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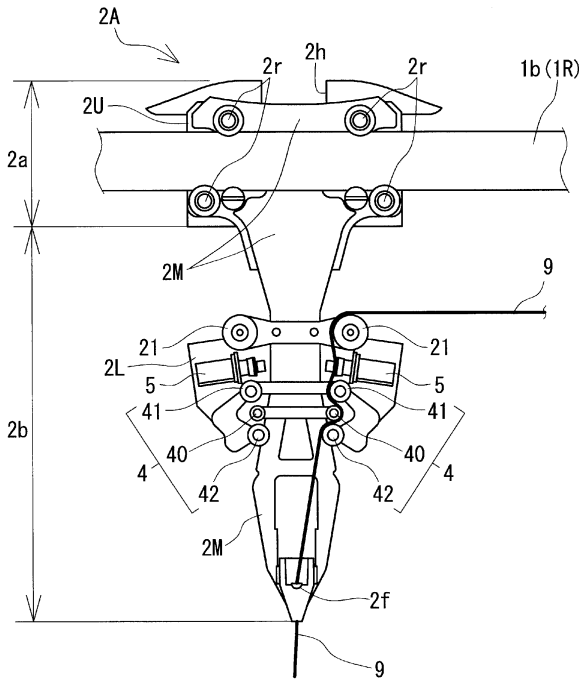
(54) FLAT KNITTING MACHINE

(57) A flat knitting machine that can speedily and accurately measure knitting yarn tension during knitting is provided. The flat knitting machine 1 includes: a needle bed 1B that has multiple knitting needles; a yarn feeder 2A that is attached to a rail 1R that is parallel to the length direction of the needle beds 1B, the yarn feeder 2A travelling along the rail 1R and feeding yarn (9) to a needle bed gap of the needle beds 1B; a knitting condition adjustment apparatus 5 that adjusts a knitting condition related to yarn feeding; and a knitting condition control unit that controls the knitting condition adjustment apparatus 5 based on the tension of the knitting yarn 9. The yarn feeder 2A includes a tension sensor 4 that acquires information related to the tension of the knitting yarn 9 and outputs the information to the knitting condition control unit.

Fig. 3



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Description

TECHNICAL FIELD

[0001] The present invention relates to a flat knitting machine.

BACKGROUND ART

[0002] A flat knitting machine includes a needle bed in which multiple knitting needles are arranged side-by-side, and is provided with yarn feeders (hereinafter, sometimes called "YF") that are attached to a rail, travel along the rail, and feed knitting yarn to the knitting needles of the needle bed.

[0003] Patent Document 1 discloses a configuration in which a YF is driven by a linear motor, or a drive motor or the like is attached to a YF, such that the YF is self-propelled. The drive motor provided for the YF and the control apparatus for control thereof are supplied with electrical power through contact power supply that is performed via a contact strip provided on the rail.

[0004] Patent Document 2 discloses a moving body (reference sign 300 in Patent Document 2) that travels on a rail to which the YF is attached, and that moves the YF by inserting a changeover pin into the YF. In Patent Document 2, the insertion and removal of the changeover pin is performed using electrical power that is supplied to the moving body through contact between a conductive sheet provided on the rail and a carbon brush provided on the moving body.

PRIOR ART DOCUMENT

PATENT DOCUMENTS

[0005]

Patent Document 1: German Patent Application Publication No. 4308251
Patent Document 2: Chinese Patent Application Publication No. 101139777

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0006] Each YF receives a supply of knitting yarn from a knitting yarn supply source such as a cone around which the knitting yarn is wound. When the YF moves, the knitting yarn is pulled by the YF and fed out from the cone. Here, in order to improve the quality of the knitted fabric, appropriate tension (set tension) needs to be applied to the knitting yarn while knitting the knitted fabric. However, there are cases where the tension of the knitting yarn becomes inappropriate due to the type of knitting yarn and state thereof, external factors such as humidity and temperature, and knitting conditions such as knitting speed and knitting operations. Conventionally, knitting yarn tension has been measured and adjusted at a position that is upstream in the knitting yarn path and separated from the needle bed gap where knitting is currently being performed, and therefore it has been difficult to speedily detect changes in the knitting yarn tension in the vicinity of the needle bed gap, and adjustment of the tension tends to be delayed.

[0007] The present invention was achieved in light of the foregoing circumstances, and an object thereof is to provide a flat knitting machine in which knitting yarn tension can be speedily and accurately measured during knitting.

MEANS FOR SOLVING THE PROBLEMS

[0008] A flat knitting machine of the present invention includes: a needle bed having a plurality of knitting needles;
a yarn feeder that is attached to a rail that is parallel to a length direction of the needle beds, the yarn feeder travelling along the rail and feeding knitting yarn to a needle bed gap of the needle beds;
a knitting condition adjustment apparatus that adjusts a knitting condition related to yarn feeding; and
a knitting condition control unit that controls the knitting condition adjustment apparatus based on a tension of the knitting yarn,
wherein the yarn feeder includes a tension sensor that acquires information correlated with the tension of the knitting yarn and outputs the information to the knitting condition control unit.

[0009] In an aspect of the flat knitting machine of the present invention, the tension sensor includes a guide shaft portion that extends in a thickness direction of the yarn feeder and is configured to be displaceable in a direction intersecting the thickness direction of the yarn feeder, the knitting yarn being guided on a circumferential surface of the guide shaft portion, and
the tension sensor outputs an extent of displacement of the guide shaft portion to the knitting condition control unit.

[0010] In an aspect of the flat knitting machine of the present invention, the knitting condition adjustment apparatus is a tension adjustment apparatus that is provided on the yarn feeder and adjusts the tension of the knitting yarn by acting on a portion of the knitting yarn that is upstream of the tension sensor.

[0011] In an aspect of the flat knitting machine of the present invention including the tension adjustment apparatus, the yarn feeder includes a carrier portion that is attached to the rail, and a suspended portion that extends downward from the carrier portion and has a smaller width than the carrier portion, and
the tension adjustment apparatus is provided at a position on a lateral side of the suspended portion in a front view of the yarn feeder from a direction orthogonal to the rail.

