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(54) WIRE WINDING DEVICE AND WIRE WINDING METHOD

(57) A wire winding device (9) provided with wire storing means (40) configured to draw a wire rod (6) delivered from a tip end of a flyer (30) as a stored wire and wire winding means (15) configured to wind the wire rod (6) supplied from the wire storing means (40) around a winding core (12a, 23), the wire winding device (9) includes: a nozzle (47) configured to be able to be divided along an axial core direction, the nozzle (47) being configured to be capable of, in a coupled state, holding the wire rod (6) that has been drawn out; and a divided-piece moving mechanism (48) configured to divide and couple divided pieces of the nozzle (47).

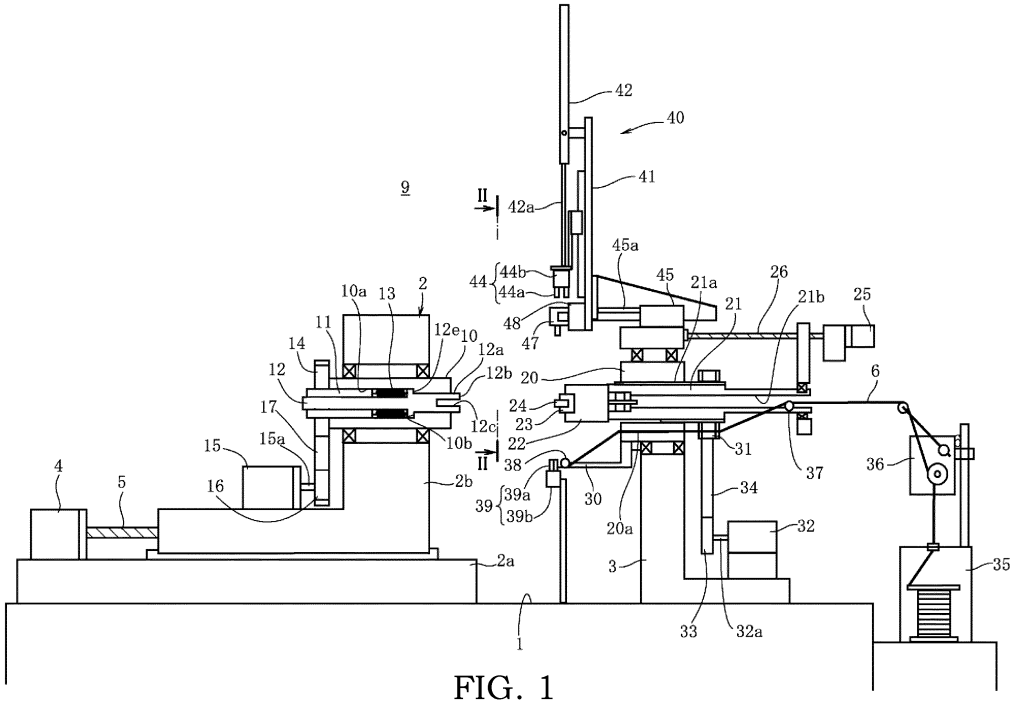

FIG. 1

EP 3 826 039 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to a wire winding device and a wire winding method in which a wire rod is wound once the wire rod is stored.

BACKGROUND ART

[0002] As a coil compatible with downsizing of motors, a so called alpha winding coil (or, also referred to as "the outer-outer winding" coil) in which a wire rod is tightly wound such that an unnecessary gap is not formed between winding layers and in which a winding starting end and a winding terminating end of the wire rod are provided on the same winding layer is known.

[0003] As the alpha winding coil, there is known a two-row spiral coil including first and second coils that are formed by winding the wire rod in a spiral and an inside crossover wire that links inner end portions of the first and second coils. As a wire winding device for such a two-row spiral coil, a device including wire storing means for linearly drawing and storing the wire rod is proposed (see JPH11-297559A).

[0004] In this wire winding device, in a stage before the wire winding, the wire rod delivered from a tip end of a flyer is linearly drawn out and stored as a stored wire. Subsequently, a first wire winding in which the flyer is revolved around a winding core such that the wire rod delivered from the tip end of the flyer is wound around the winding core is performed. Next, a second wire winding in which the winding core is rotated about its axis such that the wire rod supplied from the wire storing means is wound around the winding core is performed.

[0005] With this wire winding device, by guiding the wire rod from an outer winding of each of wire winding portions, it is possible to relatively easily manufacture the two-row spiral coil in which the winding starting end and the winding terminating end of the wire rod are drawn out from the same most-outer winding layer.

SUMMARY OF INVENTION

[0006] In the wire winding device disclosed in JPH11-297559A, the wire rod delivered from the tip end of the flyer is linearly drawn out as the stored wire, and therefore, the position of the wire rod that is to be wound on the winding core side is not restricted during a wire winding. If the wire rod is wound around the winding core in a state in which the winding core side position is not restricted as described above, there is a risk in that the wire rod is wound irregularly.

[0007] In order to prevent the irregular winding of the wire rod in a state in which restriction of the winding core side position is difficult, it is considered to reduce the length of the wire rod in the stored wire. However, if the length of the wire rod in the stored wire is reduced, coils formed become smaller in size, and it becomes difficult to manufacture relatively large coils.

[0008] Therefore, there is a problem in that the coils that may be manufactured by the wire winding device disclosed in JPH11-297559A are limited to those having relatively small size.

[0009] An object of the present invention is to provide a wire winding device and a wire winding method that are capable of achieving a winding of a wire rod without causing an irregular winding even if a coil is manufactured by winding relatively long wire rod.

[0010] According to one aspect of the present invention, a wire winding device provided with wire storing means configured to draw a wire rod delivered from a tip end of a flyer as a stored wire and wire winding means configured to wind the wire rod supplied from the wire storing means around a winding core, the wire winding device includes: a nozzle configured to be able to be divided along an axial core direction, the nozzle being configured to be capable of, in a coupled state, holding the wire rod that has been drawn out; and a divided-piece moving mechanism configured to divide and couple divided pieces of the nozzle.

[0011] According to another aspect of the present invention, a wire winding method includes: a wire storing step in which a wire rod delivered from a tip end of a flyer is drawn as a stored wire and a wire winding step in which the wire rod, which has been stored, is wound around a winding core, a wire rod holding step in which the wire rod that has been drawn out is held by a nozzle is performed after the wire storing step, and the wire winding step is performed after the wire rod holding step.

BRIEF DESCRIPTION OF DRAWINGS

[0012]

FIG. 1 is a front view showing a wire winding device according to a first embodiment of the present invention.

FIG. 2 is a sectional view taken along a line II-II in FIG. 1.

FIG. 3 is a sectional view corresponding to FIG. 2 and shows a state in which a wire rod, which has been stored, is wound around a winding core.

FIG. 4 is a front view showing a state in which the wire rod on the further proximal side than the wire rod, which has been stored, is wound around the winding core.

FIG. 5 is a front view corresponding to FIG. 4 and shows a state in which the wire rod, which has been stored, is wound around the winding core.

FIG. 6 is a top view showing a wire winding device according to a second embodiment of the present invention.

FIG. 7 is a front view showing a part of the wire winding device shown in FIG. 6 in a cross-section.

FIG. 8 is a sectional view taken along a line VIII-VIII

in FIG. 7 and shows wire storing means according to the second embodiment of the present invention.
FIG. 9 is an exploded configuration diagram showing a configuration around the winding core of the wire winding device according to the second embodiment of the present invention.
FIG. 10 is a top view showing a state in which the wire rod on the further proximal side than the wire rod, which has been stored, is wound around the winding core in the wire winding device according to the second embodiment of the present invention.
FIG. 11 is a top view corresponding to FIG. 10 and shows a state in which the wire rod, which has been stored, is wound around the winding core in the wire winding device according to the second embodiment of the present invention.

DESCRIPTION OF EMBODIMENTS

<First Embodiment>

[0013] A wire winding device 9 according to a first embodiment of the present invention will be described with reference to FIGs. 1 to 5.

