(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 780 020 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
21.02.2024 Bulletin 2024/08

(21) Application number: **19774830.4**

(22) Date of filing: **26.02.2019**

(51) International Patent Classification (IPC):
H01B 13/02 *(2006.01)* ***B21F 7/00*** *(2006.01)*

(52) Cooperative Patent Classification (CPC):
H01B 13/0207; B21F 7/00

(86) International application number:
PCT/JP2019/007287

(87) International publication number:
WO 2019/187900 (03.10.2019 Gazette 2019/40)

(54) ELECTRIC WIRE TWISTING DEVICE AND METHOD FOR PRODUCING TWISTED ELECTRIC WIRE

STROMDRAHTVERDRILLVORRICHTUNG UND VERFAHREN ZUR HERSTELLUNG VON VERDRILLTEM STROMDRAHT

DISPOSITIF DE TORSION DE FIL ÉLECTRIQUE ET PROCÉDÉ DE PRODUCTION DE FIL ÉLECTRIQUE TORSADÉ

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Validation States:
KH MA TN

(30) Priority: **26.03.2018 JP 2018058253**

(43) Date of publication of application:
17.02.2021 Bulletin 2021/07

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(56) References cited:
WO-A1-2017/159604
WO-A1-2017/159604
DE-B3-102016 109 151
JP-A- 2007 220 378
JP-A- 2008 277 033
JP-A- 2011 113 656
US-A1- 2012 042 984
US-B2- 9 416 488

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Description

TECHNICAL FIELD

[0001] The present invention relates to an electric wire twisting device configured to twist a plurality of electric wires and a method for producing a twisted electric wire.

BACKGROUND ART

[0002] An electric wire twisting device known to date includes a pair of clamps respectively holding one end and the other end of a plurality of electric wires and twists the plurality of electric wires by rotating at least one of the clamps. Patent Document 1, for example, describes an electric wire twisting device that includes a front rotation clamp and a rear rotation clamp respectively holding front ends and rear ends of two electric wires and that twists the two electric wires by rotating the front rotation clamp and the rear rotation clamp in opposite directions. Patent Document 2 discloses a twisting device that has at least one first platform for attaching a first functional module, which first platform can be attached in a modular manner to a first platform support of the twisting device, and a second platform for attaching a second functional module, which second platform can be attached in a modular manner to a second platform support of the twisting device, the platform supports being movable relative to one another and each having a supply connection to supply the associated platform.

CITATION LIST

PATENT DOCUMENT

[0003]

Patent Document 1: Japanese Patent Application Publication No. 2017-10769
Patent Document 2: DE 10 2016 109 151 B3

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0004] A long electric wire has a larger self-weight. Long electric wires tend to sag downward while being held by clamps. However, since a sagging portion is deflected from a rotation center line of the clamps, when the clamps rotate for twisting, a centrifugal force tends to occur in the sagging portion. Thus, if the degree of sag of electric wires is large, the electric wires are shaken greatly when the clamps rotate, resulting in failures in suitable twisting, such as variations in twisting pitch.

[0005] In view of this, it is conceivable to pull electric wires more strongly than conventional devices by the clamps so as to suppress sag of the electric wires. However, if the electric wires are stretched strongly, a large tension is applied on the electric wires, and the electric wires are easily damaged. In addition, a large tension of the electric wires tends to increase the length of untwisted portions of the electric wires at the ends thereof. Thus, there is a limitation in reducing the sag degree by stretching electric wires strongly.

[0006] Inventors of the present invention came to an idea of placing a support member for supporting electric wires below the electric wires. This can reduce the sag degree of electric wires. However, in an electric wire twisting device in which a collecting tray is disposed below electric wires, the presence of the support member below the electric wires hinders collection of twisted electric wires dropped in the collecting tray by canceling holding of clamps after twisting electric wires.

[0007] The present invention has been made in view of the foregoing circumstances, and has an object of providing an electric wire twisting device and a method for producing a twisted electric wire, and the device and method enable suitable twisting of electric wires even for relatively long electric wires and also enable collection of a twisted electric wire by dropping the twisted electric wire downward.

SOLUTION TO PROBLEM

[0008] An electric wire twisting device according to the invention is described in claim 1.

[0009] In this electric wire twisting device, the electric wire support member is moved to the electric wire support position so that the first electric wire and the second electric wire held by the first clamp and the second clamp can be supported by the electric wire support member. This can reduce the sag degree of the electric wires. Accordingly, tension generated on the electric wires can be reduced, and damage on the electric wires can be reduced. In addition, the length of untwisted portions of the electric wires at the ends thereof can be reduced. Furthermore, shaking of the electric wires can be reduced in twisting, and thus, variations in twisting pitch can be reduced so that the electric wires can be thereby suitably twisted.

[0010] In the electric wire twisting device described above, after the electric wires have been twisted, the electric wire support member is moved from the electric wire support position to the retracted position so that the electric wire support member thereby retracts from below the twisted electric wires (hereinafter refer as "a twisted electric wire"). Thus, when holding by the clamps is canceled, the twisted electric wire drops downward without being hindered by the electric wire support member. Thus, the twisted electric wire can be easily collected only by canceling holding of the clamps.

[0011] As described above, the electric wire twisting device is capable of suitably twisting the electric wires even in the case of twisting relatively long electric wires, and the resulting twisted electric wire can be dropped downward and collected.

[0012] In one preferred aspect, the electric wire twisting device further includes a rotation shaft configured to rotatably support the electric wire support member between the electric wire support position and the retracted position.

[0013] In this aspect, the electric wire support member can be made compact.

[0014] In one preferred aspect, the electric wire support member is disposed in an intermediate region among three regions, the three regions being obtained by dividing equally an area between the first clamp and the second clamp.

[0015] If the electric wire support member were not provided, electric wires held by the first clamp and the second clamp would sag most greatly at an intermediate position between the first clamp and the second clamp. On the other hand, in this aspect, since the electric wire support member is disposed in the intermediate region between the clamps, the electric wire support member supports an intermediate position where the sag degree of the electric wires is at maximum. This can reduce the sag degree of the electric wires. As a result, the electric wires can be more suitably twisted.

[0016] In one preferred aspect, the electric wire twisting device further includes a movement actuator coupled to the electric wire support member, the movement actuator being configured to move the electric wire support member between the electric wire support position and the retracted position.

[0017] In this aspect, movement of the electric wire support member from the electric wire support position to the retracted position and movement from the retracted position to the electric wire support position can be performed automatically.

[0018] In one preferred aspect, the electric wire support member includes a support portion located below the rotation center line while the electric wire support member is at the electric wire support position, and shake stoppers located at one side and another side of the support portion in a horizontal direction intersecting with the rotation center line while the electric wire support member is at the electric wire support position and located above the support portion.

[0019] In twisting electric wires, the electric wires might be shaken laterally from the rotation center line. In this aspect, however, the shake stoppers can reduce lateral shake of the electric wires. As a result, the electric wires can be more suitably twisted.

[0020] In one preferred aspect, the electric wire support member includes a support rod portion extending along a direction intersecting with the rotation center line in plan view while the electric wire support member is at the electric wire support position, and the electric wire support member has a recess that is recessed downward when seen in a direction along the rotation center line.

[0021] In this aspect, the recess can reduce lateral shake of the electric wires . As a result, the electric wires can be suitably twisted.

[0022] In one preferred aspect, at least one of the first clamp and the second clamp is movable in a direction along the rotation center line.

[0023] In this aspect, at least one of the first clamp and the second clamp is moved in a direction along the rotation center line so that the distance between the first clamp and the second clamp can be thereby adjusted in accordance with the length of electric wires. Thus, electric wires having various lengths can be twisted. In a case where the electric wire support member is at the electric wire support position, there might be a possibility that the electric wire support member hinders movement of the clamp in the direction along the rotation center line. However, the electric wire support member is movable to the retracted position. Thus, by moving the electric wire support member to the retracted position, the clamp can be moved in the direction along the rotation center line without being hindered by the electric wire support member. At some position of the first clamp or the second clamp, there might be a possibility that the electric wire support member might hit the first clamp or the second clamp while the electric wire support member moves from the retracted position to the electric wire support position. However, in this aspect, if there is such a possibility, the electric wire support member is kept at the retracted position so that collision between the electric wire support member and the first clamp or the second clamp can be avoided.

[0024] In one preferred aspect, the electric wire support member includes a plurality of electric wire support members arranged along a direction parallel to the rotation center line.

[0025] In this aspect, the electric wires held by the first clamp and the second clamp can be supported at a plurality of locations. As a result, the sag degree of the electric wires can be sufficiently reduced, and thus, the electric wires can be suitably twisted.

[0026] A method for producing twisted electric wire according to the invention is described in claim 9.

[0027] With this method, even in the case of twisting relatively long electric wires, the electric wires can be suitably twisted, and the resulting twisted electric wire can be dropped downward and collected.

[0028] In one preferred aspect, in the preparation step, the first clamp and the second clamp apply tension to the first electric wire and the second electric wires such that a difference between a largest height and a smallest height of each of the first electric wire and the second electric wire is 10 to 50 times as large as a diameter of each of the first electric wire and the second electric wire.

[0029] In this aspect, the difference between the largest height and the smallest height of each electric wire held by the first clamp and the second clamp is greater than or equal to 10 times as large as the diameter of the electric wire, and tension of the electric wire is relatively small. Accordingly, damage on the electric wires can be thereby sufficiently reduced. In addition, the length of untwisted portions of the electric wires at the ends thereof

can be reduced. On the other hand, the difference between the largest height and the smallest height of each electric wire is less than or equal to 50 times as large as the diameter of the electric wire, and the sag degree does not increase excessively. Thus, shaking of the electric wires can be reduced in twisting so that the electric wires can be thereby suitably twisted.

ADVANTAGEOUS EFFECTS OF INVENTION

[0030] As described above, according to the present invention, even relatively long electric wires can be suitably twisted, and the resulting twisted electric wire can be dropped downward and collected.

