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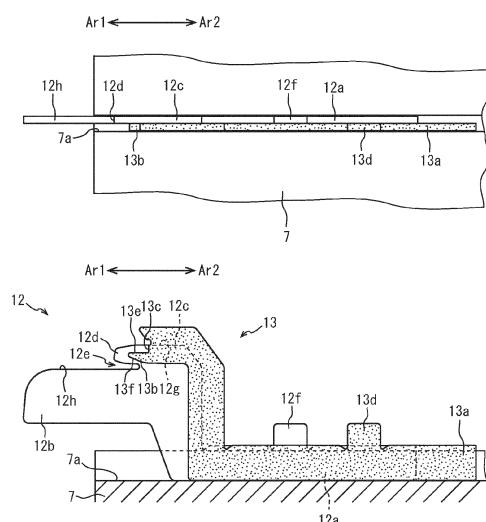
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(54) **PAIR SINKER, CIRCULAR KNITTING MACHINE INCLUDING PAIR SINKER, AND KNITTING METHOD FOR KNITTING DOUBLE FLEECE KNIT FABRIC BY CIRCULAR KNITTING MACHINE INCLUDING PAIR SINKER**

(57) A pair sinker that can suppress protrusion of a lay-in yarn on a front surface of a ground knit fabric even in a case where a state of each yarn, a state of the pair sinker, or a surrounding environment is changed, a circular knitting machine including the pair sinker, and a knitting method for knitting a double fleece knit fabric by the circular knitting machine including the pair sinker are achieved.

A pair sinker 11 are constituted by a first sinker 12 and a second sinker 13 respective base portions of which are inserted in a same sinker groove 7a of a circular knitting machine 1, the first sinker 12 includes an upper support portion 12c that supports a lay-in yarn r, a tie-in yarn t, and a knit-in yarn k and a lower support portion 12b located more downward than the upper support portion 12c, the second sinker 13 includes an insertion portion 13b that is inserted in a loop Rr of the lay-in yarn and a second sinker engaging portion 13c that pushes in the lay-in yarn r and the tie-in yarn t, and an upper end surface 13e of the insertion portion 13b is arranged in a position located more downward than an upper end surface 12g of the upper support portion 12c and more upward than an upper end surface 12h of the lower support portion 12b.

FIG. 4



## Description

### TECHNICAL FIELD

**[0001]** The present invention relates to a pair sinker, a circular knitting machine including the pair sinker, and a knitting method for knitting a double fleece knit fabric by the circular knitting machine including the pair sinker.

### BACKGROUND ART

**[0002]** Conventionally, a double fleece knit fabric in which a loop is formed by a lay-in yarn on a back surface of a ground knit fabric knitted with a tie-in yarn and a knit-in yarn has been known. The double fleece knit fabric is knitted by a circular knitting machine including a pair sinker constituted by two plates of sinkers has been known. The lay-in yarn, the tie-in yarn, and the knit-in yarn are sequentially fed to the circular knitting machine. The lay-in yarn is fed between a knitting needle and the pair sinker. The lay-in yarn is pushed out toward the knitting needle by one of the sinkers. As a result, a loop is formed on the lay-in yarn by the knitting needle and the one of the sinkers. Next, the tie-in yarn is fed to a hook of the knitting needle. The tie-in yarn is entangled with the loop of the lay-in yarn by the knitting needle. Next, the knit-in yarn is fed to the hook of the knitting needle. The knit-in yarn fed to the knitting needle is entangled with an old loop with the tie-in yarn.

**[0003]** In the above-described knitting method for knitting a double fleece knit fabric, the lay-in yarn is not pushed out by the sinker during a period from a time when the tie-in yarn is entangled to a time when the tie-in yarn and the knit-in yarn are entangled with the old loop. That is, the loop of the lay-in yarn is loosened. Therefore, when the tie-in yarn and the knit-in yarn are entangled with the old loop, a root of the loop of the lay-in yarn is drawn into the old loop by the tie-in yarn in some cases. In a case where the root of the loop of the lay-in yarn is drawn into the old loop, in the double fleece knit fabric, the root of the loop of the lay-in yarn protrudes on a front surface of the ground knit fabric. There have been known knitting methods that prevent protrusion of the loop of the lay-in yarn from the front surface of the ground knit fabric in the above-described double fleece knit fabric. For example, Patent Document 1 describes such a knitting method.

**[0004]** Patent Document 1 describes a knitting method in which, during a period from a time when the tie-in yarn is entangled with the lay-in yarn by descending the knitting needle to a time when the knitting needle is lifted to capture the knit-in yarn, the lay-in yarn is held by a pile-yarn (lay-in yarn) holding stepped portion of one of the sinkers of the pair sinker such that the lay-in yarn is not loosened. Thus, the root of the loop of the lay-in yarn is less likely to be drawn into the loop of the tie-in yarn in lifting the knitting needle. Patent Document 1 also describes a knitting method in which one of the sinkers is

caused to contact the root of the loop of the lay-in yarn such that the lay-in yarn is not loosened during a period from a time when the tie-in yarn is entangled with the lay-in yarn to a time when the tie-in yarn and the knit-in yarn are entangled with the old loop.

### CITATION LIST

#### PATENT DOCUMENT

**[0005]** Patent Document 1: Japanese Patent Publication No. 03-19943

### SUMMARY OF INVENTION

#### TECHNICAL PROBLEM

**[0006]** According to the knitting method for knitting a double fleece knit fabric by a pair sinker described in Patent Document 1, movement of the lay-in yarn is suppressed by a friction force between the lay-in yarn and the sinker. The friction force between the lay-in yarn and the sinker fluctuates depending on states of respective surfaces of the lay-in yarn and the sinker, a contact state of the lay-in yarn and the sinker, air temperature, air humidity, whether there is a lubricant, or the like. Therefore, even when adjustment is made to prevent protrusion of the root of the loop of the lay-in yarn from the front surface of the ground knit fabric according to the knitting method, the root of the loop of the lay-in yarn protrudes from the front surface of the ground knit fabric in some cases, depending on states of the lay-in yarn and the sinker, a surrounding environment, or the like. Moreover, in the knitting method, in drawing the tie-in yarn and the knit-in yarn to a position located more downward than an upper end of the sinker by the knitting needle, the sinker is separated from the lay-in yarn. Therefore, the loop of the lay-in yarn is drawn into the old loop and the root of the loop of the lay-in yarn protrudes from the front surface of the ground knit fabric in some cases.

**[0007]** For the above-described knitting method for knitting a double fleece knit fabric, it is required that the root of the loop of the lay-in yarn does not protrude from the surface of the ground knit fabric even in a case where the state of the tie-in yarn, the state of the knit-in yarn, the state of the pair sinker, or the surrounding environment is changed.

**[0008]** It is therefore an object of the present invention to provide a pair sinker that, even in a case where a state of a lay-in yarn, a state of a tie-in yarn, a state of a knit-in yarn, a state of the pair sinker, or a surrounding environment is changed, can suppress protrusion of the lay-in yarn on a front surface of the ground knit fabric, a circular knitting machine including the pair sinker, and a knitting method for knitting a double fleece knit fabric by the circular knitting machine including the pair sinker.

## SOLUTION TO PROBLEM

**[0009]** The inventors of the present invention studied on a pair sinker that, even in a case where a state of a lay-in yarn, a state of a tie-in yarn, a state of a knit-in yarn, a state of the pair sinker, or a surrounding environment is changed, can suppress protrusion of the lay-in yarn on a front surface of the ground knit fabric, a circular knitting machine including the pair sinker, a knitting method for knitting a double fleece knit fabric by the circular

**[0010]** A pair sinker according to an embodiment of the present invention is a pair sinker used for knitting a double fleece knit fabric by a circular knitting machine by knitting a ground knit fabric from a tie-in yarn and a knit-in yarn and entangling a lay-in yarn with the tie-in yarn to form a loop of the lay-in yarn on a back surface of the ground knit fabric.

**[0011]** The pair sinker is constituted by a first sinker and a second sinker respective base portions of which are located in a same sinker groove of the circular knitting machine and that are plate members movable independently from each other in a radial direction of a rotating cylinder of the circular knitting machine only by a predetermined moving amount. The first sinker extends from the base portion of the first sinker in the radial direction of the rotating cylinder and includes an upper support portion that supports the lay-in yarn, the tie-in yarn, and the knit-in yarn and a lower support portion located more downward than the upper support portion. The second sinker includes an insertion portion that extends from the base portion of the second sinker in the radial direction of the rotating cylinder and is inserted in the loop of the lay-in yarn and a second sinker engaging portion that extends upward from a base portion of the insertion portion and pushes in the lay-in yarn and the tie-in yarn. In the second sinker, the insertion portion has an upper end surface located more downward than an upper end surface of the upper support portion of the first sinker and more upward than an upper end surface of the lower support portion of the sinker.

**[0012]** As described above, the first sinker drops the lay-in yarn, the tie-in yarn, and the knit-in yarn supported by the upper support portion on the lower support portion by moving outward in the radial direction of the rotating cylinder. The insertion portion of the second sinker is inserted in the loop of the lay-in yarn dropped from the upper support portion by moving inward in the radial direction of the rotating cylinder. The insertion portion of the second sinker is located more downward than the upper end surface of the upper support portion, and therefore, the insertion portion can be moved inward in the radial direction of the rotating cylinder before the loop of the lay-in yarn reaches a position of the insertion portion. Furthermore, the insertion portion pushes out the loop of the lay-in yarn inward in the radial direction of the

rotating cylinder by moving inward in the radial direction of the rotating cylinder by the predetermined amount. That is, the second sinker reliably pulls the loop of the lay-in yarn only by the predetermined amount toward a back surface of the ground knit fabric knitted with the tie-in yarn and the knit-in yarn. Thus, the pair sinker can suppress protrusion of the lay-in yarn on a front surface of the ground knit fabric even in a case where a state of the lay-in yarn, a state of the tie-in yarn, a state of the knit-in yarn, a state of the pair sinker, or a surrounding environment is changed.

**[0013]** According to another aspect, the pair sinker of the present invention preferably has the following configuration. The first sinker is configured such that a first sinker engaging portion that pushes out the loop of the lay-in yarn in which the insertion portion of the second sinker is inserted from the insertion portion of the second sinker is located in an end portion of the upper support portion.

**[0014]** As described above, while the insertion portion of the second sinker is pulled out from the loop of the lay-in yarn, the loop of the lay-in yarn is pushed out inward in the radial direction of the rotating cylinder by the first sinker engaging portion of the first sinker. That is, the insertion portion of the second sinker is pulled out from the loop of the lay-in yarn while a state where the loop of the lay-in yarn is pushed out inward in the radial direction of the rotating cylinder by the first sinker engaging portion is maintained, and therefore, the loop of the lay-in yarn is not loosened. Thus, the pair sinker can suppress protrusion of the loop of the lay-in yarn on the front surface of the ground knit fabric even in a case where the state of the lay-in yarn, the state of the tie-in yarn, the state of the knit-in yarn, the state of the pair sinker, or the surrounding environment is changed.

**[0015]** According to another aspect, the pair sinker of the present invention preferably has the following configuration. The first sinker engaging portion extends in the radial direction of the rotating cylinder, and has an outer edge extending from the upper end surface to a lower end surface of the upper support portion when viewed in a perpendicular direction to a plate surface of the first sinker and having no recessed portion thereon. The second sinker engaging portion is an end surface facing inward in the radial direction of the rotating cylinder, is connected to the upper end surface of the insertion portion, and is located so as to extend to a position downward of the upper end surface of the upper support portion and a position upward of the upper end surface of the upper support portion when viewed in a perpendicular direction to a plate surface of the second sinker. The upper end surface of the insertion portion is located more downward than the upper end surface of the upper support portion and more upward than or equal to a lower end surface of the upper support portion.

**[0016]** By configuring the pair sinker in the above-described manner, the insertion portion of the second sinker is inserted in the loop of the lay-in yarn by moving inward

in the radial direction of the rotating cylinder. Along with this, the second sinker pulls the loop of the lay-in yarn by the second sinker engaging portion. The first sinker pushes out the loop of the lay-in yarn from the insertion portion of the second sinker without hooking the loop of the lay-in yarn by the first sinker engaging portion. Furthermore, the first sinker moves the loop of the lay-in yarn to the lower support portion of the first sinker. Thus, the pair sinker can suppress protrusion of the loop of the lay-in yarn on the front surface of the ground knit fabric even in a case where the state of the lay-in yarn, the state of the tie-in yarn, the state of the knit-in yarn, the state of the pair sinker, or the surrounding environment is changed.

**[0017]** According to another aspect, a circular knitting machine including the above-described pair sinker according to the present invention preferably has the following configuration. In the circular knitting machine in a state where the tie-in yarn entangled with the lay-in yarn and the fed knit-in yarn are drawn to a position located more downward than the upper support portion of the first sinker by a knitting needle of the circular knitting machine, the first sinker is moved outward in the radial direction of the rotating cylinder in a state where the tie-in yarn and the knit-in yarn are supported by the upper support portion of the first sinker. Furthermore, the first sinker drops the tie-in yarn and the knit-in yarn on the lower support portion from the upper support portion. Along with this, the second sinker is moved inward in the radial direction of the rotating cylinder. Furthermore, the second sinker has the insertion portion inserted in the loop of the lay-in yarn. The second sinker pushes out the loop of the lay-in yarn inward in the radial direction of the rotating cylinder by the second sinker engaging portion.