[0012] In an aspect of the flat knitting machine of the present invention including the tension adjustment apparatus, the knitting condition control unit for controlling the tension adjustment apparatus is provided on the yarn feeder.

[0013] In an aspect of the flat knitting machine of the present invention including the tension adjustment apparatus, the tension adjustment apparatus adjusts the tension of the knitting yarn by acting on the knitting yarn in a direction orthogonal to a thickness direction of the yarn feeder.

EFFECTS OF THE INVENTION

[0014] According to the flat knitting machine of the present invention in which the tension sensor is provided on the yarn feeder (hereinafter called the "YF"), the tension of the knitting yarn can be checked at a position near the knitting location in the vicinity of the needle bed gap, thus making it possible to speedily and accurately measure changes in the tension of the knitting yarn at the knitting location. It is therefore possible to adjust a knitting condition in accordance with the tension of the knitting yarn at an earlier timing than in conventional technology. Examples of the knitting condition adjustment apparatus that adjusts the knitting condition include a tension adjustment apparatus that adjusts the tension of the knitting yarn by acting on the knitting yarn, a feeding apparatus that dynamically adjusts the feeding amount of the knitting yarn, and a cam system that adjusts the amount of the knitting yarn that is pulled by the knitting needle. In all of these configurations, it is possible to change the tension of the knitting yarn, it is easier to maintain an optimum tension of the knitting yarn at the knitting location, and it is possible to improve the quality of the knitted fabric.

[0015] If the guide shaft portion is a guide shaft portion that extends in the thickness direction of the YF, the knitting yarn is not likely to become twisted or the like between the introduction guide and the guide shaft portion. Also, the guide shaft portion is configured to be displaceable in a direction intersecting the thickness direction of the YF, and therefore the guide shaft portion does not protrude beyond the YF in the thickness direction during displacement of the guide shaft portion, thus making it possible to avoid a fault such as the guide shaft portion coming into contact with another YF.

[0016] Due to the tension adjustment apparatus, which is one type of knitting condition adjustment apparatus, being provided on the YF, it is possible to immediately respond to a change in the tension of the knitting yarn at a position in the vicinity of the needle bed gap and optimize the tension of the knitting yarn.

[0017] Because multiple YFs are disposed in the flat knitting machine, and the YFs are arranged close to each other in a small space in the vicinity of the needle bed gap, the idea of providing the tension adjustment apparatus at a position close to the leading end of a YF has not existed. In contrast, in light of the problem to be solved by the present invention, in the flat knitting machine of the present invention, the tension adjustment apparatus is intentionally provided at the YF position. The more YFs there are, the greater the possibility of a tension adjustment apparatus hindering the movements of the YFs is, and this problem can be resolved by providing the tension adjustment apparatus at a position on a lateral side of the suspended portion of the YF.

[0018] Providing the knitting condition control unit on the YF makes it possible for the information acquired by the tension sensor to be used in control of the tension adjustment apparatus without being transmitted from the YF to the outside.

[0019] If the direction in which the tension adjustment apparatus acts is a direction orthogonal to the thickness direction of the YF (i.e., the planar direction of the YF), it is possible to suppress the case where the tension adjustment apparatus protrudes a large amount from the YF.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020]

FIG. 1 is a schematic front view of a flat knitting machine according to an embodiment.

FIG. 2 is a schematic diagram of a yarn feeder viewed from one side of a rail.

FIG. 3 is a schematic diagram of the yarn feeder viewed from the side opposite to that in FIG. 2.

FIG. 4 is a schematic configuration diagram of a tension sensor and a tension adjustment apparatus of the yarn feeder.

FIG. 5A is a schematic front view of a guide shaft portion of the tension sensor, and FIG. 5B is a partial cross-sectional view of the guide shaft portion.

DESCRIPTION OF THE EMBODIMENTS

First Embodiment

[0021] A flat knitting machine 1 according to an embodiment of the present invention will be described below with reference to FIGS. 1 to 5.

[0022] As shown in FIG. 1, the flat knitting machine 1 includes a pair of needle beds 1B that are arranged facing each other in the depth direction with respect to the paper plane, and yarn feeders (hereinafter, called "YF") 2A to 2D that feed knitting yarn 9 to a needle bed gap formed between the two needle beds 1B. Multiple knitting needles are aligned in each needle bed 1B, and these knitting needles are driven by a cam system (not shown) provided in a carriage 1C that moves back and forth over the needle beds 1B. Also, the YFs 2A to 2D travel along a rail 1R. The rail 1R spans between a pair of frames 1FR and 1FL, which are immovable members that are provided upright on respective end sides of the flat knitting ma-

chine 1 and are integrated with the flat knitting machine 1. Multiple rails 1R are provided parallel with each other in the depth direction with respect to the paper plane, and the rails 1R each extend parallel with the needle beds 1B at positions above the needle beds 1B. Hereinafter, when giving descriptions that are common to all of the YFs 2A to 2D, the term "YFs 2" will be used instead of distinguishing between the YFs 2A to 2D.

[0023] In this embodiment, multiple YFs 2 are attached to each rail 1R. The YFs 2A and 2B are attached to the surface of the rail 1R that is on the front side with respect to the paper plane, and the YFs 2C and 2D are attached to the surface of the rail 1R that is on the back side with respect to the paper plane. These YFs 2 travel along the rail 1R by being selected and moved by a selector 1S that hangs over the rail 1R. The YFs 2 are selected by engagement with a retractable changeover pin that is provided in the selector 1S. The selector 1S is coupled to the carriage 1C, and moves integrally with the carriage 1C. When the selector 1S selects and moves the YFs 2 to be used in knitting, knitting is performed using the knitting yarn 9 that is supplied from the YFs 2. Note that the configuration for moving the YFs 2 is not limited to the configuration in this embodiment, and can be a configuration in which the YFs 2 are self-propelled. The operations of the carriage 1C and the selector 1S are controlled by a computer 10 that is provided in the flat knitting machine 1.