BRIEF DESCRIPTION OF THE DRAWINGS

[0031]

FIG. 1 is a perspective view of an electric wire twisting device according to one preferred embodiment.
FIGS. 2 (a) and 2 (b) are views of an electric wire support device when seen in a direction along a rotation center line, where FIG. 2 (a) illustrates a state where an electric wire support member is at an electric wire support position, and FIG. 2 (b) illustrates a state where the electric wire support member is at a retracted position.
FIG. 3 is a plan view of a part of the electric wire twisting device.
FIG. 4 is a side view of a part of the electric wire twisting device.
FIG. 5 is a flowchart of a method for producing a twisted electric wire.
FIG. 6 is a perspective view of the electric wire twisting device in a twist step.
FIG. 7 is a plan view of a part of the electric wire twisting device when holding by a first clamp and a second clamp is canceled.
FIG. 8 is a perspective view of the electric wire twisting device when a twisted electric wire is collected.
FIG. 9 is a view for describing sag of electric wires in a case where the electric wire support member is not provided.
FIG. 10 is a view of an electric wire support device according to another preferred embodiment when seen in a direction along a rotation center line.
FIGS. 11(a) and 11(b) are views of an electric wire support device according to another preferred embodiment when seen in a direction along a rotation center line, where FIG. 11(a) illustrates a state where an electric wire support member is at an electric wire support position, and FIG. 11(b) illustrates a state where the electric wire support member is at a retracted position.
FIG. 12 is a conceptual illustration for describing a method for supporting electric wires while sandwiching the electric wires from both sides.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0032] A preferred embodiment of the present invention will be hereinafter described with reference to the drawings. As illustrated in FIG. 1, an electric wire twisting device 1 according to the present invention includes: a first clamp 11 configured to hold one end of each of a first electric wire 51 and a second electric wire 52; and a second clamp 12 configured to hold the other end of each of the first electric wire 51 and the second electric wire 52. The electric wire twisting device 1 also includes a motor 13 as a rotation actuator for rotating the first clamp 11. The motor 13 is configured to rotate the first clamp 11 about a rotation center line CL. The rotation center line CL is an imaginary straight line extending from the first clamp 11 toward the second clamp 12, and in this preferred embodiment, is a straight line extending horizontally.

[0033] The first clamp 11 and the motor 13 are supported by a first holder 21, and the second clamp 12 is supported by a second holder 22. The electric wire twisting device 1 includes a rail 14 extending in parallel with the rotation center line CL. The first holder 21 and the second holder 22 are supported by the rail 14. At least one of the first holder 21 or the second holder 22 is slidably engaged with the rail 14. Accordingly, at least one of the first clamp 11 and the second clamp 12 is movable in a direction along the rotation center line CL, and thus, a distance between the first clamp 11 and the second clamp 12 is adjustable. In this preferred embodiment, the first holder 21 is slidably engaged with the rail 14, whereas the second holder 22 is non-slidably engaged with the rail 14. Accordingly, the first clamp 11 is movable in the direction along the rotation center line CL, and the second clamp 12 does not move in the direction along the rotation center line CL. Alternatively, the second holder 22 may be slidably engaged with the rail 14 with the first holder 21 being non-slidably engaged with the rail 14. Both the first holder 21 and the second holder 22 may be slidably engaged with the rail 14.

[0034] Although not shown, an actuator configured to move the first holder 21 along the rail 14 is disposed inside the first holder 21. The actuator is not limited to a specific type, and may be a motor, for example.

[0035] The electric wire twisting device 1 includes electric wire support devices 30 configured to support the first electric wire 51 and the second electric wire 52. In this preferred embodiment, three electric wire support devices 30 are arranged in parallel with the rotation center line CL. The rail 14 and the electric wire support devices 30 are supported by an unillustrated frame.

[0036] As illustrated in FIG. 2(a), each of the electric wire support devices 30 includes: a first strut 41 supported by the frame; a second strut 42 extending laterally from the first strut 41; an electric wire support member 31; a rotation shaft 32 configured to rotatably support the electric wire support member 31; and an air cylinder 33

configured to rotate the electric wire support member 31. The rotation shaft 32 is disposed at a side (at the left in FIG. 2(a)) of the rotation center line CL.

[0037] The electric wire support members 31 are disposed between the first clamp 11 and the second clamp 12 with respect to a direction along the rotation center line CL (see FIG. 1) . As illustrated in FIGS. 2(a) and 2(b), the electric wire support members 31 are configured to rotate between an electric wire support position below the rotation center line CL and a retracted position deviated from below the rotation center line CL. In this preferred embodiment, the position illustrated in FIG. 2(a) is the electric wire support position, and the position illustrated in FIG. 2(b) is the retracted position. The position below the rotation center line CL is a position lower than the rotation center line CL and on a vertical line A3 passing through the rotation center line CL.

[0038] In this preferred embodiment, the electric wire support member 31 is constituted by an L-shaped support rod. The electric wire support member 31 includes: a straight support rod portion 31a extending in a direction intersecting with the rotation center line CL in plan view while the electric wire support member 31 is at the electric wire support position; a base rod portion 31b perpendicular to the support rod portion 31a; and a coupling portion 31c provided on the base rod portion 31b. The term "direction intersecting with a member" includes both a direction perpendicularly intersecting with the member and a direction obliquely intersecting with the member. In this preferred embodiment, as illustrated in FIG. 3, the support rod portion 31a perpendicularly intersects with the rotation center line CL in plan view.

[0039] As illustrated in FIG. 2 (a), the front end of the second strut 42 is provided with a bracket 35 extending downward. The rotation shaft 32 rotatably couples the coupling portion 31c of the electric wire support member 31 to the bracket 35.

[0040] The lower end of the first strut 41 is provided with a bracket 36, and a base portion 33a of the air cylinder 33 is rotatably coupled to the bracket 36. A front end portion 33b of the air cylinder 33 is rotatably coupled to the coupling portion 31c of the electric wire support member 31. As illustrated in FIG. 2 (a), when a rod 33R of the air cylinder 33 is stretched, the electric wire support member 31 moves to the electric wire support position as indicated by arrow A1. As illustrated in FIG. 2(b), when the rod 33R of the air cylinder 33 contracts, the electric wire support member 31 moves to the retracted position as indicated by arrow A2.

[0041] Positions of the electric wire support members 31 of the electric wire support devices 30 are not specifically limited, but in this preferred embodiment, as illustrated in FIG. 4, the electric wire support members 31 of the electric wire support devices 30 are individually disposed in a region B1 near the first clamp 11, an intermediate region B2, and a region B3 near the second clamp 12, and these regions are obtained by dividing equally an area between the first clamp 11 and the second clamp 12 into three regions.

[0042] As illustrated in FIG. 4, a collecting tray 45 for collecting a twisted electric wire 50 is disposed below the rail 14. The collecting tray 45 is disposed below the rotation center line CL and below the electric wire support position of the electric wire support members 31.

[0043] The configuration of the electric wire twisting device 1 has been described above. Next, a method for producing the twisted electric wire 50 by using the electric wire twisting device 1 will be described. FIG. 5 is a flowchart depicting a method for producing a twisted electric wire 50.

[0044] First, a preparation step S1 is performed. In the preparation step S1, the first clamp 11 holds an end of each of electric wires 51 and 52 and the second clamp 12 holds the other end of each of the electric wires 51 and 52. The air cylinder 33 is driven so that the electric wire support members 31 are moved to the electric wire support position. Consequently, the electric wires 51 and 52 come to a state where the electric wires 51 and 52 are held by the first clamp 11 and the second clamp 12 and supported by the electric wire support members 31 (see FIGS. 1, 2(a), 3, and 4).

[0045] In the electric wire twisting device 1, the distance between the first clamp 11 and the second clamp 12 is adjustable in accordance with the lengths of the first electric wire 51 and the second electric wire 52. Tension on the electric wires 51 and 52 can be adjusted by adjusting the distance between the first clamp 11 and the second clamp 12 (hereinafter referred to as a clamp distance). For example, when the clamp distance is increased, the electric wires 51 and 52 are stretched strongly so that tension thereof can be increased. In contrast, when the clamp distance is reduced, the tension can be reduced. It should be noted that when the tension is small, the sag degree of the electric wires 51 and 52 is large. On the other hand, when the tension is large, damage easily occurs in the electric wires 51 and 52 and end portions of the electric wires 51 and 52 tend to remain untwisted in twisting the electric wires 51 and 52. In view of this, it is preferable to adjust the clamp distance such that damage and untwisted end portions are less likely to occur in the electric wires 51 and 52 and tension that does not excessively increase the sag degree is applied. In this preferred embodiment, the clamp distance is adjusted such that a distance ΔH between a largest height H1 and a smallest height H2 of each of the electric wires 51 and 52 (see FIG. 4) is 10 to 50 times as large as the diameter of each of the electric wire 51 and 52 (where the diameters of the electric wires 51 and 52 are illustrated larger than those of actual electric wires) . Accordingly, suitable tension can be applied to the electric wires 51 and 52. The suitable tension varies depending on, for example, the length, outer diameter, and material of the electric wires 51 and 52. The above example is merely an example of suitable tension, and tension applied to the electric wires 51 and 52 is not limited to specific values.

[0046] Then, a twist step S2 is performed. As illustrated in FIG. 6, in the twist step S2, the motor 13 is driven so that the first clamp 11 is thereby rotated about the rotation center line CL. Accordingly, the first electric wire 51 and the second electric wire 52 are twisted to be a twisted electric wire 50. In twisting the electric wires 51 and 52, the electric wires 51 and 52 might be shaken from the rotation center line CL. In this preferred embodiment, however, since the electric wire support members 31 are disposed below the electric wires 51 and 52, downward shaking of the electric wires 51 and 52 is suppressed. Thus, the electric wires 51 and 52 can be properly twisted so that variations in twisting pitch of the twisted electric wire 50 can be reduced. As a result, high-quality twisted electric wire 50 can be obtained.

[0047] When the motor 13 is stopped, the twist step S2 is finished. After the end of the twist step S2, a collection step S3 of collecting the twisted electric wire 50 is performed. In the collection step S3, the air cylinder 33 is driven so that the electric wire support members 31 are moved to the retracted position (see FIG. 2(b)). Accordingly, the electric wire support members 31 retract to a position deviated from a vertical line passing through the twisted electric wire 50. Thereafter, as illustrated in FIG. 7, the first clamp 11 and the second clamp 12 are opened so that holding by the first clamp 11 and the second clamp 12 is canceled. Then, as illustrated in FIG. 8, the twisted electric wire 50 is dropped by its self-weight to be collected in the collecting tray 45 (see FIG. 4) . At this time, since the electric wire support members 31 are at the retracted position, the electric wire support members 31 do not hinder collection of the twisted electric wire 50.