**[0018]** As described above, in the circular knitting machine including the pair sinker, the first sinker is moved outward in the radial direction of the rotating cylinder. Thus, the circular knitting machine drops the lay-in yarn, the tie-in yarn, and the knit-in yarn supported by the upper support portion of the first sinker on the lower support portion of the first sinker. Furthermore, the circular knitting machine moves the second sinker inward in the radial direction of the rotating cylinder. Thus, in the circular knitting machine, the insertion portion of the second sinker located more downward than the upper end surface of the upper support portion of the first sinker is inserted in the loop of the lay-in yarn dropped from the upper support portion of the first sinker.

**[0019]** In the circular knitting machine, the loop of the lay-in yarn is pushed out inward in the radial direction of the rotating cylinder only by a predetermined moving amount by the insertion portion of the second sinker. That is, in the circular knitting machine, the loop of the lay-in yarn is pulled toward the back surface of the ground knit fabric knitted with the tie-in yarn by a predetermined amount by the second sinker. Thus, the circular knitting machine including the pair sinker can suppress protrusion of the loop of the lay-in yarn on the front surface of

the ground knit fabric even in a case where the state of the lay-in yarn, the state of the tie-in yarn, the knit-in yarn, the state of the pair sinker, or the surrounding environment is changed.

**[0020]** According to another aspect, the circular knitting machine including the above-described pair sinker according to the present invention preferably has the following configuration. The first sinker is moved inward in the radial direction of the rotating cylinder while the second sinker having the insertion portion inserted in the loop of the lay-in yarn is moved outward in the radial direction of the rotating cylinder. Furthermore, outward movement of the loop of the lay-in yarn in the radial direction of the rotating cylinder is stopped by the first sinker engaging portion of the first sinker.

**[0021]** As described above, in the circular knitting machine including the pair sinker, the insertion portion of the second sinker is pulled out from the loop of the lay-in yarn. At this time, in the circular knitting machine, the loop of the lay-in yarn is pushed out inward in the radial direction of the rotating cylinder by the first sinker engaging portion of the first sinker. That is, the insertion portion of the second sinker is pulled out while a state where the lay-in yarn has been pushed out inward in the radial direction of the rotating cylinder by the first sinker engaging portion, and therefore, the lay-in yarn is not loosened. Thus, the circular knitting machine including the pair sinker can suppress protrusion of the loop of the lay-in yarn on the front surface of the ground knit fabric even in a case where the state of the lay-in yarn, the state of the tie-in yarn, the state of the knit-in yarn, the state of the pair sinker, or the surrounding environment is changed.

**[0022]** According to another aspect, a knitting method for knitting a double fleece knit fabric using a lay-in yarn, a tie-in yarn, and a knit-in yarn by the circular knitting machine including the pair sinker according to the present invention preferably includes the following steps.

**[0023]** In a lay-in yarn loop forming step included in the knitting method, the second sinker is moved to a position located more outward in the radial direction of the rotating cylinder than the knitting needle of the circular knitting machine and, in a state where the knitting needle has been moved to a position located more upward than the upper support portion of the first sinker, the lay-in yarn is fed to a position located more upward than the upper support portion of the first sinker and between the knitting needle and the second sinker. Furthermore, the lay-in yarn is pushed out more inward in the radial direction of the rotating cylinder than the knitting needle by the second sinker engaging portion of the second sinker to form a loop of the lay-in yarn.

**[0024]** In a tie-in yarn loop forming step included in the knitting method, the tie-in yarn is fed to a position located more upward than the second sinker and the second sinker is moved outward in the radial direction of the rotating cylinder. Subsequently, the tie-in yarn is drawn to a position located more downward than the upper end surface of the upper support portion of the first sinker by the knit-

ting needle. Subsequently, the lay-in yarn and the tie-in yarn are pushed out to a position located more inward in the radial direction of the rotating cylinder than the knitting needle by the second sinker engaging portion. Furthermore, the knitting needle is lifted to the upper support portion and the tie-in yarn is entangled with lay-in yarn to form a loop of the tie-in yarn in a position located more outward in the radial direction of the rotating cylinder than the lay-in yarn.

**[0025]** In a knit-in yarn loop forming step included in the knitting method, the second sinker is moved outward in the radial direction of the rotating cylinder and the knit-in yarn is fed to a position located more upward than the upper support portion of the first sinker. Furthermore, the tie-in yarn and the knit-in yarn are drawn to a position located more downward than the upper end surface of the upper support portion of the first sinker by the knitting needle to form a loop of the knit-in yarn.

**[0026]** In a knitting step included in the knitting method, the first sinker is moved outward in the radial direction of the rotating cylinder and the lay-in yarn, the tie-in yarn, and the knit-in yarn are removed from the upper support portion of the first sinker. Furthermore, the tie-in yarn and the knit-in yarn are drawn to a position located more downward than the lower support portion of the first sinker by the knitting needle to entangle the tie-in yarn and the knit-in yarn with an already formed old loop supported by the lower support portion of the first sinker.

**[0027]** In a lay-in yarn adjusting step included in the knitting method, when the lay-in yarn, the tie-in yarn, and the knit-in yarn are removed from the upper support portion of the first sinker in the knitting step, the insertion portion of the second sinker is inserted in the loop of the lay-in yarn. Furthermore, the loop of the lay-in yarn is pushed out inward in the radial direction of the rotating cylinder by the second sinker engaging portion of the second sinker.

**[0028]** In a new loop forming step included in the knitting method, the second sinker is moved outward in the radial direction of the rotating cylinder. Along with this, the first sinker is moved inward in the radial direction of the rotating cylinder and the loop of the lay-in yarn is removed from the insertion portion of the second sinker by the first sinker engaging portion of the first sinker. Along with this, the loop of the lay-in yarn is pushed out to a position located more inward in the radial direction of the rotating cylinder than the knitting needle, thereby forming a new loop formed of the tie-in yarn and the knit-in yarn.

**[0029]** As described above, the knitting method for knitting a double fleece knit fabric by the circular knitting machine including the pair sinker includes the lay-in yarn loop forming step, the tie-in yarn loop forming step, the knit-in yarn loop forming step, the knitting step, the lay-in yarn adjusting step, and the new loop forming step. In the lay-in yarn adjusting step, the loop of the lay-in yarn supported by the upper support portion of the first sinker is dropped on the lower support portion of the first sinker

by moving the first sinker outward in the radial direction of the rotating cylinder. The insertion portion of the second sinker is inserted in the loop of the lay-in yarn by inward movement of the second sinker in the radial direction of the rotating cylinder. Furthermore, the loop of the lay-in yarn is pulled by the predetermined amount inward in the radial direction of the rotating cylinder by the inward movement of the second sinker in the radial direction of the rotating cylinder only by the predetermined amount. That is, the loop of the lay-in yarn is reliably pulled by the predetermined amount toward the back surface of the ground knit fabric knitted with the tie-in yarn. Thus, the knitting method can suppress protrusion of the loop of the lay-in yarn on the front surface of the ground knit fabric even in a case where the state of the lay-in yarn, the state of the tie-in yarn, the state of the knit-in yarn, the state of the pair sinker, or the surrounding environment is changed. Note that, as a height, a positional relationship in the up-down direction when the first sinker and the second sinker are inserted in one sinker groove is indicated.

**[0030]** The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the invention.

**[0031]** As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items.

**[0032]** It will be further understood that the terms "including," "comprising" or "having" and variations thereof when used in this specification, specify the presence of stated features, steps, operations, elements, components, and/or their equivalents but do not preclude the presence or addition of one or more other features, steps, operations, elements, components, and/or groups thereof.

**[0033]** It will be further understood that the terms "mounted," "connected," "coupled," and/or their equivalents are used broadly and encompass both direct and indirect mounting, connecting and coupling. Further, "connected" and "coupled" are not restricted to physical or mechanical connections or couplings, and can include connections or couplings, whether direct or indirect.

**[0034]** Unless otherwise defined, all terms (including technical and scientific terms) used herein have the same meaning as commonly understood by one having ordinary skill in the art to which this invention belongs.

**[0035]** It will be further understood that terms, such as those defined in commonly used dictionaries, should be interpreted as having a meaning that is consistent with their meaning in the context of the relevant art and the present disclosure and will not be interpreted in an idealized or overly formal sense unless expressly so defined herein.

**[0036]** In describing the invention, it will be understood that a number of techniques and steps are disclosed. Each of these has individual benefit and each can also be used in conjunction with one or more, or in some cases all, of the other disclosed techniques.

**[0037]** Accordingly, for the sake of clarity, this description will refrain from repeating every possible combination of the individual steps in an unnecessary fashion. Nevertheless, the specification and claims should be read with the understanding that such combinations are entirely within the scope of the invention and the claims.

**[0038]** In this specification, embodiments of a pair sinker, a circular knitting machine including the pair sinker, and a knitting method for knitting a double fleece knit fabric by the circular knitting machine including the pair sinker according to the present invention will be described.

**[0039]** In the following description, for purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of the present invention. It will be evident, however, to one skilled in the art that the present invention may be practiced without these specific details.

**[0040]** The present disclosure is to be considered as an exemplification of the invention, and is not intended to limit the invention to the specific embodiments illustrated by the figures or description below.

#### [Double Fleece Knit Fabric]

**[0041]** A double fleece knit fabric herein is a knit fabric constituted by a front loop, a back loop, and a looped fleece knitted on a back surface of a knit fabric. The double fleece knit fabric is formed by knitting the front loop with a tie-in yarn, the back loop with a knit-in yarn, and the fleece with the lay-in yarn. The double fleece knit fabric is knitted such that, after entangling the tie-in yarn with the lay-in yarn, the knit-in yarn is overlaid on the tie-in yarn.

#### [Loop]

**[0042]** A loop herein is a portion formed in a ring shape by bending a middle portion of a yarn by a knitting needle and a sinker. The loop is formed in an  $\Omega$  shape in which a portion formed in a ring shape is partially opened.

#### [Old Loop]

**[0043]** An old loop herein is a portion already formed in a ring shape in an upstream knitting step. In the double fleece knit fabric, the old loop is constituted by already knitted knit-in yarn and tie-in yarn. The double fleece knit fabric is formed by knitting a newly formed new loop of the knit-in yarn and the tie-in yarn into the old loop.

#### [Lay-in Yarn]

**[0044]** A lay-in yarn herein is a yarn that forms the fleece loop in knitting of the double fleece knit fabric. In a case where the lay-in yarn, the tie-in yarn, and the knit-in yarn are a unit of knitting, the lay-in yarn is fed to a circular knitting machine first.

#### [Tie-in Yarn]

**[0045]** A tie-in yarn herein is a yarn that forms the front loop in knitting of the double fleece knit fabric. The tie-in yarn is fed to the circular knitting machine next to the lay-in yarn.

#### [Knit-in Yarn]

**[0046]** A knit-in yarn herein is a yarn that forms the back loop in knitting of the double fleece knit fabric. The knit-in yarn is fed to the circular knitting machine next to the tie-in yarn.

#### [Circular Knitting Machine]

**[0047]** A circular knitting machine herein is a device used for forming a tubular knit fabric. The circular knitting machine includes a cylindrical rotating cylinder (needle bed) that rotates in a state where a plurality of knitting needles are stored and a disk-shaped sinker dial that rotates in a state where a plurality of sinkers are stored. The circular knitting machine knits a tubular knit fabric using the knitting needles and the sinkers. A plurality of yarns is fed to the circular knitting machine. The circular knitting machine can efficiently knit a tubular knit fabric by spirally overlaying the plurality of fed yarns.

#### [Entangling, Entangled]

**[0048]** "Entangling, entangled" herein represents a state where one yarn is contacted by another yarn therearound. In a case where the another yarn is caused to pass through a loop of the one yarn and thus a loop of the another yarn is formed, the another yarn is entangled with the loop of the one yarn to form a loop. By forming the loop by entangling the yarns with each other, a certain limitation is imposed on the loop such that a size of the loop is not changed by a friction force or the like.

### ADVANTAGEOUS EFFECTS OF INVENTION

**[0049]** According to one embodiment of the present invention, protrusion of the loop of the lay-in yarn on the front surface of the ground knit fabric can be suppressed even in a state where the state of the lay-in yarn, the state of the tie-in yarn, the state of the knit-in yarn, the state of the pair sinker, or the surrounding environment is changed.

### BRIEF DESCRIPTION OF DRAWINGS

#### [0050]

FIG. 1 is a cross-sectional view of a major knitting portion of a circular knitting machine according to an embodiment of the present invention.

FIG. 2 is a side view of a first sinker inserted in a

sinker groove according to an embodiment of the present invention.

FIG. 3 is a side view of a second sinker inserted in a sinker groove according to an embodiment of the present invention.

FIG. 4 illustrates a top view and a side view of a pair sinker inserted in a sinker groove according to an embodiment of the present invention.

FIG. 5 is a flowchart illustrating steps of a knitting method for knitting a double fleece knit fabric according to an embodiment of the present invention.

FIG. 6 is a performance chart line of a knitting needle, a first sinker, and a second sinker in the knitting method for knitting a double fleece knit fabric according to an embodiment of the present invention.

FIG. 7 is a schematic view illustrating a state when a lay-in yarn is fed in a lay-in yarn loop forming step.

FIG. 8 is a schematic view illustrating a state when the lay-in yarn is pushed out in the lay-in yarn loop forming step and a state when a tie-in yarn is fed in a tie-in yarn loop forming step.

FIG. 9 is a schematic view illustrating a state when the tie-in yarn is drawn in in the tie-in yarn loop forming step.

FIG. 10 is a schematic view illustrating a state when the tie-in yarn is pushed out in the tie-in yarn loop forming step.

FIG. 11 is a schematic view illustrating a state when a knit-in yarn is fed in a knit-in yarn loop forming step.

FIG. 12 is a schematic view illustrating a state when the knit-in yarn is drawn in the knit-in yarn loop forming step.