[0024] The YFs 2 are each supplied with knitting yarn 9 from a knitting yarn supply source (not shown) such as a cone that is arranged above the flat knitting machine 1 for example, and the knitting yarn 9 is fed via a tension equipment 90 and also a side tension device (not shown) provided on a lateral side of the flat knitting machine 1. In other words, the YFs 2 in this embodiment are configured to receive a supply of the knitting yarn 9 from its lateral side. In contrast to this example, a configuration is possible in which the YFs 2 receive a supply of the knitting yarn 9 from above.

[0025] A tension sensor that measures the tension of the knitting yarn 9 and a power supply portion that supplies electrical power to the tension sensor are provided at positions on the each of the YFs 2 in the flat knitting machine 1 of this embodiment. First, the overall configuration of the YF 2A of this embodiment will be briefly described with reference to FIGS. 2 and 3, and then configurations provided on the YF 2A will be described.

Yarn feeder

[0026] FIG. 2 is a diagram showing the YF 2A attached to the rail 1R, as viewed from the front side with respect to the paper plane in FIG. 1, and FIG. 3 is a diagram showing the YF 2A as viewed from the back side with respect to the paper plane in FIG. 1. FIGS. 2 and 3 show only one ridge 1b that is provided on a side surface of the rail 1R, and the YF 2A slides along this ridge 1b. For the sake of convenience, the side shown in FIG. 2 will be called the front side of the YF 2A, and the side shown in FIG. 3 will be called the back side of the YF 2A. The YF 2A of this embodiment shown in FIGS. 2 and 3 includes a main body portion 2M, a lower mounting portion 2L, and an upper mounting portion 2U. Of course, the configuration of the YF 2A shown in FIGS. 2 and 3 is merely one example, and there is no limitation to this configuration. Note that the knitting yarn 9 is emphasized in FIGS. 2 and 3 in order to aid understanding of the path of the knitting yarn 9.

[0027] As shown in FIG. 3, the main body portion 2M is an elongated member that extends downward from the rail 1R, and includes traveling rollers 2r that sandwich the ridge 1b of the rail 1R from above and below. More specifically, the main body portion 2M is divided into a carrier portion 2a on which the traveling rollers 2r are provided, and a suspended portion 2b that extends so as to hang downward from the carrier portion 2a. In order to ensure strength, the main body portion 2M is preferably made of a metal. A pin groove 2h for receiving the changeover pin of the selector 1S shown in FIG. 1 is provided in the upper edge of the carrier portion 2a. Also, a yarn feeding opening 2f for guiding the knitting yarn 9 to the needle bed gap is provided at the lower end of the suspended portion 2b, and a roller-shaped introduction guide 21 for guiding the knitting yarn 9 toward the yarn feeding opening 2f is provided somewhat upward of the intermediate portion. The introduction guide 21 of this embodiment is configured by a roller that has a rotation shaft that extends in the thickness direction of the main body portion 2M. The introduction guide 21 is provided on a small piece that extends in the extending direction of the rail 1R and is fixed to the suspended portion 2b, and more specifically in a portion of the small piece that projects out from the suspended portion 2b. Note that the introduction guide 21 is not limited to being a roller, and may be a tubular member through which the knitting yarn 9 can pass, for example.

[0028] The lower mounting portion 2L is attached at a position that is below the introduction guide 21. Although the lower mounting portion 2L appears to be a plate-shaped member in the drawings, it is actually constituted by combining a plate piece and a framework member or the like. This lower mounting portion 2L is for the mounting of electrical devices such as a tension sensor 4 and a tension adjusting apparatus 5 that are shown in FIG. 3, and is made of an insulating material. A portion of the lower mounting portion 2L projects laterally from the main body portion 2M in a front view of the YF 2A from a direction orthogonal to the extending direction of the rail 1R, and the tension sensor 4 and the tension adjusting apparatus 5 are provided on the back side (side shown in FIG. 3) of this projecting portion.

[0029] The upper mounting portion 2U is a plate-shaped member that is provided on the front side (side shown in FIG. 2) of the carrier portion 2a. The upper mounting portion 2U is for the mounting of a later-described control circuit 20 and the like, and is made of an

insulating material. The front side of the carrier portion 2a may be formed with a box-like shape, and the upper mounting portion 2U may be stored inside the carrier portion 2a. In this case, if the carrier portion 2a is provided with a lid, it is possible to protect the control circuit 20 from dust and oil.

Power supply portion

[0030] A power supply portion 3 supplies electrical power to a later-described control circuit 20, the tension sensor 4, and the tension adjusting apparatus 5. The power supply portion 3 may be an active power supply that supplies electrical power from its own power supply, such as abattery, or maybe a passive power supply that receives electrical power from outside of the YF 2A and supplies that electrical power to the control circuit 20 and the like. Examples of methods for supplying electrical power to the passive power supply include a contact type of power supply such as that described in Patent Document 1 or 2, and a contactless power supply method that utilizes electromagnetic induction or the like.

Control circuit

[0031] The control circuit 20 is provided on the front side of the upper mounting portion 2U, and is electrically connected to the power supply portion 3. In this embodiment, the tension adjusting apparatus 5 is provided on the YF 2A, and the control circuit 20 of this embodiment has a tension control portion (knitting condition control unit) that controls the tension adjusting apparatus 5 based on information from the tension sensor 4. Also, the YF 2A of this embodiment may include a transceiver as will be described later, and in this case, a communication control portion for the transceiver can be provided in the control circuit 20. These control portions provided on the YF 2A are controlled in coordination with each other by an overall control portion provided in the computer 10 of the flat knitting machine 1.

Tension sensor

[0032] The tension sensor 4 is provided on the lower mounting portion 2L of the YF 2A, acquires information indicating a physical amount that is correlated with the tension of the knitting yarn 9, and outputs the acquired information to the control circuit 20 as an electrical signal. Providing the tension sensor 4 on the YF 2A makes it possible for slack and tension of the knitting yarn 9 to be detected more swiftly than in conventional technology. There are no particular limitations on the acquired physical amount, as long as it changes in correlation with change in the tension of the knitting yarn 9.