[0048] Although FIGS. 7 and 8 illustrate a state where the first clamp 11 and the second clamp 12 stand vertically (a state where the pair of holding pieces are arranged laterally), the first clamp 11 and the second clamp 12 may cancel holding in a state where the first clamp 11 and the second clamp 12 stand laterally (a state where the pair of holding pieces is arranged vertically) . The state of the clamps 11 and 12 in the collection step S3 is not limited to a specific state.

[0049] As described above, in the electric wire twisting device 1 according to this embodiment, by moving the electric wire support members 31 to the electric wire support position, the electric wires 51 and 52 held by the first clamp 11 and the second clamp 12 can be supported by the electric wire support members 31. Thus, the sag degree of the electric wires 51 and 52 can be reduced without strongly stretching the electric wires 51 and 52 by the clamps 11 and 12. Accordingly, even in a case where the electric wires 51 and 52 are relatively long, tension generated on the electric wires 51 and 52 can be reduced so that damage on the electric wires 51 and 52 can be thereby reduced. In addition, the length of untwisted portions of the electric wires 51 and 52 at the ends thereof can be reduced. Furthermore, shaking of the electric wires 51 and 52 can be reduced in twisting, and thus, variations in twisting pitch can be reduced so that the electric wires 51 and 52 can be thereby suitably twisted.

[0050] In the electric wire twisting device 1 according to this preferred embodiment, after the electric wires 51 and 52 have been twisted, the electric wire support members 31 are moved from the electric wire support position to the retracted position so that the electric wire support members 31 thereby retract from below the twisted electric wire 50. Thereafter, when holding by the clamps 11 and 12 is canceled, the twisted electric wire 50 is dropped downward without being hindered by the electric wire support members 31. Thus, the twisted electric wire 50 can be easily collected only by canceling holding by the clamps 11 and 12. In some cases, the pitch of the twisted electric wire 50 is measured after the electric wires 51 and 52 have been twisted. In the electric wire twisting device 1 according to this preferred embodiment, the pitch can be measured without being hindered by the electric wire support members 31, advantageously.

[0051] As described above, the electric wire twisting device 1 according to this preferred embodiment is capable of suitably twisting the electric wires 51 and 52 even in the case of twisting relatively long electric wires 51 and 52, and the resulting twisted electric wire 50 can be dropped downward and collected.

[0052] The electric wire support members 31 only need to be movable between the electric wire support position and the retracted position, and a mode and a trajectory of the movement are not specifically limited. In this preferred embodiment, however, the electric wire support devices 30 include the rotation shafts 32 rotatably supporting the electric wire support members 31, and the electric wire support members 31 are movable between the electric wire support position and the retracted position by rotation of the electric wire support members 31. As illustrated in FIGS. 2(a) and 2(b), since the electric wire support members 31 are rotatable, the trajectory of movement of the electric wire support members 31 is relatively small. Thus, small space is sufficient for movement so that the electric wire support members 31 can be made compact. The rotation shafts 32 are disposed at the side of the electric wires 51 and 52 and center portions of the electric wires 51 and 52 can be supported by a compact mechanism.

[0053] As illustrated in FIG. 9, if the electric wire support members 31 were not provided, the electric wires 51 and 52 held by the clamps 11 and 12 would sag significantly and the sag degree would be at maximum at longitudinal centers thereof. On the other hand, in the electric wire twisting device 1 according to this preferred embodiment, as illustrated in FIG. 4, the electric wire support member 31 is disposed in the intermediate region B2 among the regions obtained by dividing equally the area between the first clamp 11 and the second clamp 12 into three regions. Since center portions of the electric wires 51 and 52 are supported, the sag degree of the electric wires 51 and 52 can be reduced. Thus, the electric wires 51 and 52 can be suitably twisted without

strongly stretching the electric wires 51 and 52 by the clamps 11 and 12.

[0054] Each of the electric wire support devices 30 does not need to include the movement actuator for moving the electric wire support member 31 (the air cylinder 33 in the preferred embodiment), and movement of the electric wire support member 31 between the electric wire support position and the retracted position may be performed manually. In this preferred embodiment, however, since the air cylinder 33 is provided as a movement actuator for moving the electric wire support member 31, movement of the electric wire support member 31 from the electric wire support position to the retracted position and movement from the retracted position to the electric wire support position can be performed automatically.

[0055] In this preferred embodiment, the electric wire support member 31 includes the support rod portion 31a extending in the direction intersecting with the rotation center line CL in plan view while the electric wire support member 31 is at the electric wire support position (see FIG. 2(a)). The support rod portion 31a has a simple configuration. Thus, the advantages described above can be obtained at low cost with the simple configuration.

[0056] The electric wire twisting device 1 according to this preferred embodiment includes the collecting tray 45 located below the electric wire support position of the electric wire support members 31 (see FIG. 4) . After the electric wires 51 and 52 have been twisted, holding by the clamps 11 and 12 is canceled, and the twisted electric wire 50 is dropped downward by its self-weight to be thereby easily collected in the collecting tray 45.

[0057] The method for collecting the twisted electric wire 50 is not limited to a specific method. For example, a belt conveyor may be disposed below the rotation center line CL with the collecting tray being disposed at a downstream end of the belt conveyor in the conveyance direction. In this case, when holding by the clamps 11 and 12 is canceled, the twisted electric wire 50 is dropped onto the belt conveyor, conveyed by the belt conveyor, and then collected in the collecting tray.

[0058] In the electric wire twisting device 1 according to this preferred embodiment, the first clamp 11 is movable in the direction along the rotation center line CL. Thus, the distance between the first clamp 11 and the second clamp 12 (clamp distance) is adjustable in accordance with the lengths of the electric wires 51 and 52. Thus, electric wires 51 and 52 having various lengths can be twisted. For example, in the case of twisting electric wires whose length is 2/3 of the length of the electric wires 51 and 52 illustrated in FIG. 3, the first clamp 11 is moved toward the second clamp 12 to thereby adjust the clamp distance to 2/3. Thus, even in the case where electric wires to be twisted are changed to electric wires having a 2/3 length, these electric wires can be held by the first clamp 11 and the second clamp 12 while tension thereof is kept within a predetermined range.

[0059] In the case where the clamp distance is adjusted to 2/3 as described above, the electric wire support member 31 near the first clamp 11 and the first clamp 11 are at the same location with respect to the direction along the rotation center line CL. Thus, while the electric wire support members 31 are at the retracted position, when the first clamp 11 is moved and then the electric wire support members 31 are moved from the retracted position to the electric wire support position, the electric wire support member 31 near the first clamp 11 collides against the first clamp 11. In such a case, while the electric wire support member 31 near the first clamp 11 is kept at the retracted position, the other electric wire support members 31 are moved to the electric wire support position. Accordingly, the electric wires 51 and 52 can be supported by the other electric wire support members 31 while collision of the electric wire support member 31 near the first clamp 11 against the first clamp 11 is avoided.

[0060] In adjusting the clamp distance, while the electric wire support members 31 are at the electric wire support position, the first clamp 11 may be moved in the direction along the rotation center line CL. In this case, the electric wire support member 31 near the first clamp 11 at the electric wire support position hinders movement of the first clamp 11. In such a case, however, it is sufficient to move the electric wire support member 31 near the first clamp 11 to the retracted position beforehand. Accordingly, collision against the first clamp 11 can be avoided, and hindering by the electric wire support member 31 in moving the first clamp 11 can be prevented.

[0061] In the electric wire twisting device 1 according to this preferred embodiment, the plurality of electric wire support members 31 are provided along the direction parallel to the rotation center line CL. The number of electric wire support members 31 is not specifically limited, and three electric wire support members 31 are provided in this preferred embodiment. Thus, the electric wires 51 and 52 held by the first clamp 11 and the second clamp 12 can be supported at three locations. As a result, the sag degree of the electric wires 51 and 52 can be sufficiently reduced, and the electric wires 51 and 52 can be suitably twisted.

[0062] In the preparation step S1, the degree of tension applied by the first clamp 11 and the second clamp 12 to the electric wires 51 and 52 is not specifically limited, and in this preferred embodiment, the degree of tension is set at such a degree that a difference ΔH between a largest height H1 and a smallest height H2 of each of the electric wires 51 and 52 is 10 to 50 times as large as the diameter of each of the electric wires 51 and 52. Since the tension is not excessively large, damage on the electric wires 51 and 52 can be sufficiently reduced, and the length of untwisted portions of the twisted electric wire 50 at the ends thereof can be reduced. In addition, since the tension is not excessively small, an increase in sag degree of the electric wires 51 and 52 can be prevented so that the electric wires 51 and 52 can be thereby suitably twisted. As a result, variations in twisting pitch of the twisted electric wire 50 can be reduced, resulting in a

high-quality twisted electric wire 50.

[0063] Although one preferred embodiment of the present invention has been described above, the present invention is, of course, not limited to this preferred embodiment. The present invention can be performed in various modes. Next, another preferred embodiment will be briefly described.

[0064] As illustrated in FIG. 10, in the preferred embodiment, the support rod portion 31a may include: a support portion 31s located below the rotation center line CL while the electric wire support member 31 is at the electric wire support position; and shake stoppers 37 disposed at one and the other sides of the support portion 31s in a horizontal direction (i.e., the left-right direction in FIG. 10) orthogonal to the rotation center line CL and located above the support portion 31s. The shake stoppers 37 may be made of upward projections, for example. As described above, as long as the electric wire support member 31 includes the shake stoppers 37, in twisting the electric wires 51 and 52, the shake stoppers 37 prevent lateral shake of the electric wires 51 and 52. As a result, the electric wires 51 and 52 can be more suitably twisted.

[0065] As illustrated in FIGS. 11(a) and 11(b), the support rod portion 31a of the electric wire support member 31 may include a recess 31d that extends in a direction intersecting with the rotation center line CL in plan view while the electric wire support member 31 is at the electric wire support position and is recessed downward when seen in a direction along the rotation center line CL. In this preferred embodiment, a bottom portion of the recess 31d serves as a support portion and side portions of the recess 31d constitute the shake stoppers. One side portion 31f of the recess 31d extends to be gradually apart from the rotation center line CL in an upward direction. The other side portion 31g extends vertically. Each of the side portions 31f and 31g is not specifically limited to a specific shape. For example, both the side portions 31f and 31g may extend to be gradually apart from the rotation center line CL in the upward direction or may extend vertically. The other part of the configuration is the same as that of the preferred embodiment described above, and thus, description thereof will not be repeated. In FIGS. 11(a) and 11(b), components already described in the preferred embodiment are denoted by the same reference characters.