[0014] As shown in FIG. 1, the wire winding device 9 includes a pair of spindles supporting bases 2 and 3 on a base 1. The one spindle supporting base 2 has a fixed base 2a that is fixed to the base 1 and a movable base 2b that is provided on the fixed base 2a. The movable base 2b is provided so as to be movable on the fixed base 2a in the front-rear direction (the left-to-right direction in FIG. 1) by a movable base drive motor 4 and a ball screw 5. In other words, the movable base 2b is movable in the direction towards the spindle supporting base 3 and in the direction away from the spindle supporting base 3.

[0015] On the movable base 2b, a hollow spindle 10 is supported so as to be freely rotatable about its axis via a bearing. A sleeve 11 is fixed to the proximal end side of a hollow portion 10a of the spindle 10. The proximal end side of a winding jig 12 is received in the sleeve 11 so as to be freely slidable in the axial direction.

[0016] A distal end portion 12a of the winding jig 12 is formed to have a substantially circular cross-sectional shape. The distal end portion 12a of the winding jig 12 projects out from the tip end side of the spindle 10 facing towards the spindle supporting base 3. The distal end portion 12a of the winding jig 12 forms a part of a winding core around which a wire rod 6 which will be described below is to be wound. A fitting recessed portion 12c is formed on a tip end surface 12b of the distal end portion 12a of the winding jig 12. The fitting recessed portion 12c is fitted (fitting at different diameters) to a fitting convex member 24 that is fixed to a winding jig 23 on the side of a flyer spindle 20, which will be described below, so as to be rotated integrally. By having such a configuration, the winding jig 12 and the winding jig 23 are rotated integrally.

[0017] A flange portion 12e is formed on a part of an outer circumference of the winding jig 12. A spring 13 is interposed between the flange portion 12e and a tip end of the sleeve 11. A step portion 10b is formed on an inner circumference of the hollow portion 10a of the spindle 10. The winding jig 12 is biased by the spring 13 in the direction towards the tip end of the spindle 10 until the flange portion 12e is brought into contact with the step portion 10b of the hollow portion 10a.

[0018] The sleeve 11 projects out from a proximal end of the spindle 10, and a gear 14 is fixed to this projected portion. A gear 16 is fixed to a driving shaft 15a of a spindle drive motor 15. A belt 17 is suspended over the gears 14 and 16. Thus, as the spindle drive motor 15 is driven, the spindle 10 is rotated together with the winding jig 12.

[0019] In the other spindle supporting base 3, the tubular flyer spindle 20 is freely rotatably supported via a bearing. An L-shaped flyer 30 is fixedly provided on the flyer spindle 20. A spline portion 21a, which is formed on an outer circumference of a rotating shaft 21, is coaxially spline-connected to an inner circumference of the flyer spindle 20. A winding jig support member 22 is coaxially supported by a tip end of the rotating shaft 21 via a bearing so as to be freely rotatable. The winding jig 23 forming a part of the winding core, around which the wire rod 6, which will be described below, is wound, is coaxially fitted to a tip end of the winding jig support member 22.

[0020] The winding jig 23 is formed to have a substantially circular cross-sectional shape having the diameter substantially the same as that of the distal end portion 12a of the winding jig 12 described above. The fitting convex member 24 is fixed to the winding jig 23 so as to project out from a tip end surface thereof. The winding jig 23, the flyer spindle 20, the rotating shaft 21, and the winding jig support member 22 are arranged so as to be coaxial with the above-described spindle 10. The winding jig 23 is arranged so as to oppose to the above-described winding jig 12 in the axial direction.

[0021] With such a configuration, as the movable base 2b is moved towards the spindle supporting base 3 side, the winding jig 23 comes into contact with and is fitted to the tip end surface 12b of the winding jig 12 such that the fitting convex member 24 and the fitting recessed portion 12c are rotated integrally. At this time, the winding jig 12 is pushed against the winding jig 23 by the spring 13. With such a configuration, the winding jig 23 is coupled to the winding jig 12 integrally.

[0022] The rotating shaft 21 that is coaxially spline-connected to the flyer spindle 20 is made movable by a sleeve drive motor 25 and a ball screw 26 in the axial direction with respect to the spindle supporting base 3.

[0023] The proximal end side of the spline portion 21a of the rotating shaft 21 projects out towards the rear side (the right side in FIG. 1) of the spindle supporting base 3, and this projected portion is spline-connected to a gear 31. In addition, a gear 33 is fixed to a driving shaft 32a of a drive motor 32. A belt 34 is suspended over these

gears 31 and 33. With such a configuration, as the rotating shaft 21 and the flyer spindle 20 are rotationally driven by the drive motor 32, a tip end portion of the flyer 30 is revolved around the winding jig 23.

[0024] A wire rod source 35 is arranged behind the spindle supporting base 3. After a predetermined tension is applied by a tension device 36 to the wire rod 6 delivered from the wire rod source 35, the wire rod 6 is guided to a hollow portion 21b in the rotating shaft 21 through the proximal end side and guided by being suspended over a pulley 37 that is provided in the hollow portion 21b. The wire rod 6 is then guided to the outside of the rotating shaft 21 through a hole formed in an outer circumferential surface of the rotating shaft 21 and is lead through the gear 31 to a through hole 20a that penetrates through the flyer spindle 20 in the axial direction. The wire rod 6 that has been drawn out from the through hole 20a is then guided to a pulley 38 provided at the tip end of the flyer 30.

[0025] A lower chuck device 39 is provided beside the flyer 30. The lower chuck device 39 has a main body portion 39b and a pair of clamping pieces 39a that are provided so as to project upwards from the main body portion 39b. The pair of clamping pieces 39a are opened/closed by a fluid pressure. The lower chuck device 39 holds the wire rod 6 by clamping a tip end of the wire rod 6 by the pair of clamping pieces 39a.

[0026] The wire winding device 9 includes wire storing means 40 that is provided above the spindle supporting base 3. The wire storing means 40 has a cylinder supporting base 41, a wire rod drawing cylinder 42, an upper chuck device 44, and a forward-backward driving cylinder 45.

[0027] The cylinder supporting base 41 is provided so as to be movable in the front-rear direction (the left-to-right direction in FIG. 1) with respect to the spindle supporting base 3. The cylinder supporting base 41 is attached with a rod 45a of the forward-backward driving cylinder 45. Thus, by driving the forward-backward driving cylinder 45, it is possible to move the cylinder supporting base 41.

[0028] The wire rod drawing cylinder 42 that is an air cylinder is attached to the cylinder supporting base 41. The wire rod drawing cylinder 42 has a rod 42a that extends downward. The upper chuck device 44 is fixed to a tip end (a lower end) of the rod 42a. The upper chuck device 44 is moved by the wire rod drawing cylinder 42 so as to be able to come closer to and move away from the winding core (the winding jig 23). The upper chuck device 44 has a main body portion 44b and a pair of clamping pieces 44a that are provided so as to project downward from the main body portion 44b. The pair of clamping pieces 44a are opened/closed by the fluid pressure. The upper chuck device 44 holds the wire rod 6 by clamping the wire rod 6 by the pair of clamping pieces 44a. The wire storing means 40 is configured such that the wire rod 6 is drawn upward and stored by holding the wire rod 6, which has been delivered from the tip end of the flyer 30, with the upper chuck device 44 and by moving the upper chuck device 44 away from the flyer 30 by lifting the upper chuck device 44 upward in the figure by the wire rod drawing cylinder 42 being contracted.

[0029] The wire winding device 9 in this embodiment includes: a nozzle 47 that is configured to be able to be divided along the axial core direction and that is capable of holding, in a coupled state, an end portion of the wire rod 6 that has been drawn out; and a divided-piece moving mechanism (a fluid pressure cylinder 48) that causes divided pieces 47b and 47c forming the left and right parts of the nozzle 47 (see FIGs. 2 and 3) to be divided to be separated and coupled with each other. The nozzle 47 in this embodiment is attached to the cylinder supporting base 41 via the divided-piece moving mechanism (the fluid pressure cylinder 48).