[0033] FIGS. 4 and 5 will be referenced while describing the tension sensor 4 of this embodiment. As shown in FIG. 4, the tension sensor 4 is provided at a position downstream from the introduction guide 21 in the knitting yarn 9 feeding direction (on the side corresponding to the yarn feeding opening 2f of the main body portion 2M in FIGS. 2 and 3), is in contact with the knitting yarn 9, and acquires a physical amount that corresponds to stress applied by the knitting yarn 9. More specifically, the tension sensor 4 is configured by guide rollers 41 and 42 and a guide shaft portion 40 that is attached in a cantilevered manner at a position between the guide rollers 41 and 42. The tension of the knitting yarn 9 spanning between the guide rollers 41 and 42 is measured by the guide shaft portion 40. The guide shaft portion 40 is configured to be displaceable in the left-right direction with respect to the paper plane, and acquires, as the physical amount, a strain amount that corresponds to the amount of displacement.

[0034] The configuration of the guide shaft portion 40 will be described in more detail below with reference to FIG. 5. The guide shaft portion 40 of this embodiment includes a roller 4r, and the roller 4r is rotatably supported at the leading end of a roller support shaft 4b that extends in a direction conforming to the left-right direction with respect to the paper plane (the extending direction of the rail 1R in FIG. 3). The rear end of the roller support shaft 4b is sandwiched by a pair of a wall portions 4w, and the roller support shaft 4b can be displaced in the left-right direction with respect to the paper plane. A groove portion 4g that extends orthogonal to the axial direction of the roller support shaft 4b is formed in the upper surface of an intermediate portion of the roller support shaft 4b, and a small piece 4p is fitted into the groove portion 4g. An end portion of the small piece 4p that is on the side opposite to the groove portion 4g is supported by a strain sensor 4s. For this reason, when the roller support shaft 4b that supports the guide shaft portion 40 becomes displaced due to tension in the knitting yarn 9, the small piece 4p is pressed by the groove portion 4g and bends. The strain sensor 4s detects a strain amount of the small piece 4p caused by the bending. Of course, the small piece 4p itself may be configured by a strain sensor. The above-described configuration of the tension sensor 4 is merely one example, and the measurement of tension may be realized using another detection principle.

[0035] Information indicating the physical amount acquired by the tension sensor 4 (the strain amount in this embodiment) is input as an electrical signal to the control circuit 20 shown in FIG. 2. The control circuit 20 controls the tension adjusting apparatus 5 based on this information. When the tension of the knitting yarn 9 is adjusted, the control circuit 20 references a look up table that is stored in a memory of the control circuit 20, for example. The look up table indicates a correlation relationship between the physical amounts and tensions of the knitting yarn 9, for example. The control circuit 20 compares the obtained tension of the knitting yarn 9 with a set tension that is stored in the memory, and causes the tension adjusting apparatus 5 to operate such that the tension of the knitting yarn 9 approaches the set tension. For example, if the obtained tension is lower than the set ten-

sion, the tension adjusting apparatus 5 is caused to operate such that the tension of the knitting yarn 9 increases. Conversely, if the obtained tension is higher than the set tension, the tension adjusting apparatus 5 is caused to operate such that the tension of the knitting yarn 9 decreases. The tension of the knitting yarn 9 is brought closer to the set tension by repeating this operation of the tension adjusting apparatus 5, measurement by the tension sensor 4, and tension comparison by the control circuit 20.

Tension adjustment apparatus

[0036] As shown in FIG. 4, the tension adjusting apparatus 5 of this embodiment adjusts the tension of the knitting yarn 9 by acting on a portion of the knitting yarn 9 that spans between the introduction guide 21 and the tension sensor 4. The tension adjusting apparatus 5 is a knitting condition adjustment apparatus that optimizes the tension of the knitting yarn 9 by directly acting on the knitting yarn 9 so as to adjust the tension itself of the knitting yarn 9, which is a knitting condition. The tension adjusting apparatus 5 is not necessarily required to be provided on the YF 2A, and may be provided at a position of the side tension device of the flat knitting machine 1 shown in FIG. 1 as in conventional technology. However, adjusting the knitting yarn 9 at a position closer to the needle bed gap as with the tension adjusting apparatus 5 of this embodiment is preferable due to being able to swiftly adjust the tension of the knitting yarn 9. The tension adjusting apparatus 5 of this embodiment is provided at a position on a lateral side of the suspended portion 2b in a front view of the YF 2A from a direction orthogonal to the rail 1R. For this reason, the tension adjusting apparatus 5 does not interfere with a member (e.g., a YF on another rail) in the vicinity of the traveling route of the YF 2A. Also, the tension adjusting apparatus 5 of this embodiment is configured so as to not protrude beyond the width of the carrier portion 2a in the extending direction of the rail 1R, and thus allowing the YFs 2A and 2B shown in FIG. 1 to be arranged close together in the left-right direction. Here, if the tension adjusting apparatus 5 is provided external to the YF 2A, it is necessary to be capable of transmitting the information acquired by the tension sensor 4 from the YF 2A.

[0037] The tension adjusting apparatus 5 of this embodiment adjusts the tension of the knitting yarn 9 by sandwiching the knitting yarn 9 between an immovable fixed piece 51 that is fixed to the lower mounting portion 2L and a movable piece 50 that moves linearly in a direction of movement toward and away from the fixed piece 51. The movable piece 50 can be configured to be operated by a solenoid or the like, and the force by which the knitting yarn 9 is sandwiched by the fixed piece 51 and the movable piece 50 can be changed by changing the amount of electrical power supplied to the solenoid. The stronger the force sandwiching the knitting yarn 9 is, the more difficult it is for the knitting yarn 9 to move, and the higher the tension of the knitting yarn 9 becomes on a downstream side of the tension adjusting apparatus 5. Conversely, the weaker the force sandwiching the knitting yarn 9 is, the easier it is for the knitting yarn 9 to move, and the lower the tension of the knitting yarn 9 becomes on the downstream side of the tension adjusting apparatus 5. The above-described linear movement direction of the movable piece 50, that is to say the direction in which the tension adjusting apparatus 5 acts on the knitting yarn 9, is a direction that is orthogonal to the thickness direction of the YF 2A, that is to say a direction parallel to the planar direction of the main body portion 2M of the YF 2A. For this reason, even when the movable piece 50 moves, the movable piece 50 does not protrude beyond the YF 2A in the thickness direction, and the movement of the movable piece 50 does not interfere with a member in the vicinity of the traveling route of the YF 2A.