FIG. 13 is a schematic view illustrating a state when the lay-in yarn is removed from an upper support portion of the first sinker in a knitting step.

FIG. 14 is a schematic view illustrating a state when the tie-in yarn and the knit-in yarn are entangled with an old loop in the knitting step and the lay-in yarn is hooked on in a lay-in yarn adjusting step.

FIG. 15 is a schematic view illustrating a state when the lay-in yarn is pushed out in the lay-in yarn adjusting step.

FIG. 16 is a schematic view illustrating a state when the loop of the lay-in yarn is removed in a new loop forming step.

## DESCRIPTION OF EMBODIMENT

**[0051]** Embodiments will be described hereinafter with reference to the drawings. In the drawings, the same or corresponding parts are denoted by the same reference numerals, and description thereof will not be repeated. The dimensions of components in the drawings do not strictly represent actual dimensions of the components and dimensional proportions of the components, for example.

## <Overall Configuration of Circular Knitting Machine 1>

**[0052]** With reference to FIG. 1 to FIG. 3, a circular knitting machine 1 according to an embodiment of the present invention will be described. FIG. 1 is a cross-sectional view of a major knitting portion of the circular knitting machine 1. FIG. 2 is a side view of a first sinker 12. FIG. 3 is a side view of a second sinker 13. In this embodiment, FIG. 4 is a side view of a pair sinker 11. The circular knitting machine 1 uses a lay-in yarn r, a tie-in yarn t, and a knit-in yarn k to knit a double fleece knit fabric.

**[0053]** As illustrated in FIG. 1, the circular knitting machine 1 is used to knit a tubular knit fabric. The circular knitting machine 1 mainly includes a frame 2, a rotating cylinder 3, a knitting needle cam folder 4, a knitting needle cam 5, a knitting needle 6, a sinker dial 7, a sinker cap 8, a first sinker cam 9, a second sinker cam 10, a pair sinker 11, a yarn carrier ring support 14, a yarn carrier ring 15, a yarn carrier holder 16, and a yarn carrier 17. The circular knitting machine 1 is installed such that an axial line of the rotating cylinder 3 is directed in an up-down direction.

**[0054]** The frame 2 supports main components of the circular knitting machine 1. The frame 2 is formed substantially in a cylindrical shape. The rotating cylinder 3 and the sinker dial 7 are supported in the frame 2. An unillustrated winder, an unillustrated power source for the rotating cylinder 3 or the like, and the like are provided in the frame 2. The sinker cap 8 and the yarn carrier ring support 14 are provided on an outer peripheral portion of the frame 2.

**[0055]** The rotating cylinder 3 successively moves a plurality of knitting needles 6. The rotating cylinder 3 is formed substantially in a cylindrical shape. The rotating cylinder 3 is configured to rotate with the axial line as center of rotation by the unillustrated power source. A plurality of knitting needle grooves 3a that store and guide the knitting needles 6 are provided on an outer periphery of the rotating cylinder 3. The knitting needle grooves 3a extend in an axial direction of the rotating cylinder 3. The knitting needle grooves 3a are located at equal intervals in a circumferential direction of the rotating cylinder 3. That is, the knitting needle grooves 3a are provided on an outer peripheral surface of the rotating cylinder 3 such that one knitting needle groove 3a is located at each equal central angle with the axial line of the rotating cylinder 3 as center.

**[0056]** The knitting needle cam folder 4 stores the knitting needle cam 5 that moves the knitting needle 6. The knitting needle cam folder 4 is formed substantially in a cylindrical shape. The knitting needle cam folder 4 is supported by the frame 2 such that an axial line of the rotating cylinder 3 and an axial line of the knitting needle cam folder 4 overlap each other. Thus, an inner periphery of the knitting needle cam folder 4 and an outer periphery of the rotating cylinder 3 are concentrically located when axially viewed. The knitting needle cam 5 is stored so as

to be attachable and detachable on the inner periphery of the knitting needle cam folder 4. The knitting needle cam 5 is a cylindrical grooved cam that determines a position of the knitting needle 6 in the up-down direction (axial direction of the rotating cylinder 3) for each rotation angle of the rotating cylinder 3. The knitting needle cam 5 is located so as to be opposed to the knitting needle grooves 3a of the rotating cylinder 3.

**[0057]** The knitting needle 6 is a needle for knitting a knit fabric by which a middle portion of a yarn is made pass through an old loop Ro (knocked over) to knit the yarn. The knitting needle 6 is formed of a plate. The knitting needle 6 includes a hook 6a that captures the yarn at a tip portion thereof. In the hook 6a, a latch 6b configured such that an opening portion thereof can be opened and closed is provided. With the opening portion of the hook 6a closed by the latch 6b in the knitting needle 6, the yarn is not hooked on the hook 6a. The knitting needle 6 includes a knitting needle protruding portion 6c that protrudes in a perpendicular direction to a longitudinal direction of the knitting needle 6 and along a plate surface of the plate in a middle portion thereof. Each of the knitting needles 6 is located in a corresponding one of the knitting needle grooves 3a of the rotating cylinder 3. The knitting needle protruding portion 6c is located in a cam groove of the knitting needle cam 5. Thus, each of the knitting needles 6 rotates with the rotating cylinder 3 and is moved in the up-down direction along the cam groove of the knitting needle cam 5.

**[0058]** The sinker dial 7 successively moves a plurality of pair sinkers 11. The sinker dial 7 is formed substantially in a disk shape. The sinker dial 7 is fixed to the rotating cylinder 3 such that the axial line of the rotating cylinder 3 and an axial line of the sinker dial 7 overlap each other. That is, the sinker dial 7 rotates integrally with the rotating cylinder 3. The sinker dial 7 includes a plurality of sinker grooves 7a that store and guide the pair sinkers 11 on an upper surface thereof. The sinker grooves 7a are located at equal intervals in a circumferential direction of the sinker dial 7. The sinker grooves 7a are provided such that one sinker groove 7a extends in a radial direction of the sinker dial 7 at every equal central angle with the axial line of the sinker dial 7 as center. The sinker dial 7 is fixed to the rotating cylinder 3 such that each of the sinker grooves 7a is located between adjacent ones of the knitting needle grooves 3a of the rotating cylinder 3.

**[0059]** The sinker cap 8 stores the first sinker cam 9 and the second sinker cam 10 that move the pair sinker 11. The sinker cap 8 is formed substantially in a disk shape. The sinker cap 8 is located in the frame 2 such that the axial line of the rotating cylinder 3 and an axial line of the sinker cap 8 overlap each other. A lower surface of the sinker cap 8 is opposed to an upper surface of the sinker dial 7. The first sinker cam 9 and the second sinker cam 10 are stored so as to be attachable and detachable on the lower surface of the sinker cap 8. The first sinker cam 9 and the second sinker cam 10 are plate cams that determine a position of the pair sinker 11 in

the radial direction of the sinker dial 7 at every rotation angle. The first sinker cam 9 and the second sinker cam 10 are located so as to be opposed to the sinker grooves 7a of the sinker dial 7.

**[0060]** The pair sinker 11 is a member that distributes a yarn to be fed to the knitting needle 6, holds the old loop Ro, assists passing of the knitting needle 6 through the old loop Ro, or the like. Each of the pair sinkers 11 is stored in a corresponding one of the plurality of sinker grooves 7a of the sinker dial 7 in a movable state. Each of the pair sinkers 11 is located between corresponding adjacent ones of the knitting needles 6 stored in the rotating cylinder 3. The pair sinker 11 is constituted by the first sinker 12 and the second sinker 13. Accordingly, the first sinker 12 and the second sinker 13 are inserted in one sinker groove 7a.

**[0061]** The first sinker 12 includes a first sinker protruding portion 12f (see FIG. 2) that protrudes to a position located more upward than the sinker groove 7a. Similarly, the second sinker 13 includes a second sinker protruding portion 13d (see FIG. 3) that protrudes to a position located more upward than the sinker groove 7a. The first sinker protruding portion 12f is inserted in a cam groove of the first sinker cam 9. The second sinker protruding portion 13d is inserted in the cam groove of the second sinker cam 10. Thus, the first sinker 12 and the second sinker 13 rotate with the sinker dial 7. Each of the first sinker 12 and the second sinker 13 is independently moved in a radial direction of the rotating cylinder 3 (the radial direction of the sinker dial 7) by a corresponding one of the first sinker cam 9 and the second sinker cam 10.

**[0062]** The yarn carrier ring support 14 supports the yarn carrier ring 15. The yarn carrier ring support 14 is constituted by a plurality of bar members. A plurality of yarn carrier ring supports 14 are fixed in a circumferential direction of the frame 2 so as to extend upward from the outer peripheral portion of the frame 2. The yarn carrier ring 15 is fixed to an end portion of each of the plurality of yarn carrier ring supports 14. A plurality of yarn carrier holders 16 are provided to the yarn carrier rings 15. Furthermore, the yarn carrier 17 that guides the yarn to a position near the knitting needle 6 and the pair sinker 11 is provided in each of the yarn carrier holders 16. The yarn carrier 17 is arranged above the knitting needle 6 and the pair sinker 11.

**[0063]** In the circular knitting machine 1 configured in the above-described manner, a plurality of yarns are fed to a position near the knitting needle 6 and the pair sinker 11 from the plurality of yarn carrier holders 16 via the yarn carriers 17. The circular knitting machine 1 captures each of the yarns by the knitting needle 6 by rotating the rotating cylinder 3 and also distributes the yarns to the knitting needle 6 by the pair sinker 11 and supports a loop. Also, the circular knitting machine 1 moves the knitting needle 6 upward and downward by rotating the rotating cylinder 3. Furthermore, the circular knitting machine 1 moves the pair sinker 11 in the radial direction

of the rotating cylinder 3 to entangle the plurality of yarns with the old loop Ro and thus continuously knits a knit fabric.

<Pair Sinker 11>

**[0064]** Next, with reference to FIG. 2 and FIG. 3, the pair sinker 11 for a double fleece knit fabric will be specifically described. FIG. 2 is a side view of the first sinker 12 forming the pair sinker 11. FIG. 3 is a side view of the second sinker 13 forming the pair sinker 11. FIG. 4 is a top view and a side view of the pair sinker 11 inserted in the sinker groove 7a. The first sinker 12 and the second sinker 13 are located in the same sinker groove 7a.

**[0065]** As illustrated in FIG. 2, the first sinker 12 is a plate member that supports the lay-in yarn r, the tie-in yarn t, and the knit-in yarn k. The first sinker 12 includes a first sinker base portion 12a, a lower support portion 12b, an upper support portion 12c, a first sinker engaging portion 12d, a groove portion 12e, and a first sinker protruding portion 12f. The first sinker 12 is configured to be movable in a direction indicated by an arrow Ar1, that is, inward in the radial direction of the rotating cylinder 3 (which will be hereinafter simply referred to as "inward in the radial direction") and in a direction indicated by an arrow Ar2, that is, outward in the radial direction of the rotating cylinder 3 (which will be hereinafter simply referred to as "outward in the radial direction") in the sinker groove 7a of the sinker dial 7.

**[0066]** The first sinker base portion 12a that is a base portion of the first sinker 12 is a plate portion that serves as a base that supports each component of the first sinker 12. The first sinker base portion 12a is formed substantially in a rectangular shape when viewed in a perpendicular direction to a plate surface of the first sinker 12. The first sinker base portion 12a is located in the sinker groove 7a. One plate surface of the first sinker base portion 12a contacts a side surface of the sinker grooves 7a so as to be slidable.

**[0067]** As illustrated in FIG. 4, the other plate surface of the first sinker base portion 12a contacts one plate surface of a second sinker base portion 13a in the second sinker 13 (half-tone dot meshing portion) so as to be slidable. A lower end surface of the first sinker base portion 12a contacts a bottom surface of the sinker groove 7a so as to be slidable. That is, for the first sinker 12, a position thereof in the circumferential direction and a position thereof in the up-down direction in the sinker dial 7 are defined. As described above, the first sinker base portion 12a having a rectangular shape is located in the sinker groove 7a, so that attitude and moving state of the first sinker 12 are stabilized.

**[0068]** The lower support portion 12b illustrated in FIG. 2 supports the old loop Ro, the lay-in yarn r, the tie-in yarn t, and the knit-in yarn k. The lower support portion 12b is formed substantially in a rectangular shape when viewed in the perpendicular direction to the plate surface of the first sinker 12. The lower support portion 12b is

located more upward than the first sinker base portion 12a. The lower support portion 12b extends inward in the radial direction (the direction indicated by the arrow Ar1) from the first sinker base portion 12a and is arranged so as to face in the longitudinal direction. An upper end surface 12h of the lower support portion 12b protrudes more upward than the sinker groove 7a. The lower support portion 12b supports the old loop Ro, the lay-in yarn r, the tie-in yarn t, and the knit-in yarn k by the upper end surface 12h.

**[0069]** The upper support portion 12c supports the lay-in yarn r, the tie-in yarn t, and the knit-in yarn k. The upper support portion 12c is formed substantially in a rectangular shape that is shorter than the lower support portion 12b when viewed from a side. The upper support portion 12c is located more upward than the lower support portion 12b. The upper support portion 12c extends inward in the radial direction from the first sinker base portion 12a and is arranged so as to face in the longitudinal direction. The upper support portion 12c supports the lay-in yarn r, the tie-in yarn t, and the knit-in yarn k by an upper end surface 12g. An end of the upper end surface 12g of the upper support portion 12c includes an inclined surface used for dropping the lay-in yarn r, the tie-in yarn t, and the knit-in yarn k downward. Furthermore, the upper support portion 12c includes the first sinker engaging portion 12d that drops a loop Rr of the lay-in yarn r hooked on the second sinker 13 on a front end surface of the upper support portion 12c.

