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(71) Applicant: **SHIMA SEIKI MFG., LTD.**
Wakayama 641-8511 (JP)

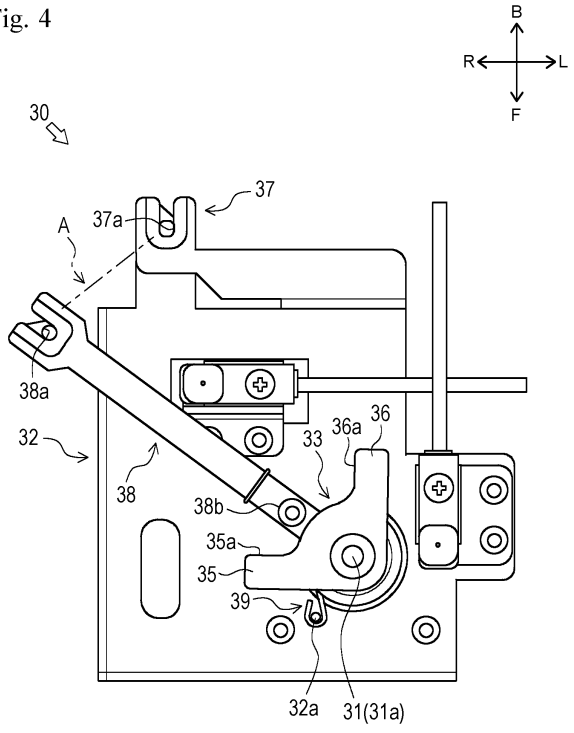
(72) Inventor: **YAMADA, Yuya**
Wakayama, 6418511 (JP)

(74) Representative: **Schmidbauer, Andreas Konrad**
Wagner & Geyer Partnerschaft mbB
Patent- und Rechtsanwälte
Gewürzmühlstrasse 5
80538 München (DE)

(54) YARN TENSION CONTROL DEVICE, KNOTTER DEVICE, AND FLAT KNITTING MACHINE

(57) A yarn tension control device, a knotter device, and a flat knitting machine capable of controlling tension applied to a yarn are provided. A motor (31) that generates a driving force, a cam (33) configured to be rotatable by the driving force of the motor (31), a pair of yarn guides (37A, 37B) that guides a yarn (A) to a predetermined position, a kick spring (39) that generates a biasing force, and an arm that is freely-rocked and supported along a virtual plane passing between the pair of yarn guides (37A, 37B) are provided, and the arm includes an insertion hole (38a) through which the yarn (A) guided by the pair of yarn guides (37A, 37B) is inserted and a pin (38b) on which the cam (33) can act, is biased by the kick spring (39) in a direction of applying a tension to the yarn (A), and rocks in a direction away from the pair of yarn guides (37A, 37B) with reference to a position where the biasing force of the kick spring (39) and the tension of the yarn (A) are balanced by an action of the cam (33) on the pin (38b) to increase the tension applied to the yarn (A).

Fig. 4



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Description

Technical Field

[0001] The disclosure relates to a technique of a yarn tension control device, and a knotter device and a flat knitting machine including the yarn tension control device.

Background Art

[0002] Conventionally, a device for applying tension to a yarn fed to a textile machine by a biasing force of a spring is known. For example, Patent Literature 1 discloses a device that is provided in a knotter device and applies a constant tension to a yarn by a biasing force of a spring. Furthermore, it is also known that a device adapted to apply tension to a yarn by a biasing force of a spring is provided in a flat knitting machine.

[0003] However, since the device disclosed in Patent Literature 1 applies a constant tension to the yarn even in a state other than a yarn knotting operation, there is a problem that a load is applied to the yarn more than necessary. Therefore, a yarn tension applying device capable of controlling the tension applied to the yarn is desired.

Citation List

Patent Literature

[0004] Patent Literature 1: JP 2614775 B2

Summary of Invention

Technical Problem

[0005] The disclosure has been made in view of the above circumstances, and an object of the disclosure is to provide a yarn tension control device, a knotter device, and a flat knitting machine capable of controlling tension applied to a yarn.

Solution to Problem

[0006] The problem to be solved by the disclosure is as described above, and means for solving the problem will be described below.

[0007] In other words, a yarn tension control device according to the disclosure includes: a motor that generates a driving force; a cam configured to be rotatable by the driving force of the motor; a pair of yarn guides that guides a yarn to a predetermined position; a spring that generates a biasing force; and an arm that is freely-rocked and supported along a virtual plane passing between the pair of yarn guides, includes an insertion section through which the yarn guided by the pair of yarn guides is inserted and an action section on which the cam can act, is biased by the spring in a direction of applying a tension to the yarn, and rocks in a direction away from the pair of yarn guides with reference to a position where the biasing force of the spring and the tension of the yarn are balanced by an action of the cam on the action section to increase the tension applied to the yarn.

[0008] With such a configuration, the tension applied to the yarn can be controlled.

[0009] Furthermore, the arm decreases the tension applied to the yarn by rocking in a direction of approaching the pair of yarn guides with reference to the balanced position by an action of the cam on the action section.

[0010] With such a configuration, the tension applied to the yarn can be more finely controlled.

[0011] Furthermore, one end of the spring is fixed to the arm, and the other end of the spring is fixed to the cam.

[0012] With this configuration, the biasing force of the spring can be controlled.

[0013] Furthermore, the cam includes a first cam configured to be capable of acting on the action section of the arm, and a second cam to which the other end of the spring is fixed, and is configured to be capable of switching between the first cam and the second cam to change which one of the first cam and the second cam is to be rotated by the driving force of the motor.

[0014] With such a configuration, the biasing force of the spring can be controlled, and the tension applied to the yarn can be easily increased.

[0015] Furthermore, the cam includes a first cam configured to act on the action section of the arm and a second cam to which the other end of the spring is fixed, one of the first cam and the second cam is fixed to a motor shaft of the motor, and the other one of the first cam and the second cam is connected to the one of the first cam and the second cam with a differential gear interposed between the first cam and the second cam, and is configured to rotate in a direction opposite to the one of the first cam and the second cam along with rotation of the one of the first cam and the second cam.

[0016] With such a configuration, the biasing force of the spring can be controlled, and the tension applied to the yarn can be easily increased.

[0017] Furthermore, a knotter device includes the yarn tension control device according to any one of claims 1 to 5.

[0018] With such a configuration, the tension applied to the yarn can be changed before, during, and after a yarn knotting operation.

[0019] Furthermore, a flat knitting machine includes the yarn tension control device according to any one of claims 1 to 5.

[0020] With such a configuration, the crossover of the yarn at the time of weft yarn inversion at a knitted fabric end can be suppressed from becoming long.

Advantageous Effects of Invention

[0021] As an effect of the disclosure, the tension ap-

plied to the yarn can be controlled.

Brief Description of Drawings

[0022]

FIG. 1 is a schematic diagram illustrating an example of a yarn feeding mechanism to which a yarn tension control device according to a first embodiment of the disclosure is applied;
FIG. 2 is a perspective view of the yarn tension control device of the same;
FIG. 3 is a bottom view of the yarn tension control device of the same before a yarn knotting operation;
FIG. 4 is a bottom view of the yarn tension control device of the same during the yarn knotting operation;
FIG. 5 is a bottom view of the yarn tension control device of the same at the end of the yarn knotting operation;
FIG. 6A is a bottom view of a cam and the like of a first different example; FIG. 6B is a bottom view of a cam and the like of a second different example;
FIG. 7 is a perspective view of a yarn tension control device according to a second embodiment;
FIG. 8A is also a side sectional view illustrating a state in which a first cam and a motor shaft are meshed with each other; FIG. 8B is a side sectional view illustrating a state in which a second cam and the motor shaft are meshed with each other;
FIG. 9A is a bottom view of the yarn tension control device of the same before the yarn knotting operation; FIG. 9B is a bottom view of the yarn tension control device during the yarn knotting operation; FIG. 9C is a bottom view of the yarn tension control device at the end of the yarn knotting operation;
FIG. 10 is a front view of a yarn tension control device according to a third embodiment;
FIG. 11A is a bottom view of the yarn tension control device of the same during the yarn knotting operation; FIG. 11B is a bottom view of the yarn tension control device at the end of the yarn knotting operation; FIG. 11C is a bottom view of the yarn tension control device before the yarn knotting operation; and
FIG. 12 is a schematic diagram illustrating an example of a yarn feeding mechanism in a case where a yarn tension control device is applied to a flat knitting machine.

Description of Embodiments

[0023] In the following description, directions indicated by arrows U, D, F, B, L, and R in the drawings are defined as an upward direction, a downward direction, a forward direction, a backward direction, a left direction, and a right direction, respectively. Furthermore, in the drawings, illustration of each component is appropriately omitted for simplification of illustration.

[0024] As illustrated in FIG. 1, a yarn feeding mechanism 1 is configured to feed a yarn A used for knitting a knitted fabric from a yarn cone 2 to a flat knitting machine 4 through a knotter device 3. In the yarn feeding mechanism 1, the knotter device 3 is disposed downstream in a yarn feeding direction of the yarn cone 2, and the flat knitting machine 4 is disposed downstream in the yarn feeding direction of the knotter device 3.

[0025] In the flat knitting machine 4, a yarn feeder 5 moves along a needle bed 7 in conjunction with a carriage 6. A large number of knitting needles 8 are arranged in line on the needle bed 7, and the knitting needles 8 advance and retreat to a tooth gap 9 to pull the yarn A from the yarn feeder 5 to knit a knitted fabric product C.

[0026] The knotter device 3 joins the yarn A being used in the flat knitting machine 4 and a new yarn A wound around the yarn cone 2. The knotter device 3 includes a yarn selecting section 10 and a yarn joining section 20.

[0027] The yarn selecting section 10 is configured to guide the yarn A selected from a plurality of the yarns A fed from the yarn cone 2 to the yarn joining section 20. The yarn joining section 20 is configured to join the yarn A selected by the yarn selecting section 10 and the yarn A being used in the flat knitting machine 4. The yarn joining section 20 is disposed downstream in the yarn feeding direction of the yarn selecting section 10. The yarn joining section 20 includes a yarn tension control device 30.

[0028] Hereinafter, a configuration of the yarn tension control device 30 will be described with reference to FIGS. 2 and 4. Note that a cam 33 and an arm 38 are rotatable or capable of rocked members, and the description will be made below with reference to positions illustrated in FIGS. 2 and 4.

[0029] The yarn tension control device 30 controls a tension of the yarn A when carrying out a yarn knotting operation. The yarn tension control device 30 includes a motor 31, a motor base 32, the cam 33, a yarn guide 37, the arm 38, and a kick spring 39.

[0030] The motor 31 generates a driving force. As the motor 31, any motor can be used, but a stepping motor and a servo motor are suitable. The motor 31 includes a motor shaft 31a rotatable by the generated driving force. The motor 31 is disposed with an axial direction of the motor shaft 31a oriented in a vertical direction, and is provided so that a rotation amount and a rotation direction of the motor shaft 31a can be adjusted by a control unit (not illustrated).

