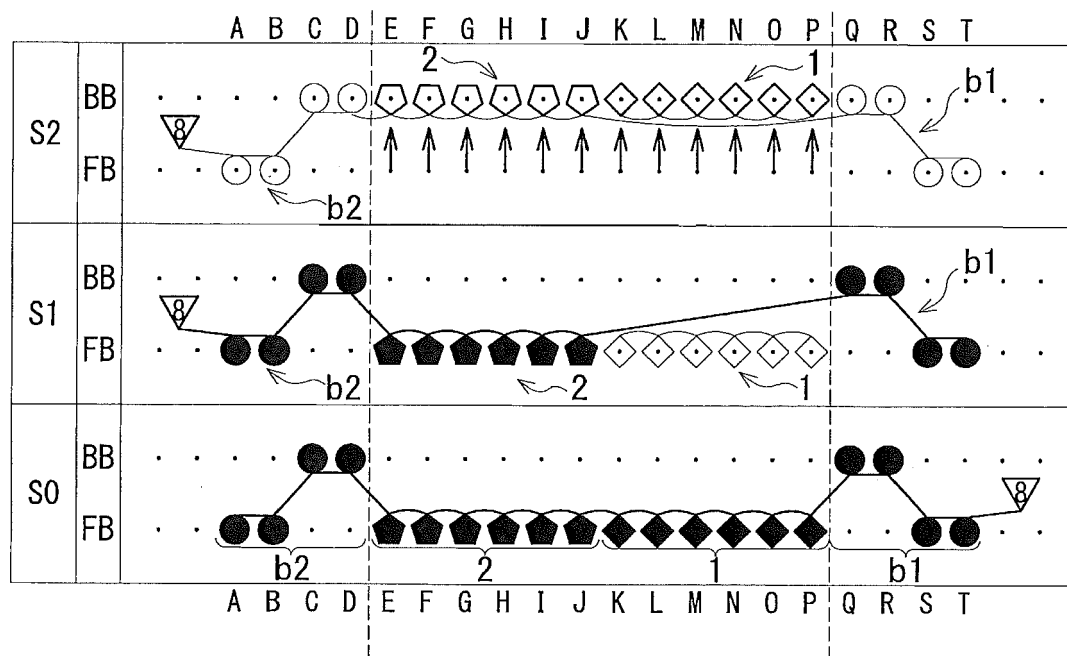


Fig. 2

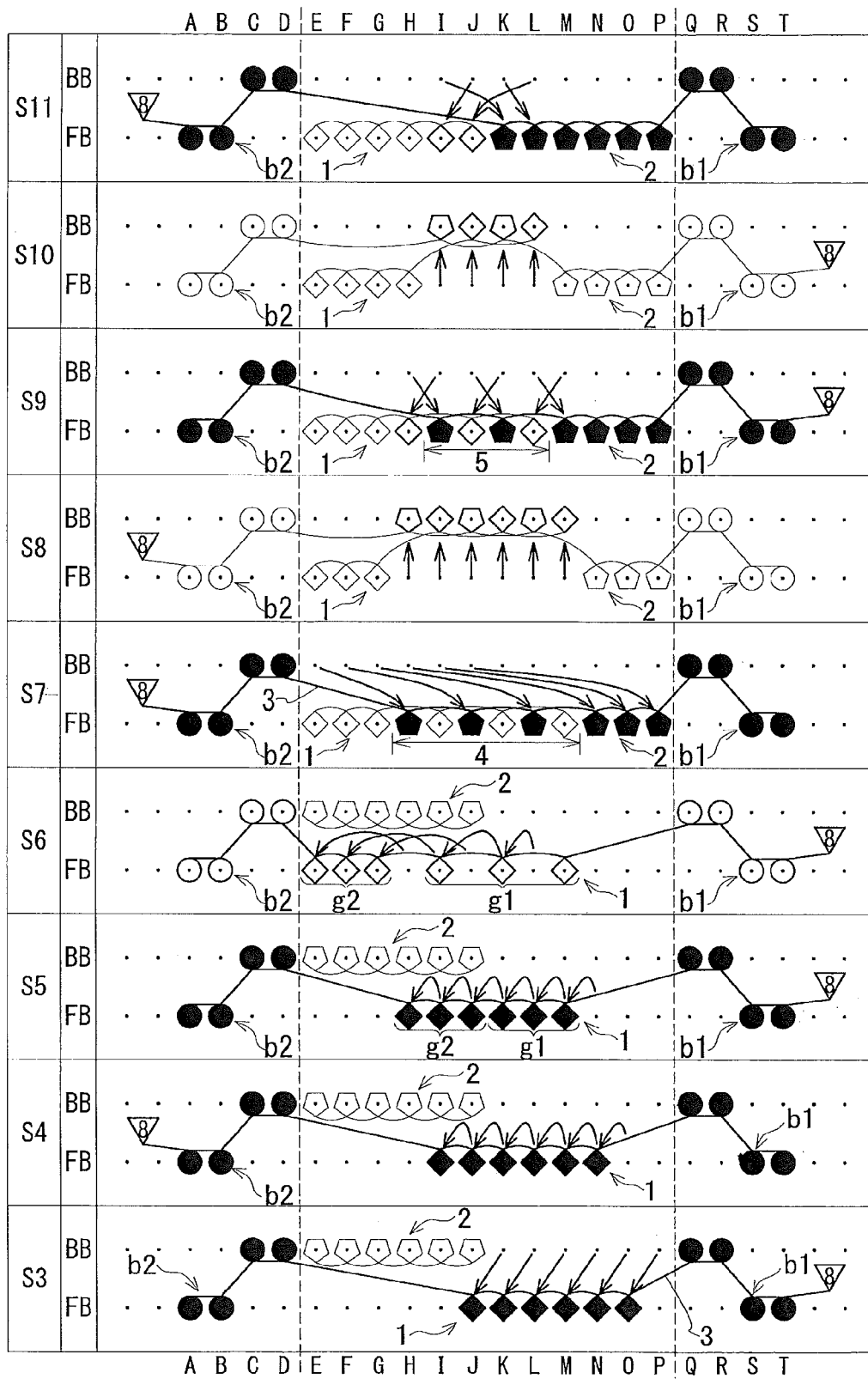
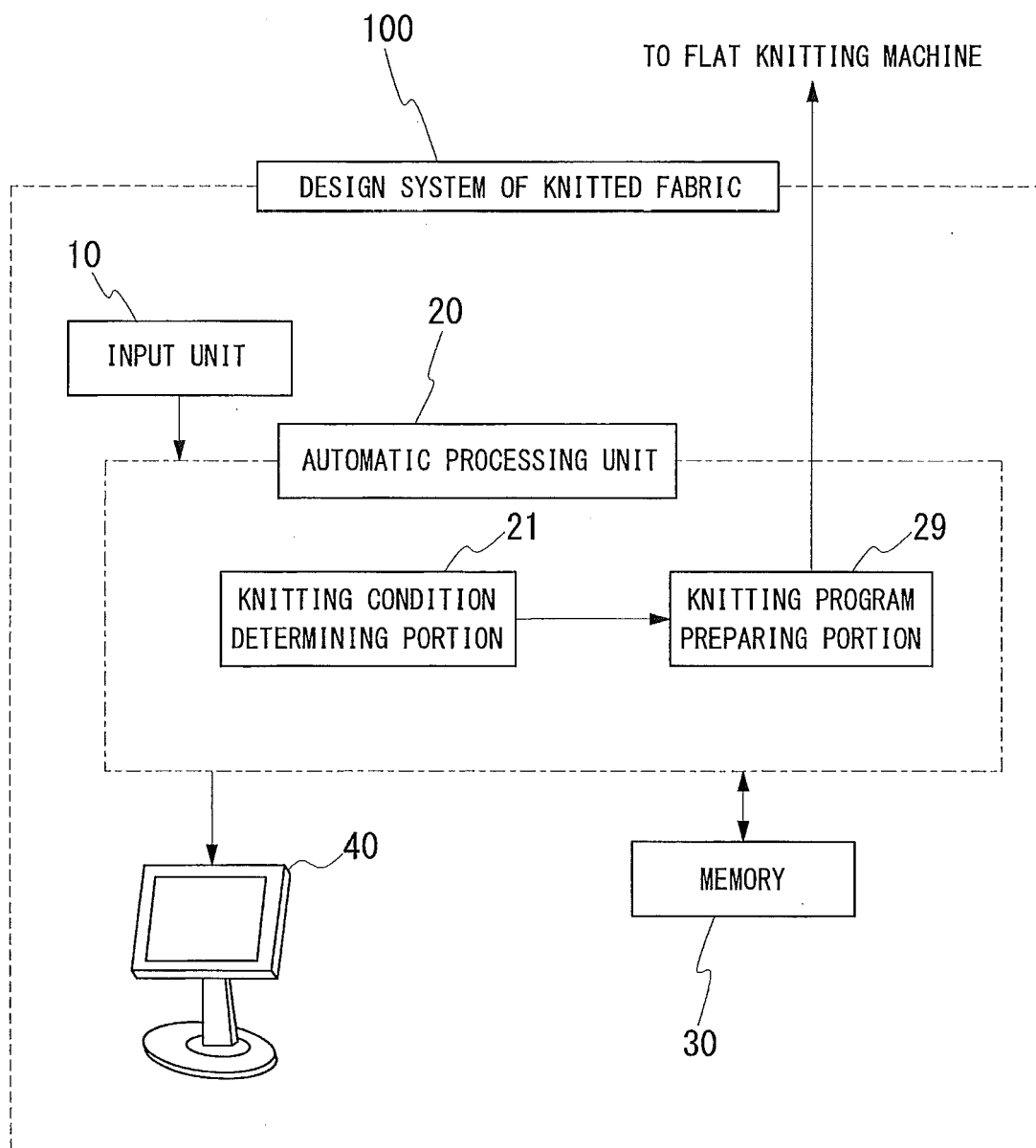


Fig. 3





EUROPEAN SEARCH REPORT

Application Number
EP 15 17 6494

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			D04B
Place of search		Date of completion of the search	Examiner
Munich		1 December 2015	Kirner, Katharina
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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