[0066] In this preferred embodiment, since the support rod portion 31a includes the recess 31d, lateral shake of the electric wires 51 and 52 can be prevented in twisting the electric wires 51 and 52, in the same manner as in the preferred embodiment.

[0067] While the first clamp 11 and the second clamp 12 hold the electric wires 51 and 52, the electric wires 51 and 52 are separated laterally (see FIG. 1). In this preferred embodiment, the side portion 31f of the support rod portion 31a is tilted with respect to the vertical line, and the lateral width of the recess 31d decreases in a downward direction. Thus, when the electric wire support member 31 is moved from the retracted position to the electric wire support position, the recess 31d enables the electric wires 51 and 52 to be disposed close to the rotation center line CL. As a result, the electric wires 51 and 52 can be further suitably twisted.

[0068] The electric wire support members 31 described above are merely an example, and are not limited to a specific shape and specific dimensions. The cross-sectional shape of each electric wire support member 31 is not limited to a circle, and may be a rectangle or other shapes.

[0069] Although three electric wire support members 31 are provided in the preferred embodiment, but the number of electric wire support members 31 may be one. In this case, the electric wire support member 31 is preferably disposed in the intermediate region B2 obtained by dividing equally the area between the first clamp 11 and the second clamp 12 into three regions. However, arrangement of the electric wire support member 31 is not specifically limited, and the electric wire support member 31 may be disposed in another region B1 or B3.

[0070] In the preferred embodiment, the electric wire support devices 30 may be movable in a direction parallel to the rotation center line CL. For example, a rail extending in parallel with the rotation center line CL may be provided such that the electric wire support devices 30 are slidably engaged with the rail. The electric wire support devices 30 may be configured to be detachably disposed at a plurality of locations with respect to a direction parallel to the rotation center line CL.

[0071] In the case where the plurality of electric wire support members 31 are provided, the distance between the first clamp 11 and the electric wire support member 31 near the first clamp 11 and the distance between the second clamp 12 and the electric wire support member 31 near the second clamp 12 with respect to the direction along the rotation center line CL may be equal or may be different from each other. The distance between two adjacent electric wire support members 31 may be equal to or different from the distance between the first clamp 11 and the electric wire support member 31 near the first clamp 11 or the distance between the second clamp 12 and the electric wire support member 31 near the second clamp 12. In a case where three or more electric wire support members 31 are provided, the distance between two adjacent electric wire support members 31 may be equal or different from each other.

[0072] The expression "to support electric wires" herein refers to prevention of downward movement of the electric wires. The expression "to support electric wires" is not limited to a case where the electric wires are supported from below and includes a case where the electric wires are sandwiched at both sides so that downward movement thereof is prevented. As illustrated in FIG. 12, for example, the recess 31d of the electric wire support member 31 may sandwich the first electric wire 51 and the second electric wire 52 at both sides to thereby prevent downward movement of the first electric wire 51 and

the second electric wire 52. In this case, a space S may be generated between the electric wires 51 and 52 and the recess 31d.

[0073] Although the electric wire support members 31 support the first electric wire 51 and the second electric wire 52 at the electric wire support position, while the electric wires 51 and 52 are being twisted, one or both of the electric wires 51 and 52 are temporarily separated from the electric wire support members 31 in some cases. The term "support" herein is not limited to a case where the electric wires 51 and 52 are supported by the electric wire support members 31 while being always in contact with the electric wire support members 31 and includes a case where the electric wires 51 and 52 are temporarily separated from the electric wire support members 31 during twisting.

[0074] The number of electric wires twisted by the electric wire twisting device 1 is not limited to two, and three or more electric wires may be twisted by the electric wire twisting device 1.

[0075] The first clamp 11 and the second clamp 12 are not limited to any configuration. The first clamp 11 may hold the first electric wire 51 and the second electric wire 52 by binding one end of the first electric wire 51 and one end of the second electric wire 52 together as in the preferred embodiment, or may include two holding portions that individually hold one end of the first electric wire 51 and one end of the second electric wire 52. Similarly, the second clamp 12 may hold the first electric wire 51 and the second electric wire 52 by binding the other end of the first electric wire 51 and the other end of the second electric wire 52 together, or may include two holding portions that individually hold the other end of the first electric wire 51 and the other end of the second electric wire 52.

[0076] In the preferred embodiment, in the twist step, the first clamp 11 rotates about the rotation center line CL and the second clamp 12 does not rotate. Alternatively, the second clamp 12 may be configured to be rotatable about the rotation center line CL and the electric wire twisting device 1 may include a rotation actuator (e.g., a motor) that causes the second clamp 12 to rotate. The first clamp 11 and the second clamp 12 may be configured to rotate in opposite directions in the twist step or may be configured such that only the second clamp 12 rotates in the twist step.

[0077] Although the electric wire support members 31 are rotatable about the horizontal line in the preferred embodiment, the rotation direction thereof is not specifically limited. Specifically, the electric wire support members 31 may be rotatable about the vertical line and move while rotating in the horizontal direction. The mode of movement of the electric wire support members 31 is not specifically limited. The electric wire support members 31 may be configured to move in a direction intersecting with the rotation center line CL in plan view. The electric wire support members 31 may be configured to be movable between the electric wire support position and the retracted position by stretching and contracting in the direction intersecting with the rotation center line CL in plan view. The electric wire support members 31 may also be configured to move between the electric wire support position and the retracted position by parallel movement.

[0078] The movement actuator for moving the electric wire support member 31 is not limited to the air cylinder 33. The movement actuator may be another type of actuator, such as a hydraulic cylinder, a solenoid, or a motor.

[0079] The rotation actuator for rotating the first clamp 11 or the second clamp 12 is not limited to the motor 13.

[0080] The electric wire twisting device and the method for producing a twisted electric wire according to the present invention are effective especially for long wires (e.g., electric wires having a length of 4 to 5 m), but the length of electric wires are not specifically limited.

DESCRIPTION OF REFERENCE CHARACTERS

[0081]

1	electric wire twisting device
11	first clamp
12	second clamp
13	motor (rotation actuator)
30	electric wire support device
31	electric wire support member
31a	support rod portion
31d	recess
31s	support portion
32	rotation shaft
33	air cylinder (movement actuator)
37	shake stoppers
45	collecting tray
50	twisted electric wire
51	first electric wire
52	second electric wire
CL	rotation center line

Claims

1. An electric wire twisting device (1) comprising:

a first clamp (11) configured to hold one end of a first electric wire (51) and one end of a second electric wire (52);
a second clamp (12) configured to hold another end of the first electric wire (51) and another end of the second electric wire (52);
a rotation actuator configured to rotate at least one of the first clamp (11) and the second clamp (12) about a rotation center line (CL), the rotation center line (CL) extending from the first clamp (11) toward the second clamp (12); and
an electric wire support member (31) configured to be movable between an electric wire support position and a retracted position, the electric

wire support position being located between the first clamp (11) and the second clamp (12) and below the rotation center line (CL), the electric wire support member (31) being configured to support the first electric wire (51) and the second electric wire (52) while the electric wire support member (31) is at the electric wire support position, **characterized in that** the retracted position being deviated from below the rotation center line (CL), and the electric wire support member (31) being configured to allow the first electric wire (51) and the second electric wire (52) to drop downward without being hindered by the electric wire support member (31) while the electric wire support member (31) is at the retracted position.

2. The electric wire twisting device (1) according to claim 1, further comprising a rotation shaft (32) configured to rotatably support the electric wire support member (31) between the electric wire support position and the retracted position.

3. The electric wire twisting device (1) according to claim 1 or 2, wherein the electric wire support member (31) is disposed in an intermediate region (B2) among three regions (B1-B3), the three regions (B1-B3) being obtained by dividing equally an area between the first clamp (11) and the second clamp (12).

4. The electric wire twisting device (1) according to any one of claims 1 to 3, further comprising a movement actuator (33) coupled to the electric wire support member (31), the movement actuator (33) being configured to move the electric wire support member (31) between the electric wire support position and the retracted position.

5. The electric wire twisting device (1) according to any one of claims 1 to 4, wherein
the electric wire support member (31) includes

a support portion (31s) located below the rotation center line (CL) while the electric wire support member (31) is at the electric wire support position, and
shake stoppers (37) located at one side and another side of the support portion (31s) in a horizontal direction intersecting with the rotation center line (CL) while the electric wire support member (31) is at the electric wire support position and located above the support portion (31s).

6. The electric wire twisting device (1) according to any one of claims 1 to 5, wherein

the electric wire support member (31) includes

a support rod portion (31a) extending along a direction intersecting with the rotation center line (CL) in plan view while the electric wire support member (31) is at the electric wire support position, and
the electric wire support member (31) has a recess (31d) that is recessed downward when seen in a direction along the rotation center line (CL).

7. The electric wire twisting device (1) according to any one of claims 1 to 6, wherein at least one of the first clamp (11) and the second clamp (12) is movable in a direction along the rotation center line (CL).

8. The electric wire twisting device (1) according to any one of claims 1 to 7, wherein the electric wire support member (31) comprises a plurality of electric wire support members (31) arranged along a direction parallel to the rotation center line (CL).

9. A method for producing a twisted electric wire by the electric wire twisting device (1) according to claim 1, the method comprising:

a preparation step of causing the first clamp (11) to hold one end and another end of the first electric wire (51), causing the second clamp (12) to hold one end and another end of the second electric wire (52), and moving the electric wire support member (31) to the electric wire support position;
a twist step of rotating at least one of the first clamp (11) and the second clamp (12) to thereby twist the first electric wire (51) and the second electric wire (52); and
a collection step of moving the electric wire support member (31) to the retracted position and canceling holding by the first clamp (11) and the second clamp (12) to thereby drop the first electric wire (51) and the second electric wire (52) that are twisted without being hindered by the electric wire support member (31) and collect the first electric wire (51) and the second electric wire (52) that are twisted.

10. The method for producing a twisted electric wire according to claim 9, wherein in the preparation step, the first clamp (11) and the second clamp (12) apply tension to the first electric wire (51) and the second electric wires (52) such that a difference between a largest height and a smallest height of each of the first electric wire (51) and the second electric wire (52) is 10 to 50 times as large as a diameter of each of the first electric wire (51) and the second electric wire (52).