[0031] The motor base 32 supports the motor 31. The motor base 32 is formed in an appropriate shape capable of supporting the motor 31, and is provided below the motor 31 so as to pass through the motor shaft 31a. The motor base 32 is provided with a pin 32a.

[0032] The pin 32a is provided to extend downward from a lower surface of the motor base 32 in the vicinity of a portion through which the motor shaft 31a is inserted. An end portion of the kick spring 39 described later is engaged with the pin 32a.

[0033] The cam 33 is configured to be rotatable by the driving force of the motor 31. More specifically, the cam 33 is inserted into and fixed to a lower end of the motor shaft 31a below the motor base 32, and is provided to rotate around an axis of the motor shaft 31a as the motor shaft 31a rotates. The cam 33 is formed in a substantially L-shaped plate shape, and is disposed with a plate surface facing the vertical direction. A first protrusion 35 and a second protrusion 36 are formed on the cam 33.

[0034] The first protrusion 35 is a protrusion on one side of the two protrusions constituting the substantially L-shape of the cam 33, and acts on a pin 38b of the arm 38 described later when the cam 33 rotates in a clockwise direction in the bottom view. The first protrusion 35 is formed to extend substantially rightward from a portion through which the motor shaft 31a is inserted to a position where the first protrusion can act on the pin 38b. A first pressing surface 35a facing the pin 38b is formed on the first protrusion 35, and presses the pin 38b on the first pressing surface 35a when the cam 33 rotates in the clockwise direction in the bottom view.

[0035] The second protrusion 36 is a protrusion on the other side of the two protrusions constituting the substantially L-shape of the cam 33, and acts on the pin 38b of the arm 38 described later when the cam 33 rotates in a counterclockwise direction in the bottom view. The second protrusion 36 is formed so as to extend substantially rearward from the portion through which the motor shaft 31a is inserted to a position where the second protrusion can act on the pin 38b. The second protrusion 36 is formed so as to extend in a direction substantially perpendicular to the first protrusion 35. A second pressing surface 36a facing the pin 38b is formed on the second protrusion 36, and presses the pin 38b on the second pressing surface 36a when the cam 33 rotates in the counterclockwise direction in the bottom view.

[0036] The yarn guide 37 is adapted to guide the yarn A to a predetermined position. The yarn guide 37 extends from the motor base 32 to the side (back side in the present embodiment) of the motor base 32. A pair of the yarn guides 37 are disposed vertically. Hereinafter, the yarn guide 37 on an upper side may be referred to as a yarn guide 37A, and the yarn guide 37 on a lower side may be referred to as a yarn guide 37B. As illustrated in FIG. 4, an insertion hole 37a is formed at a distal end of the yarn guide 37, and the yarn A fed from the yarn cone 2 is inserted into the insertion hole 37a. The insertion hole 37a of the yarn guide 37A and the insertion hole 37a of the yarn guide 37B are formed at overlapping positions in the bottom view.

[0037] The arm 38 is adapted to change the tension applied to the yarn A guided by the yarn guide 37. The arm 38 is a rigid body having a longitudinal rod shape and a plate shape, and is disposed with a plate surface facing the vertical direction. The arm 38 is inserted into and fixed to the motor shaft 31a, and is provided to rock around the axis of the motor shaft 31a. The arm 38 is disposed between the motor base 32 and the cam 33 and between the yarn guide 37A and the yarn guide 37B in the vertical direction, and is freely-rocked and supported along a virtual plane passing between the yarn guide 37A and the yarn guide 37B. The virtual plane is a plane that intersects with a line segment connecting the insertion hole 37a of the yarn guide 37A and the insertion hole 37a of the yarn guide 37B, and is a horizontal plane in the present embodiment. The arm 38 includes an insertion hole 38a and the pin 38b.

[0038] The insertion hole 38a illustrated in FIG. 4 is formed so as to vertically penetrate a distal end of the arm 38, and the yarn A guided by the yarn guide 37 is inserted through the insertion hole. The insertion hole 38a is formed at a position where a distance in the plan view from an axial center of the motor shaft 31a to a center of the insertion hole 38a is the same as a distance in the plan view from the axial center of the motor shaft 31a to a center of the insertion hole 37a of the yarn guide 37. Thus, the insertion hole 38a is formed at a position where the center of the insertion hole 38a can coincide with the center of the insertion hole 37a of the yarn guide 37 when the arm 38 is rocked.

[0039] The cam 33 can act on the pin 38b. An outer shape of the pin 38b is formed in a columnar shape and is provided to extend from a lower surface of the arm 38 to the same height as a lower surface of the cam 33 or below the lower surface of the cam 33. The pin 38b is provided in the vicinity of the cam 33 in a longitudinal direction of the arm 38 and at a position not overlapping the cam 33 in the bottom view. More specifically, the pin 38b is provided between the first protrusion 35 and the second protrusion 36 in a circumferential direction around the axis of the motor shaft 31a in the bottom view. As described above, the pin 38b is provided at a position where the first pressing surface 35a of the first protrusion 35 and the second pressing surface 36a of the second protrusion 36 can abut on each other when the cam 33 rotates.

[0040] The kick spring 39 biases the arm 38. The kick spring 39 is provided between the motor base 32 and the arm 38 such that the motor shaft 31a is inserted through a center portion of the kick spring 39. One end of the kick spring 39 is fixed to the arm 38, and the other end of the kick spring 39 is fixed to the pin 32a of the motor base 32. The kick spring 39 thus disposed biases the arm 38 in a direction of applying a tension to the yarn A, more specifically, in a direction in which the arm 38 rocks counterclockwise in the bottom view. FIG. 4 illustrates a state in which the biasing force of the kick spring 39 applied to the arm 38 and the tension of the yarn A are balanced.

[0041] Hereinafter, an operation of each member of the yarn tension control device 30 when controlling the tension of the yarn A will be described with reference to FIGS. 3 to 5. The yarn tension control device 30 controls the tension applied to the yarn A when knotting the yarn A selected by the yarn selecting section 10 in the yarn joining section 20 and the yarn A being used in the flat knitting machine 4. Hereinafter, before carrying out the

yarn knotting operation is referred to as "before the yarn knotting operation", the middle of carrying out the yarn knotting operation is referred to as "during the yarn knotting operation", and the time when the knot is finally tightened in the yarn knotting operation is referred to as "end of the yarn knotting operation".

[0042] As illustrated in FIG. 3, before the yarn knotting operation, the motor 31 is driven to rotate the cam 33 in the clockwise direction from a position illustrated in FIG. 4 to bring the first pressing surface 35a of the first protrusion 35 into contact with the pin 38b of the arm 38. By further rotating the cam 33 in the clockwise direction in the bottom view, the first protrusion 35 presses the pin 38b of the arm 38 against the biasing force of the kick spring 39, and rocks the arm 38 from a position illustrated in FIG. 4 in which the biasing force of the kick spring 39 applied to the arm 38 and the tension of the yarn A are balanced to a position where the center of the insertion hole 38a of the arm 38 coincides with the center of the insertion hole 37a of the yarn guide 37, in the clockwise direction in the bottom view, that is, in a direction in which a distal end portion of the arm 38 approaches the insertion hole 37a of the yarn guides 37A and 37B in the plan view.

[0043] Thus, the yarn A can be guided to a position where the tension is not applied to the yarn A. Therefore, an unnecessary load can be prevented from being applied to the yarn A before the yarn knotting operation. Hereinafter, the position of the arm 38 illustrated in FIG. 3 is referred to as a "first position".

[0044] As illustrated in FIG. 4, during the yarn knotting operation, the motor 31 is driven to rotate the cam 33 in the counterclockwise direction in the bottom view from the position illustrated in FIG. 3, and the cam 33 is moved to the position where neither the first protrusion 35 nor the second protrusion 36 abuts on the pin 38b of the arm 38. Then, the cam 33 does not act on the arm 38, and only the biasing force of the kick spring 39 is applied to the arm. At this time, the arm 38 rocks by a predetermined angle in the counterclockwise direction in the bottom view from the first position illustrated in FIG. 3 by the biasing force of the kick spring 39. Thus, the portion of the yarn A inserted through the insertion hole 38a of the arm 38 is pulled by the arm 38.

[0045] Thus, the slack of the yarn A generated during the yarn knotting operation can be removed by the tension of the kick spring 39 applied to the yarn A during the yarn knotting operation. Hereinafter, the position of the arm 38 illustrated in FIG. 4 is referred to as a "second position".

[0046] As illustrated in FIG. 5, at the end of the yarn knotting operation, the motor 31 is driven to rotate the cam 33 in the counterclockwise direction in the bottom view from the position illustrated in FIG. 4 to bring the second pressing surface 36a of the second protrusion 36 into contact with the pin 38b of the arm 38. When the cam 33 is further rotated in the counterclockwise direction in the bottom view, the second protrusion 36 presses the pin 38b of the arm 38, and rocks the arm 38 further from the second position illustrated in FIG. 4 in the counterclockwise direction in the bottom view, that is, in a direction in which the distal end portion of the arm 38 is separated from the insertion hole 37a of the yarn guides 37A and 37B in the plan view. Thus, the yarn A is forcibly pulled by the arm 38.

[0047] Thus, the knot of the yarn A can be tightened by forcibly pulling the yarn A at the end of the yarn knotting operation. Hereinafter, the position of the arm 38 illustrated in FIG. 5 is referred to as a "third position".

[0048] As described above, the yarn tension control device 30 according to the present embodiment can change the tension applied to the yarn A according to each scene of the yarn knotting operation. Therefore, while reducing the load applied to the yarn A when the yarn knotting operation is not carried out, the slack of the yarn A can be removed or the knot of the yarn A can be strengthened when the yarn knotting operation is carried out. Furthermore, since the arm 38 is formed of a rigid body, it is possible to perform control with excellent responsiveness.

[0049] Although the first embodiment of the disclosure has been described above, the disclosure is not limited to the above embodiment, and appropriate modifications can be made within the scope of the technical idea of the disclosure described in the claims.

[0050] For example, in the present embodiment, the cam 33 causes the arm 38 to rock in the clockwise direction in the bottom view and in the counterclockwise direction in the bottom view by the two protrusions of the first protrusion 35 and the second protrusion 36, but may cause the arm 38 to rock in the clockwise direction in the bottom view and in the counterclockwise direction in the bottom view by one protrusion. That is, the cam 33 does not necessarily have to include two protrusions, and may include one protrusion.

[0051] FIG. 6A illustrates a cam 33A which is a first different example of the cam 33, and illustrates a state in which the biasing force of the kick spring 39 applied to the arm 38 and the tension of the yarn A are balanced. The cam 33A illustrated in FIG. 6A is different from the cam 33 illustrated in FIGS. 2 to 5 in that the second protrusion 36 is not provided. In the cam 33A, in a case where it is desired to prevent a load from being applied to the yarn A before the yarn knotting operation, the cam 33A is rotated in the clockwise direction in the bottom view to press the pin 38b of the arm 38 by the first pressing surface 35a, similarly to FIG. 3. As a result, the arm 38 can be rocked to the first position illustrated in FIG. 3.