**[0070]** The first sinker engaging portion 12d has an outer edge extending inward in the radial direction from the upper end surface 12g of the upper support portion 12c to a lower end surface of the upper support portion 12c when viewed in the perpendicular direction to the plate surface of the first sinker 12 and having no recessed portion thereon. Thus, the first sinker engaging portion 12d has a function as a guide that guides to the lower support portion 12b the lay-in yarn r, the tie-in yarn t, and the knit-in yarn k that contact an end surface of the first sinker engaging portion 12d located inward in the radial direction and downward to the lower support portion 12b.

**[0071]** The groove portion 12e captures the old loop Ro. The groove portion 12e is formed by the upper end surface 12h of the lower support portion 12b and the lower end surface of the upper support portion 12c. That is, the groove portion 12e is located between the lower support portion 12b and the upper support portion 12c. The groove portion 12e captures the old loop Ro by the upper end surface 12h of the lower support portion 12b and the lower end surface of the upper support portion 12c such that the old loop Ro supported by the upper end surface 12h of the lower support portion 12b does not float upward due to upward movement of the knitting needle 6.

**[0072]** The first sinker protruding portion 12f transmits power from the first sinker cam 9 to the first sinker 12. The first sinker protruding portion 12f is located in a middle portion of the first sinker base portion 12a. The first sinker protruding portion 12f protrudes from the first sink-

er base portion 12a to a position located more upward than the sinker grooves 7a so as to extend along the plate surface of the first sinker 12. The first sinker protruding portion 12f is located in the cam groove of the first sinker cam 9.

**[0073]** The second sinker 13 illustrated in FIG. 3 is a plate member that pushes out the lay-in yarn r and the knit-in yarn k. The second sinker 13 includes a second sinker base portion 13a, an insertion portion 13b, and a second sinker engaging portion 13c. The second sinker 13 is configured to be movable in the direction indicated by the arrow Ar1, that is, inward in the radial direction, and in the direction indicated by the arrow Ar2, that is, outward in the radial direction, in the sinker groove 7a of the sinker dial 7.

**[0074]** The second sinker base portion 13a that is a base portion of the second sinker 13 is a plate portion that serves as a base that supports each component of the second sinker 13. The second sinker base portion 13a is formed substantially in a rectangular shape when viewed from a side. The second sinker base portion 13a is located in the sinker groove 7a.

**[0075]** As illustrated in FIG. 4, one plate surface of the second sinker base portion 13a contacts the other plate surface of the first sinker base portion 12a so as to be slidable. The other plate surface of the second sinker base portion 13a contacts a side surface of the sinker groove 7a so as to be slidable. A lower end surface of the second sinker base portion 13a contacts the bottom surface of the sinker groove 7a so as to be slidable. That is, for the second sinker 13, a position thereof in the circumferential direction and a position thereof in the up-down direction in the sinker dial 7 are defined. As described above, the second sinker base portion 13a having a rectangular shape is located in the sinker groove 7a, so that attitude and moving state of the second sinker 13 are stabilized.

**[0076]** The insertion portion 13b illustrated in FIG. 3 is inserted in the loop Rr of the lay-in yarn r. The insertion portion 13b protrudes inward in the radial direction (the direction indicated by the arrow Ar1) when viewed in a perpendicular direction to the plate surface of the second sinker base portion 13a. The insertion portion 13b includes a flat upper end surface 13e and a lower end surface 13f that is an inclined surface. The lower end surface 13f is an inclined surface a position of which is located more upward as proceeding inward in the radial direction. A tip end of the insertion portion 13b is formed so as to be smaller than an inner diameter of the loop Rr of the lay-in yarn r. The insertion portion 13b is located more upward than the second sinker base portion 13a. The insertion portion 13b extends inward in the radial direction from the second sinker base portion 13a.

**[0077]** As illustrated in FIG. 3 and FIG. 4, the upper end surface 13e of the insertion portion 13b is located more downward than the upper end surface 12g of the upper support portion 12c in the first sinker 12 inserted in the sinker groove 7a when viewed in a perpendicular

direction to the plate surface of the second sinker base portion 13a. Furthermore, the lower end surface 13f of the insertion portion 13b is located more upward than the upper end surface 12h of the lower support portion 12b in the first sinker 12 when viewed in a perpendicular direction to the plate surface of the second sinker base portion 13a. By forming the above-described configuration, the tip end of the insertion portion 13b is included in a range of an inner diameter portion of the loop Rr of the lay-in yarn r located between the upper end surface 12g of the upper support portion 12c and the upper end surface 12h of the lower support portion 12b. The insertion portion 13b can be inserted in the loop Rr of the lay-in yarn r immediately after the loop Rr of the lay-in yarn r has moved away from the upper end surface 12g of the upper support portion 12c. Thus, the pair sinker 11 can increase a time in which the insertion portion 13b can be inserted in the loop Rr of the lay-in yarn r.

**[0078]** The second sinker engaging portion 13c illustrated in FIG. 3 pushes out the lay-in yarn r and the tie-in yarn t. The second sinker engaging portion 13c extends from a base end that is an end portion of the insertion portion 13b in a side closer to the second sinker base portion 13a upward and inward in the radial direction. That is, the second sinker engaging portion 13c is an end surface inclined inward in the radial direction. A lower end of the second sinker engaging portion 13c is connected to the upper end surface 13e of the insertion portion 13b. The second sinker engaging portion 13c is located so as to extend to a position located downward of the upper end surface 12g of the upper support portion 12c and a position located upward of the upper end surface 12g of the upper support portion 12c in the first sinker 12. By forming the above-described configuration, the second sinker engaging portion 13c inclined inward in the radial direction can push out the lay-in yarn r and the tie-in yarn t inward of the rotating cylinder 3.

**[0079]** The second sinker engaging portion 13c is located so as to extend from a position downward of the upper end surface 12g of the upper support portion 12c to a position upward of the upper end surface 12g in the first sinker 12 when viewed in a perpendicular direction to the plate surfaces of the first sinker 12 and the second sinker 13 that are inserted in the sinker groove 7a. As described above, the second sinker engaging portion 13c is configured to push out the lay-in yarn r and the tie-in yarn t supported by the upper end surface 12g of the upper support portion 12c in the first sinker 12.

**[0080]** The second sinker protruding portion 13d transmits power from the second sinker cam 10 to the second sinker 13. The second sinker protruding portion 13d is formed in a position that does not overlap the first sinker protruding portion 12f when viewed from a side. In this embodiment, the second sinker protruding portion 13d is formed in a middle portion of the second sinker base portion 13a. However, the second sinker protruding portion 13d may be formed in an end portion thereof and there is no particular limitation on a position of the second

sinker protruding portion 13d. The second sinker protruding portion 13d protrudes from the second sinker base portion 13a to a position located more upward than the sinker groove 7a so as to extend along the plate surface of the second sinker 13. The second sinker protruding portion 13d is inserted in the cam groove of the second sinker cam 10.

#### <Knitting Method for Knitting Double Fleece Knit Fabric>

**[0081]** Next, a knitting method for knitting a double fleece knit fabric by the circular knitting machine 1 including the pair sinker 11 will be described. The double fleece knit fabric is a knit fabric in which a loop Rr of the lay-in yarn r is formed on a back surface of a ground knit fabric knitted from the tie-in yarn t and the knit-in yarn k. The circular knitting machine 1 knits a double fleece knit fabric with yarns fed in an order of the lay-in yarn r, the tie-in yarn t, and the knit-in yarn k. The circular knitting machine 1 forms a loop of the lay-in yarn r, a loop of the tie-in yarn t, and a loop of the knit-in yarn k by one knitting needle 6, the first sinker 12 located in one side of the one knitting needle 6 in the circumferential direction of the rotating cylinder 3, and the second sinker 13 located in the other side of the one knitting needle 6 in the circumferential direction of the rotating cylinder 3.

**[0082]** FIG. 5 is a flowchart illustrating steps of the knitting method for knitting a double fleece knit fabric. FIG. 6 is a performance line chart of the knitting needle 6, the first sinker 12, and the second sinker 13 in the knitting method for knitting a double fleece knit fabric. FIG. 7 is a view illustrating a feeding state of the lay-in yarn r in a lay-in yarn loop forming step S1. FIG. 8 is a view illustrating a pushing-out state of the lay-in yarn r in the lay-in yarn loop forming step S1 and a feeding state of the tie-in yarn t in a tie-in yarn loop forming step S2. FIG. 9 is a view illustrating a drawing-in state of the tie-in yarn t in the tie-in yarn loop forming step S2. FIG. 10 is a view illustrating a pushing-out state of the tie-in yarn t in the tie-in yarn loop forming step S2. FIG. 11 is a view illustrating a feeding state of the knit-in yarn k in a knit-in yarn loop forming step S3. FIG. 12 is a view of a drawing-in state of the knit-in yarn k in the knit-in yarn loop forming step S3. FIG. 13 is a view illustrating a state where the yarns are removed from the upper support portion 12c of the first sinker 12 in a knitting step S4. FIG. 14 is a view illustrating a state where the tie-in yarn t and the knit-in yarn k are entangled with the old loop Ro in the knitting step S4 and the lay-in yarn r is hooked on in a lay-in yarn adjusting step S5. FIG. 15 is a view illustrating pushing-out of the lay-in yarn r in the lay-in yarn adjusting step S5. FIG. 16 is a view illustrating a state where the loop Rr of the lay-in yarn r is removed in a new loop forming step S6.

**[0083]** The knitting method for knitting a double fleece knit fabric by the circular knitting machine 1 including the pair sinker 11 includes the lay-in yarn loop forming step S1, the tie-in yarn loop forming step S2, the knit-in yarn

loop forming step S3, the knitting step S4, the lay-in yarn adjusting step S5, and the new loop forming step S6. In FIG. 6, a broken line is a performance line chart of the first sinker 12. A solid line is a performance line chart of the second sinker 13. A two-dot chain line is a performance line chart of the knitting needle 6. The performance line chart of the first sinker 12 and the performance line chart of the second sinker 13 illustrate positions moving outward in the radial direction of the circular knitting machine 1 as the first sinker 12 and the second sinker 13 proceed from a reference line in a direction indicated by an arrow Ar3. The performance line chart of the knitting needle 6 illustrates a position moving above the circular knitting machine 1 as the knitting needle 6 proceeds from a reference line in a direction indicated by an arrow Ar4.

**[0084]** As illustrated in FIG. 5 through FIG. 7, in the lay-in yarn loop forming step S1, the first sinker 12 is located in a forward position P1 that is an innermost position in the radial direction in a movable range. The second sinker 13 (half-tone dot meshing) is located in a rearward position P6 that is an outermost position in the radial direction in the movable range (see A in FIG. 6). The second sinker 13 is located more outward in the radial direction than the knitting needle 6. The hook 6a and the latch 6b are located more upward than the upper support portion 12c of the first sinker 12. At this time, the hook 6a and the latch 6b are in a state where they are passing through the old loop Ro. That is, the knitting needle 6 is located in the old loop Ro. In this positional relationship, the lay-in yarn r is fed from the yarn carrier 17 to a position located more upward than the upper support portion 12c of the first sinker 12 and between the knitting needle 6 and the second sinker 13. At this time, the lay-in yarn r is fed to a position located more downward than the opened latch 6b.

**[0085]** As illustrated in FIG. 5, FIG. 6, and FIG. 8, in the lay-in yarn loop forming step S1, the second sinker 13 is moved to a forward position P3 (see B in FIG. 6). The second sinker engaging portion 13c of the second sinker 13 is moved to a position located more inward in the radial direction than the knitting needle 6. The lay-in yarn r is pushed to a position located more inward in the radial direction than the knitting needle 6 by the second sinker engaging portion 13c of the second sinker 13. In the lay-in yarn r, the loop Rr is formed by the knitting needle 6 and the second sinker 13.

**[0086]** As illustrated in FIG. 5, FIG. 6, and FIG. 9, in the tie-in yarn loop forming step S2, the tie-in yarn t is fed to a position located more upward than the second sinker 13 and more downward than the hook 6a of the knitting needle 6 (see FIG. 8). The second sinker 13 is moved to a front intermediate position P4 located more outward in the radial direction than the forward position P3 (see C in FIG. 6). The tie-in yarn t is drawn to a position located more downward than the upper end surface 12g of the upper support portion 12c of the first sinker 12 by the knitting needle 6 in a state where the tie-in yarn t is captured by the hook 6a of the knitting needle 6 (see C

in FIG. 6). At this time, the tie-in yarn t passes under the lay-in yarn r. The latch 6b of the knitting needle 6 is closed by the old loop Ro. Thus, the loop Rt of the tie-in yarn is formed.

**[0087]** As illustrated in FIG. 5, FIG. 6, and FIG. 10, in the tie-in yarn loop forming step S2, the second sinker 13 is moved to the forward position P3 located more inward in the radial direction than the front intermediate position P4 (see D in FIG. 6). The lay-in yarn r and the tie-in yarn t are pushed to a position located more inward in the radial direction than the knitting needle 6 by the second sinker engaging portion 13c. At the same time, the tie-in yarn t is lifted to the upper support portion 12c of the first sinker 12 (see D in FIG. 6). Thus, the loop Rt of the tie-in yarn t is shifted to a substantially horizontal posture from a posture extending in a substantially up-down direction. Furthermore, the tie-in yarn t is pushed out with the lay-in yarn r to a position located more inward in the radial direction than the knitting needle 6. The latch 6b of the knitting needle 6 is opened by the loop Rt of the tie-in yarn t.