[0030] As shown in FIG. 3, the nozzle 47 has base portions 47d each formed of a hexahedron and tubular portions 47e that respectively project out from the base portions 47d. In the nozzle 47, a through hole 47a extending in the central axis direction of the tubular portions 47e is formed so as to penetrate through the tubular portions 47e and the base portions 47d. As shown in FIG. 2, the nozzle 47 is configured such that the tubular portions 47e and the base portions 47d are divided along the axial core direction of the through hole 47a. The nozzle 47 is attached to the cylinder supporting base 41 via the divided-piece moving mechanism (the fluid pressure cylinder 48) that divides and couples the divided pieces 47b and 47c forming the left and right parts of the nozzle 47.

[0031] The divided-piece moving mechanism in this embodiment is the fluid pressure cylinder 48 having a main body portion 48a and a pair of movable pieces 48b and 48c that are attached to the main body portion 48a and moved by the fluid pressure. The pair of movable pieces 48b and 48c are provided above the winding jig 23. As shown in FIG. 3, the main body portion 48a of the fluid pressure cylinder 48 is attached to the cylinder supporting base 41 so as to be able to clamp the wire rod 6 that has run through the winding jig 23 and extends in the vertical direction with the pair of movable pieces 48b and 48c from the both sides. The divided pieces 47b and 47c forming the left and right parts of the nozzle 47 are respectively attached to the pair of movable pieces 48b and 48c that are moved toward and away from each other by the fluid pressure of the fluid pressure cylinder 48.

[0032] In other words, the divided pieces 47b and 47c on the left and right sides are attached so as to be movable independently with each other to the left and right by the pair of movable pieces 48b and 48c. As shown in FIG. 2, the nozzle 47 is configured such that, in a state in which the divided pieces 47b and 47c on the left and right sides are separated, the wire rod 6 and the upper chuck device 44 holding the wire rod 6 can be inserted between the divided pieces 47b and 47c. By bringing opposing faces of the divided pieces 47b and 47c on the left and right sides into contact with each other in a state

in which the wire rod 6 is inserted between the divided pieces 47b and 47c on the left and right sides, as shown in FIG. 3, the wire rod 6 is received in the through hole 47a formed in the opposing faces. With such a configuration, the nozzle 47 holds the wire rod 6 so as to be movable in the longitudinal direction.

[0033] The nozzle 47 according to this embodiment is configured to be able to hold, in a case in which the wire rod 6 held by the upper chuck device 44 is drawn out by the contraction of the wire rod drawing cylinder 42, the flyer 30 side end portion of the wire rod 6 that has been drawn in and extends in the vertical direction as the upper chuck device 44 is moved away from the flyer 30.

[0034] Next, a wire winding method using the wire winding device 9 will be described.

[0035] As described above, the wire winding device 9 includes the wire storing means 40 that draws the wire rod 6, which has been delivered from the tip end of the flyer 30, as the stored wire and the nozzle 47 that is capable of holding the end portion of the wire rod 6 that has been drawn out. The wire winding method using the wire winding device 9 includes: a wire storing step in which the wire rod 6, which has been delivered from the tip end of the flyer 30, is drawn as the stored wire; a wire rod holding step in which the end portion of the wire rod 6 that has been drawn out is held by the nozzle 47 after the wire storing step; and a wire winding step in which the wire rod 6, which has been stored, is wound around the winding core (the distal end portion 12a of the winding jig 12) after the wire rod holding step.

[0036] In a case in which a coil to be obtained is a so called alpha winding coil (or, also referred to as "the outer-outer winding" coil) in which inner ends of the wire rod 6 are linked and a winding starting end and the winding terminating end of the wire rod 6 are placed on the most outer layer, another wire winding step in which, a portion of the wire rod 6, which has been delivered from the tip end of the flyer 30, on the further proximal side than a stored portion is wound around the winding core (the winding jig 23), is performed between the wire storing step and the wire winding step. These steps will be described below in detailed.

<Wire Storing Step>

[0037] A routing operation of the wire rod 6 to the wire winding device 9 is first performed. In the routing operation of the wire rod 6, as shown in FIG. 1, the wire rod 6 delivered from the wire rod source 35 is guided to the pulley 38 of the tip end of the flyer 30 via the tension device 36, the pulley 37, and the through hole 20a. Furthermore, the tip end portion of the wire rod 6 that has passed through the pulley 38 is set so as to be held by the lower chuck device 39.

[0038] Next, the wire rod drawing cylinder 42 of the wire storing means 40 is operated to lower the upper chuck device 44 at the tip end of the rod 42a to the vicinity of the lower chuck device 39. At this time, the winding jig 23 is moved backward together with the rotating shaft 21 by the sleeve drive motor 25 so as not to interfere with the lowering of the upper chuck device 44.

[0039] In addition, as shown in FIG. 2, the fluid pressure cylinder 48 that is the divided-piece moving mechanism separates the pair of movable pieces 48b and 48c to separate the divided pieces 47b and 47c forming the left and right parts of the nozzle 47 respectively attached thereto such that the upper chuck device 44 can be lowered and lifted between the movable pieces 48b and 48c.

[0040] After the upper chuck device 44 is lowered to the vicinity of the lower chuck device 39, the end portion of the wire rod 6 held by the lower chuck device 39 is caused to be held by the upper chuck device 44 by clamping the wire rod 6 by the pair of clamping pieces 44a. Subsequently, the wire rod 6 is released by the lower chuck device 39. Next, as shown by a solid line arrow in FIG. 2, the rod 42a of the wire rod drawing cylinder 42 is contracted to lift the upper chuck device 44 holding the end portion of the wire rod 6. By doing so, it is possible to draw the wire rod 6 from the tip end of the flyer 30 upward and to relatively easily store the wire rod 6 thus drawn as the stored wire. As described above, because the wire storing step is performed by moving the upper chuck device 44 holding the wire rod 6, which has been delivered from the tip end of the flyer 30, away from the flyer 30 to draw the wire rod 6 held by the upper chuck device 44, it is possible to relatively easily perform the wire storing.

<Wire Rod Holding Step>

[0041] In this step, the end portion of the wire rod 6, which has been drawn out in the wire storing step, is held by the nozzle 47. In the wire storing step, the nozzle 47 is in the divided state as shown in FIG. 2. The nozzle 47 is provided at a position capable of holding the end portion of the wire rod 6, which has been drawn in by lifting the upper chuck device 44 holding the end portion of the wire rod 6, in the vicinity of the flyer 30 (in other words, the flyer 30-side end portion of the wire rod 6 that is placed between the upper chuck device 44 that has been lifted up and the flyer 30). The fluid pressure cylinder 48 that is the divided-piece moving mechanism brings the pair of movable pieces 48b and 48c closer to each other, and as shown in FIG. 3, causes the divided pieces 47b and 47c on the left and right sides, which are respectively attached to the movable pieces 48b and 48c, to be coupled. By doing so, the wire rod 6 placed between the divided pieces 47b and 47c on the left and right sides is held by the coupled nozzle 47 so as to be movable in the longitudinal direction. As described above, the wire rod holding step is performed by coupling the nozzle 47 in the divided state at the flyer 30 side end portion of the wire rod 6 that has been drawn in.

<First Wire Winding Step>

[0042] A first wire winding step is a separate wire winding step from a second wire winding step, which will be described below. In the first wire winding step, the portion of the wire rod 6, which has been delivered from the tip end of the flyer 30, on the further proximal side than the stored portion is wound around the winding core (the winding jig 23).

[0043] Specifically, as in FIG. 1, the winding jigs 12 and 23 are moved in the direction in which they come to closer to each other by the movement of the movable base 2b by the movable base drive motor 4 and the movement of the rotating shaft 21 by the sleeve drive motor 25. At this time, by the forward movement of the wire storing means 40 by the forward-backward driving cylinder 45, the wire rod 6 extending from the wire storing means 40 is also moved forward by a distance corresponding to the moved distance of the winding jig 23.