[0052] On the other hand, in a case where the yarn A is desired to be forcibly pulled out at the end of the yarn knotting operation, the pin 38b of the arm 38 is pressed by the second pressing surface 35b, which is a surface on an opposite side of the first pressing surface 35a of the first protrusion 35, by rotating the cam 33A in the counterclockwise direction in the bottom view by nearly 360° from the position illustrated in FIG. 6A. Thus, the

arm 38 can be rocked to the third position illustrated in FIG. 5 to tighten the knot of the yarn A.

[0053] Furthermore, in the present embodiment, one end of the kick spring 39 is fixed to the arm 38, and the other end of the kick spring 39 is fixed to the motor base 32. However, the other end of the kick spring 39 may be fixed to the cam 33 instead of the motor base 32. Consequently, the other end of the kick spring 39 is moved by rotating the cam 33, so that the biasing force of the kick spring 39 applied to the arm 38 can be changed. Therefore, the tension applied to the yarn A during the yarn knotting operation can be controlled according to the ease of expansion and contraction of the yarn A, and the like.

[0054] Specifically, in a case where the tension applied to the yarn A by the kick spring 39 is too large due to the yarn A being relatively difficult to stretch, and the like, the cam 33 can be rotated so that the biasing force of the kick spring 39 decreases. On the other hand, in a case where the tension applied to the yarn A by the kick spring 39 is too small due to the yarn A being relatively easy to stretch, and the like, the cam 33 can be rotated so that the biasing force of the kick spring 39 increases.

[0055] However, in a case where the other end of the kick spring 39 is fixed to the cam 33, when the cam 33 is rotated to press and rock the arm 38, as the first protrusion 35 or the second protrusion 36 of the cam 33 approaches the pin 38b of the arm 38, the arm 38 escapes due to the force of the kick spring 39, and there is a problem that alignment of the arm 38 to the first position cannot be accurately performed. In order to solve this problem, a cam 33B illustrated in FIG. 6B can be configured.

[0056] FIG. 6B illustrates the cam 33B which is a second different example of the cam 33, and illustrates a state in which the biasing force of the kick spring 39 applied to the arm 38 and the tension of the yarn A are balanced. The cam 33B illustrated in FIG. 6B is different from the cam 33 illustrated in FIGS. 2 to 5 in that a third protrusion 46 is provided. In the cam 33B, the other end of the kick spring 39 is fixed to the first protrusion 35. The third protrusion 46 is formed between the first protrusion 35 and the pin 38b of the arm 38 so as to extend substantially rightward from a portion through which the motor shaft 31a is inserted. A third pressing surface 46a facing the pin 38b is formed on the third protrusion 46. The third pressing surface 46a is formed at a position closer to the pin 38b than the first pressing surface 35a of the first protrusion 35.

[0057] In the cam 33B, since a distance from the pin 38b of the arm 38 to the third pressing surface 46a is shorter than a distance to the first pressing surface 35a, in a case where the cam 33B is rotated in the clockwise direction in the bottom view, the third pressing surface 46a can be easily brought into contact with the pin 38b before the arm 38 escapes. On the other hand, in a case where the cam 33B is rotated in the counterclockwise direction in the bottom view, the first protrusion 35 is separated from the arm 38, and thus the biasing force of the kick spring 39 increases, and the tension of the yarn A increases with the increase in the biasing force. When the yarn A reaches a predetermined tension, the displacement of the angle of the arm 38 by the biasing force of the kick spring 39 is settled, but the yarn A can be forcibly pulled by the second protrusion 36 pressing the pin 38b to rock the arm 38 to the third position illustrated in FIG. 5.

[0058] Furthermore, a sensor that measures the tension applied to the yarn A may be disposed, and the position of the arm 38 may be adjusted based on a measurement value of the sensor. Thus, the tension applied to the yarn A can be controlled to a desired value.

[0059] Furthermore, a motor capable of acquiring shaft torque may be used as the motor 31, and the position of the arm 38 may be adjusted on the basis of a value of the shaft torque acquired by the motor 31. Thus, the tension applied to the yarn A can be controlled to a desired value. Note that the shaft torque acquired by the motor 31 includes not only the tension applied to the yarn A but also the biasing force of the kick spring 39. Therefore, it is preferable to provide a sensor that detects the position of the arm 38 so that a position of an end point of the kick spring 39 can be grasped by the sensor. Thus, since the change in the biasing force of the kick spring 39 can be grasped, the tension to be applied to the yarn A can be calculated by subtracting the biasing force of the kick spring 39 from the shaft torque acquired by the motor 31.

[0060] Next, a yarn tension control device 50 according to a second embodiment will be described with reference to FIGS. 7 to 9A, 9B, and 9C. The yarn tension control device 50 according to the second embodiment differs from the yarn tension control device 30 according to the first embodiment mainly in that a lifting and lowering member 41a is disposed on a motor shaft 31a, and a first cam 53 and a second cam 56 are disposed instead of the cam 33. Note that in FIGS. 7 to 9A, 9B, and 9C, a motor base 32 and a yarn guide 37 are not illustrated. Furthermore, the first cam 53, the second cam 56, and an arm 38 are rotatable or capable of rocked members, and hereinafter, the description will be made with reference to positions illustrated in FIGS. 7 and 9B.

[0061] The lifting and lowering member 41a is formed in a hollow shape with one end opened, and is provided so as to enclose the motor shaft 31a. The cross-sectional shape of the opening portion of the lifting and lowering member 41a is similar to, but not limited to, the cross-sectional shape of the motor shaft 31a, for example, and the lifting and lowering member 41a is rotatable together with the motor shaft 31a and is provided to be vertically movable by a solenoid (not illustrated) provided below the lifting and lowering member 41a. A lower end of the lifting and lowering member 41a is formed in a shape capable of meshing with the first cam 53 and the second cam 56. A lower end portion of the lifting and lowering member 41a is formed in, for example, a polygonal shape in the bottom view having a diameter larger than that of the other portion of the lifting and lowering member 41a,

and is formed in, for example, a decagonal shape to a pentadecagonal shape in the bottom view.

[0062] The first cam 53 is for rocking the arm 38, and is inserted into the lower end of the lifting and lowering member 41a. The first cam 53 is formed in a plate shape, and is disposed with a plate surface facing the vertical direction. A protrusion 55 is formed on the first cam 53.

[0063] The protrusion 55 extends leftward and rearward from a portion through which the lifting and lowering member 41a is inserted to a position where the protrusion can act on a pin 38b of the arm 38, and is formed to abut on the pin 38b when the first cam 53 rotates. The protrusion 55 is provided with a first pressing surface 55a and a second pressing surface 55b. When the first cam 53 rotates in the clockwise direction in the bottom view, the pin 38b is pressed on the first pressing surface 55a. When the first cam 53 rotates in the counterclockwise direction in the bottom view, the pin 38b is pressed on the second pressing surface 55b.

[0064] The second cam 56 is for controlling the biasing force of a kick spring 39, and is inserted into the lifting and lowering member 41a above the first cam 53. The second cam 56 is formed in a plate shape, and is disposed with a plate surface facing the vertical direction. A protrusion 58 is formed on the second cam 56.

[0065] The protrusion 58 extends substantially rightward from a portion through which the lifting and lowering member 41a is inserted. The other end of the kick spring 39 is fixed to the protrusion 58.

[0066] The lifting and lowering member 41a is provided so as to be vertically movable between a position at which its lower end meshes with the first cam 53 illustrated in FIG. 8A and a position at which its lower end meshes with the second cam 56 illustrated in FIG. 8B. When the lifting and lowering member 41a is located at the position illustrated in FIG. 8A, the first cam 53 can be rotated by driving the motor 31. On the other hand, when the lifting and lowering member 41a is located at the position illustrated in FIG. 8B, the second cam 56 can be rotated by driving the motor 31. As described above, the first cam 53 and the second cam 56 are configured to be capable of switching between the first cam 53 and the second cam 56 to change which one of the first cam 53 and the second cam 56 is to be rotated by the driving force of the motor 31.

[0067] Next, an operation of each member of the yarn tension control device 50 when controlling the tension of the yarn A will be described with reference to FIGS. 9A, 9B, and 9C.

[0068] As illustrated in FIG. 9A, before the yarn knotting operation, the motor 31 is driven while the lifting and lowering member 41a is moved to the position illustrated in FIG. 8A, so that the first cam 53 is rotated in the clockwise direction in the bottom view and the pin 38b of the arm 38 is pressed by the first pressing surface 55a. As a result, the arm 38 can be rocked to the first position illustrated in FIG. 3.

[0069] As illustrated in FIG. 9B, during the yarn knotting operation, the first cam 53 is rotated in the counterclockwise direction in the bottom view to a position where the protrusion 55 does not abut on the pin 38b of the arm 38. Then, the arm 38 is rocked to the second position illustrated in FIG. 4 in the counterclockwise direction in the bottom view by the biasing force of the kick spring 39, so that a portion of the yarn A inserted into the insertion hole 38a of the arm 38 is pulled by the arm 38. Thus, the slack of the yarn A generated during the yarn knotting operation can be removed.

[0070] At this time, the second cam 56 can be rotated by driving the motor 31 in a state where the lifting and lowering member 41a is moved to the position illustrated in FIG. 8B. Thus, the biasing force of the kick spring 39 applied to the arm 38 can be changed, and eventually, the tension applied to the yarn A can be controlled when removing the slack of the yarn A.

[0071] Thus, by making the cam that presses the arm 38 and the cam to which the other end of the kick spring 39 is fixed separate members, the biasing force of the kick spring 39 can be made variable, and the forcible tension application to the yarn A by the pulling of the arm 38 can be independently carried out, so that both can be achieved.

[0072] As illustrated in FIG. 9C, at the end of the yarn knotting operation, the motor 31 is driven in a state where the lifting and lowering member 41a is moved to the position illustrated in FIG. 8A, and the first cam 53 is rotated in the counterclockwise direction in the bottom view, whereby the protrusion 55 presses the pin 38b of the arm 38. Thus, the arm 38 can be rocked to the third position illustrated in FIG. 5, and eventually, the knot of the yarn A can be tightened.

[0073] Although the second embodiment of the disclosure has been described above, the disclosure is not limited to the above embodiment, and appropriate modifications can be made within the scope of the technical idea of the disclosure described in the claims.

[0074] For example, in the present embodiment, in order to switch which one of the first cam 53 and the second cam 56 is rotated by the driving force of the motor 31, the lifting and lowering member 41a is moved up and down by a solenoid or the like, but the first cam 53 and the second cam 56 may be moved up and down, respectively.

[0075] Next, a yarn tension control device 60 according to a third embodiment will be described with reference to FIGS. 10 and 11A, 11B, and 11C. The yarn tension control device 60 according to the third embodiment differs from the yarn tension control device 30 according to the first embodiment mainly in including a first cam 63 and a second cam 66 instead of the cam 33, and including a differential gear 69. Note that, in FIGS. 10 and 11A, 11B, and 11C, a motor base 32 and a yarn guide 37 are not illustrated.