Other remarks

[0038] In order to realize a tension of the knitting yarn 9 that corresponds to the type of knitting yarn 9 and the knitting structure of the knitted fabric, it is preferable that the YF 2A is configured to be able to exchange information with the computer 10 of the flat knitting machine 1 shown in FIG. 1. For example, the YF 2A is provided with a transceiver that is optical wireless or the like such that information can be exchanged between the control circuit 20 of the YF 2A and the computer 10. The transceiver can be provided in the control circuit 20, and can be controlled by a communication control portion provided in the control circuit 20. The control circuit 20 is capable of selecting information that is to be transmitted, and selecting received information.

Second Embodiment

[0039] It is sufficient that the tension adjusting apparatus 5 can change the tension of the knitting yarn 9. For example, the tension adjusting apparatus 5 may have a configuration in which a pair of comb-shaped members are arranged such that the comb teeth thereof fit between each other. In this case, the tension of the knitting yarn 9 can be changed by arranging the knitting yarn 9 so as to be woven between adjacent comb teeth, and changing the gap between the two comb-shaped members in the thickness direction of the comb-shaped members.

Third Embodiment

[0040] The knitting condition adjustment apparatus of the present invention is not limited to the tension adjusting apparatus 5. Any apparatus can be set as the knitting condition adjustment apparatus of the present invention as long as it can optimize the tension of the knitting yarn 9 as a result of changing some sort of condition related to knitting. For example, the flat knitting machine 1 may

be configured to include a feeding apparatus in which the knitting yarn 9 is sandwiched between a pair of rollers, at least one of which is driven to rotate, and in which the knitting yarn 9 is dynamically fed by rotation of the rollers, and in this case, the feeding apparatus and a feeding control portion for control thereof are respectively set as the knitting condition adjustment apparatus and the knitting condition control unit. In this case, the tension of the knitting yarn 9 can be optimized by adjusting the feeding amount of the knitting yarn 9 based on tension-related information from the tension sensor 4. In the case of the feeding apparatus, it is possible to reduce the tension of the knitting yarn 9 by increasing the rotation speed of the rollers so as to increase the feeding amount of the knitting yarn 9. Alternatively, a cam system, which adjusts the amount of the knitting yarn 9 that is pulled by a knitting needle, and a cam control portion for control of the cam system can be respectively set as the knitting condition adjustment apparatus and the knitting condition control unit. In this case, the tension of the knitting yarn 9 can be optimized by adjusting the pulling amount of the knitting needle based on tension-related information from the tension sensor 4.

[0041] Furthermore, the concept of adjusting a knitting condition also includes prompting a user to change a knitting condition in order to optimize the tension of the knitting yarn 9. For example, a tension abnormality notification apparatus, which is a display, a warning lamp, or the like for notifying the user of a tension abnormality, and a notification control portion for control of the tension abnormality notification apparatus can be respectively set as the knitting condition adjustment apparatus and the knitting condition control unit. When the tension abnormality is notified, an overall control portion of the flat knitting machine 1 can determine that knitting operations are to be paused.

Claims

1. A flat knitting machine (1) comprising:

a needle bed (1B) having a plurality of knitting needles;
a yarn feeder (2A) that is attached to a rail (1R) that is parallel to a length direction of the needle beds (1B), the yarn feeder (2A) travelling along the rail (1R) and feeding knitting yarn (9) to a needle bed gap of the needle beds (1B);
a knitting condition adjustment apparatus (5) that adjusts a knitting condition related to yarn feeding; and
a knitting condition control unit (20) that controls the knitting condition adjustment apparatus (5) based on a tension of the knitting yarn (9),
wherein the yarn feeder (2A) includes a tension sensor (4) that acquires information correlated with the tension of the knitting yarn (9) and outputs the information to the knitting condition control unit (20).

2. The flat knitting machine (1) according to claim 1,
wherein the tension sensor (4) includes a guide shaft portion (40) that extends in a thickness direction of the yarn feeder (2A) and is configured to be displaceable in a direction intersecting the thickness direction of the yarn feeder (2A), the knitting yarn (9) being guided on a circumferential surface of the guide shaft portion (40), and
the tension sensor (4) outputs an extent of displacement of the guide shaft portion (40) to the knitting condition control unit (20) .

3. The flat knitting machine (1) according to claim 1 or 2,
wherein the knitting condition adjustment apparatus (5) is a tension adjustment apparatus (5) that is provided on the yarn feeder (2A) and adjusts the tension of the knitting yarn (9) by acting on a portion of the knitting yarn (9) that is upstream of the tension sensor (4) .

4. The flat knitting machine (1) according to claim 3,
wherein the yarn feeder (2A) includes a carrier portion (2a) that is attached to the rail (1R), and a suspended portion (2b) that extends downward from the carrier portion (2a) and has a smaller width than the carrier portion (2a), and
the tension adjustment apparatus (5) is provided at a position on a lateral side of the suspended portion (2b) in a front view of the yarn feeder (2A) from a direction orthogonal to the rail (1R).

5. The flat knitting machine (1) according to claim 3 or 4,
wherein the knitting condition control unit (20) for controlling the tension adjustment apparatus (5) is provided on the yarn feeder (2A).

6. The flat knitting machine (1) according to any one of claims 3 to 5,
wherein the tension adjustment apparatus (5) adjusts the tension of the knitting yarn (9) by acting on the knitting yarn (9) in a direction orthogonal to a thickness direction of the yarn feeder (2A).