Patentansprüche

1. Eine Stromdrahtverdrillungsvorrichtung (1) umfassend:

   eine erste Klemme (11), die konfiguriert ist ein Ende eines ersten Stromdrahts (51) und ein Ende eines zweiten Stromdrahts (52) zu halten;
   eine zweite Klemme (12), die dazu konfiguriert ist, ein anderes Ende des ersten Stromdrahts (51) und ein anderes Ende des zweiten Stromdrahts (52) zu halten;
   einen Rotationsaktuator, der konfiguriert ist die erste Klemme (11) und/oder die zweite Klemme (12) um eine Drehmittellinie (CL) zu drehen, wobei sich die Drehmittellinie (CL) von der ersten Klemme (11) zur zweiten erstreckt Klemme (12) erstreckt; und
   ein Stromdraht-Stützelement (31), das konfiguriert ist zwischen einer Stromdraht-Stützposition und einer zurückgezogenen Position bewegbar zu sein, wobei die Stromdraht-Stützposition zwischen der ersten Klemme (11) und der zweiten Klemme (12) und unterhalb der Drehmittellinie liegt (CL), wobei das Stromdraht-Stützelement (31) konfiguriert ist, den ersten Stromdraht (51) und den zweiten Stromdraht(52) zu stützen, während sich das Stromdraht-Stützelement (31) in der Stromdraht-Stützposition befindet,
   gekennzeichnet dadurch, dass
   die zurückgezogene Position von unterhalb der Drehmittellinie (CL) abweicht und das Stromdraht-Stützelement (31) konfiguriert ist dem ersten Stromdraht (51) und dem zweiten Stromdraht (52) zu ermöglichen, nach unten zu fallen, ohne dass dies durch das Stromdraht-Stützelement (31) behindert wird, während sich das Stromdraht-Stützelement (31) in der zurückgezogenen Position befindet.

2. Die Stromdrahtverdrillungsvorrichtung (1) gemäß Anspruch 1, die weiterhin eine Drehwelle (32) umfasst, die konfiguriert ist, das Stromdraht-Stützelement (31) zwischen der Stromdraht - Stützposition und der zurückgezogenen Position drehbar zu lagern.

3. Die Stromdrahtverdrillungsvorrichtung (1) gemäß Anspruch 1 oder 2, wobei
   das Stromdraht-Stützelement (31) in einem Zwischenbereich (B2) von drei Bereichen (B1-B3) angeordnet ist, wobei die drei Bereiche (B1-B3) B3) durch gleichmäßige Aufteilung einer Fläche zwischen der ersten Klemme (11) und der zweiten Klemme (12) erhalten wird.

4. Die Stromdrahtverdrillungsvorrichtung (1) gemäß einem der Ansprüche 1 bis 3, die weiterhin einen Bewegungsaktuator (33) umfasst, der mit dem Stromdraht-Stützelement (31) gekoppelt ist, wobei der Bewegungsaktuator (33) konfiguriert ist, das Stromdraht-Stützelement (31) zwischen der Stromdraht-Stützposition und der eingefahrenen Position zu bewegen.

5. Die Stromdrahtverdrillungsvorrichtung (1) gemäß einem der Ansprüche 1 bis 4, wobei

   das Stromdraht-Stützelement (31) umfasst
   einen Stützabschnitt (31s), der sich unterhalb der Drehmittellinie (CL) befindet, während sich das Stromdraht-Stützelement (31) in der Stromdraht-Stützposition befindet, und
   Schüttelstopper (37), die an einer Seite und an einer anderen Seite des Stützabschnitts (31s) in einer horizontalen Richtung angeordnet sind, die die Drehmittellinie (CL) schneidet, während sich das Stromdraht-Stützelement (31) in der Stromdraht-Stützposition befindet und oberhalb des Stützabschnitts (31s) positioniert ist.

6. Die Stromdrahtverdrillungsvorrichtung (1) gemäß einem der Ansprüche 1 bis 5, wobei

   das Stromdraht-Stützelement (31) einen Stützstangenabschnitt (31a) umfasst, der sich in der Draufsicht entlang einer Richtung erstreckt, die die Drehmittellinie (CL) schneidet, während sich das Stromdraht-Stützelement (31) in der Stromdraht-Stützposition befindet, und
   das Stromdraht-Stützelement (31) eine Aussparung (31d) aufweist, die in einer Richtung entlang der Drehmittellinie (CL) gesehen nach unten vertieft ist.

7. Die Stromdrahtverdrillungsvorrichtung (1) gemäß einem der Ansprüche 1 bis 6, wobei
   mindestens eine von der ersten Klemme (11) und der zweiten Klemme (12) in einer Richtung entlang der Rotationsmittellinie (CL) beweglich ist.

8. Die Stromdrahtverdrillungsvorrichtung (1) gemäß einem der Ansprüche 1 bis 6, wobei
   das Stromdraht-Stützelement (31) eine Vielzahl von Stromdraht-Stützelementen (31) umfasst, die entlang einer Richtung parallel zur Rotationsmittellinie (CL) angeordnet sind.

9. Ein Verfahren zur Herstellung eines verdrillten Stromdrahts mit der Stromdrahtverdrillungsvorrichtung (1) gemäß Anspruch 1, wobei das Verfahren umfasst:

   einen Vorbereitungsschritt, bei dem die erste Klemme (11) veranlasst wird, ein Ende und ein anderes Ende des ersten Stromdrahts (51) zu

halten, wodurch bewirkt wird, dass die zweite Klemme (12) ein Ende und ein anderes Ende des zweiten Stromdrahts (52) hält, und Bewegen des Stromdraht-Stützelements (31) in die Stromdraht-Stützposition;
einen Verdrehungsschritt zum Drehen der ersten Klemme (11) und/oder der zweiten Klemme (12), um dadurch den ersten Stromdraht (51) und den zweiten Stromdraht (52) zu verdrehen; Und
einen Sammelschritt, bei dem das Stromdraht-Stützelement (31) in die zurückgezogene Position bewegt wird und das Festhalten durch die erste Klemme (11) und die zweite Klemme (12) aufgehoben wird, um dadurch den ersten Stromdraht (51) und den zweiten Stromdraht (52) fallen zu lassen, die verdrillt sind, ohne durch das Stromdraht-Stützelement (31) behindert zu werden, und Sammeln des ersten Stromdrahts (51) und des zweiten Stromdrahts (52), die verdrillt sind.

10. Verfahren zur Herstellung eines verdrillten Elektrokabels gemäß Anspruch 9, wobei
im Vorbereitungsschritt die erste Klemme (11) und die zweite Klemme (12) Spannung auf den ersten Stromdraht (51) und den zweiten Stromdraht (52) ausüben, so dass ein Unterschied zwischen einer größten Höhe und einer kleinsten Höhe jedes ersten Stromdrahts (51) und zweiten Stromdrahts (52) 10 bis 50 Mal so groß ist wie ein Durchmesser jedes ersten Stromdrahts (51) zweiten Stromdrahts (52).

Revendications

1. Dispositif de torsion de fil électrique (1) comprenant :

une première pince (11) configurée pour tenir une extrémité d'un premier fil électrique (51) et une extrémité d'un second fil électrique (52) ;
une seconde pince (12) configurée pour maintenir une autre extrémité du premier fil électrique (51) et une autre extrémité du second fil électrique (52) ;
un actionneur de rotation configuré pour faire tourner au moins l'une des premières pinces (11) et des secondes pinces (12) autour d'une ligne centrale de rotation (CL), la ligne centrale de rotation (CL) s'étendant de la première pince (11) vers la seconde pince (12) ; et
un élément de support de fil électrique (31) configuré pour être mobile entre une position de support de fil électrique et une position rétractée, la position de support de fil électrique étant située entre la première pince (11) et la seconde pince (12) et au-dessous de la ligne centrale de rotation (CL), l'élément de support de fil électrique (31) étant configuré pour supporter le premier fil électrique (51) et le second fil électrique (52) pendant que l'élément de support de fil électrique (31) est dans la position de support de fil électrique, **caractérisé en ce que** la position rétractée est déviée par rapport à la ligne centrale de rotation (CL), l'élément de support de fil électrique (31) étant configuré pour permettre au premier fil électrique (51) et au second fil électrique (52) de tomber vers le bas sans être gêné par l'élément de support de fil électrique (31) lorsque l'élément de support de fil électrique (31) est dans la position rétractée.

2. Dispositif de torsion de fil électrique (1) selon la revendication 1, comprenant en outre un arbre de rotation (32) configuré pour supporter de manière rotative l'élément de support de fil électrique (31) entre la position de support de fil électrique et la position rétractée.

3. Dispositif de torsion de fil électrique (1) selon les revendications 1 ou 2, dans lequel l'élément de support de fil électrique (31) est disposé dans une région intermédiaire (B2) parmi trois régions (B1-B3), les trois régions (B1-B3) étant obtenues en divisant également une zone entre la première pince (11) et la seconde pince (12).

4. Dispositif de torsion de fil électrique (1) selon l'une quelconque des revendications 1 à 3, comprenant en outre un actionneur de mouvement (33) couplé à l'élément de support de fil électrique (31), l'actionneur de mouvement (33) étant configuré pour déplacer l'élément de support de fil électrique (31) entre la position de support de fil électrique et la position rétractée.

5. Dispositif de torsion de fil électrique (1) selon l'une quelconque des revendications 1 à 4, dans lequel l'élément de support du fil électrique (31) comprend

une partie de support (31s) située sous la ligne centrale de rotation (CL) lorsque l'élément de support de fil électrique (31) est en position de support de fil électrique, et
des butées de secousses (37) situées d'un côté et d'un autre côté de la partie de support (31s) dans une direction horizontale coupant la ligne centrale de rotation (CL) lorsque l'élément de support du fil électrique (31) est en position de support du fil électrique et situé au-dessus de la partie de support (31s).

6. Dispositif de torsion de fil électrique (1) selon l'une quelconque des revendications 1 à 5, dans lequel

l'élément de support de fil électrique (31) com-

prend une partie de tige de support (31a) s'étendant le long d'une direction coupant la ligne centrale de rotation (CL) en vue de dessus lorsque l'élément de support de fil électrique (31) est en position de support de fil électrique, et
l'élément de support du fil électrique (31) comporte un renfoncement (31 d) qui est en retrait vers le bas lorsqu'il est observé dans une direction le long de la ligne centrale de rotation (CL).

7. Dispositif de torsion de fils électriques (1) selon l'une quelconque des revendications 1 à 6, dans lequel au moins l'une de la première pince (11) et de la seconde pince (12) est mobile dans une direction le long de la ligne centrale de rotation (CL).