[0076] The first cam 63 is for rocking an arm 38, and is formed in the same shape as the first cam 53 of the second embodiment. A pressing surface 65a is formed

on a protrusion 65 of the first cam 63, and presses a pin 38b on the pressing surface 65a when the first cam 63 rotates in the counterclockwise direction in the bottom view.

[0077] The second cam 66 is for controlling the biasing force of a kick spring 39, and is formed in the same shape as the second cam 56 of the second embodiment. The second cam 66 is fixed to a motor shaft 31a and is provided to rotate about the axis of the motor shaft 31a as the motor shaft 31a rotates. The other end of the kick spring 39 is fixed to a protrusion 68 of the second cam 66.

[0078] The first cam 63 is coupled to the second cam 66 with the differential gear 69 provided to be interposed between the first cam 63 and the second cam 66. As a result, the first cam 63 is configured to rotate in a direction opposite to a direction in which the second cam 66 rotates in accordance with the rotation of the second cam 66 by the driving force of a motor 31.

[0079] Next, an operation of each member of the yarn tension control device 60 when controlling the tension of the yarn A will be described with reference to FIG. 11A, 11B, and 11C.

[0080] In a case where it is desired to change the biasing force of the kick spring 39 during the yarn knotting operation, as illustrated in FIG. 11A, a position of the other end of the kick spring 39 is moved by rotating the second cam 66 by the driving force of the motor 31, and the biasing force of the kick spring 39 can be changed. Specifically, by rotating the second cam 66 in the counterclockwise direction in the bottom view, the second cam 66 is separated from the arm 38, so that the biasing force of the kick spring 39 increases. On the other hand, by rotating the second cam 66 in the clockwise direction in the bottom view, the second cam 66 comes close to the arm 38, so that the biasing force of the kick spring 39 decreases.

[0081] In a case where it is desired to forcibly apply the tension to the yarn A at the end of the yarn knotting operation, as illustrated in FIG. 11B, the second cam 66 is rotated in the clockwise direction in the bottom view by the driving force of the motor 31, so that the first cam 63 is rotated in the counterclockwise direction in the bottom view to bring the pressing surface 65a of the protrusion 65 into contact with the pin 38b of the arm 38. By further rotating the first cam 63 in the counterclockwise direction in the bottom view, the protrusion 65 presses the pin 38b of the arm 38, and further rocks the arm 38 in the counterclockwise direction in the bottom view. Thus, the arm 38 can be rocked to the third position illustrated in FIG. 5, and eventually, the knot of the yarn A can be tightened.

[0082] In a case where it is not desired to apply the tension to the yarn A before the yarn knotting operation, the first cam 63 is rotated in the clockwise direction in the bottom view from the position illustrated in FIG. 11B by the driving force of the motor 31 as illustrated in FIG. 11C. When the first cam 63 rotates in the clockwise direction in the bottom view, the arm 38 rocks in the clockwise direction in the bottom view together with the first cam 63 in a state of being in contact with the first cam 63 by the biasing force of the kick spring 39. As a result, the arm 38 can be rocked to the first position illustrated in FIG. 3.

[0083] As described above, the yarn tension control devices 30, 50, and 60 according to the first to third embodiments of the disclosure are disposed in the knotter device 3, but may be disposed in the flat knitting machine 4 as illustrated in FIG. 12. Hereinafter, an example in which the yarn tension control devices 30, 50, and 60 are disposed in the flat knitting machine 4 will be described.

[0084] In the conventional flat knitting machine, when inlaying a knitting yarn from one of the left and right sides with the flat knitting machine, the tension becomes small at the time of reversing a yarn feeder at a knitted fabric end on a side far from a yarn tension control device provided in the vicinity of a side surface of the flat knitting machine. In particular, in a case where a high rigidity fiber is used as the inlay yarn, the tension application by spring biasing cannot follow a change in tension of the yarn, and there is a problem that the crossover of the inlay yarn at the time of reversal becomes long at the knitted fabric end on the far side.

[0085] In the disclosure, the yarn tension control devices 30, 50, and 60 are provided in the flat knitting machine 4, so that when inlaying the high rigidity fiber as a weft yarn, the arm 38 is rocked to the third position illustrated in FIG. 5 to strengthen the tension applied to the yarn A at the time of reversing the yarn feeder at the knitted fabric end on the side far from the yarn tension control devices 30, 50, and 60, whereby the tension change at the time of reversing is absorbed, and the yarn crossing at the time of weft yarn reversal at the knitted fabric end can be suppressed from becoming long.

Claims

1. A yarn tension control device (30, 50, 60) comprising:

a motor (31) that generates a driving force;
a cam (33, 33A, 33B, 53, 56, 63, 66) configured to be rotatable by the driving force of the motor (31);
a pair of yarn guides (37A, 37B) that guides a yarn (A) to a predetermined position; and
a spring (39) that generates a biasing force,
characterized in that the yarn tension control device further comprises an arm (38) that is freely-rocked and supported along a virtual plane passing between the pair of yarn guides (37A, 37B), includes an insertion section (38a) through which the yarn (A) guided by the pair of yarn guides (37A, 37B) is inserted and an action section (38b) on which the cam (33, 33A, 33B, 53, 63) can act, is biased by the spring (39) in a direction of applying a tension to the yarn (A),

and rocks in a direction away from the pair of yarn guides (37A, 37B) with reference to a position where the biasing force of the spring (39) and the tension of the yarn (A) are balanced by an action of the cam (33, 33A, 33B, 53, 63) on the action section (38b) to increase the tension applied to the yarn (A).

2. The yarn tension control device (30, 50, 60) according to claim 1, wherein the arm (38) decreases the tension applied to the yarn (A) by rocking in a direction of approaching the pair of yarn guides (37A, 37B) with reference to the balanced position by an action of the cam (33, 33A, 33B, 53, 63) on the action section (38b).

3. The yarn tension control device (30, 50, 60) according to claim 1 or claim 2, wherein one end of the spring (39) is fixed to the arm (38), and an other end of the spring (39) is fixed to the cam (33, 33B, 56, 66).

4. The yarn tension control device (50) according to claim 3, wherein

the cam (33, 33A, 33B, 53, 56, 63, 66) includes a first cam (53) configured to be capable of acting on the action section (38b) of the arm (38), and a second cam (56) to which the other end of the spring (39) is fixed, and
is configured to be capable of switching between the first cam (53) and the second cam (56) to change which one of the first cam (53) and the second cam (56) is to be rotated by the driving force of the motor (31).

5. The yarn tension control device (60) according to claim 3, wherein

the cam (33, 33A, 33B, 53, 56, 63, 66) includes a first cam (63) configured to act on the action section (38b) of the arm (38) and a second cam (66) to which the other end of the spring (39) is fixed,
one of the first cam (63) and the second cam (66) is fixed to a motor shaft (31a) of the motor (31), and
an other one of the first cam (63) and the second cam (66) is connected to the one of the first cam (63) and the second cam (66) with a differential gear (69) interposed between the first cam (63) and the second cam (66), and is configured to rotate in a direction opposite to the one of the first cam (63) and the second cam (66) along with rotation of the one of the first cam (63) and the second cam (66).

6. A knotter device (3) comprising the yarn tension control device (30, 50, 60) according to any one of claims 1 to 5.

7. A flat knitting machine (4) comprising the yarn tension control device (30, 50, 60) according to any one of claims 1 to 5.