[0044] As shown in FIG. 4, by doing so, the tip end surfaces of the winding jigs 12 and 23 are brought into contact with each other, and furthermore, the distal end portion 12a of the winding jig 12 pushed by the winding jig 23 is moved backward against the spring 13 to a position at which the winding jig 12 is fully received within the spindle 10. Thus, only the winding jig 23 is exposed as the winding core between the spindle 10 and the winding jig support member 22.

[0045] Next, the drive motor 32 (FIG. 1) is driven to cause the tip end of the flyer 30 to be revolved around the winding jig 23 as shown by solid line arrows in FIGs. 3 and 4. By doing so, the wire rod 6 further delivered from the tip end of the flyer 30, in other words, the portion of the wire rod 6 on the further proximal side than the stored portion, is wound around the outer circumference of the winding jig 23 until a predetermined number of turns is achieved.

[0046] At this time, the drive motor 32 (FIG. 1) configures first wire winding means (a separate wire winding means from a second wire winding means, which will be described below) that winds the portion of the wire rod 6, which has been delivered from the tip end of the flyer 30, on the further proximal side than the wire storing means 40 around the winding core (the winding jig 23). By doing so, a first-stage wire winding in the first wire winding step (the separate wire winding step from the second wire winding step) is performed on the winding jig 23.

[0047] As shown in FIG. 4, an escaping groove 10c is formed in the tip end surface of the spindle 10. The wire rod 6, which has been stored, is received in the escaping groove 10c, and thereby, an interference with the winding of the portion of the wire rod 6 on the further proximal side than the stored portion around the outer circumference of the winding jig 23 is prevented. Because the wire rod 6, which has been stored, is held by the upper chuck device 44 above the winding jig 23, the wire rod 6, which has been stored, is not drawn out when the flyer 30 is revolved, and the wire winding is performed correctly.

<Second Wire Winding Step>

[0048] In this step, as shown in FIG. 5, the wire rod 6, which has been stored, is wound around the winding core (the distal end portion 12a of the winding jig 12). When the above-described first wire winding step (the separate wire winding step from the second wire winding step) is performed, after the first-stage wire winding in the first wire winding step, the spindle 10 is moved backward from the winding jig 23 side together with the movement of the movable base 2b by the movable base drive motor 4 shown in FIG. 1. In other words, the spindle 10 is moved away from the winding jig 23. At this time, because the winding jig 12 is biased by the spring 13, the contact between the tip end surfaces of the winding jigs 12 and 23 is maintained. By doing so, as shown in FIG. 5, by the distance the spindle 10 has moved back, the distal end portion 12a of the winding jig 12 comes to project out from the tip end side of the spindle 10. The projected portion of the distal end portion 12a forms the winding core for a second stage wire winding in the wire winding step.

[0049] The second stage wire winding is performed by winding the wire rod 6, which has been stored on the wire storing means 40 side, around the outer circumference of the distal end portion 12a of the winding jig 12 until a predetermined number of turns is achieved by rotating the spindle 10 as shown by a broken line arrow in FIG. 5 by driving the spindle drive motor 15 (FIG. 1). At this time, the spindle drive motor 15 (FIG. 1) configures the second wire winding means that winds the wire rod 6 supplied from the wire storing means 40 around the winding core (the distal end portion 12a of the winding jig 12).

[0050] In this case, as shown by a solid line arrow in FIG. 5, the flyer 30 is also rotated in synchronization with the spindle 10 so as to keep a positional relationship between the flyer 30 and the winding jigs 12 and 23 constant.

[0051] In the second stage wire winding, the wire rod drawing cylinder 42 of the wire storing means 40 (FIG. 1) is set in a free state by switching a pneumatic circuit. Therefore, the upper chuck device 44 provided on the lower end of the rod 42a is in a state in which the upper chuck device 44 can be freely lowered as shown by a one-dot chain line arrow in FIG. 5. By doing so, the wire rod 6, which has been stored as the stored wire in the first-stage wire winding, is supplied for the wire winding as the upper chuck device 44 is lowered. By an air pressure caused when the air is discharged from a cylinder portion of the wire rod drawing cylinder 42 as the rod 42a is extended, a suitable tension is applied to the wire rod 6.

[0052] By performing such a wire winding, the wire rod 6 is wound around the distal end portion 12a of the winding jig 12. The wire rod 6 is held by the nozzle 47 in the vicinity of the distal end portion 12a of the winding jig 12. Therefore, the position of the distal end portion 12a of

the winding jig 12 that is the winding core of the wire rod 6 in the axial direction is restricted. If the wire rod 6 is not restricted, there is a risk in that the irregular winding of the wire rod 6 may be caused by the movement of the wire rod 6 in the axial direction of the distal end portion 12a of the winding jig 12. In contrast, in this embodiment, because the position of the wire rod 6 in the axial direction of the distal end portion 12a of the winding jig 12 is restricted, the irregular winding of the wire rod 6 is prevented from being caused.

[0053] As described above, once the first stage wire winding and the second stage wire winding are performed on the winding jig 23 and the distal end portion 12a of the winding jig 12, the end portion of the wire rod 6 is released from the upper chuck device 44, and the wire rod 6 is cut by a cutter device (not shown) on the flyer 30 side. Furthermore, by moving the winding jig 12 backward by the movement of the movable base 2b by the movable base drive motor 4 and by releasing the coupling with the winding jig 23, a completed coil formed by a so called alpha winding (or, also referred to as "the outer-outer winding") is ejected to terminate a series of wire winding operations.

<Second Embodiment>

[0054] A wire winding device 50 according to a second embodiment of the present invention will be described with reference to FIGs. 6 to 11.

[0055] As shown in FIGs. 6 and 7, similarly to the wire winding device 9 according to the above-described first embodiment, the wire winding device 50 according to the second embodiment includes a flyer 62 that delivers the wire rod 6 from a tip end. The wire winding device 50 includes a traversing mechanism 51 that moves the flyer 62 in the rotating axis direction thereof. In the second embodiment, the configuration of the wire winding device 50 will be described by setting three X-, Y-, and Z axes that are mutually orthogonal. In the figure, the X axis extends in the substantially horizontal transverse direction, the Y axis extends in the substantially horizontal front-rear direction, and the Z axis extends in the substantially vertical direction.

[0056] As shown in detail in FIG. 7, the traversing mechanism 51 includes: a transverse motor 52 that is provided on a base 50a; a ball screw 53 that is linked to an output shaft of the transverse motor 52 and that extends in the rotation-axis direction of the flyer 62; a movable body 54a to which the ball screw 53 is screwed; a guide rail 55 that is arranged on the base 50a so as to be in parallel with the ball screw 53 and that guides the movable body 54a; a movable body 54b that is guided by the guide rail 55; and a movable base 56 to which the movable bodies 54a and 54b are attached. As the transverse motor 52 is driven, the movable bodies 54a and 54b are guided by the guide rail 55 and the movable base 56 is moved in the X-axis direction.

[0057] A first head 57 is provided in an upright position on the movable base 56 that is provided on the base 50a so as to be movable in the X-axis direction. The first head 57 supports a proximal end side of a cylindrical first spindle shaft 59 via a bearing 58 so as to be freely rotatable and supports a first center body 61, which is not rotatable, in an inner circumference of the first spindle shaft 59 via bearings 60. An annular flange portion 59a is integrally provided on a tip end of the first spindle shaft 59, and the flyer 62 is attached to the flange portion 59a.

[0058] The flyer 62 is attached at a position that is decentered from the rotating axis of the first spindle shaft 59. A plurality of rollers 62a for guiding the wire rod 6 are provided on the flyer 62. A tubular body 62b that delivers the wire rod 6 is provided on a tip end of the flyer 62.