8. Dispositif de torsion de fil électrique (1) selon l'une des revendications 1 à 7, dans lequel l'élément de support de fil électrique (31) comprend une pluralité d'éléments de support de fil électrique (31) disposés le long d'une direction parallèle à la ligne centrale de rotation (CL).

9. Procédé de production d'un fil électrique torsadé par le dispositif de torsion de fil électrique (1) selon la revendication 1, le procédé comprenant :

une étape de préparation consistant à faire en sorte que la première pince (11) tienne une extrémité et une autre extrémité du premier fil électrique (51), à faire en sorte que la seconde pince (12) tienne une extrémité et une autre extrémité du seconde fil électrique (52), et à déplacer l'élément de support du fil électrique (31) vers la position de support du fil électrique ;
une étape de torsion consistant à faire tourner au moins l'une de la première pince (11) et de la seconde pince (12) pour tordre le premier fil électrique (51) et le second fil électrique (52) ; et
une étape de collecte consistant à déplacer l'élément de support de fil électrique (31) vers la position rétractée et à annuler le maintien par la première pince (11) et la seconde pince (12) pour faire tomber le premier fil électrique (51) et le second fil électrique (52) qui sont tordus sans être gênés par l'élément de support de fil électrique (31) et collecter le premier fil électrique (51) et le second fil électrique (52) qui sont tordus.

10. Procédé de fabrication d'un fil électrique torsadé selon la revendication 9, dans lequel, lors de l'étape de préparation, la première pince (11) et la seconde pince (12) appliquent une tension au premier fil électrique (51) et au second fil électrique (52) de telle sorte que la différence entre la plus grande et la plus petite hauteur de chacun du premier fil électrique (51) et du second fil électrique (52) est de 10 à 50 fois supérieure au diamètre de chacun du premier fil électrique (51) et du second fil électrique (52).

FIG.1

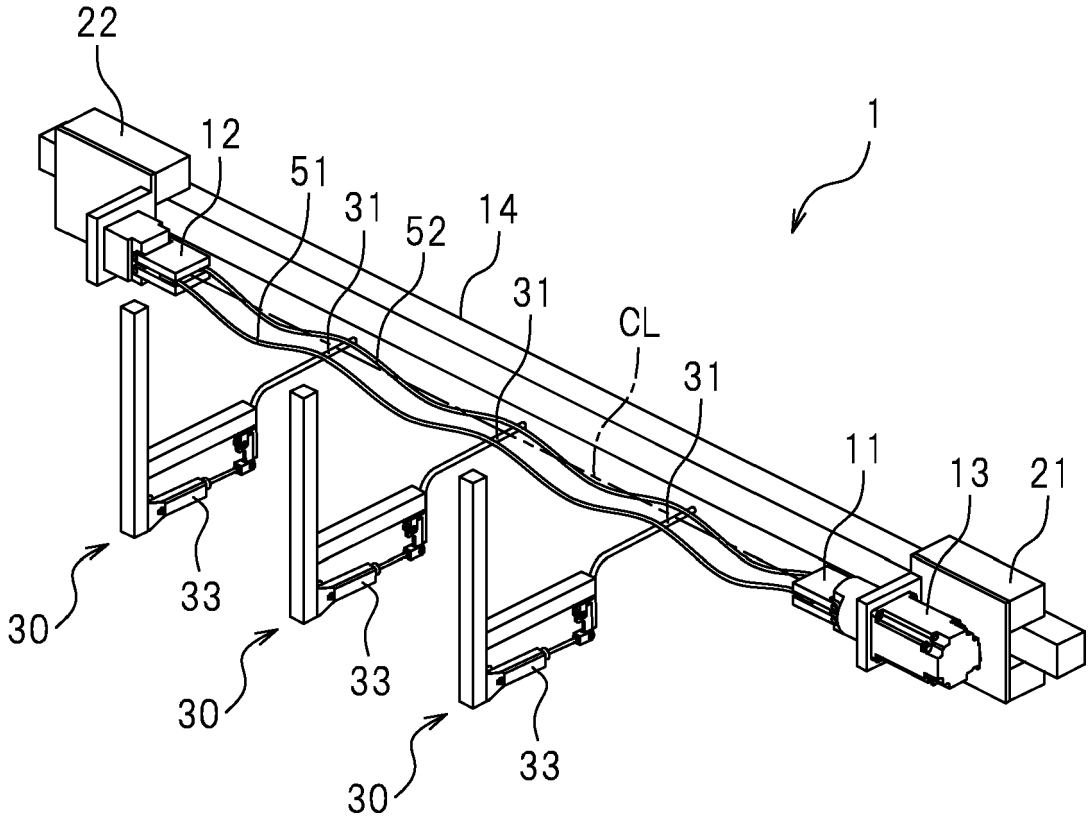


FIG.2

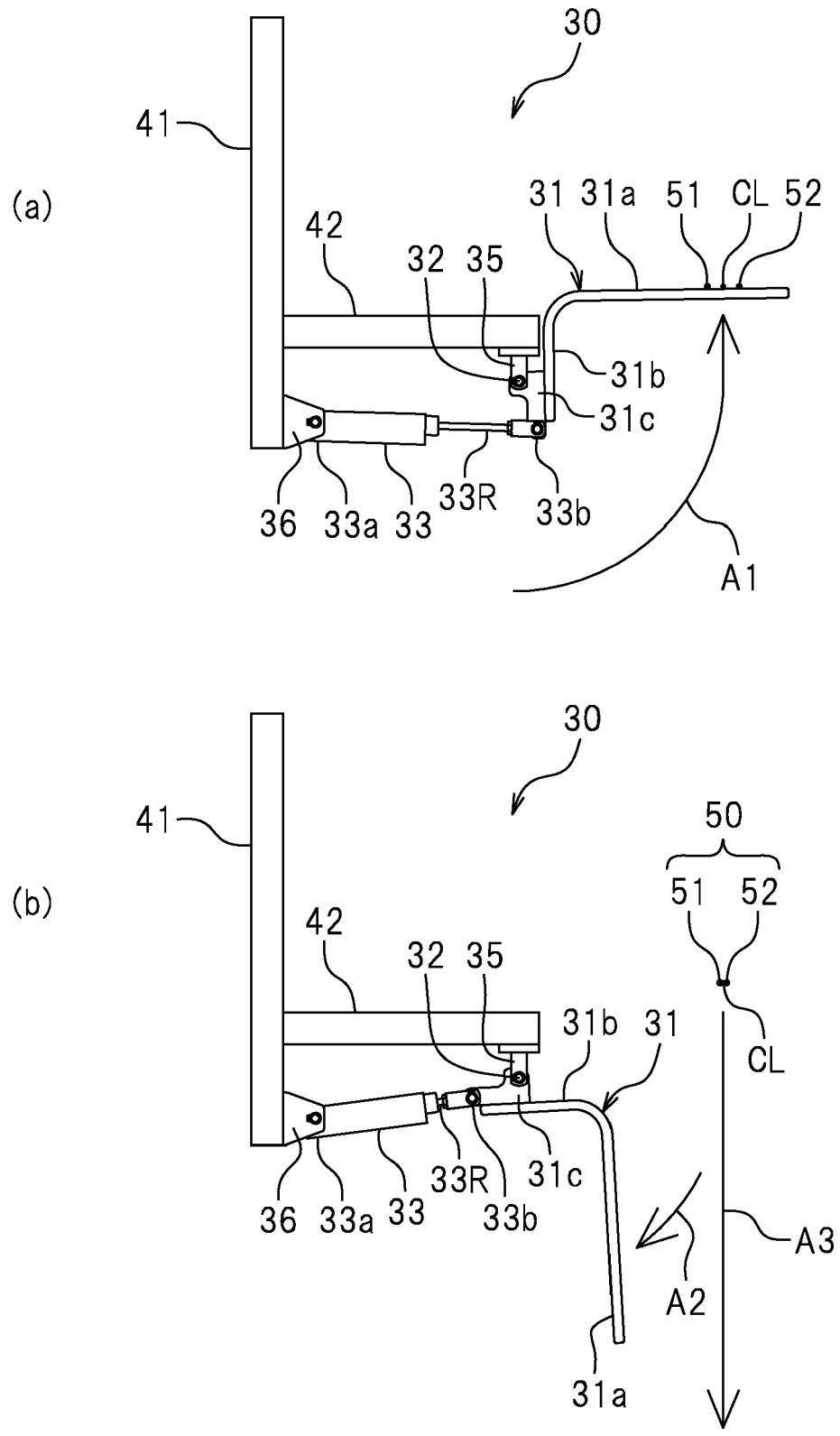

(a)
30
41
42
32
35
31
31a
51
CL
52
31b
31c
36
33a
33
33R
33b
A1
(b)
30
41
50
51
52
42
32
35
31b
31
CL
36
33a
33
33R
33b
31c
A3
A2
31a