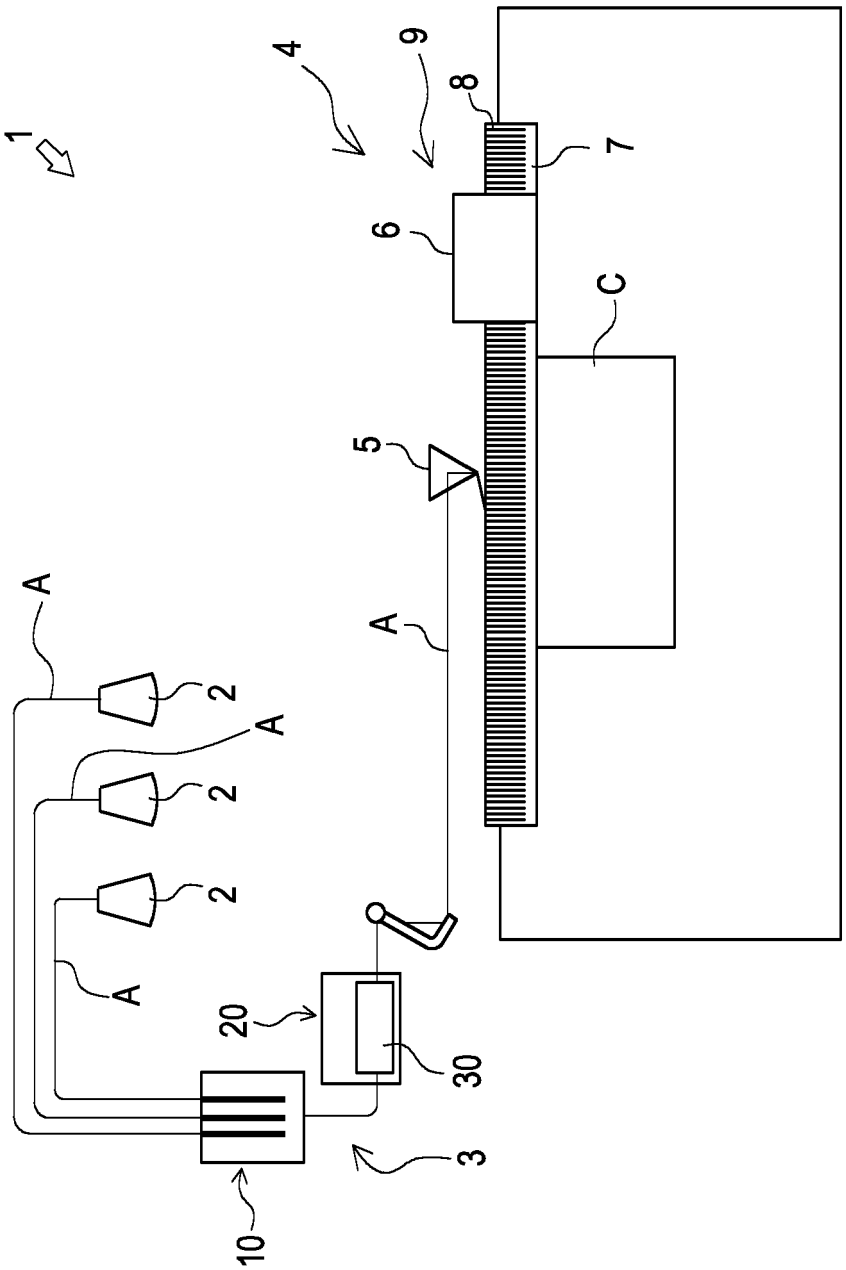


Fig. 1

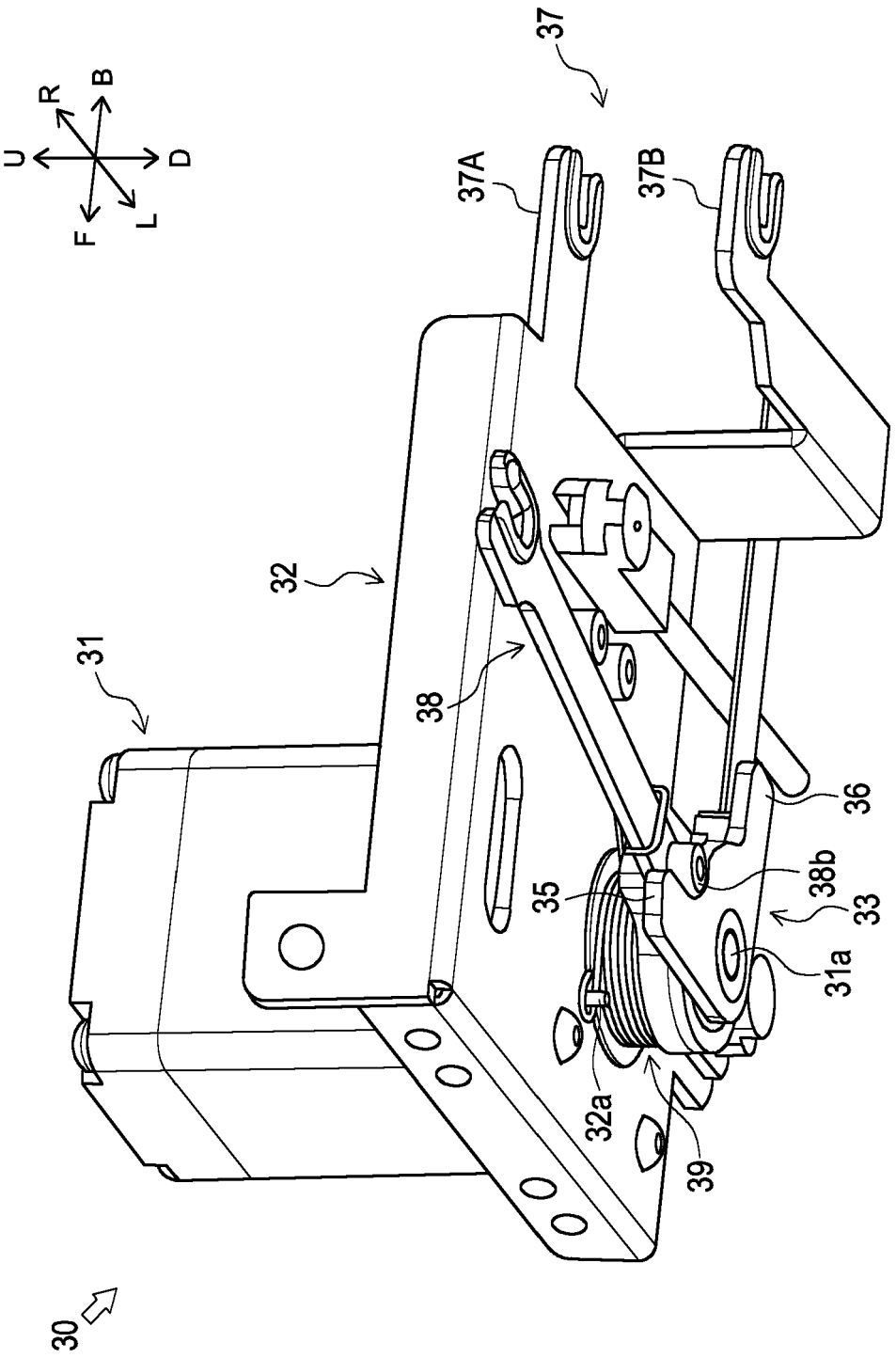


Fig. 2

Fig. 3

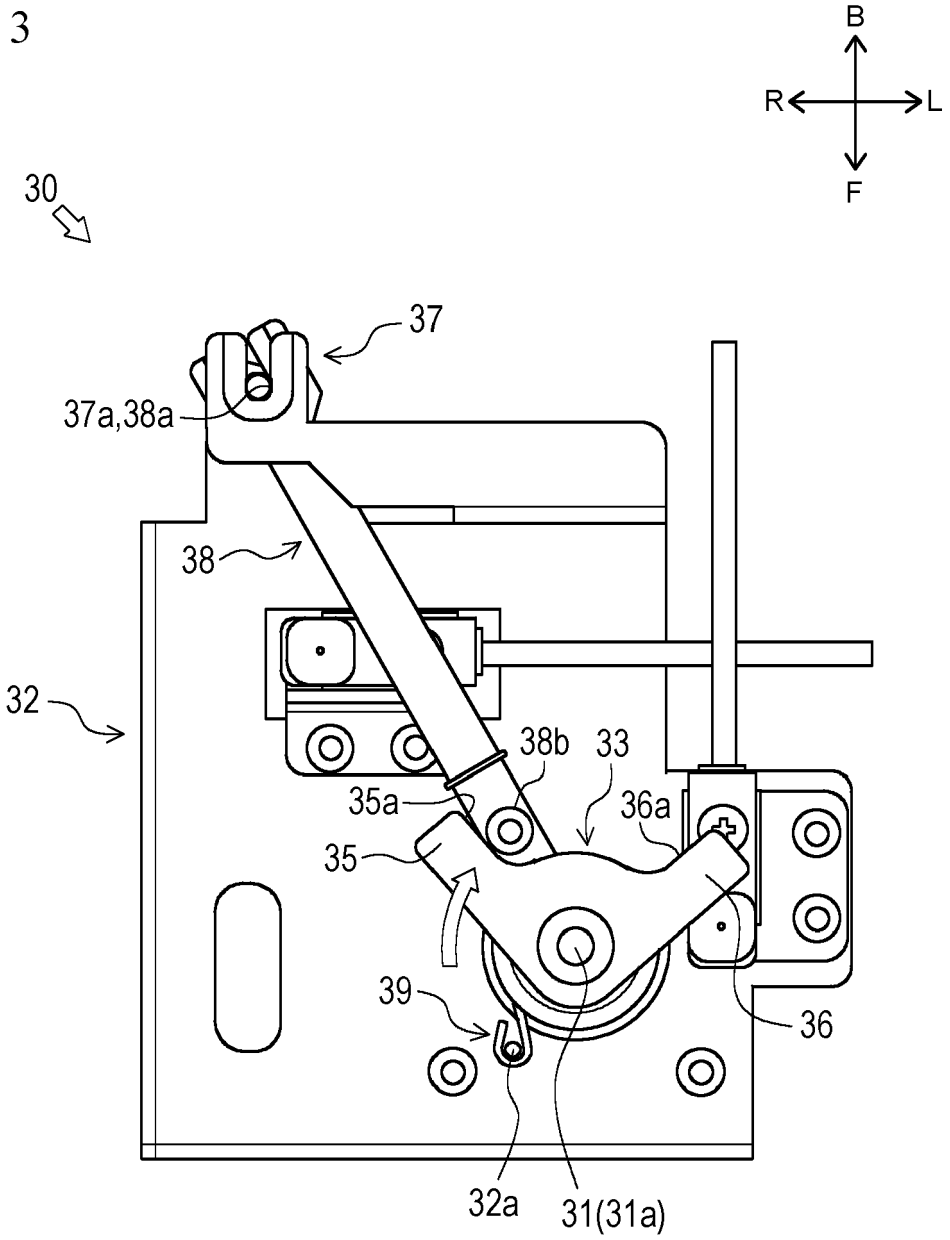


Fig. 4

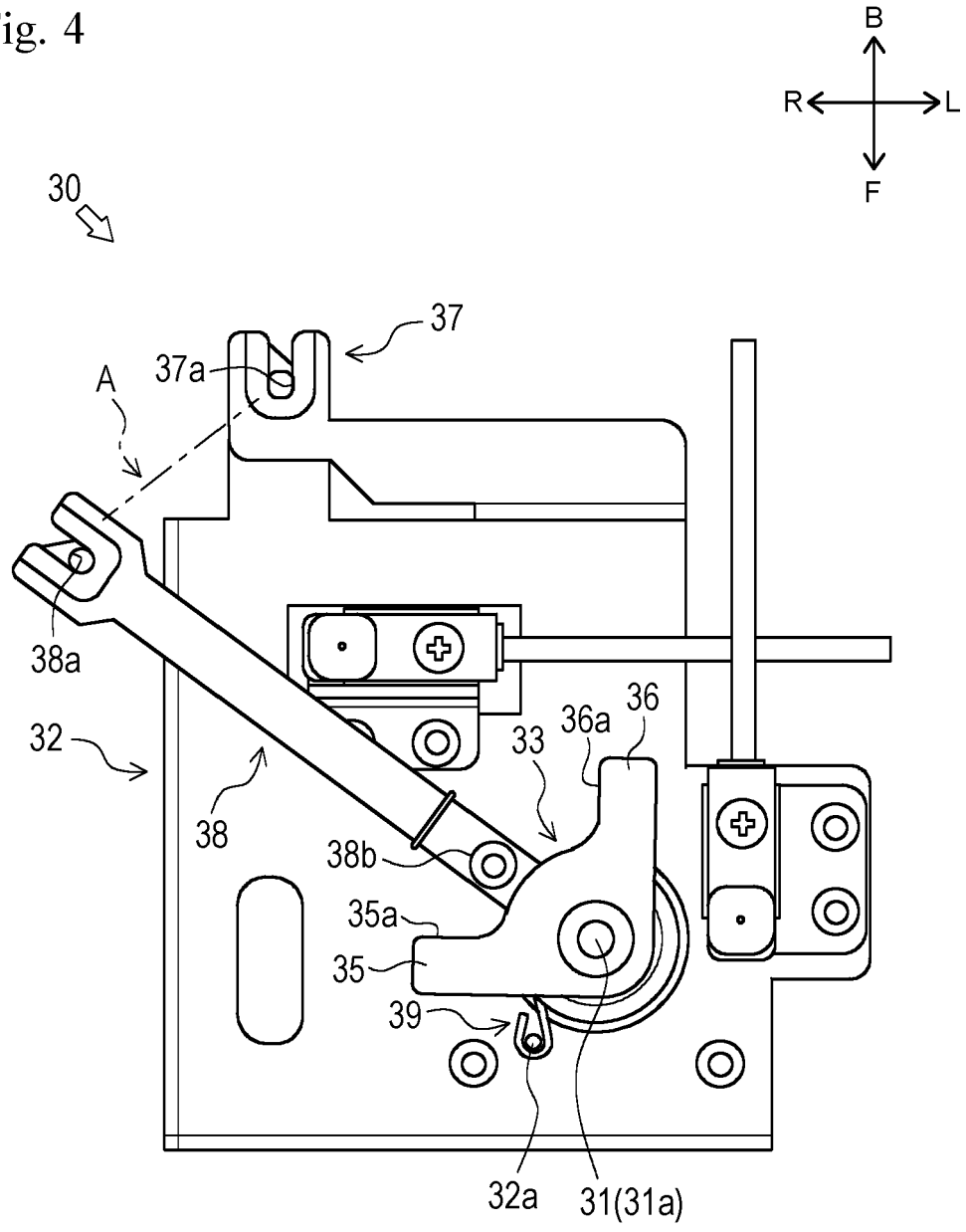


Fig. 5

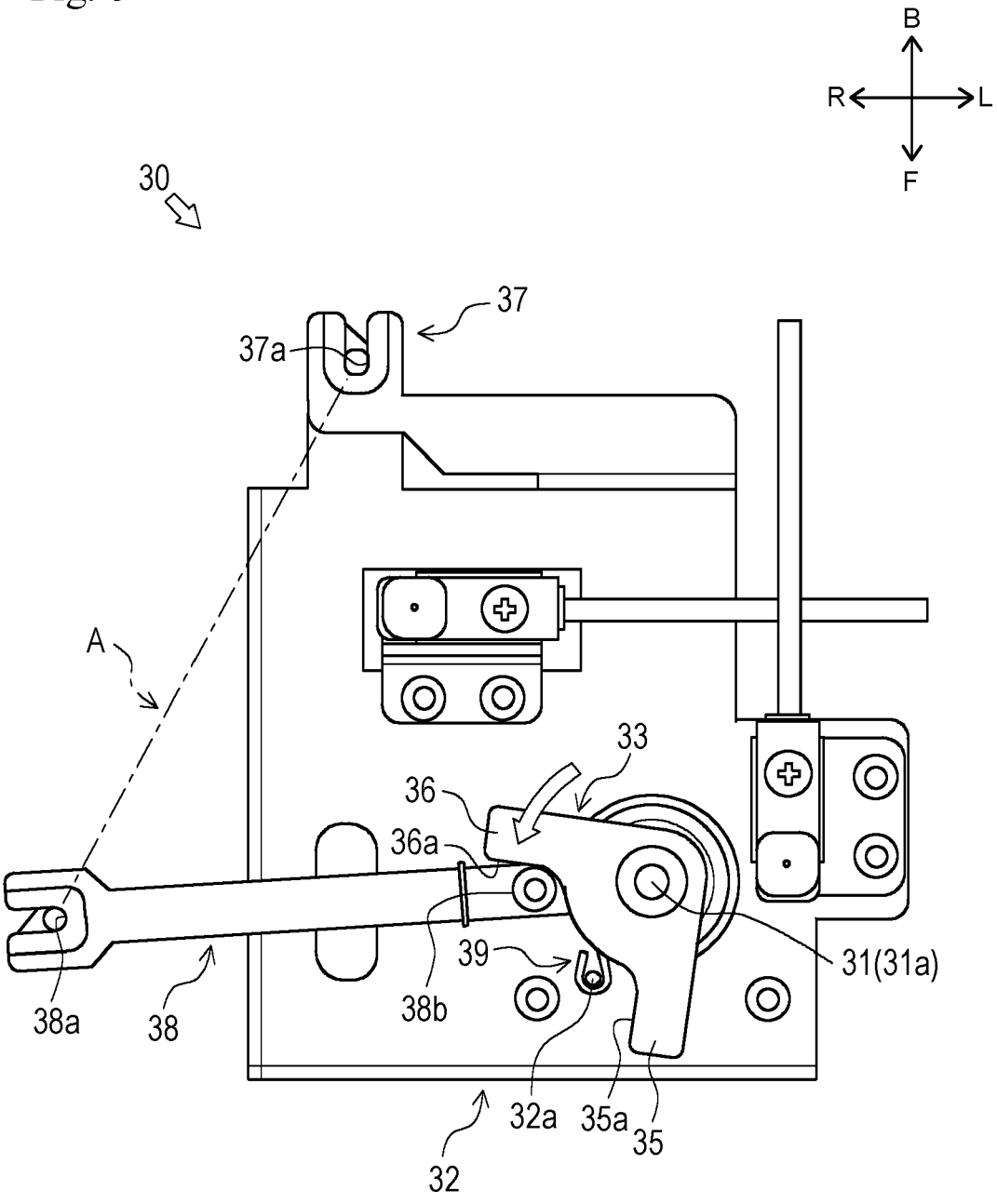