[0059] The movable base 56 is provided with a flyer rotating motor 66, and a pulley 67 is attached to an output shaft of the flyer rotating motor 66. A pulley 65 is attached at the vicinity of a tip end of the first spindle shaft 59, and the pulley 65 and the pulley 67 are linked via a belt 68. With such a configuration, as the flyer rotating motor 66 is driven, the first spindle shaft 59 is rotated, and the flyer 62 is rotated about the rotating axis of the first spindle shaft 59. A through hole 59b is formed in the first spindle shaft 59, to which the flyer 62 is attached, in the vicinity of the flyer 62 so as to extend in parallel with the rotating axis. The wire rod 6 is inserted through the through hole 59b. In other words, the wire rod 6 inserted through the through hole 59b is arranged so as to extend in parallel with the rotating axis of the flyer 62.

[0060] In the first center body 61, a through hole 61a is formed so as to be coaxial with the rotating axis of the first spindle shaft 59. A rod 69 is inserted through the through hole 61a. The rod 69 is spline-engaged with the through hole 61a so as to be movable in the rotation-axis direction of the flyer 62 and so as not to be rotatable relative to the first center body 61. With such a configuration, the rod 69 is configured to be movable relative to the first center body 61, and the winding core (a bobbin 71) is attached to a tip end of the rod 69.

[0061] As shown in FIGs. 9 and 10, the winding core in the second embodiment is the bobbin 71 in which three disc-shaped flanges 71b, 71c, and 71d are formed around a tubular winding body portion 71a so as to have predetermined gaps, and the flange 71c in the middle is formed with a notch 71e through which the wire rod 6 runs. The tip end of the rod 69 is provided with a lock mechanism 72 to which the bobbin 71 that is the winding core is attached.

[0062] The lock mechanism 72 is configured such that the bobbin 71 is clamped between a holding tool 73 and the tip end of the rod 69. The holding tool 73 includes a coupling shaft 73a a tip end thereof is engaged with the lock mechanism 72 and a holding plate 73b that is attached to a proximal end of the coupling shaft 73a. In a state in which the holding plate 73b is mounted to the tip end of the rod 69, the holding plate 73b holds the one flange 71b of the bobbin 71 from the outside.

[0063] The coupling shaft 73a is formed to have a cir-

cular column shape having an outer diameter slightly smaller than an inner diameter of the tubular winding body portion 71a of the bobbin 71 and is formed such that its length is longer than the whole length of the winding body portion 71a. An annular groove 73c is formed around a tip end of the coupling shaft 73a. The holding plate 73b is formed to have an outer diameter that is substantially the same as an outer diameter of the one flange 71b of the bobbin 71.

[0064] The lock mechanism 72 includes: a coupling hole 72a that is a hole bored along the axial center from the tip end of the rod 69 such that the coupling shaft 73a of the holding tool 73 can be inserted thereinto; a lateral hole 72b that is formed in the tip end portion of the rod 69 so as to intersects the coupling hole 72a; spheres 72c that are inserted into the lateral hole 72b and engage with the annular groove 73c in the coupling shaft 73a; a maneuvering member 72d that is fitted to the rod 69 so as to cause the spheres 72c to be inserted into/ejected from the annular groove 73c by moving in the axial direction; a spring 72e that biases the maneuvering member 72d in the direction in which the spheres 72c are inserted into the annular groove 73c; and so forth.

[0065] A slit 71f is formed in the winding body portion 71a of the bobbin 71 so as to extend in the axial direction from an edge portion of the winding body portion 71a. A protrusion 69a that can enter the slit 71f is formed on the rod 69. Therefore, as the tip end of the coupling shaft 73a inserted into the winding body portion 71a of the bobbin 71 is inserted into the coupling hole 72a and as the holding tool 73 is attached to the rod 69, the protrusion 69a enters the slit 71f and the rotation of the bobbin 71 relative to the rod 69 is prohibited.

[0066] As shown in FIG. 6, the wire winding device 50 is provided with a moving mechanism 75 that moves the bobbin 71 separately from the traversing mechanism 51. As shown in FIG. 7, the moving mechanism 75 moves the rod 69 having the bobbin 71 provided at the tip end thereof in the axial direction, and the moving mechanism 75 is supported by a frame 76 that is provided behind the first head 57 that is moved together with the movable base 56.

[0067] As shown in FIG. 7, the frame 76 is provided with a guide shaft 77 that extends in parallel with the rotating axis of the flyer 62. The guide shaft 77 is installed at the upper part in the frame 76 so as to be rotatable about the center axis thereof. A pulley 78a is attached to the first spindle shaft 59 supported by the first head 57 at a rear end portion of the first spindle shaft 59 behind the first head 57. A pulley 78b that is a separate pulley from the pulley 78a is attached to the guide shaft 77 so as not to be rotatable relative to the guide shaft 77. The pulley 78a and the pulley 78b are linked via a belt 78c. Therefore, as the first spindle shaft 59 is rotated, the guide shaft 77 is also rotated.

[0068] The moving mechanism 75 has a second head 79 substantially parallel with the first head 57, and the guide shaft 77 is inserted into the second head 79. The second head 79 is configured by being supported by the guide shaft 77 so as to be movable along the guide shaft 77. The second head 79 supports a cylindrical second spindle shaft 81 that is freely rotatable via a bearing 80 and supports a second center body 83 in an inner circumference of the second spindle shaft 81 so as not to be rotatable via a bearing 82.

[0069] A pulley 84 is attached to a rear end portion of the second spindle shaft 81. In addition, a pulley 85 is attached to a portion of the second head 79, at which the guide shaft 77 is inserted, so as to be rotatable and so as not to be movable in the axial direction relative to the second head 79. The pulley 85 is configured so as not to be rotatable and so as to be movable in the axial direction relative to the guide shaft 77. The pulley 84 and the pulley 85 are linked via a belt 86. With such a configuration, as the guide shaft 77 is rotated, the second spindle shaft 81 is also rotated.

[0070] The second spindle shaft 81 is provided such that its rotating axis is decentered from the rotating axis of the first spindle shaft 59. As the first spindle shaft 59 is rotated, the guide shaft 77 is also rotated, and therefore, by the rotation of the guide shaft 77, the second spindle shaft 81 is also rotated in synchronization with the rotation of the first spindle shaft 59. The second spindle shaft 81 is formed with a through hole 81a through which the wire rod 6 is inserted. In addition, a through hole 83a is formed in the second center body 83 so as to be coaxial with the through hole 61a of the first center body 61, and a rear end portion of the rod 69 is fixed to the through hole 83a so as not to be movable in the axial direction.

[0071] As described above, because the center axis of the first center body 61 and the center axis of the second center body 83 are linked so as to be decentered from each other, the rotation of each of the center bodies 61 and 83 is restricted, and so, the center bodies 61 and 83 are each prevented from being rotated.

[0072] A winding-core moving motor 87 is fixed to the movable base 56 covered by the frame 76, and a ball screw 88 parallel with the guide shaft 77 is linked to an output shaft of the winding-core moving motor 87. The movable base 56 is provided with a pivotably supporting member 89 that pivotably supports a rear end portion of the ball screw 88. The ball screw 88 is screwed with a lower part of the second head 79. With such a configuration, as the winding-core moving motor 87 is driven, the second head 79 is moved along the guide shaft 77, and the rod 69 fixed to the second center body 83 is also moved in the axial direction. As described above, with the moving mechanism 75, it is possible to move the bobbin 71 provided on the tip end of the rod 69 forward and backward by driving the winding-core moving motor 87.

[0073] As shown in FIGs. 6 to 8, similarly to the wire winding device 9 according to the above-described first embodiment, the wire winding device 50 according to the second embodiment includes a wire storing means 90 that draws the wire rod 6 delivered from the tip end of

the flyer 62 as the stored wire. The wire storing means 90 according to the second embodiment includes: a rail 91 that is provided so as to extend in the rotation-axis direction of the flyer 62; a chuck device 92 that is attached to the rail 91 so as to be movable; a pair of pulleys 93a and 93b that are respectively pivotably supported on both ends of the rail 91 via base plates 93c; a motor 94 that rotates the one pulley 93b; and a belt 95 that is suspended over the pair of pulleys 93a and 93b and attached with the chuck device 92.