**[0088]** As illustrated in FIG. 5, FIG. 6, and FIG. 11, in the knit-in yarn loop forming step S3, the knit-in yarn k is fed from the yarn carrier 17 to a position located more upward than the upper support portion 12c of the first sinker 12 and more downward than the hook 6a of the knitting needle 6 (see E in FIG. 6).

**[0089]** As illustrated in FIG. 5, FIG. 6, and FIG. 12, in the knit-in yarn loop forming step S3, the second sinker 13 is moved to a rearward intermediate position P5 located more outward in the radial direction than the forward position P3 (see F in FIG. 6). The loop Rt of the tie-in yarn t and the knit-in yarn k are drawn to a position located more downward than the upper end surface 12g of the upper support portion 12c of the first sinker 12 by the knitting needle 6 (see F in FIG. 6). At this time, the knit-in yarn k is moved along an inner peripheral surface of the hook 6a, so that the knit-in yarn k is located more outward in the radial direction than the loop Rt of the tie-in yarn t. Thus, in the knit-in yarn k, a loop Rk of the knit-in yarn k is formed in a position located more outward in the radial direction than the loop Rt of the tie-in yarn t. The latch 6b of the knitting needle 6 is closed by the old loop Ro.

**[0090]** As illustrated in FIG. 5, FIG. 6, and FIG. 13, in the knitting step S4, the first sinker 12 is moved toward a rearward position P2 that is an outmost position in the radial direction in the movable range in a direction of the arrow in FIG. 13 (see G in FIG. 6). The lay-in yarn r, the loop Rt of the tie-in yarn t, and the loop Rk of the knit-in yarn k supported by the upper support portion 12c of the first sinker 12 are dropped (removed) from the upper support portion 12c of the first sinker 12 toward the lower support portion 12b. At the same time, the loop Rt of the tie-in yarn t and the loop Rk of the knit-in yarn k are drawn to a position located more downward than the lower support portion 12b of the first sinker 12 by the knitting needle 6 (see G in FIG. 6). At this time, the loop Rt of the tie-in

yarn t and the loop Rk of the knit-in yarn k pass through the old loop Ro (knocked over). That is, the loop Rt of the tie-in yarn t and the loop Rk of the knit-in yarn k are entangled with the old loop Ro that is supported by the lower support portion 12b of the first sinker 12 and has been already knitted.

**[0091]** As illustrated in FIG. 5, FIG. 6, and FIG. 14, in the lay-in yarn adjusting step S5, when the loop Rr of the lay-in yarn r, the loop Rt of the tie-in yarn t, and the loop Rk of the knit-in yarn k are dropped from the upper support portion 12c of the first sinker 12 in the knitting step S4, the second sinker 13 is moved toward the forward position P3 located more inward in the radial direction than the rearward intermediate position P5 in a direction of the arrow in FIG. 14 (see H in FIG. 6). The insertion portion 13b of the second sinker 13 is inserted in the loop Rr of the lay-in yarn r.

**[0092]** As illustrated in FIG. 5, FIG. 6, and FIG. 15, in the lay-in yarn adjusting step, the second sinker 13 is moved to the forward position P3 located more inward in the radial direction than the rearward intermediate position P5 (see I in FIG. 6). The loop Rr of the lay-in yarn r is pushed out inward in the radial direction by the second sinker engaging portion 13c of the second sinker 13 (see I in FIG. 6). Thus, a root of the loop Rr of the lay-in yarn r entangled with the loop Rt of the tie-in yarn t is pulled from a front surface of a ground knit fabric knitted with the loop Rt of the tie-in yarn t toward a back surface of the ground knit fabric knitted with the loop Rk of the knit-in yarn k. In a case where the root of the loop Rr of the lay-in yarn r protrudes on the front surface of the ground fabric, the root of the loop Rr of the lay-in yarn r is drawn toward the back surface of the ground fabric from the front surface of the ground fabric.

**[0093]** As illustrated in FIG. 5, FIG. 6, and FIG. 16, in the new loop forming step S6, the first sinker 12 is moved to the forward position P1 located more inward in the radial direction than the rearward position P2. Along with this, the second sinker 13 is moved outward in the radial direction in a direction of the arrow in FIG. 16 (see J in FIG. 6). Thus, outward movement of the loop Rr of the lay-in yarn r in the radial direction is stopped by the first sinker 12. Furthermore, the loop Rr of the lay-in yarn r is removed from the insertion portion 13b of the second sinker 13. Thus, the loop Rr of the lay-in yarn r is dropped from the insertion portion 13b of the moved second sinker 13 to the lower support portion 12b of the first sinker 12. The loop Rt of the tie-in yarn t and the loop Rk of the knit-in yarn k are captured as a new loop Rn by the knitting needle 6. The loop Rt and the loop Rk become an old loop Ro by a next feeder.

**[0094]** The insertion portion 13b of the second sinker 13 forming the pair sinker 11 of the circular knitting machine 1 used for knitting a fleece knit fabric is located more downward than the upper end surface 12g of the upper support portion 12c of the first sinker 12 and more upward than the upper end surface 12h of the lower support portion 12b of the first sinker 12. Accordingly, in the

knitting step S4, the insertion portion 13b of the second sinker 13 is inserted in the loop Rr of the lay-in yarn r dropped from the upper support portion 12c of the first sinker 12 before the loop Rr reaches the lower support portion 12b of the first sinker 12. The loop Rr of the lay-in yarn r is pushed out inward in the radial direction only by a predetermined moving amount by the second sinker 13. That is, the loop Rr of the lay-in yarn r is reliably pulled toward the back surface of the ground fabric only by the predetermined amount by the second sinker 13.

**[0095]** Moreover, the loop Rr of the lay-in yarn r is pushed out inward in the radial direction by the first sinker engaging portion 12d of the first sinker 12 while the insertion portion 13b of the second sinker 13 is pulled out therefrom. That is, the insertion portion 13b of the second sinker 13 is pulled out from the loop Rr of the lay-in yarn r while the loop Rr is maintained in a state where the loop Rr is pushed out inward in the radial direction by the first sinker engaging portion 12d, and therefore, the loop Rr is not loosened. Thus, the pair sinker 11, the circular knitting machine 1 including the pair sinker 11, and the knitting method for knitting a double fleece knit fabric can suppress protrusion of the loop Rr of the lay-in yarn r on the front surface of the ground knit fabric by the pair sinker 11 even in a case where the state of the lay-in yarn r, the state of the tie-in yarn t, the state of the knit-in yarn k, the state of the pair sinker 11, or the surrounding environment is changed.

**[0096]** The embodiment of the present invention has been described above, but the above-described embodiment is merely an example for carrying out the present invention. Therefore, the present invention is not limited to the above-described embodiment and the above-described embodiment can be appropriately modified and implemented without departing from the gist of the present invention.

**[0097]** In this embodiment, with the pair sinker 11, the circular knitting machine 1 including the pair sinker 11, and the knitting method for knitting a double fleece knit fabric by the circular knitting machine 1, a double fleece knit fabric is knitted with yarns fed in an order of the lay-in yarn r, the tie-in yarn t, and the knit-in yarn k. However, a double fleece knit fabric knitted by a pair sinker, a circular knitting machine including the pair sinker, and a knitting method for knitting a double fleece knit fabric by the circular knitting machine may be knitted by knitting a ground knit fabric formed of a front loop and a back loop from two yarns and also knitting a scaly fleece with another yarn on a back side knit fabric.

1 Circular knitting machine  
3 Rotating cylinder  
11 Pair sinker  
12 First sinker  
12b Lower support portion  
12c Upper support portion  
13 Second sinker  
13b Insertion portion

13c Second sinker engaging portion  
r Lay-in yarn  
t Tie-in yarn  
k Knit-in yarn  
5 Rr Loop of lay-in yarn

## Claims

- 10 1. A pair sinker used for knitting a double fleece knit fabric by a circular knitting machine by knitting a ground knit fabric from a tie-in yarn and a knit-in yarn and entangling a lay-in yarn with the tie-in yarn to form a loop of the lay-in yarn on a back surface of the ground knit fabric,  
15 wherein

the pair sinker is constituted by a first sinker and a second sinker respective base portions of which are located in a same sinker groove of the circular knitting machine and that are plate members movable independently from each other in a radial direction of a rotating cylinder of the circular knitting machine,

20 the first sinker extends from the base portion of the first sinker in the radial direction of the rotating cylinder and includes an upper support portion that supports the lay-in yarn, the tie-in yarn, and the knit-in yarn and a lower support portion located more downward than the upper support portion, and

25 the second sinker extends from the base portion of the second sinker in the radial direction of the rotating cylinder and includes an insertion portion that is inserted in the loop of the lay-in yarn and a second sinker engaging portion that extends upward from a base portion of the insertion portion and pushes in the lay-in yarn and the tie-in yarn, the insertion portion having an upper end surface located more downward than an upper end surface of the upper support portion and more upward than an upper end surface of the lower support portion.

- 30 2. The pair sinker according to claim 1, wherein  
35 the first sinker is configured such that a first sinker engaging portion that pushes out the loop of the lay-in yarn in which the insertion portion of the second sinker is inserted from the insertion portion of the second sinker is located in an end portion of the upper support portion.

- 40 3. The pair sinker according to claim 2, wherein  
45

the first sinker engaging portion extends in the radial direction of the rotating cylinder and has

- an outer edge extending from the upper end surface to a lower end surface of the upper support portion when viewed in a perpendicular direction to a plate surface of the first sinker and having no recessed portion thereon, 5
- the second sinker engaging portion is an end surface facing inward in the radial direction of the rotating cylinder, is connected to the upper end surface of the insertion portion, and is located so as to extend to a position downward of the upper end surface of the upper support portion and a position upward of the upper end surface of the upper support portion when viewed in a perpendicular direction to a plate surface of the second sinker, and 10
- the upper end surface of the insertion portion is located more downward than the upper end surface of the upper support portion and more upward than or equal to a lower end surface of the upper support portion. 15
4. A circular knitting machine including the pair sinker according to any one of the claims 1 to 3, wherein 20
- in a state where the tie-in yarn entangled with the lay-in yarn and the fed knit-in yarn are drawn to a position located more downward than the upper support portion of the first sinker by a knitting needle of the circular knitting machine, 25
- the first sinker is moved outward in the radial direction of the rotating cylinder in a state where the tie-in yarn and the knit-in yarn are supported by the upper support portion and drops the tie-in yarn and the knit-in yarn on the lower support portion from the upper support portion, 30
- the second sinker is moved inward in the radial direction of the rotating cylinder, has the insertion portion inserted in the loop of the lay-in yarn, and pushes out the loop of the lay-in yarn inward in the radial direction of the rotating cylinder by the second sinker engaging portion. 35
5. The circular knitting machine according to claim 4, wherein 40
- the first sinker is moved inward in the radial direction of the rotating cylinder while the second sinker having the insertion portion inserted in the loop of the lay-in yarn is moved outward in the radial direction of the rotating cylinder, and outward movement of the loop of the lay-in yarn in the radial direction of the rotating cylinder is stopped by the first sinker engaging portion of the first sinker. 45
6. A knitting method for knitting a double fleece knit fabric using a lay-in yarn, a tie-in yarn, and a knit-in yarn by the circular knitting machine according to claim 4 or 5, the knitting method comprising: 50
- 55

a knitting step of moving the first sinker outward in the radial direction of the rotating cylinder, removing the lay-in yarn, the tie-in yarn, and the knit-in yarn from the upper support portion of the first sinker, and drawing in the tie-in yarn and the knit-in yarn to a position located more downward than the lower support portion of the first sinker by the knitting needle to entangle the tie-in yarn and the knit-in yarn with an already knitted old loop supported by the lower support portion of the first sinker;

a lay-in yarn adjusting step of inserting, when the lay-in yarn, the tie-in yarn, and the knit-in yarn are removed from the upper support portion of the first sinker in the knitting step, the insertion portion of the second sinker in the loop of the lay-in yarn, and pushing out the loop of the lay-in yarn inward in the radial direction of the rotating cylinder by the second sinker engaging portion of the second sinker; and

a new loop forming step of moving the first sinker inward in the radial direction of the rotating cylinder while moving the second sinker outward in the radial direction of the rotating cylinder and pushing out the loop of the lay-in yarn to a position located more inward in the radial direction of the rotating cylinder than the knitting needle while removing the loop of the lay-in yarn from the insertion portion of the second sinker by the first sinker engaging portion of the first sinker to form a new loop formed of the tie-in yarn and the knit-in yarn.