Fig. 6A

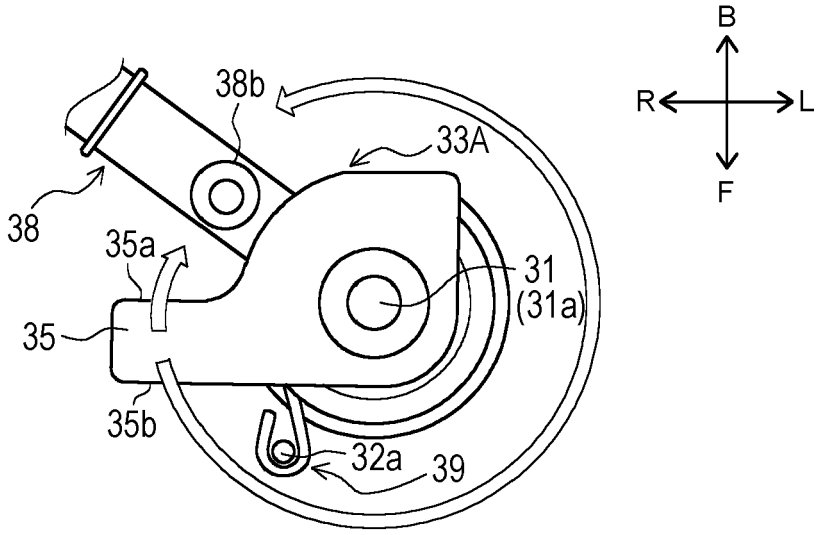

38b
33A
38
35a
31
(31a)
35
35b
32a
39
B
R
L
F

Fig. 6B

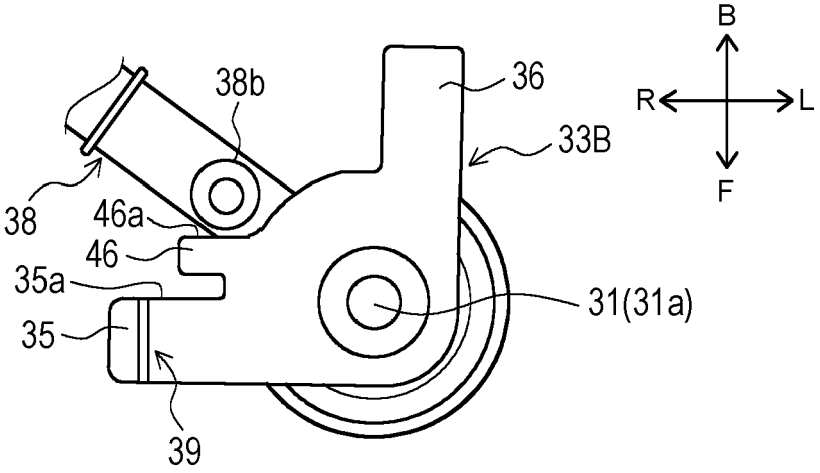

38b
36
33B
38
46a
46
35a
31(31a)
35
39
B
R
L
F

Fig. 7

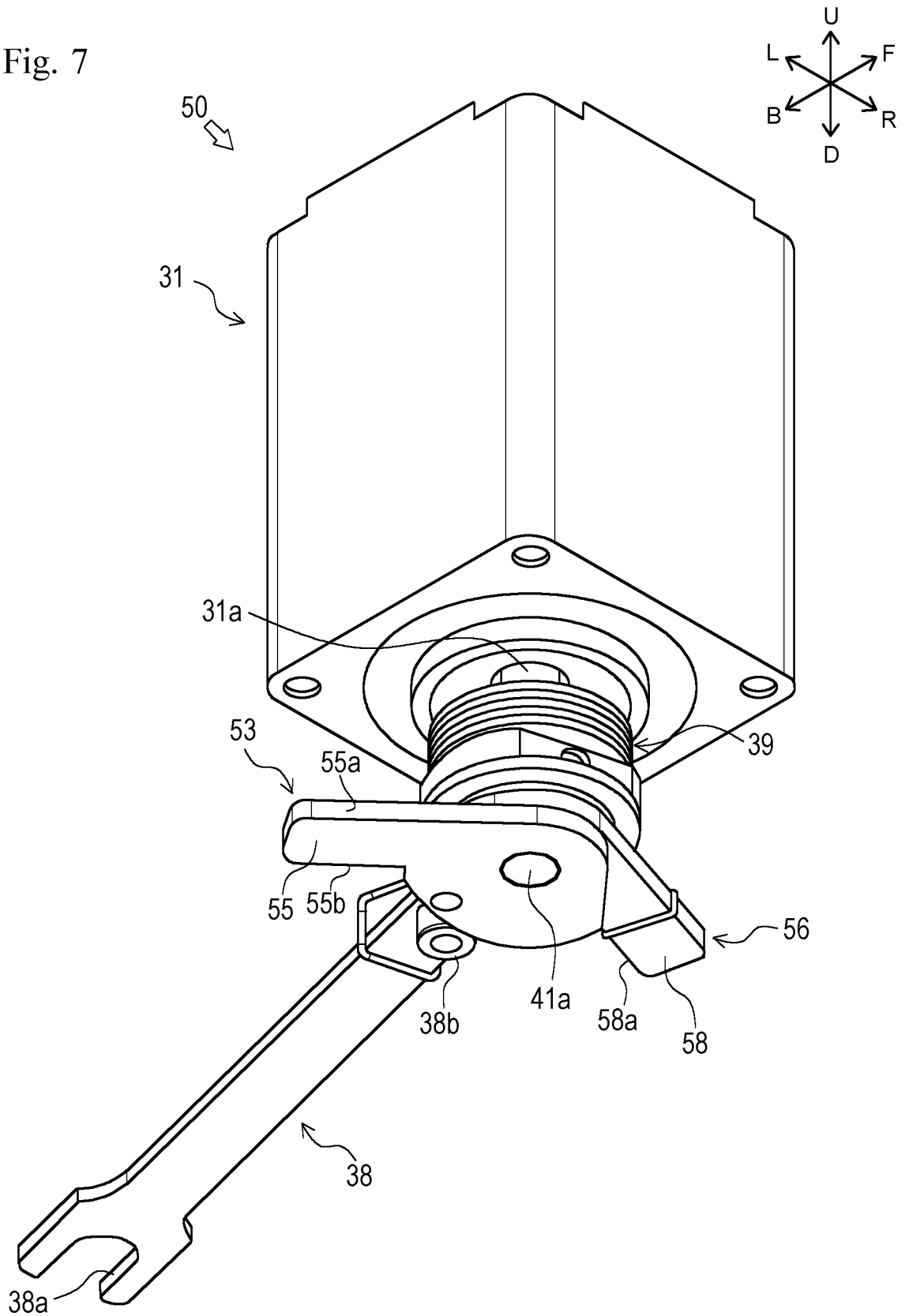