[0074] The rail 91 is provided with a movable body 91a that is moved along the rail 91, and the chuck device 92 is provided on the movable body 91a. The chuck device 92 has a main body portion 92b and a pair of clamping pieces 92a that are provided so as to project downward from the main body portion 92b. The pair of clamping pieces 92a are opened/closed by the fluid pressure. The movable body 91a is attached to the belt 95 extending between the pair of pulleys 93a and 93b.

[0075] In the wire storing means 90, the motor 94 is driven to circulate the belt 95 in a state in which the end portion of the wire rod 6 is held by the chuck device 92. By doing so, as shown by a solid line arrow in FIG. 7, the chuck device 92 attached to the belt 95 is moved along the rail 91 so as to move away from the flyer 62 and the bobbin 71. Therefore, in the wire storing means 90, by driving the motor 94, it is possible to draw the wire rod 6 held by the chuck device 92 from the tip end of the flyer 62 as the stored wire.

[0076] The wire storing means 90 is attached to the base 50a via a three-axial moving device 96. The three-axial moving device 96 is configured to be able to move the wire storing means 90 in the three axial directions. The three-axial moving device 96 is configured by a combination of X-axis, Y-axis, and Z-axis direction extension/contraction actuators 97 to 99. The X-axis direction extension/contraction actuator 97 is configured such that followers 97c are moved by a ball screw 97b that is rotated by a motor 97a. The Y-axis direction extension/contraction actuators 98 are configured such that followers 98c are respectively moved by ball screws 98b that are respectively rotated by motors 98a. The Z-axis direction extension/contraction actuators 99 are configured such that followers 99c are respectively moved by ball screws 99b that are respectively rotated by motors 99a. A housing 97d of the X-axis direction extension/contraction actuator 97 is attached to the base 50a via an attachment base 96a that extends in the X-axis direction.

[0077] The pair of followers 97c of the X-axis direction extension/contraction actuator 97 are provided so as to have a predetermined interval therebetween, and the followers 98c of the Y-axis direction extension/contraction actuators 98 are respectively attached to the followers 97c. Housings 99d of the Z-axis direction extension/contraction actuators 99 are respectively attached to housings 98d of the Y-axis direction extension/contraction actuators 98. As described above, the pair of Z-axis direction extension/contraction actuators 99 are provided so as to have a predetermined interval in the X-axis direction, and the rail 91 of the wire storing means 90 is installed on the followers 99c of the pair of Z-axis direction extension/contraction actuators 99 so as to extend in the X-axis direction. The motors (servomotors) 97a to 99a of the respective extension/contraction actuators 97 to 99 are connected to a controller (not shown) and they are controlled on the basis of a control signal from the controller.

[0078] In addition, the wire winding device 50 according to the second embodiment includes: the nozzle 47 that is configured to be able to be divided along the axial core direction (in other words, the X-axis direction) and that is capable of holding, in a coupled state, the end portion of the wire rod 6 that has been drawn out; and the divided-piece moving mechanism (the fluid pressure cylinder 48) that causes the divided pieces 47b and 47c forming the left and right parts of the nozzle 47 to be divided to be separated and coupled with each other. The nozzle 47 and the divided-piece moving mechanism (the fluid pressure cylinder 48) in the second embodiment are the same as those in the above-described first embodiment, and repetitive description thereof is omitted. The nozzle 47 and the divided-piece moving mechanism (the fluid pressure cylinder 48) in the second embodiment are attached to the base 50a via a nozzle moving mechanism 100.

[0079] The nozzle moving mechanism 100 is configured by a combination of X-axis, Y-axis, and Z-axis direction extension/contraction actuators 101 to 103. The X-axis direction extension/contraction actuator 101 is configured such that a follower 101c is moved by a ball screw 101b that is rotated by a motor 101a. The Y-axis direction extension/contraction actuator 102 is configured such that a follower 102c is moved by a ball screw 102b that is rotated by a motor 102a. The Z-axis direction extension/contraction actuator 103 is configured such that a follower 103c is moved by a ball screw 103b that is rotated by a motor 103a.

[0080] The divided-piece moving mechanism (the fluid pressure cylinder 48) provided with the nozzle 47 is attached to a one end portion of an extension plate 104 that extends in the X-axis direction. The nozzle 47 is provided on an upper part of the divided-piece moving mechanism (the fluid pressure cylinder 48), and the divided pieces 47b and 47c of the nozzle 47 are arranged so as to be separable in the Y-axis direction. In addition, the nozzle 47 is arranged such that, in a state in which the divided pieces 47b and 47c are coupled, the through hole 47a faces the X axis. In other words, the divided-piece moving mechanism (the fluid pressure cylinder 48) is attached to the one end portion of the extension plate 104 such that the through hole 47a faces the X axis. Other end portion of the extension plate 104 is attached to the follower 101c of the X-axis direction extension/contraction actuator 101 that is movable in the X-axis direction.

[0081] A housing 101d of the X-axis direction extension/contraction actuator 101 is attached to the follower

103c of the Z-axis direction extension/contraction actuator 103 such that the extension plate 104 is movable in Z the axial direction together with the X-axis direction extension/contraction actuator 101.

[0082] In addition, a housing 103d of the Z-axis direction extension/contraction actuator 103 is attached to the follower 102c of the Y-axis direction extension/contraction actuator 102 such that the extension plate 104 is movable in the Y-axis direction together with the Z-axis and X-axis direction extension/contraction actuators 101 and 103. A housing 102d of the Y-axis direction extension/contraction actuator 102 then extends in the Y-axis direction and is fixed to the base 50a.

[0083] By moving the chuck device 92 away from the bobbin 71, the wire rod 6 is drawn out from the tip end of the flyer 62. In a state in which the divided pieces 47b and 47c of the nozzle 47 are separated, the nozzle moving mechanism 100 moves the nozzle 47 to a position at which the wire rod 6 that has been drawn out and extends in the X-axis direction can be clamped by the divided pieces 47b and 47c. Subsequently, the divided-piece moving mechanism (the fluid pressure cylinder 48) couples the divided pieces 47b and 47c, and thereby, the wire rod 6 that has been drawn out and extends in the X-axis direction is held by the nozzle 47.

[0084] Next, the wire winding method using the wire winding device 50 will be described.

[0085] The wire winding device 50 includes the wire storing means 90 that draws the wire rod 6 as the stored wire and the nozzle 47 that is capable of holding the flyer 62 side end portion of the wire rod 6 that has been drawn out. The wire winding method using the wire winding device 50 has: the wire storing step in which the wire rod 6 delivered from the tip end of the flyer 62 is drawn out as the stored wire; the wire rod holding step in which the flyer 62 side end portion of the wire rod 6 that has been drawn out is held by the nozzle 47 after the wire storing step; and the wire winding step in which the wire rod 6, which has been stored, is wound around the winding core (the bobbin 71).

[0086] Furthermore, a separate wire winding step in which a portion of the wire rod 6 delivered from the tip end of the flyer 62 on the further proximal side than the stored portion is wound around the winding core (the bobbin 71) is performed between the wire storing step and wire winding step. By doing so, it becomes possible to obtain a so called alpha winding coil (or, also referred to as "the outer-outer winding" coil) in which the inner ends of the wire rod 6 are linked and the winding starting end and the winding terminating end of the wire rod 6 are placed on the most outer layer. These steps are described in detail below.