FIG. 1

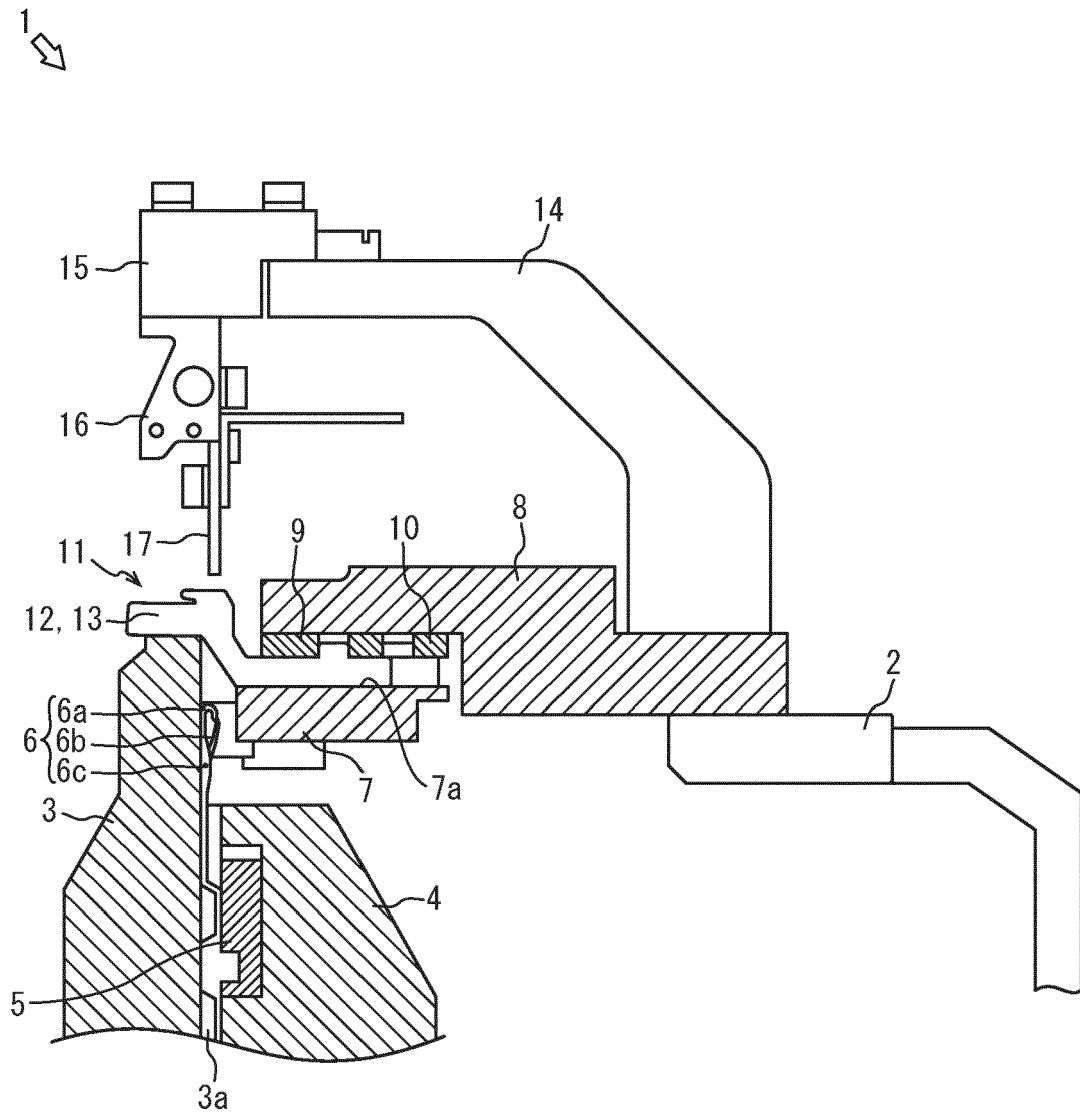


FIG. 2

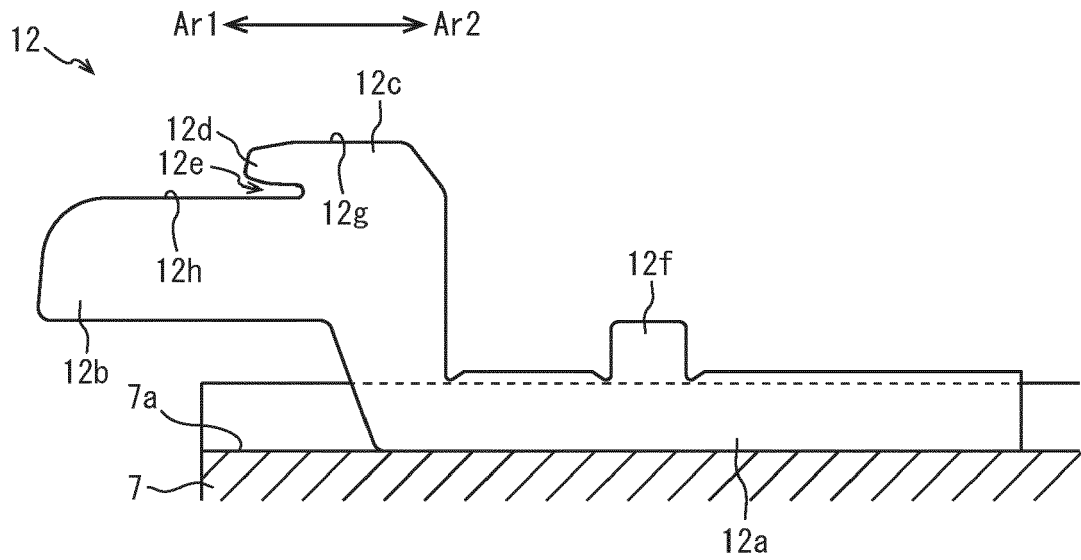


FIG. 3

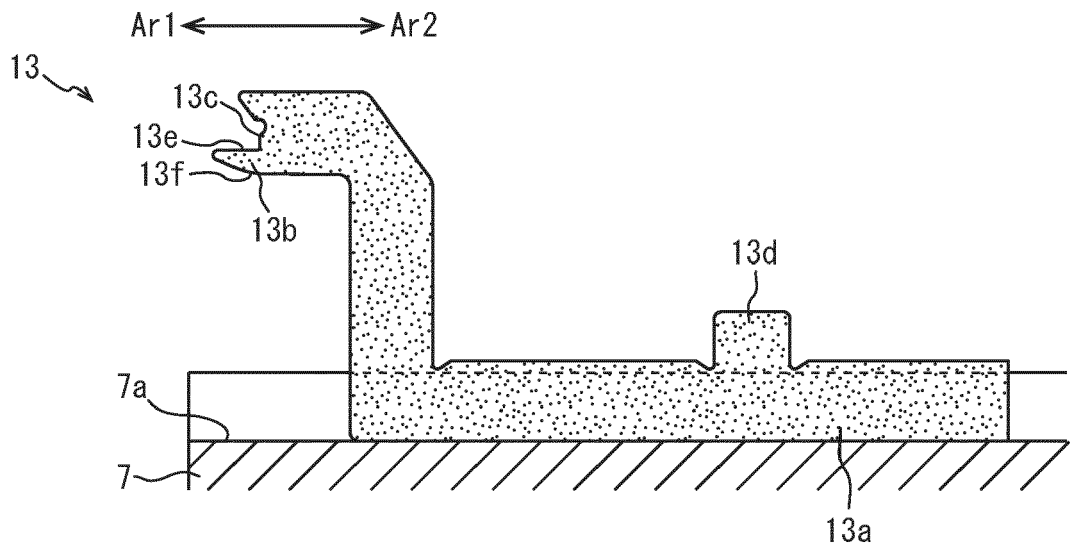


FIG. 4

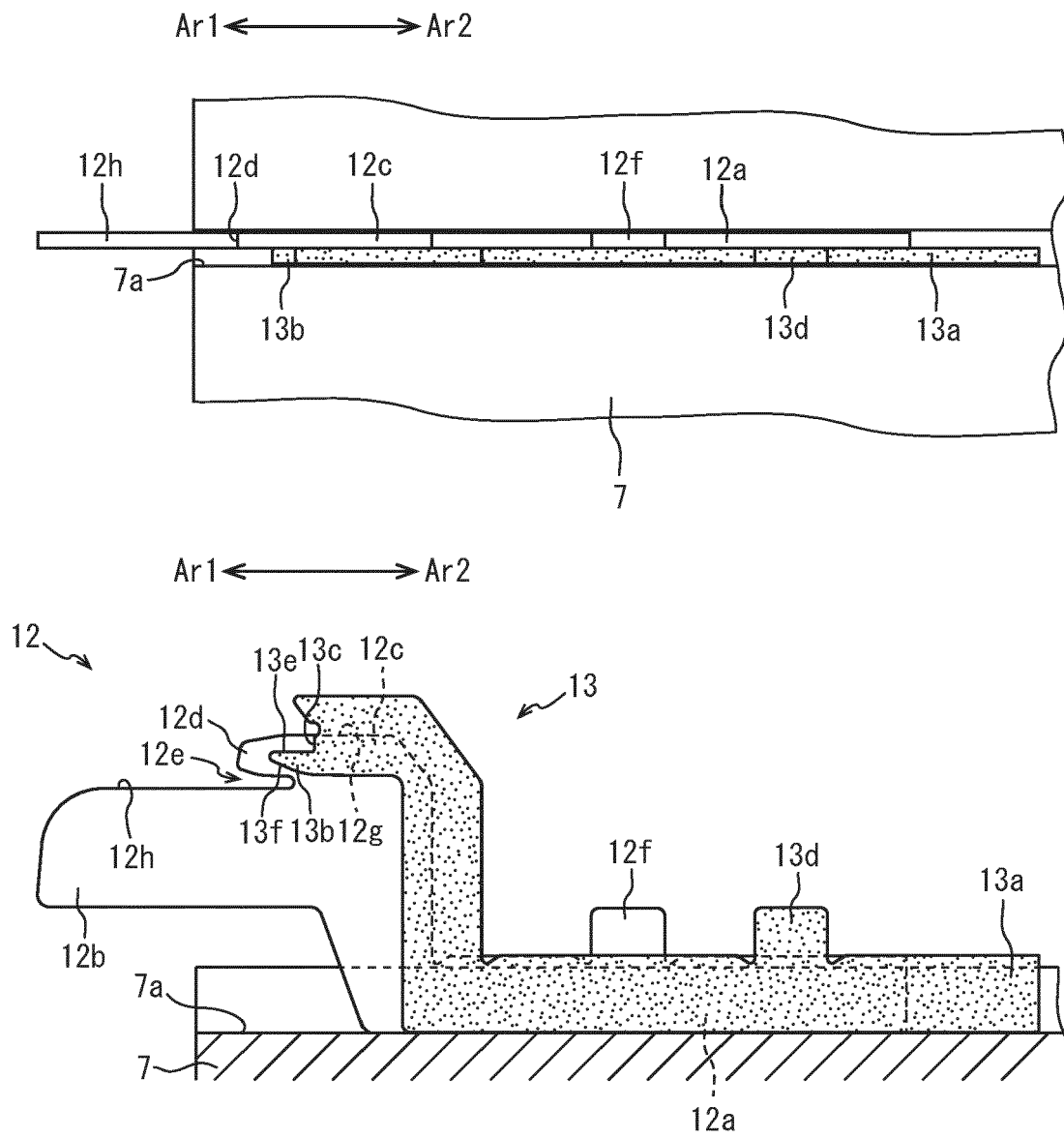


FIG. 5

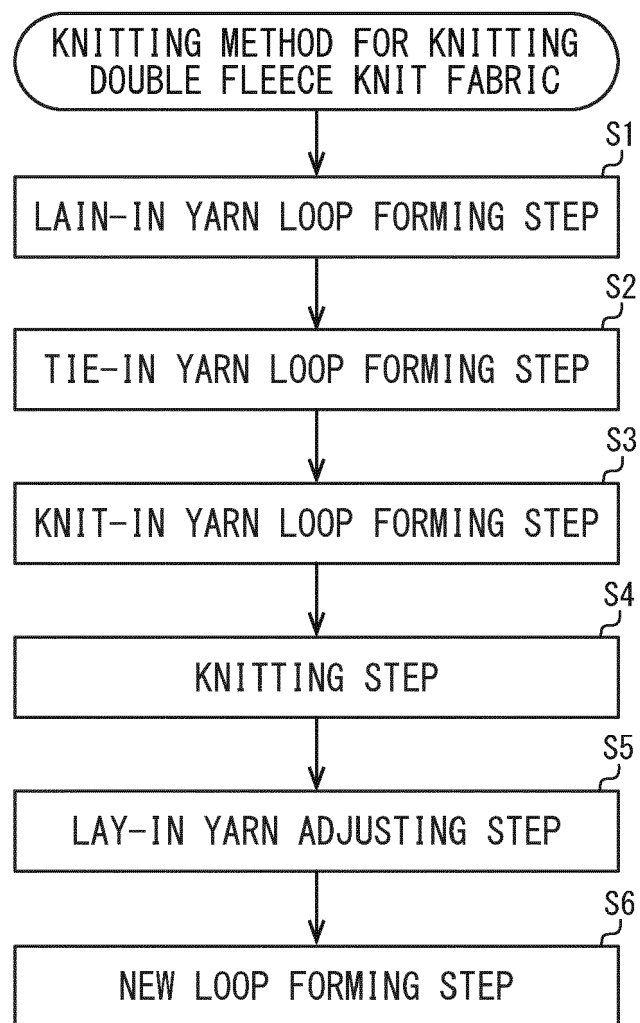


FIG. 6

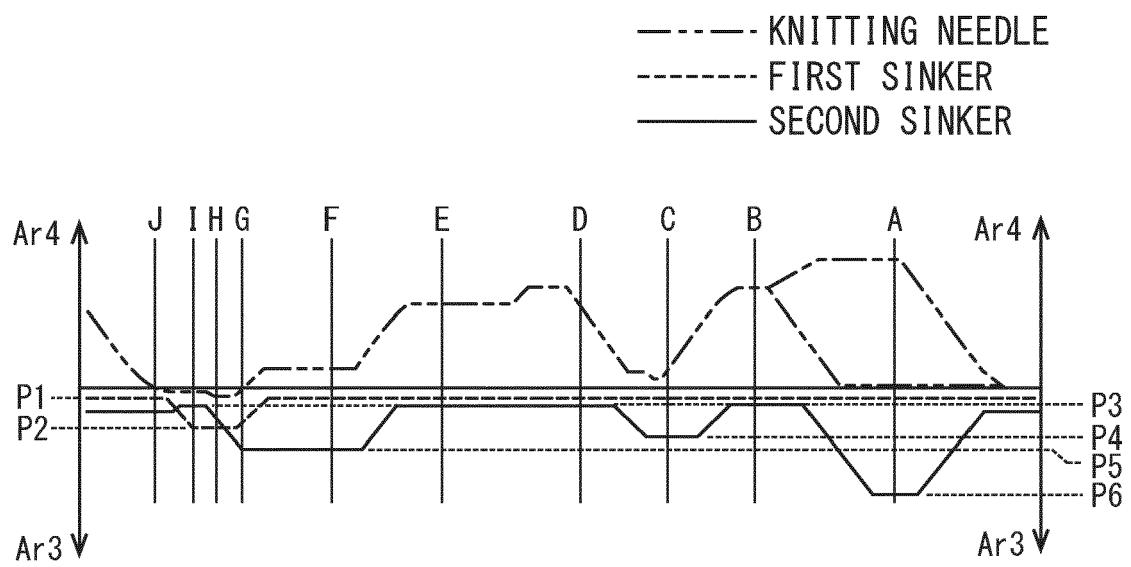


FIG. 7

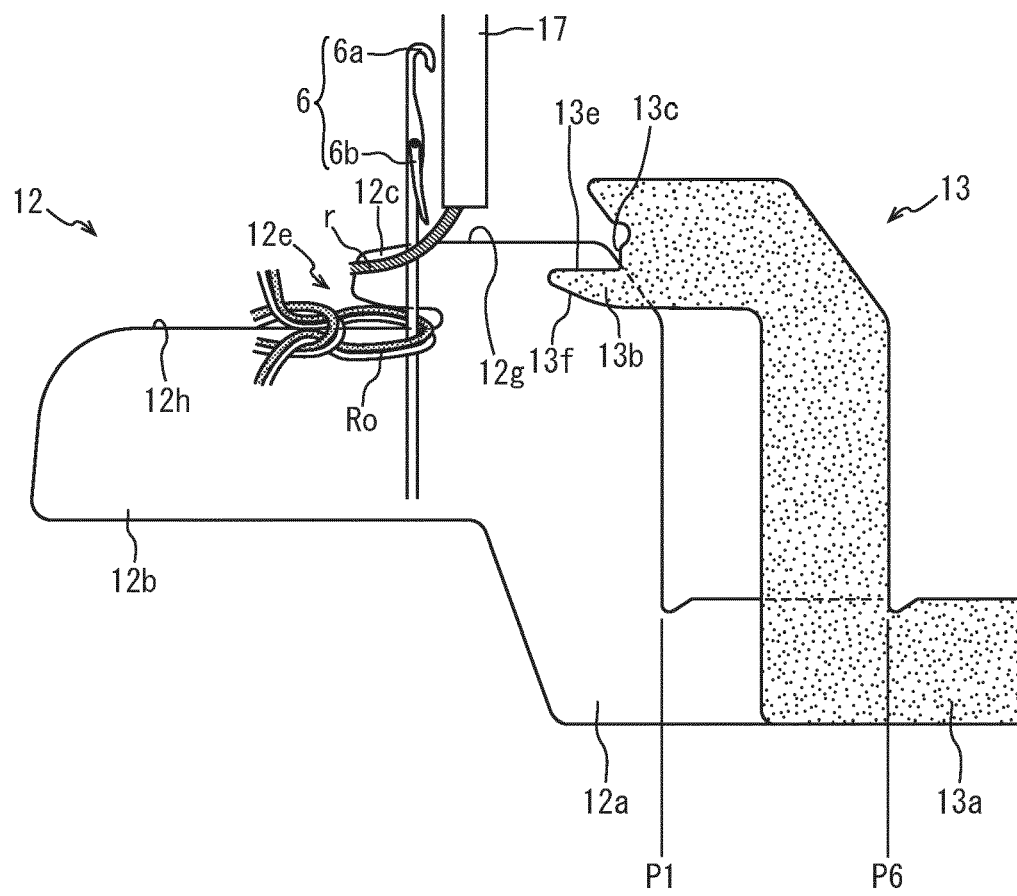


FIG. 8

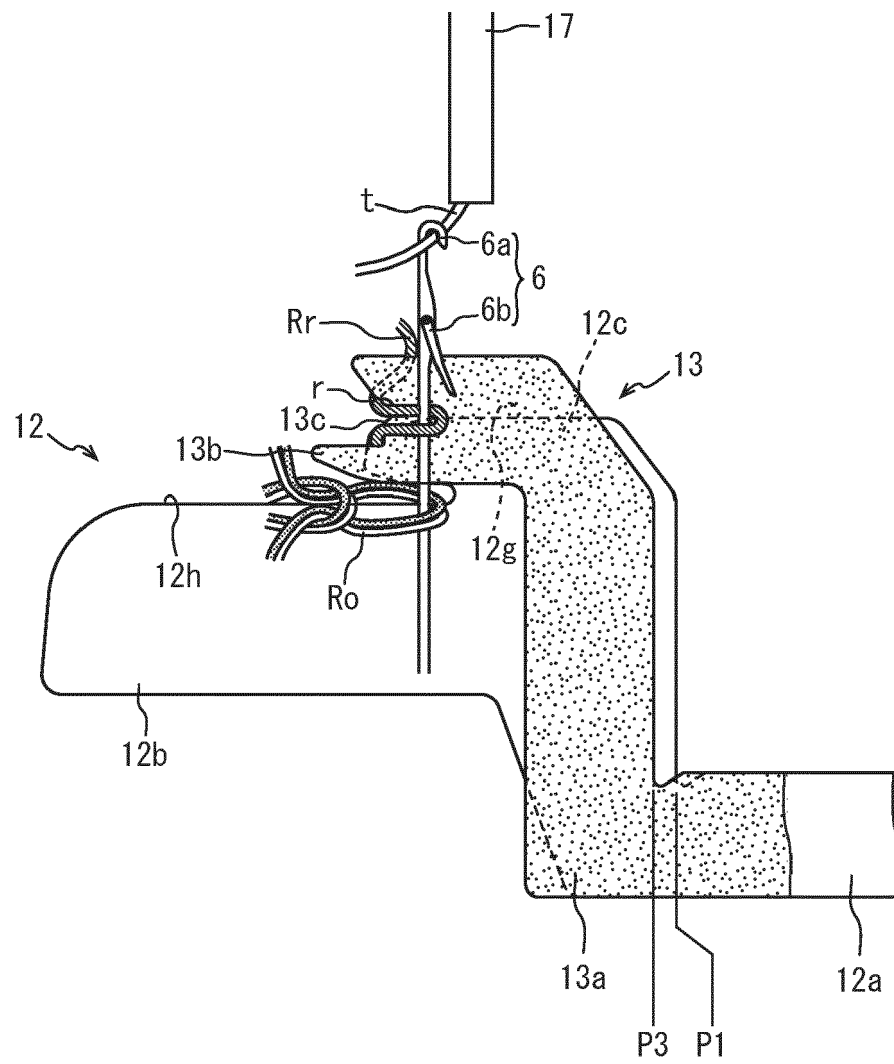


FIG. 9

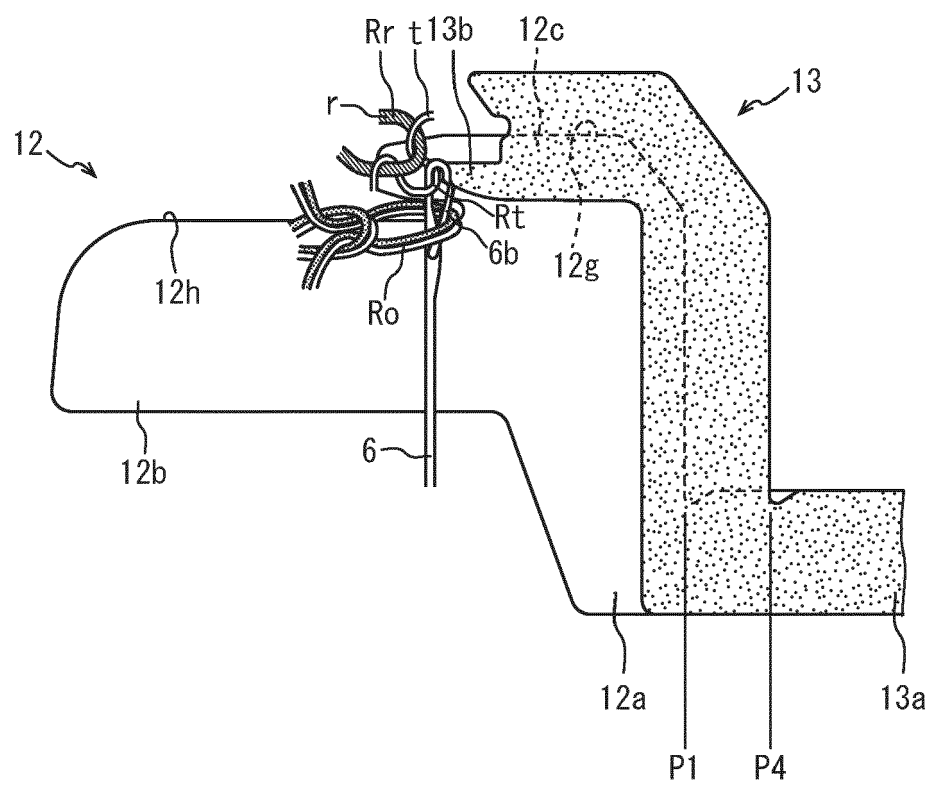