Fig. 8A

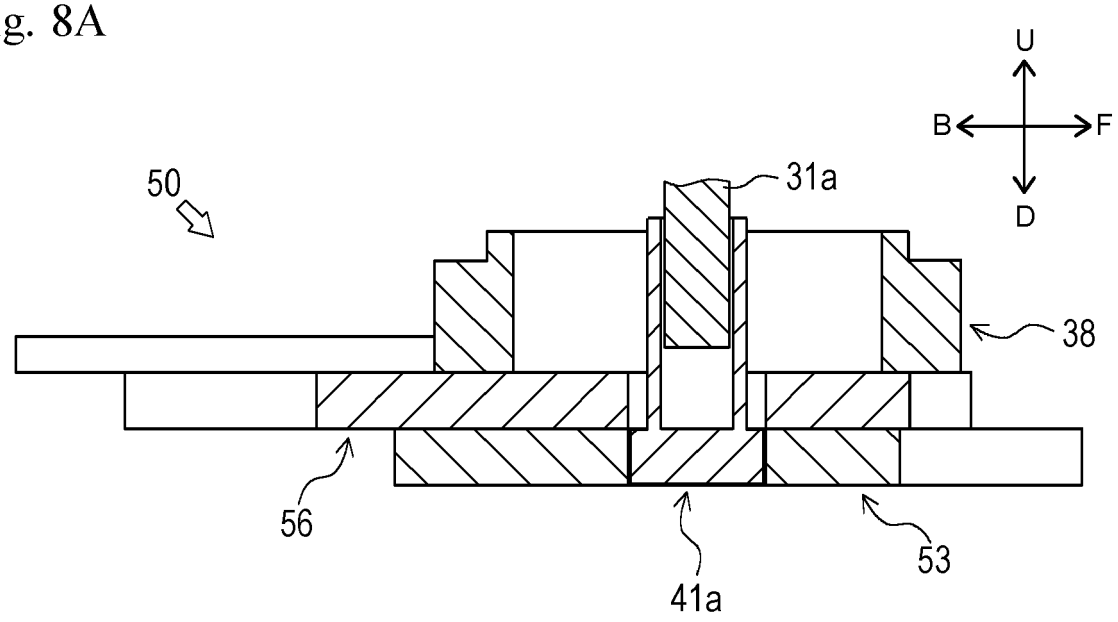


Fig. 8B

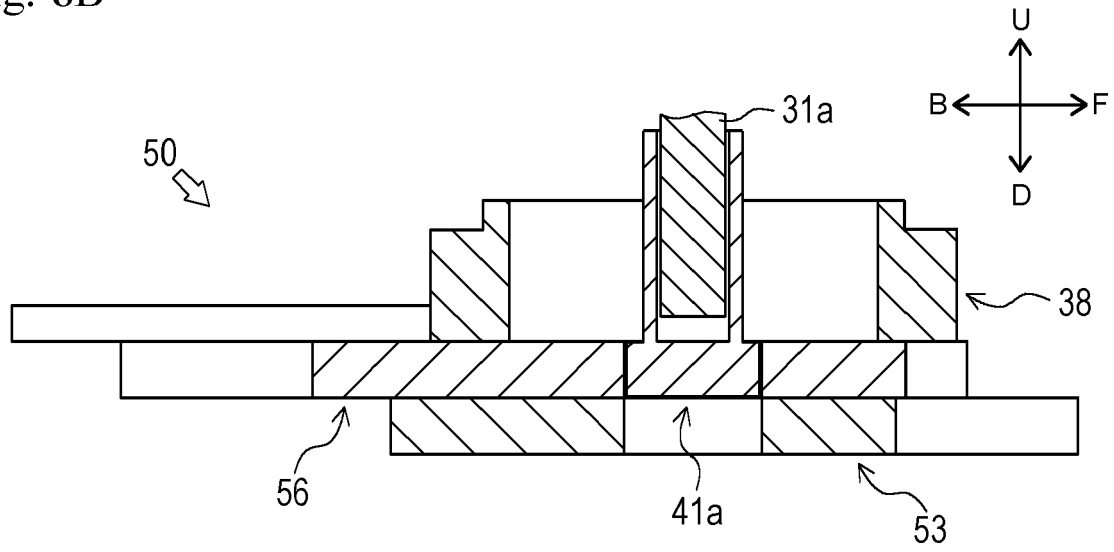


Fig. 9A

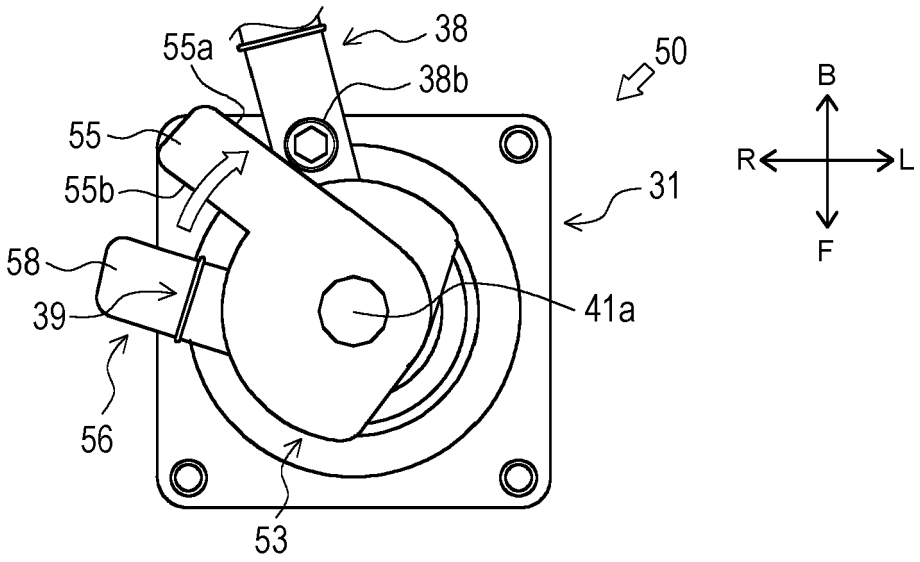


Fig. 9B

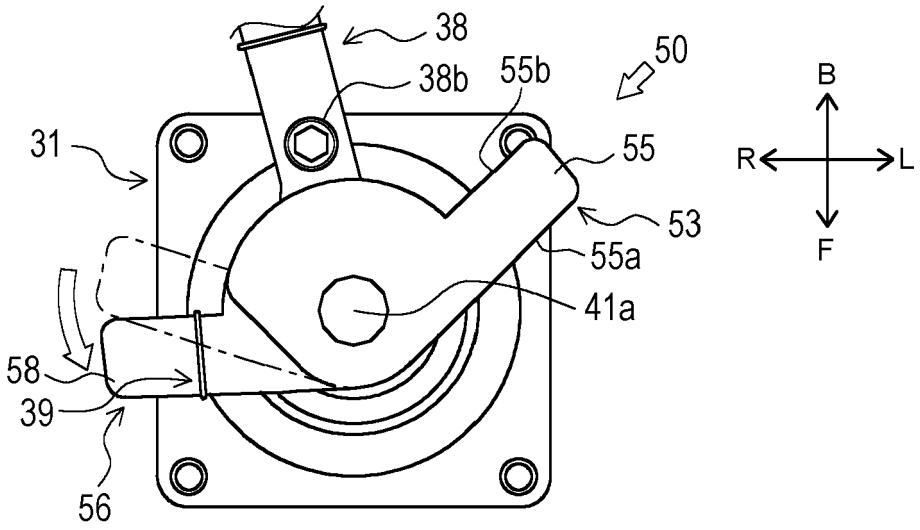
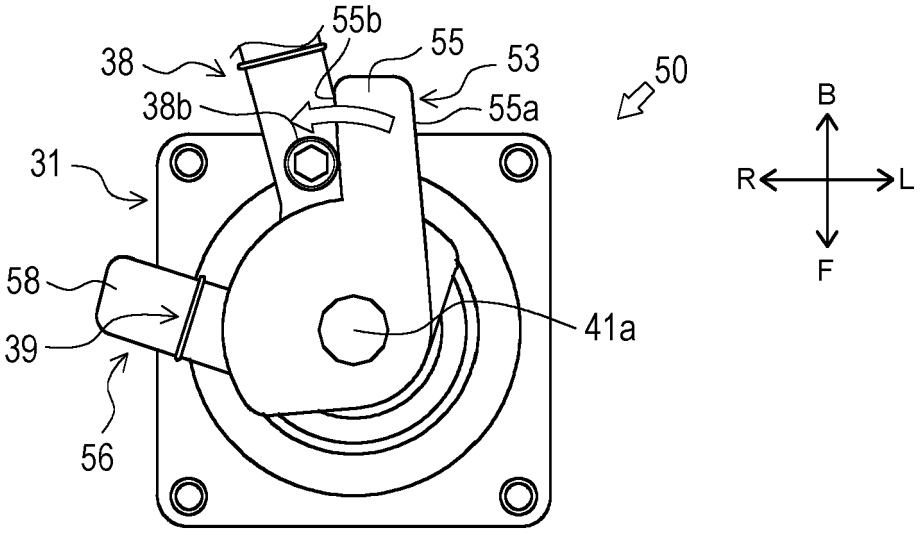