Fig. 1

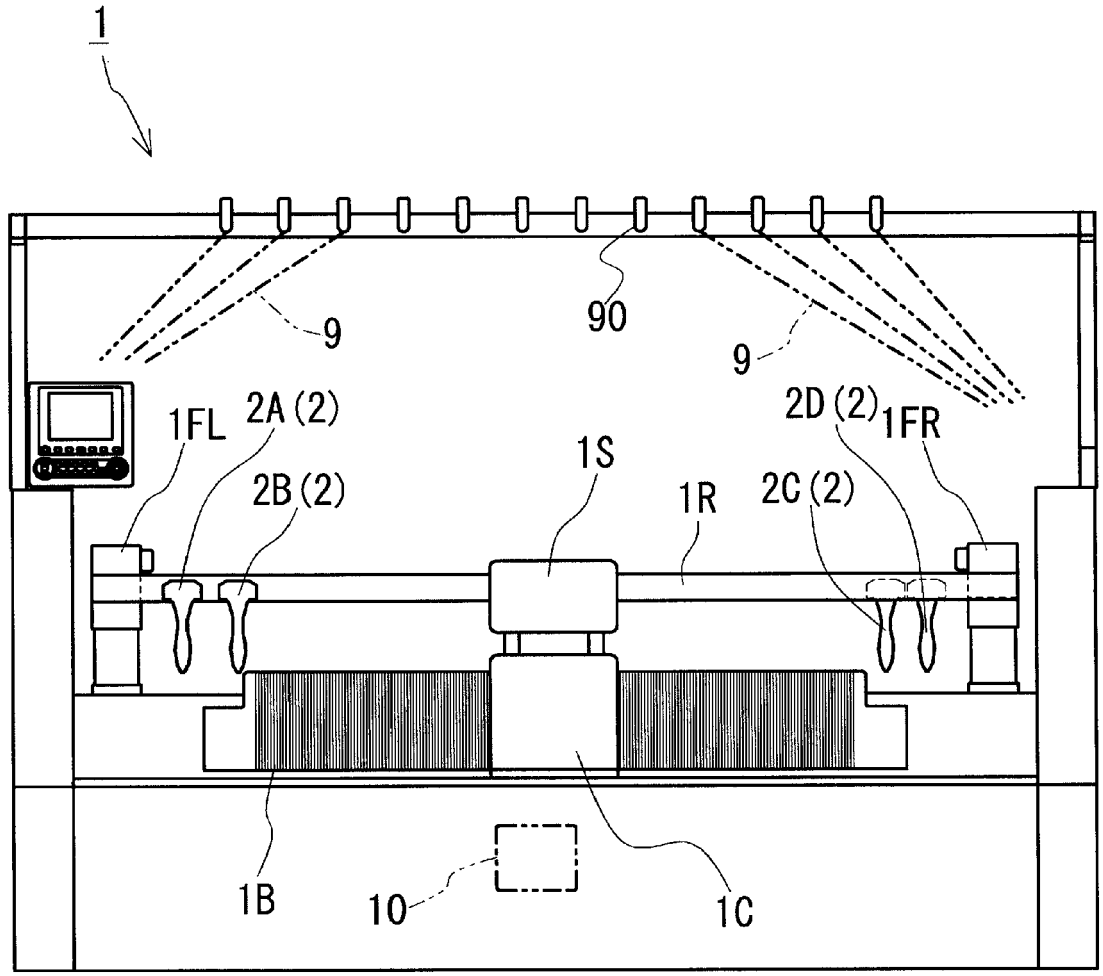


Fig. 2

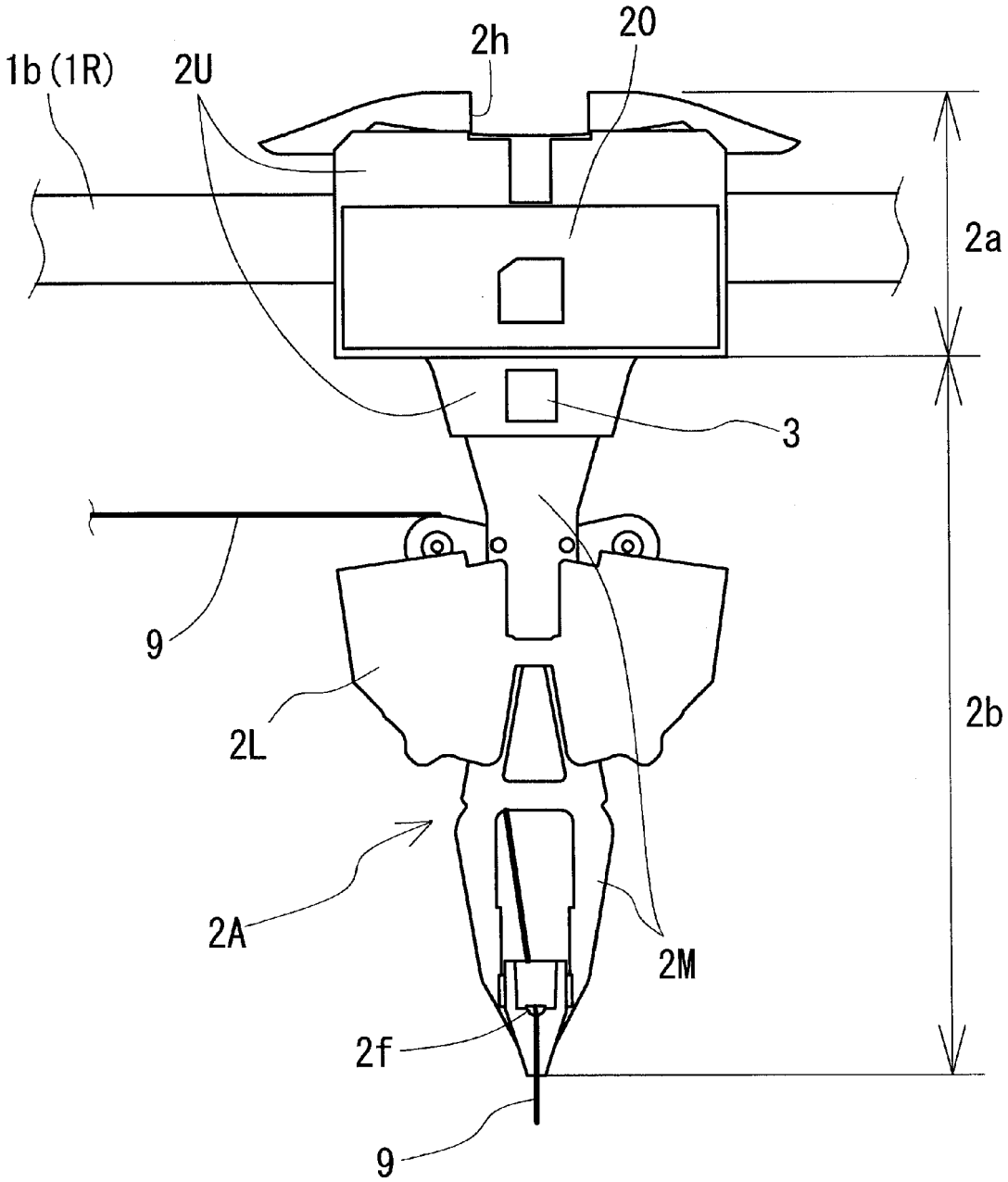


Fig. 3

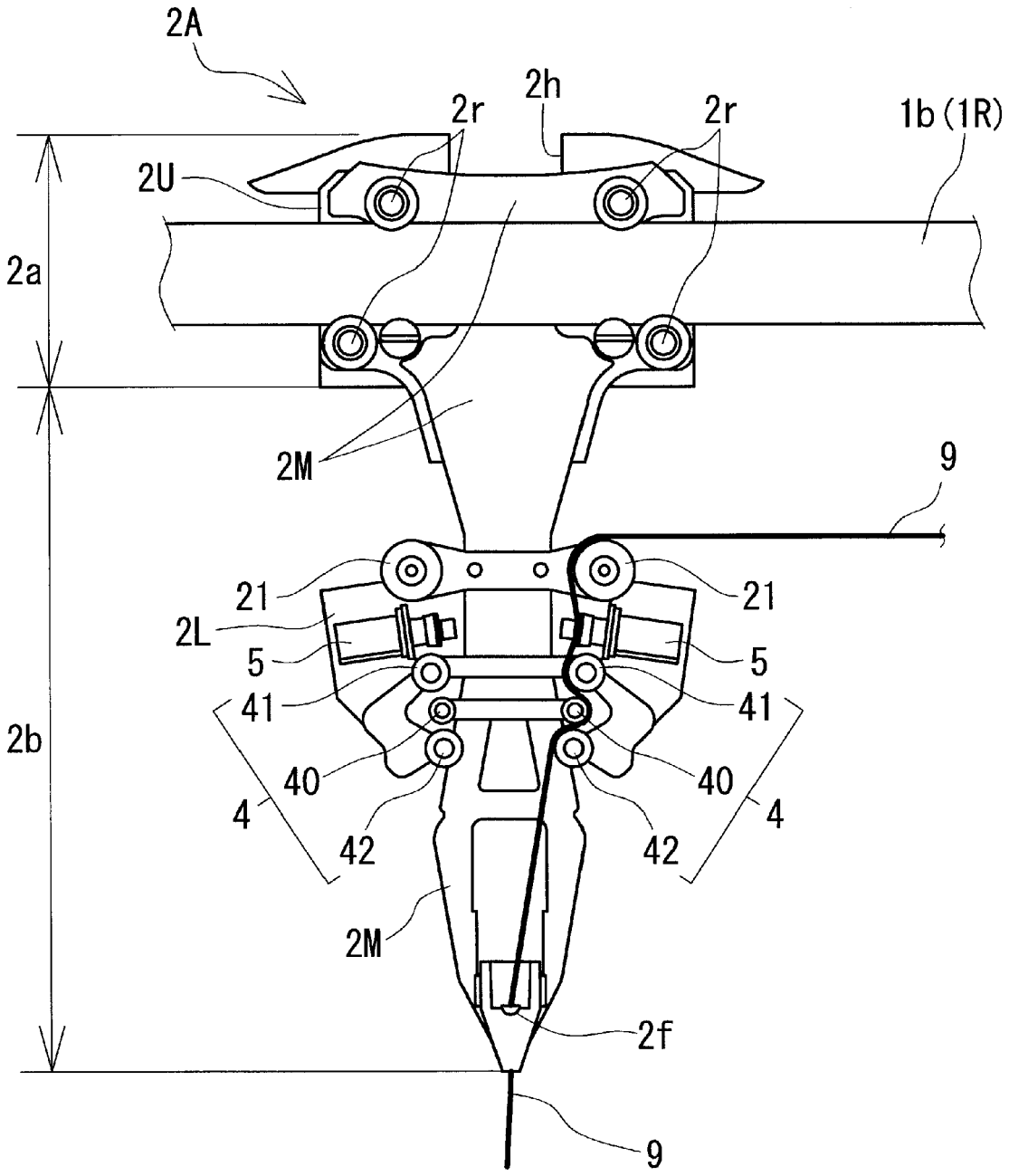


Fig. 4