<Wire Storing Step>

[0087] The routing operation of the wire rod 6 to the wire winding device 50 is first performed. As shown in FIG. 7, in the routing operation of the wire rod 6, the wire rod 6 supplied from the wire rod source (not shown) is allowed to run through, via a tension device (not shown), the through hole 81a of the second spindle shaft 81, and the through hole 59b of the first spindle shaft 59 in this order from the behind the frame 76. The wire rod 6 is then guided to the tubular body 62b at the tip end of the flyer 62 via a plurality of rollers 62a provided on the flyer 62. The wire rod 6 delivered from the tubular body 62b is then held by the chuck device 92 of the wire storing means 90.

[0088] The chuck device 92 holds the wire rod 6 in a state in which the chuck device 92 is approached to the flyer 62, and subsequently, the motor 94 of the wire storing means 90 is driven to circulate the belt 95, and the chuck device 92 attached to the belt 95 is moved away from the flyer 62 along the rail 91 as shown by the solid line arrow in FIG. 7. By doing so, the wire rod 6 held by the chuck device 92 is drawn in from the tip end of the flyer 62 as the stored wire.

[0089] In the wire storing step, the nozzle 47 is moved by the nozzle moving mechanism 100 to a standby position at which the nozzle 47 is moved away from a moving path of the chuck device 92.

<Wire Rod Holding Step>

[0090] In this step, the end portion of the wire rod 6, which has been drawn out in the wire storing step, is held by the nozzle 47. Specifically, as shown in FIG. 10, the divided pieces 47b and 47c of the nozzle 47 are separated, as shown by one-dot chain lines, by the fluid pressure cylinder 48 that is the divided-piece moving mechanism. In a state in which the divided pieces 47b and 47c are separated, the nozzle 47 is then moved by the nozzle moving mechanism 100 to a position in the vicinity of the flyer 62 at which the flyer 62 side end portion of the wire rod 6 extending in the X-axis direction can be clamped by the divided pieces 47b and 47c.

[0091] The divided pieces 47b and 47c of the nozzle 47 are moved closer to each other and coupled by the fluid pressure cylinder 48 that is the divided-piece moving mechanism, as shown by broken line arrows. By doing so, the wire rod 6 that has been drawn out and extends in the X-axis direction is held so as to be movable in the longitudinal direction by being inserted through the through hole 47a of the nozzle 47 that has been coupled. As described above, the wire rod holding step is performed by coupling the nozzle 47 in the divided state at the flyer 62 side end portion of the wire rod 6 that has been drawn in.

<First Wire Winding Step>

[0092] The first wire winding step is the separate wire winding step from the second wire winding step, which will be described below. In the first wire winding step, the portion of the wire rod 6 delivered from the tip end of the flyer 62 on the further proximal side than the stored por-

tion is wound around the winding core (the bobbin 71).

[0093] Specifically, the flyer rotating motor 66 shown in FIG. 7 is driven to rotate the first spindle shaft 59 shown in FIG. 10 as shown by a solid line arrow, and thereby, the flyer 62 provided on the first spindle shaft 59 is revolved around the bobbin 71. By doing so, the wire rod 6 further delivered from the tip end of the flyer 62, in other words, the wire rod 6 on the further proximal side than the stored portion of the wire rod 6 is wound around the bobbin 71 until a predetermined number of turns is achieved.

[0094] At this time, the flyer rotating motor 66 configures the first wire winding means (a separate wire winding means from the second wire winding means, which will be described below) that winds the portion of the wire rod 6 delivered from the tip end of the flyer 62 on the further proximal side than the wire storing means 90 around the winding core (the bobbin 71).

[0095] In the second embodiment, the winding core is the bobbin 71 that is formed with the three flanges 71b, 71c, and 71d around the winding body portion 71a. In the first-stage wire winding in the first wire winding step (the separate wire winding step from the second wire winding step), the wire rod 6 is wound around the winding body portion 71a between the pair of flanges 71c and 71d on the first spindle shaft 59 side, and the movement of the winding core (the bobbin 71) in the axial direction is achieved by the moving mechanism 75 (see FIG. 7).

<Second Wire Winding Step>

[0096] In this step, the wire rod 6, which has been stored, is wound around the bobbin 71. In the second stage wire winding in the second wire winding step, the wire rod 6 is wound around the winding body portion 71a between the pair of flanges 71b and 71c on the wire storing means 90 side. In the second embodiment, as shown in FIG. 11, the wire rod 6, which has been stored, is wound around the bobbin 71 by revolving, by the nozzle moving mechanism 100, the nozzle 47 that is holding the wire rod 6 so as to be movable by the coupled divided pieces 47b and 47c around the bobbin 71 that is the winding core.

[0097] As described above, the nozzle moving mechanism 100 configures the second wire winding means that winds the wire rod 6 supplied from the wire storing means 90 around the winding core (the bobbin 71) by revolving the nozzle 47 in the coupled state around the winding core (the bobbin 71).

[0098] In this wire winding step, the bobbin 71 is placed so as to project out from the first spindle shaft 59 by the moving mechanism 75 (see FIG. 7), and thereby, an interference of the flyer 62 provided on the first spindle shaft 59 with the nozzle 47 revolving around the bobbin 71 is prevented.

[0099] By revolving the nozzle 47 around the bobbin 71 that is not rotated and fixed as described above as shown by a solid line arrow in FIG. 11, the chuck device 92 holding the end portion of the wire rod 6 approaches the nozzle 47 as shown by a broken line arrow in the wire storing means 90 (see FIG. 7), and the wire rod 6 that has passed through the nozzle 47 is sequentially wound around the bobbin 71 that is the winding core.

[0100] Upon the delivery of the stored wire, motor control means (not shown) for controlling the motor 94 of the wire storing means 90 shown in FIG. 7 controls the rotation of the motor 94 in the counter direction as a result of the approach of the chuck device 92 towards the nozzle 47, and thereby, a suitable tension is applied to the wire rod 6 that passes through the nozzle 47 and that is wound around the bobbin 71.

[0101] By performing such a wire winding, the wire rod 6 is wound around the bobbin 71 that is the winding core. In this wire winding, the wire rod 6 is held by the nozzle 47 around the bobbin 71. Therefore, the position of the wire rod 6 in the axial direction of the bobbin 71 is restricted. If the wire rod 6 is not restricted, there is a risk in that the irregular winding of the wire rod 6 may be caused by the movement of the wire rod 6 in the axial direction of the bobbin 71. In contrast, in this embodiment, because the position of the wire rod 6 in the axial direction of the bobbin 71 is restricted, the irregular winding of the wire rod 6 is prevented from being caused.

[0102] In addition, in this embodiment, because the wire storing is performed by moving the chuck device 92 holding the wire rod 6 delivered from the tip end of the flyer 62 away from the flyer 62 and by drawing the wire rod 6 held by the chuck device 92, it is possible to perform the wire storing relatively easily. Furthermore, because the nozzle 47 can be moved by the nozzle moving mechanism 100, it is possible to control the position of the wire rod 6 in the axial direction of the winding core (the bobbin 71), and so, it is possible to achieve a versatility of the wire winding.

[0103] After the bobbin 71 that is the winding core is subjected to the first stage wire winding and the second stage wire winding, the end portion of the wire rod 6 is released from the chuck device 92, and the wire rod 6 is cut by the cutter device (not shown) at the flyer 62 side. Subsequently, the lock mechanism 72 is released, and the bobbin 71 that is the winding core around which the wire rod 6 is wound is removed and ejected from the tip end of the rod 69, and thereby, a series of wire winding operations are terminated.

[0104] As described above, the wire winding device 9, 50 is the wire winding device provided with the wire storing means 40, 90 configured to draw the wire rod 6, delivered from the tip end of the flyer 30, 62, as the stored wire and the wire winding means (the spindle drive motor 15, the nozzle moving mechanism 100) configured to wind the wire rod 6 supplied from the wire storing means 40, 90 around the winding core (the distal end portion 12a of the winding jig 12, the bobbin 71), and the wire winding device 9, 50 includes the nozzle 47 configured to be able to be divided along the axial core direction, the nozzle 47 being configured to be capable of, in the

coupled state, holding the wire rod 6 that has been drawn out; and the divided-piece moving mechanism (the fluid pressure cylinder 48) configured to divide and couple the divided pieces 47b and 47c of the nozzle 47.