FIG.3

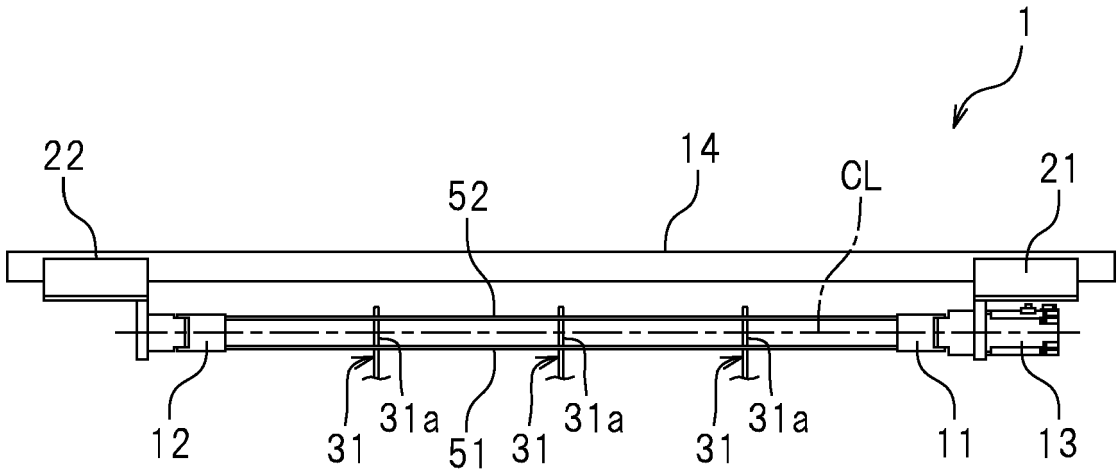

1
22
52
14
CL
21
12
31
31a
51
31
31a
31
31a
11
13

FIG.4

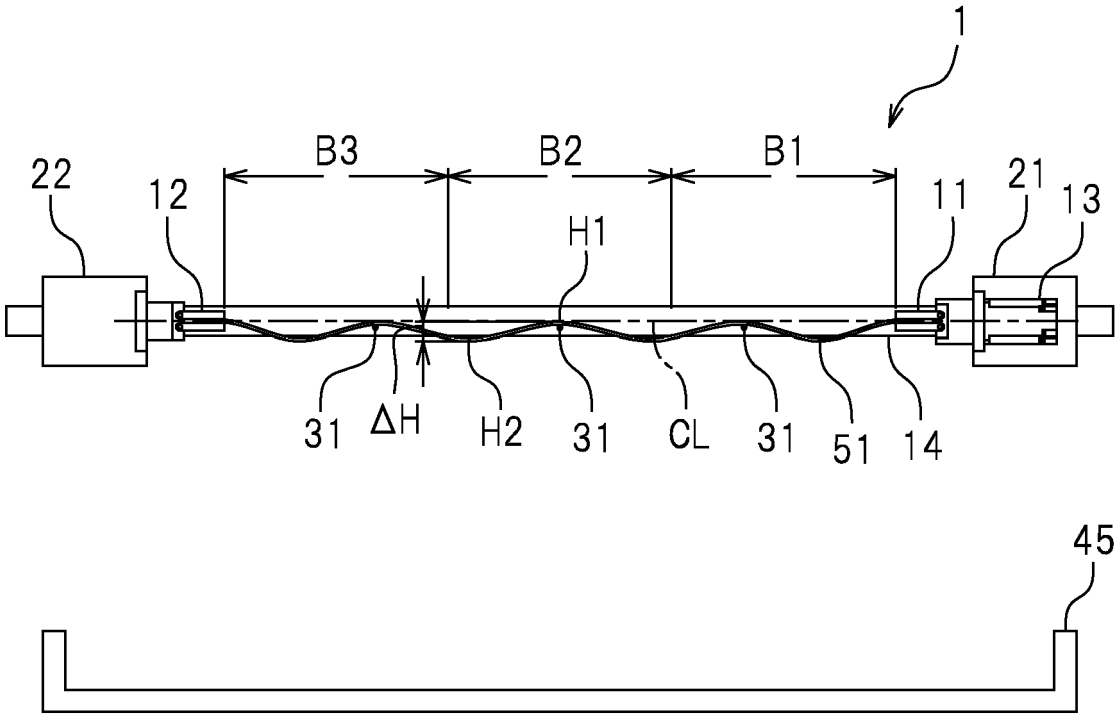

1
B3
B2
B1
22
12
H1
11
21
13
31
ΔH
H2
31
CL
31
51
14
45

FIG.5

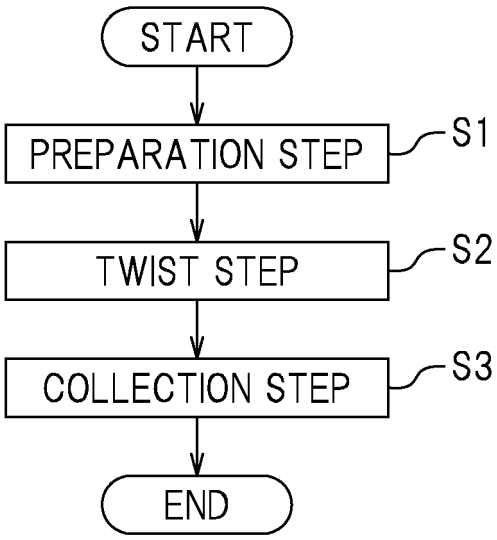

START
PREPARATION STEP
S1
TWIST STEP
S2
COLLECTION STEP
S3
END

FIG.6

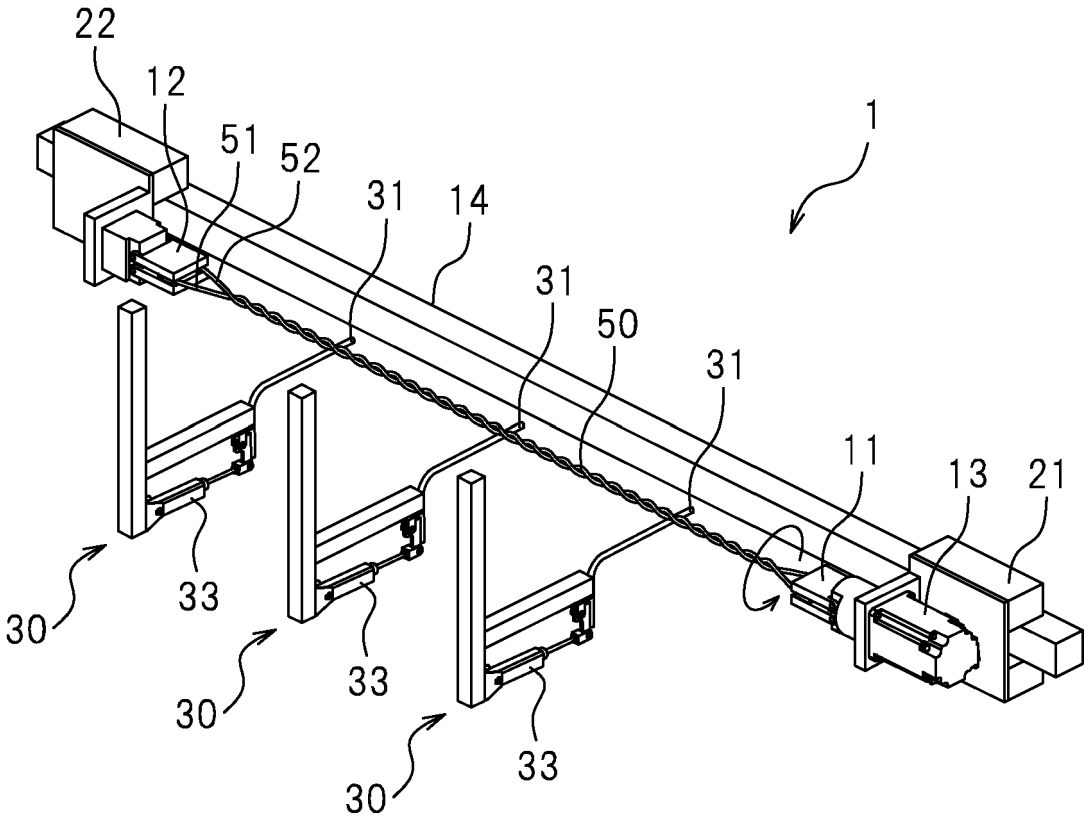

22
12
51
52
31
14
1
31
50
31
11
13
21
30
33
30
33
30
33

FIG.7

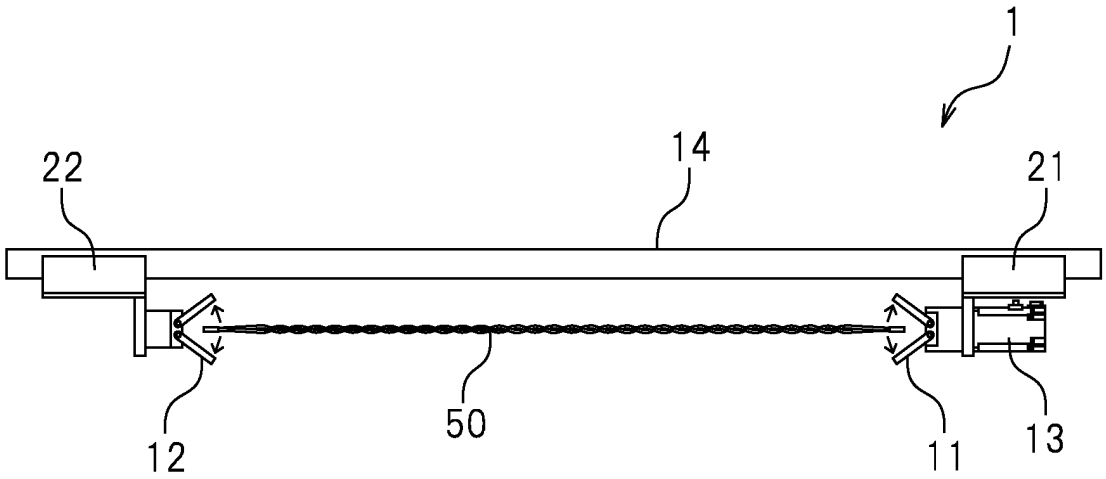


FIG.8

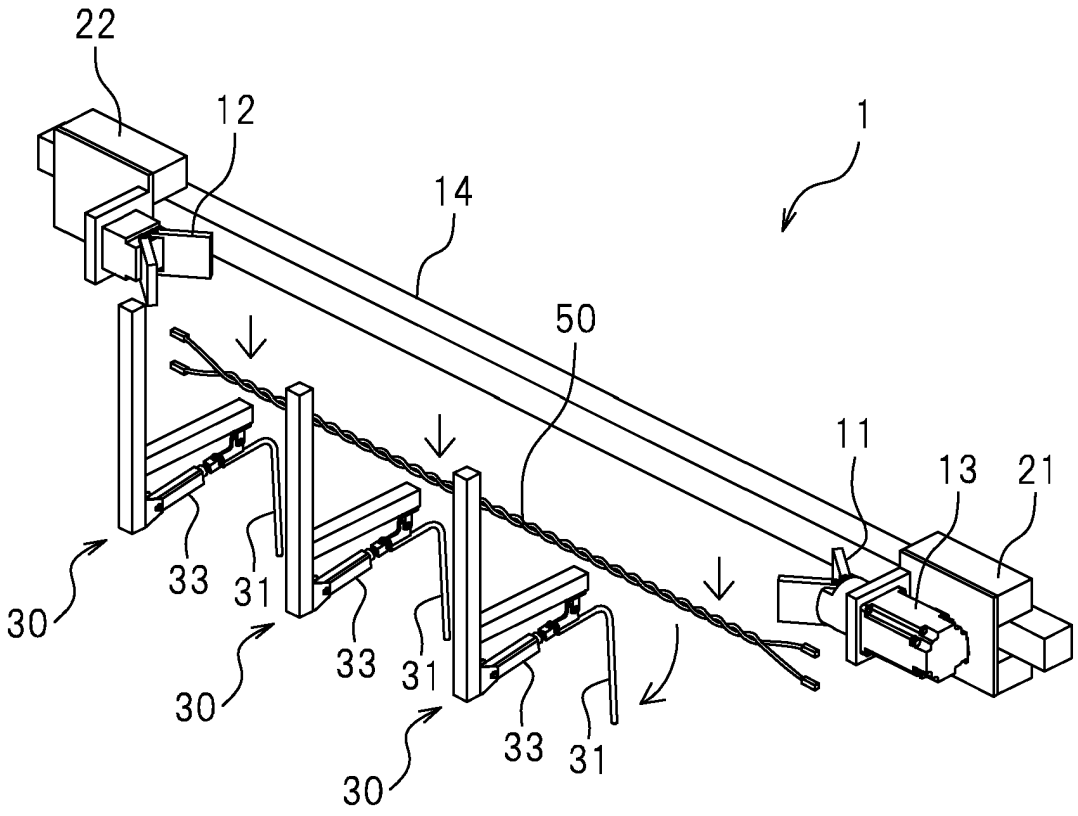


FIG.9

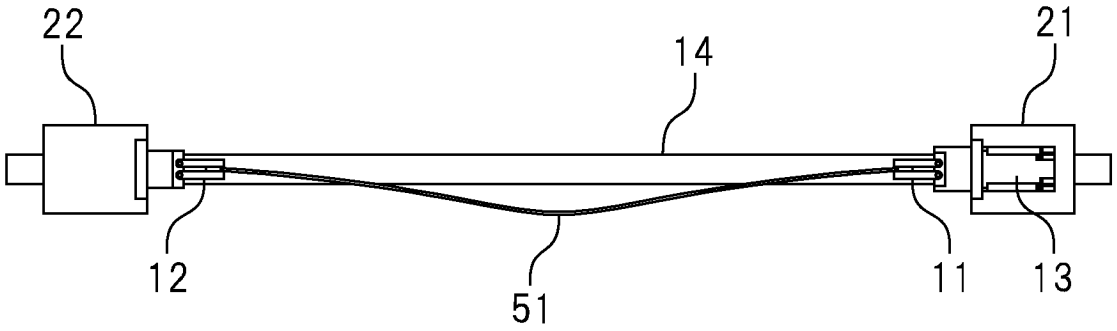