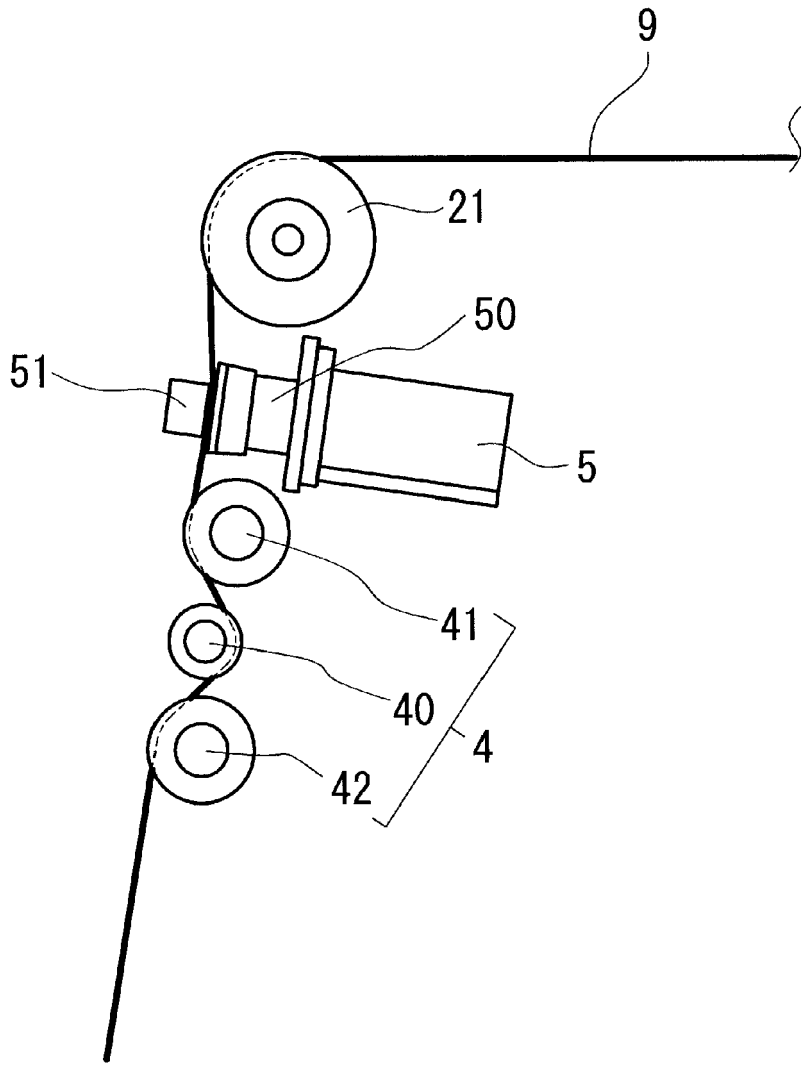
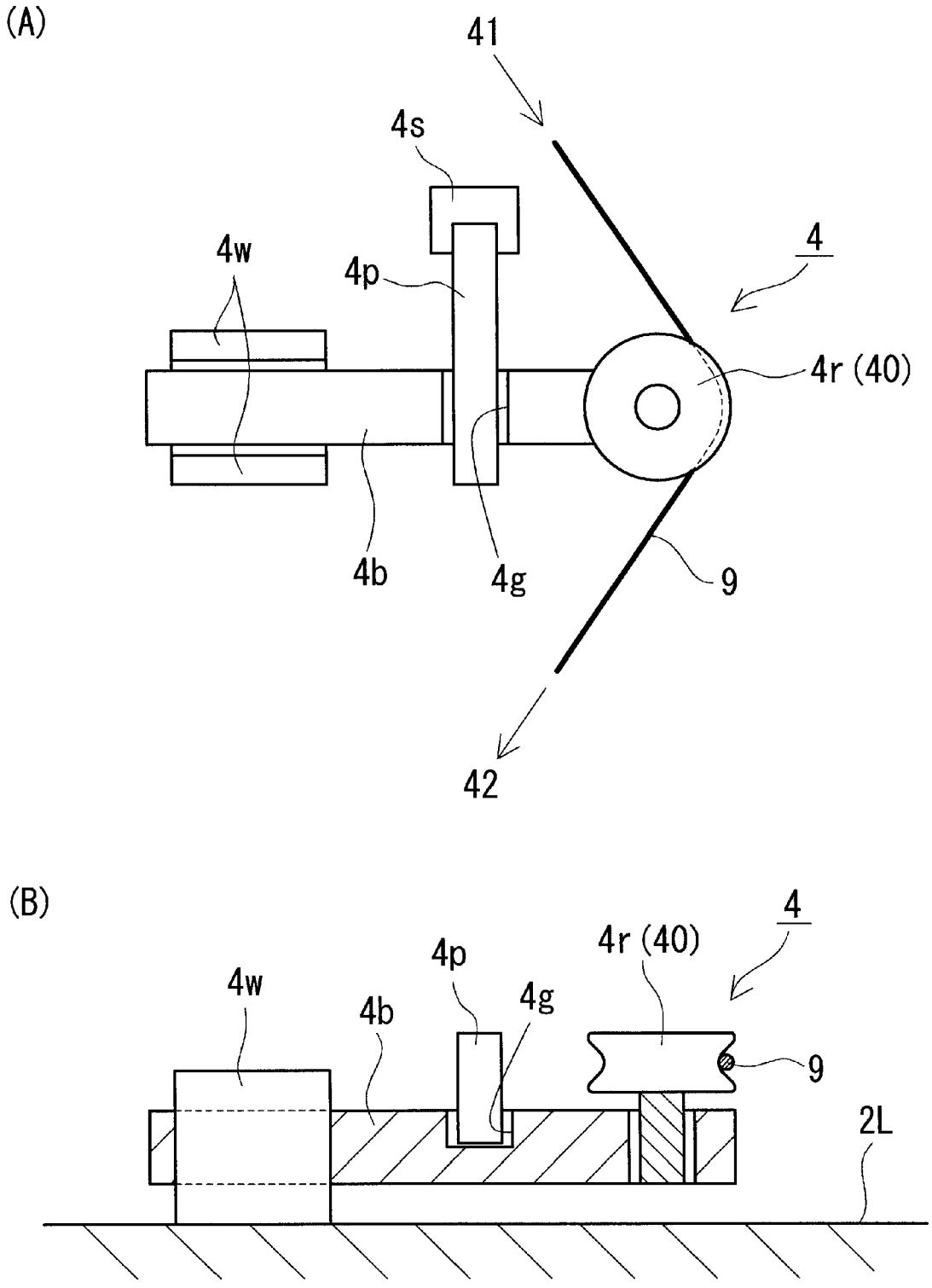


Fig. 5



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Application Number
EP 19 16 6015

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Place of search	Date of completion of the search	Examiner
Munich	25 June 2019	Messai, Sonia

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