Fig. 9C



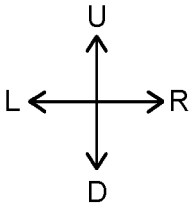


Fig. 10

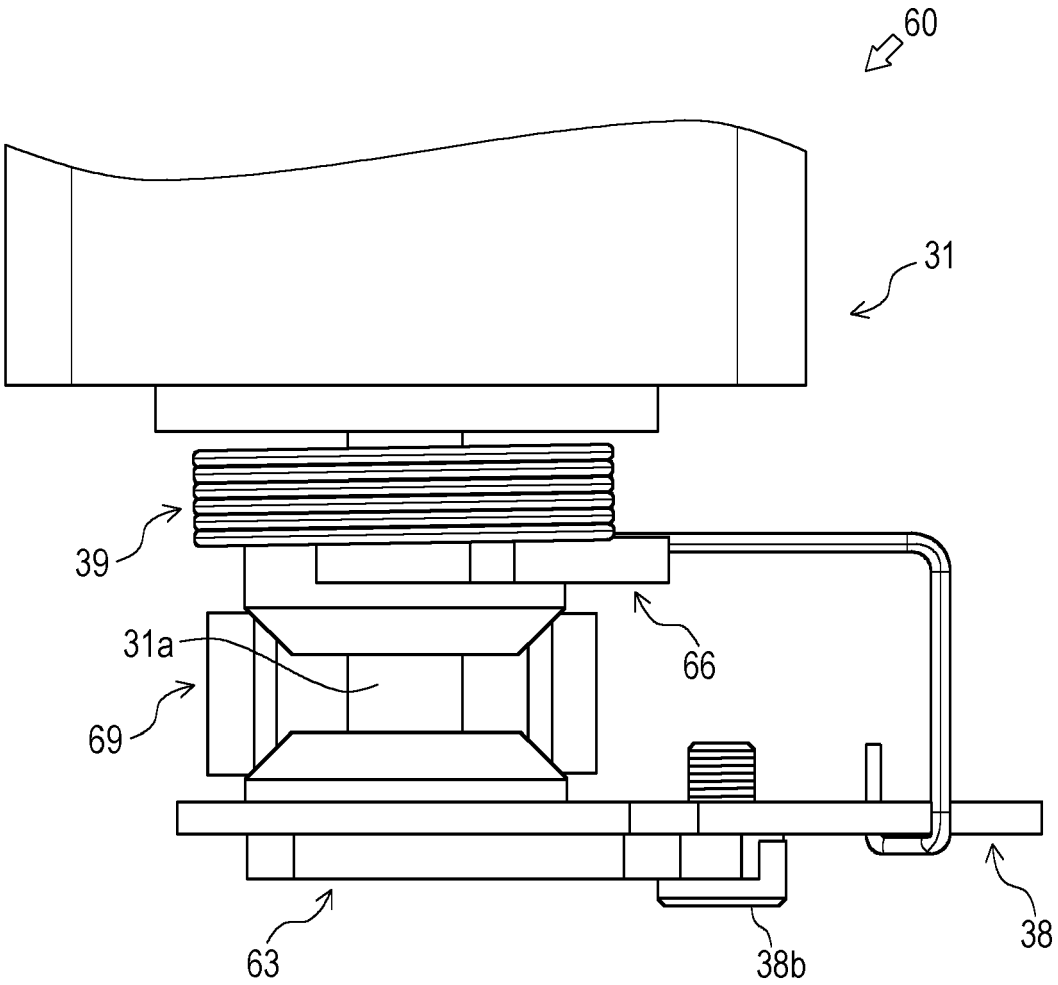


Fig. 11A

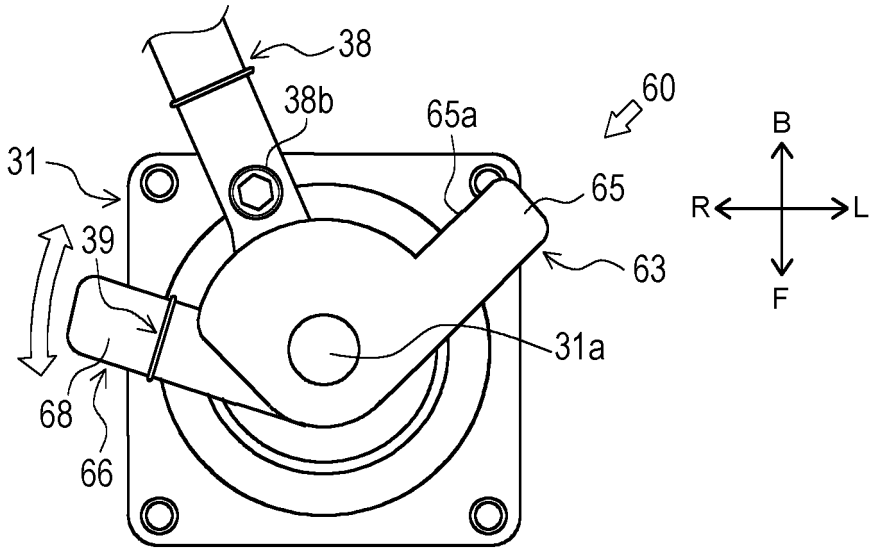


Fig. 11B

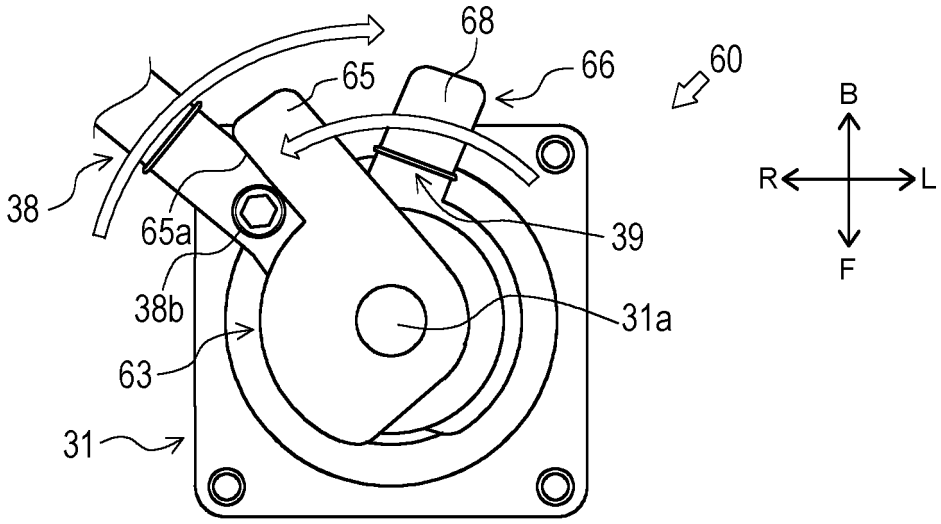
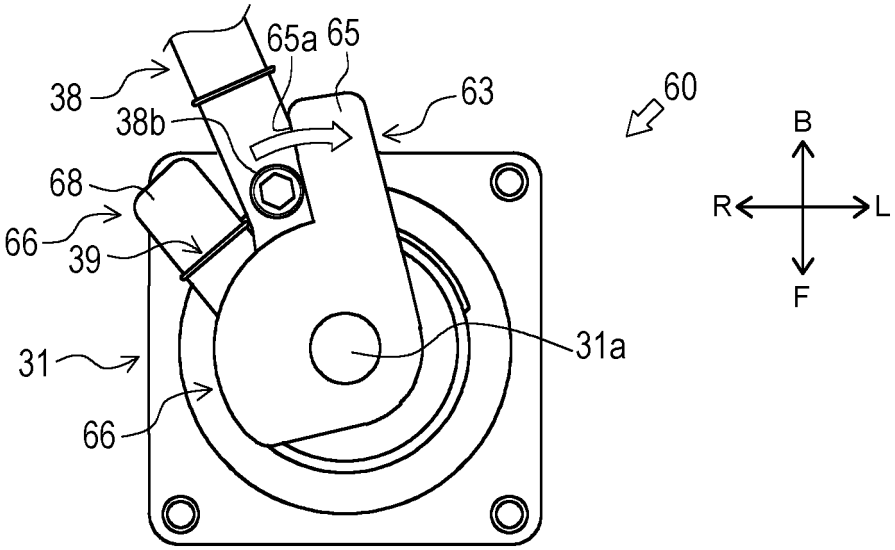


Fig. 11C



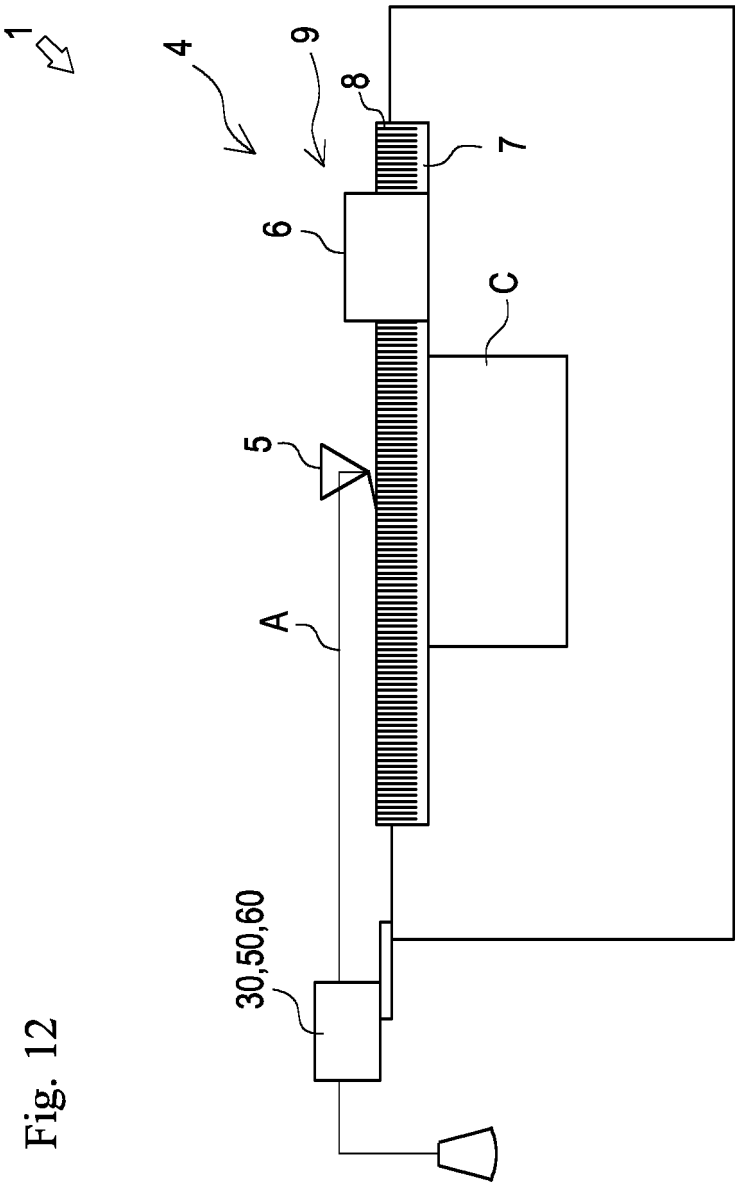


Fig. 12

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EUROPEAN SEARCH REPORT

Application Number
EP 23 17 6866

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	JP S53 162841 U (UNKNOWN) 20 December 1978 (1978-12-20) * pages 3, 5, 7; figures 1-5 *	1-7	INV. D04B15/54
A	US 3 514 977 A (BROWN LEONARD ET AL) 2 June 1970 (1970-06-02) * column 4, lines 3-26;61-71; claims 1-7; figures 1-4 *	1-7	
A	US 4 700 553 A (GOLLER ERNST [DE] ET AL) 20 October 1987 (1987-10-20) * column 3, lines 41-54; claims 1-10; figures 1-4 *	1-7	

TECHNICAL FIELDS SEARCHED (IPC)

D04B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	23 October 2023	Messai, Sonia

CATEGORY OF CITED DOCUMENTS

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23-10-2023

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP S53162841 U	20-12-1978	JP S5928063 Y2	14-08-1984
		JP S53162841 U	20-12-1978
US 3514977 A	02-06-1970	CH 457690 A	15-06-1968
		DE 1560991 A1	01-04-1971
		GB 1084568 A	27-09-1967
		US 3514977 A	02-06-1970
US 4700553 A	20-10-1987	DE 3602431 A1	30-07-1987
		EP 0231484 A1	12-08-1987
		ES 2007570 B3	01-07-1994
		JP H028060 B2	22-02-1990
		JP S62184158 A	12-08-1987
		US 4700553 A	20-10-1987

EPO FORM P0459

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Patent documents cited in the description

- JP 2614775 B **[0004]**