22
14
21
12
51
11
13

FIG.10

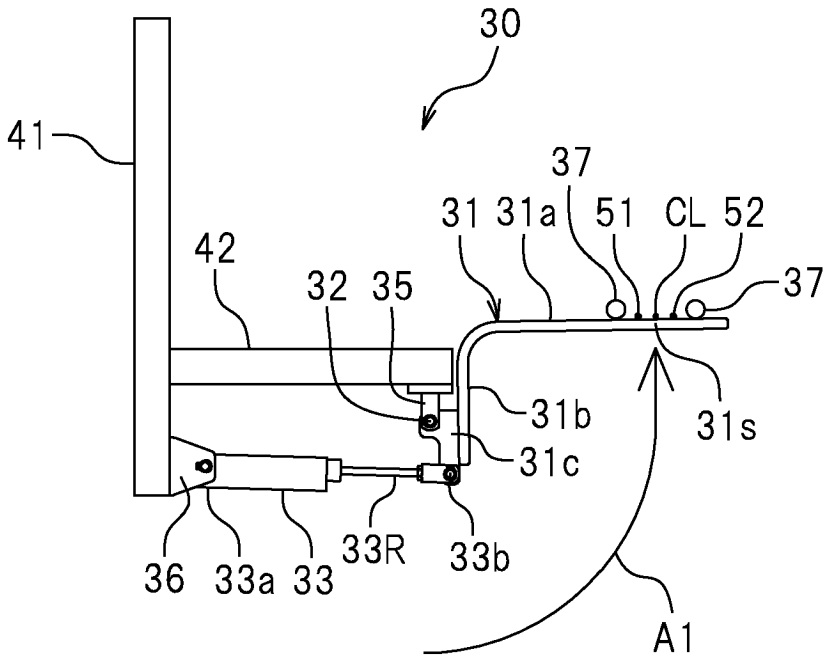
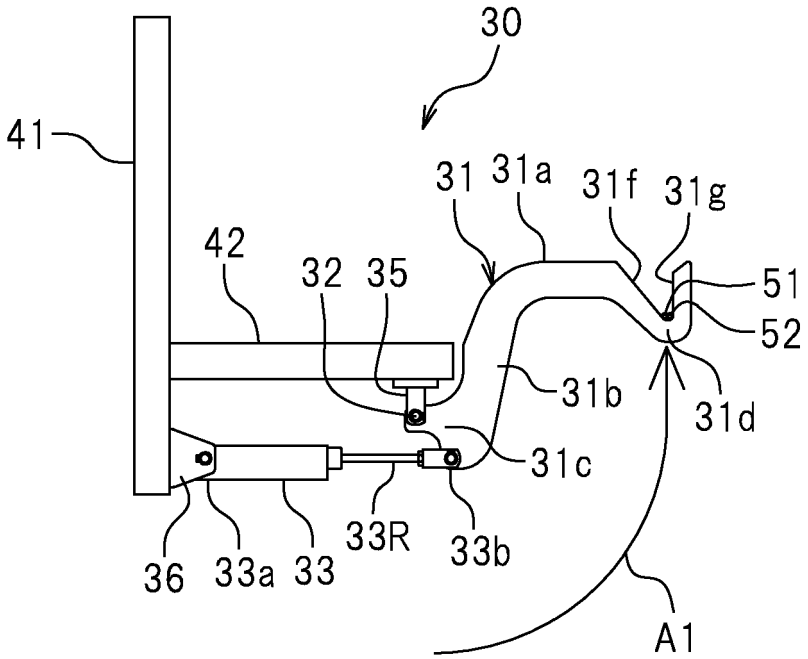

30
41
37
31
31a
51
CL
52
42
32
35
37
31b
31s
31c
36
33a
33
33R
33b
A1

FIG.11

(a)


30
41
31
31a
31f
31g
42
32
35
51
52
31b
31d
31c
36
33a
33
33R
33b
A1

(b)

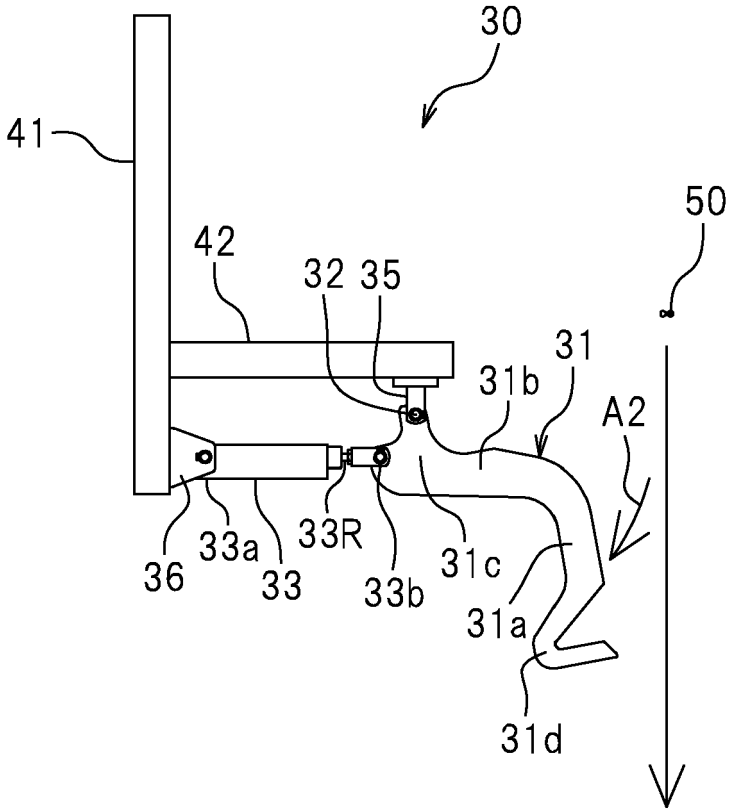
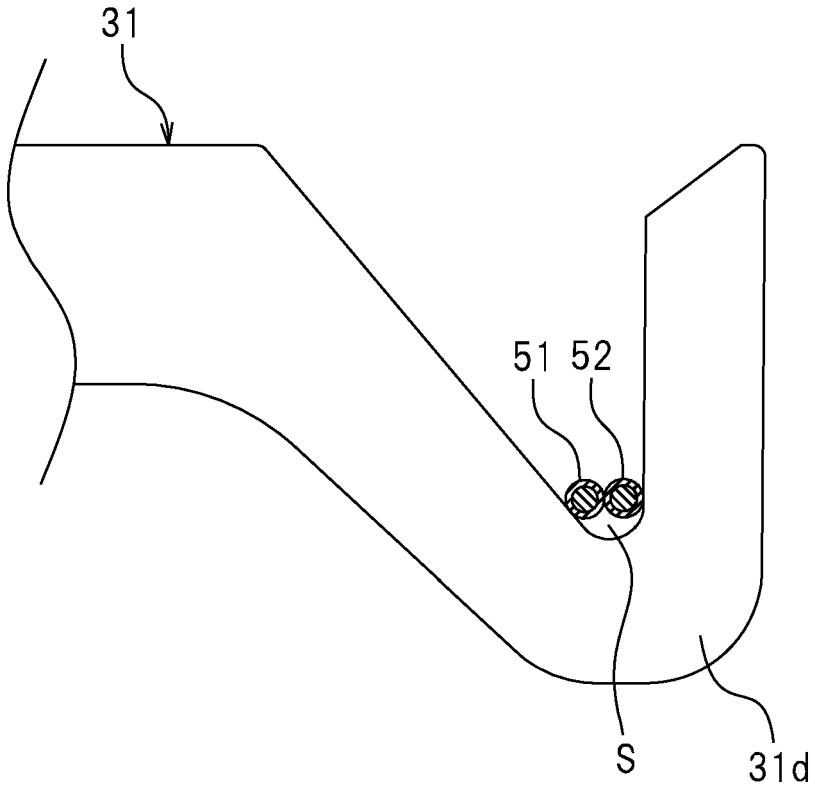

30
41
50
42
32
35
31
31b
A2
36
33a
33
33R
33b
31c
31a
31d

FIG.12



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2017010769 A **[0003]**
- DE 102016109151 B3 **[0003]**