FIG. 10

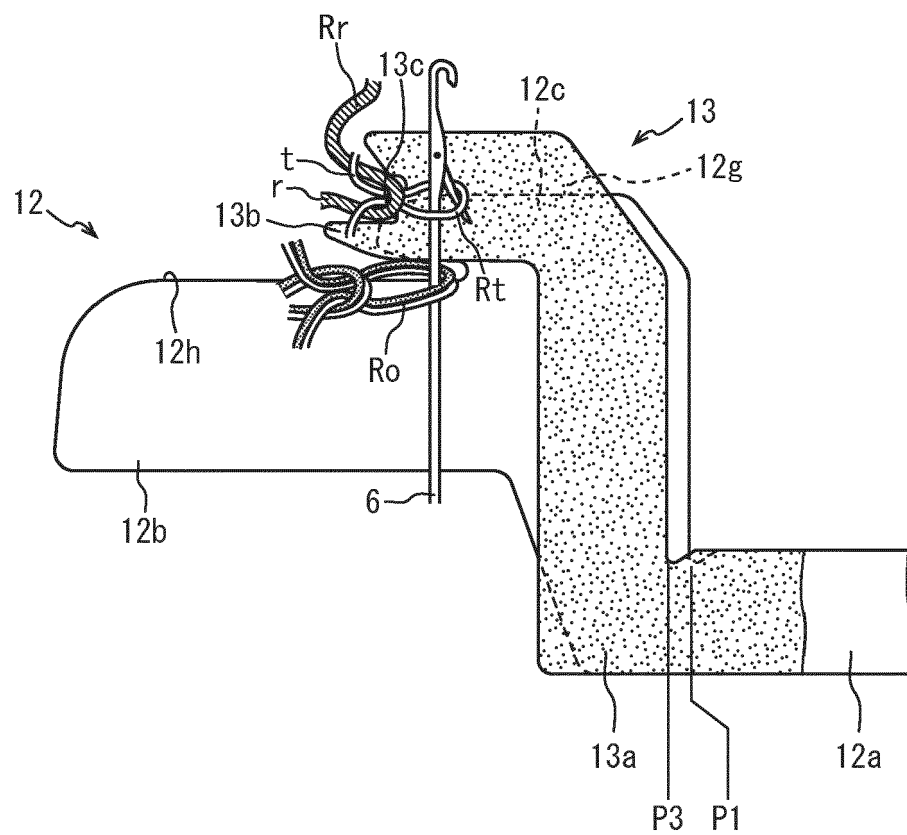


FIG. 11

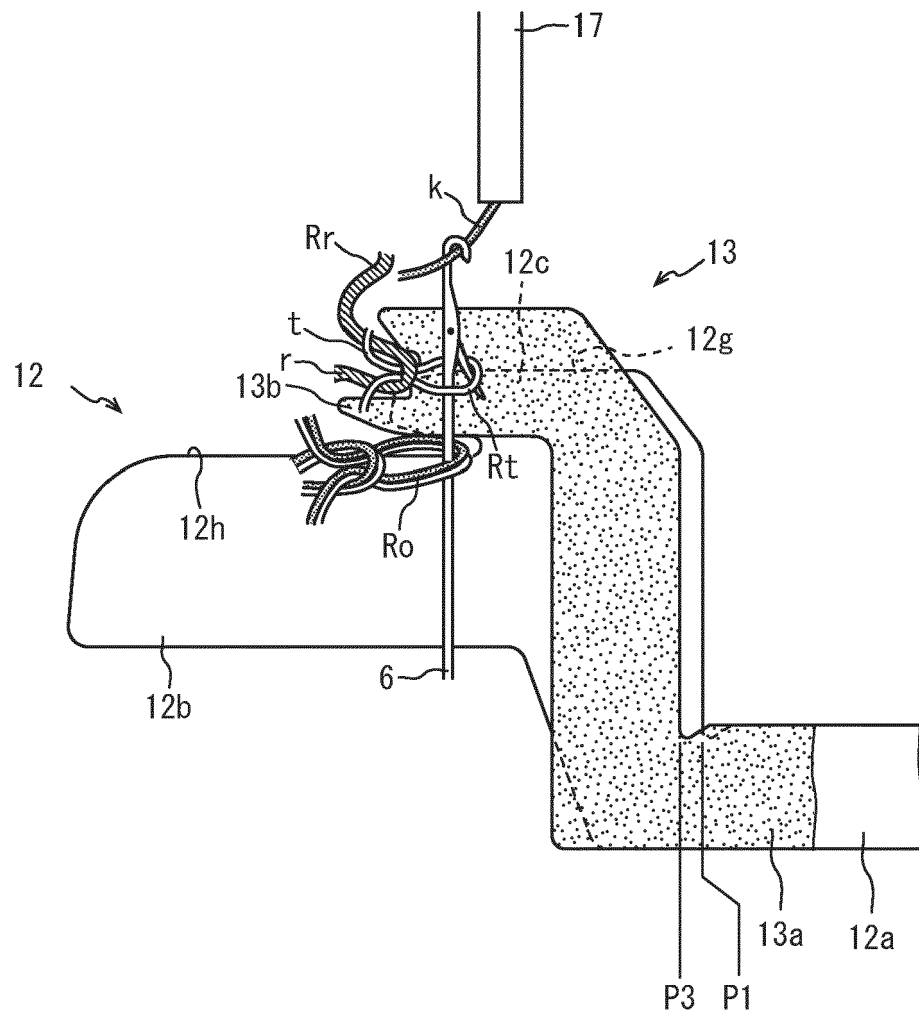


FIG. 12

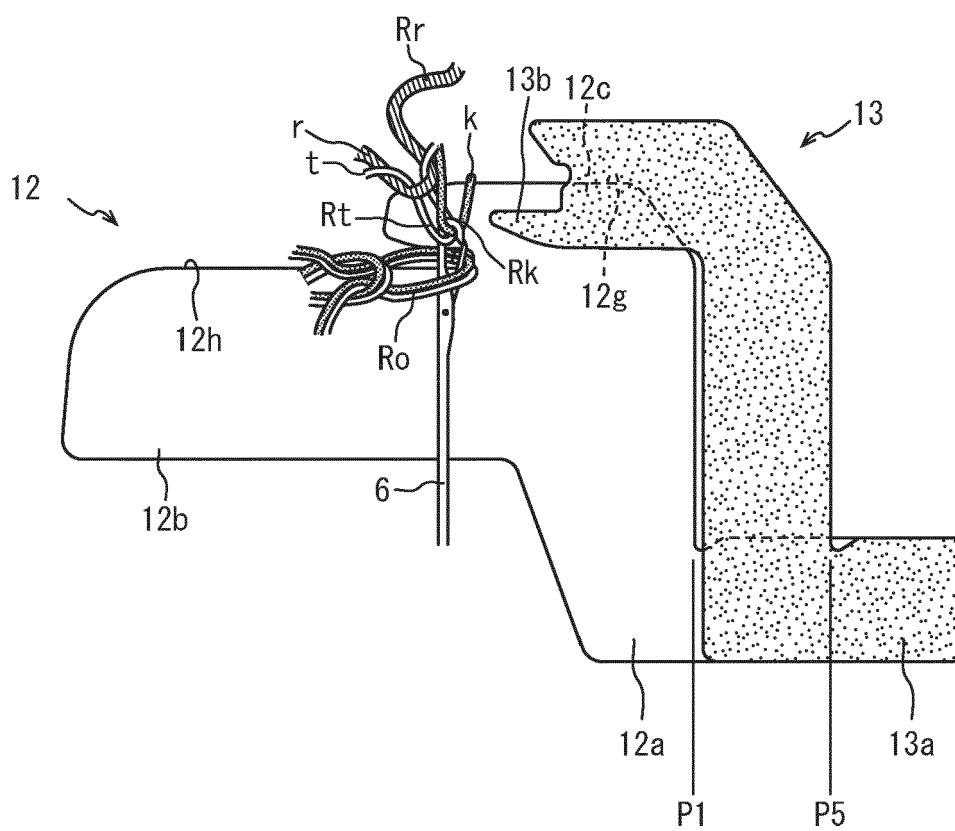


FIG. 13

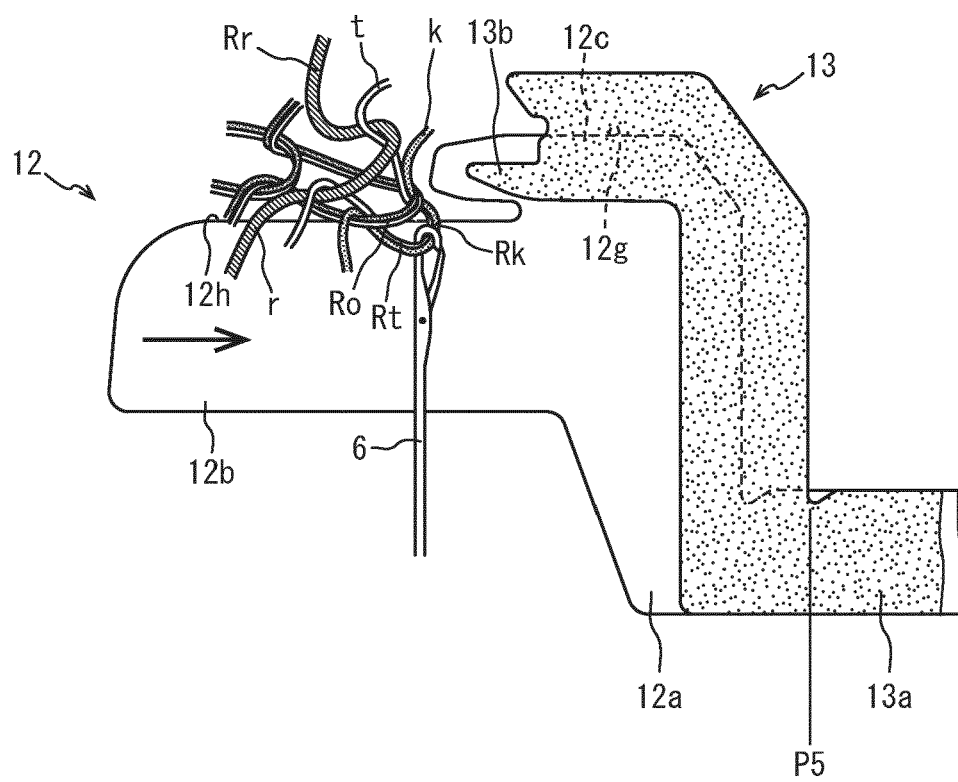


FIG. 14

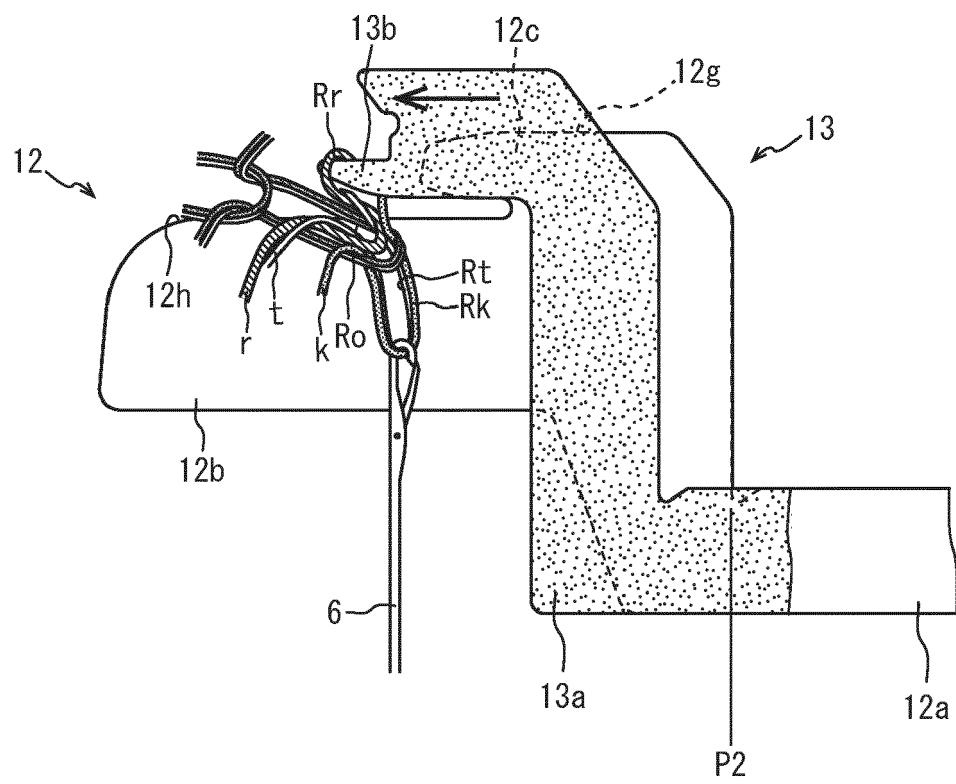


FIG. 15

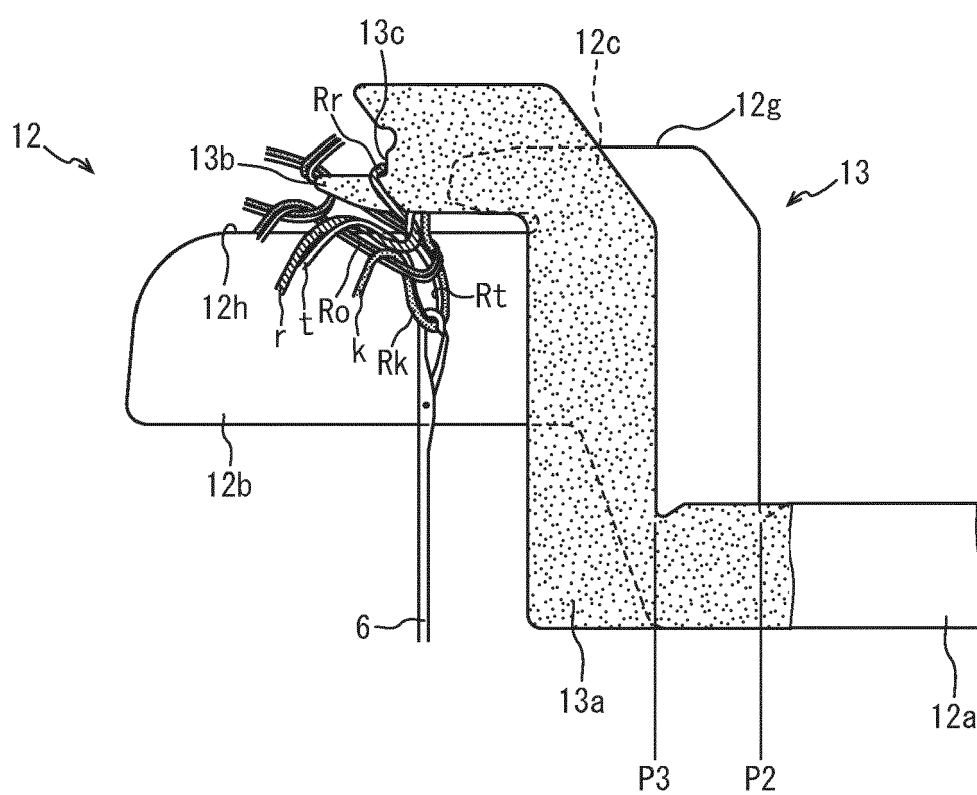
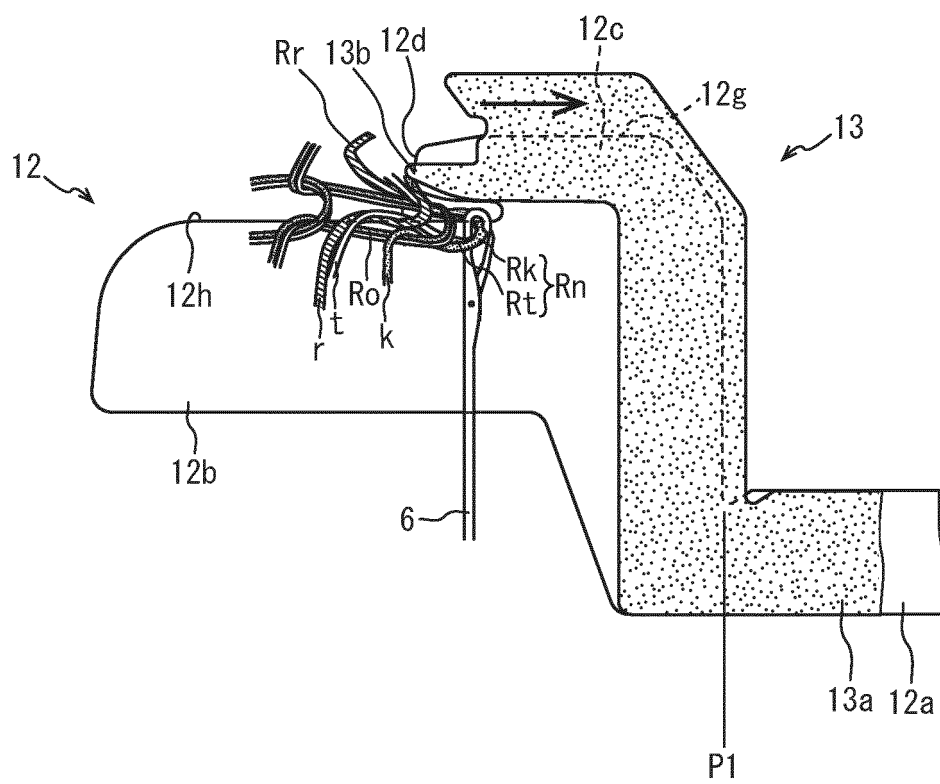


FIG. 16





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Application Number

EP 21 21 0381

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|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|-------------------|
| Place of search                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Date of completion of the search | Examiner          |
| Munich                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 21 March 2022                    | Kirner, Katharina |
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