[0105] The wire storing means 40, 90 in this case includes the chuck device 44, 92, configured to move so as to be able to come closer to and move away from the winding core (the distal end portion 12a of the winding jig 12, the winding jig 23, and the bobbin 71), the wire storing means 40, 90 is configured to store the wire rod 6 by holding the wire rod 6 by the chuck device 44, 92 and by moving the chuck device 44, 92 away from the flyer 30, 62, the wire rod 6 being delivered from the tip end of the flyer 30, 62, and it is preferable that the nozzle 47 be provided so as to be able to hold the flyer 30, 62 side end portion of the wire rod 6 that has been drawn in as the chuck device 44, 92 is moved away from the flyer 30, 62.

[0106] In addition, the wire winding device 9, 50 may further includes the nozzle moving mechanism 100 configured to move the nozzle 47. The nozzle moving mechanism 100 may also configure the wire winding means, the wire winding means being configured to be able to revolve the nozzle 47 in the coupled state around the winding core (the bobbin 71), the wire winding means being configured to wind the wire rod 6 supplied from the wire storing means 90 around the winding core (the bobbin 71). It is preferable that the wire winding device 9, 50 further includes another wire winding means (the drive motor 32, the flyer rotating motor 66) configured to wind the portion of the wire rod 6, delivered from the tip end of the flyer 30, 62, on the further proximal side than the wire storing means 40, 90 around the winding core (the winding jig 23, the bobbin 71).

[0107] On the other hand, the wire winding method is the wire winding method including the wire storing step in which the wire rod 6, delivered from the tip end of the flyer 30, 62, is drawn as the stored wire and the wire winding step in which the wire rod 6, which has been stored, is wound around the winding core (the distal end portion 12a of the winding jig 12, the bobbin 71), wherein the wire rod holding step in which the wire rod 6 that has been drawn out is held by the nozzle 47 is performed after the wire storing step, and the wire winding step is performed after the wire rod holding step.

[0108] The wire storing step is performed by moving the chuck device 44, 92 holding the wire rod 6, delivered from the tip end of the flyer 30, 62, away from the flyer 30, 62 and by drawing the wire rod 6 held by the chuck device 44, 92, and the wire rod holding step is performed by using the nozzle 47 configured to be able to be divided along the axial core direction and by coupling the nozzle 47 in the divided state at the flyer 30, 62 side end portion of the wire rod 6 that has been drawn in.

[0109] It is preferable that the wire winding step be performed by winding the wire rod 6, which has been stored, around the winding core (the bobbin 71) by revolving the nozzle 47 around the winding core (the bobbin 71). In addition, it is preferable that the other wire winding step in which the portion of the wire rod 6, delivered from the tip end of the flyer 30, 62, on the further proximal side than the stored portion is wound around the winding core (the winding jig 23, the bobbin 71) is performed between the wire storing step and the wire winding step.

[0110] With the wire winding device 9, 50 and the wire winding method as described above, because the nozzle 47 that is configured to be able to be divided and that is capable of holding, in the coupled state, the wire rod 6 that has been drawn out and the divided-piece moving mechanism (the fluid pressure cylinder 48) that divides and couples the divided pieces 47b and 47c of the nozzle 47 are provided, by holding, after the wire storing, the end portion of the wire rod 6 that has been drawn out on the side of the winding core (the distal end portion 12a of the winding jig 12, the winding jig 23, and the bobbin 71) by the nozzle 47, it is possible to restrict the position of the wire rod 6, which has been stored, on the side wound around the winding core (the distal end portion 12a of the winding jig 12, the winding jig 23, and the bobbin 71) by the nozzle 47. As a result, it is possible to prevent the irregular winding of the wire rod 6 due to unrestricted position of the wire rod 6 on the side of the winding core. In other words, with the wire winding device 9, 50 and the wire winding method as described above, it is possible to wind the wire rod 6 without causing the irregular winding even if the coil is manufactured by winding relatively long wire rod 6.

[0111] By performing the wire storing by moving the chuck device 44, 92 holding the wire rod 6 away from the flyer 30, 62, it is possible to perform the wire storing relatively easily. In addition, by moving the nozzle 47 by the nozzle moving mechanism 100, it becomes possible to control the position of the wire rod 6 on the side of the winding core, and so, not only a spiral coil, but also a helical coil can be produced, and thus, a versatility of the wire winding can be achieved. By revolving the nozzle 47 around the winding core (the bobbin 71), it is also possible to wind the wire rod 6, which has been stored, around the winding core (the bobbin 71). Furthermore, by winding the portion of the wire rod 6 on the further proximal side than the stored portion around the winding core (the winding jig 23, the bobbin 71), it is also possible to easily manufacture a so called alpha winding coil (or, also referred to as "the outer-outer winding" coil).

[0112] Embodiments of this invention were described above, but the above embodiments are merely examples of applications of this invention, and the technical scope of this invention is not limited to the specific constitutions of the above embodiments.

[0113] This application claims priority based on Japanese Patent Application No.2018-135687 filed with the Japan Patent Office on July 19, 2018, the entire contents of which are incorporated into this specification.

Claims

1. A wire winding device provided with wire storing means configured to draw a wire rod delivered from a tip end of a flyer as a stored wire and wire winding means configured to wind the wire rod supplied from the wire storing means around a winding core, the wire winding device comprising:

   a nozzle configured to be able to be divided along an axial core direction, the nozzle being configured to be capable of, in a coupled state, holding the wire rod that has been drawn out; and
   a divided-piece moving mechanism configured to divide and couple divided pieces of the nozzle.

2. The wire winding device according to claim 1, wherein
   the wire storing means includes a chuck device configured to move so as to be able to come closer to and move away from the winding core,
   the wire storing means is configured to store the wire rod by holding the wire rod by the chuck device and by moving the chuck device away from the flyer, the wire rod being delivered from the tip end of the flyer, and
   the nozzle is provided so as to be able to hold a flyer-side end portion of the wire rod that has been drawn in as the chuck device is moved away from the flyer.

3. The wire winding device according to claim 1 or 2, further comprising
   a nozzle moving mechanism configured to move the nozzle.

4. The wire winding device according to claim 3, wherein
   the nozzle moving mechanism configures the wire winding means, the wire winding means being configured to be able to revolve the nozzle in the coupled state around the winding core, the wire winding means being configured to wind the wire rod supplied from the wire storing means around the winding core.

5. The wire winding device according to any one of claims 1 to 4, further comprising
   another wire winding means configured to wind a portion of the wire rod delivered from the tip end of the flyer on a further proximal side than the wire storing means around the winding core.

6. A wire winding method comprising: a wire storing step in which a wire rod delivered from a tip end of a flyer is drawn as a stored wire and a wire winding step in which the wire rod, which has been stored, is wound around a winding core, wherein
   a wire rod holding step in which the wire rod that has been drawn out is held by a nozzle is performed after the wire storing step, and
   the wire winding step is performed after the wire rod holding step.

7. The wire winding method according to claim 6, wherein
   the wire storing step is performed by moving a chuck device holding the wire rod delivered from the tip end of the flyer away from the flyer and by drawing the wire rod held by the chuck device, and
   the wire rod holding step is performed by using the nozzle configured to be able to be divided along an axial core direction and by coupling the nozzle in a divided state at a flyer-side end portion of the wire rod that has been drawn in.

8. The wire winding method according to claim 6 or 7, wherein
   the wire winding step is performed by winding the wire rod, which has been stored, around the winding core by revolving the nozzle around the winding core.

9. The wire winding method according to any one of claims 6 to 8, wherein
   another wire winding step in which a portion of the wire rod delivered from the tip end of the flyer on a further proximal side than the stored portion is wound around the winding core is performed between the wire storing step and the wire winding step.

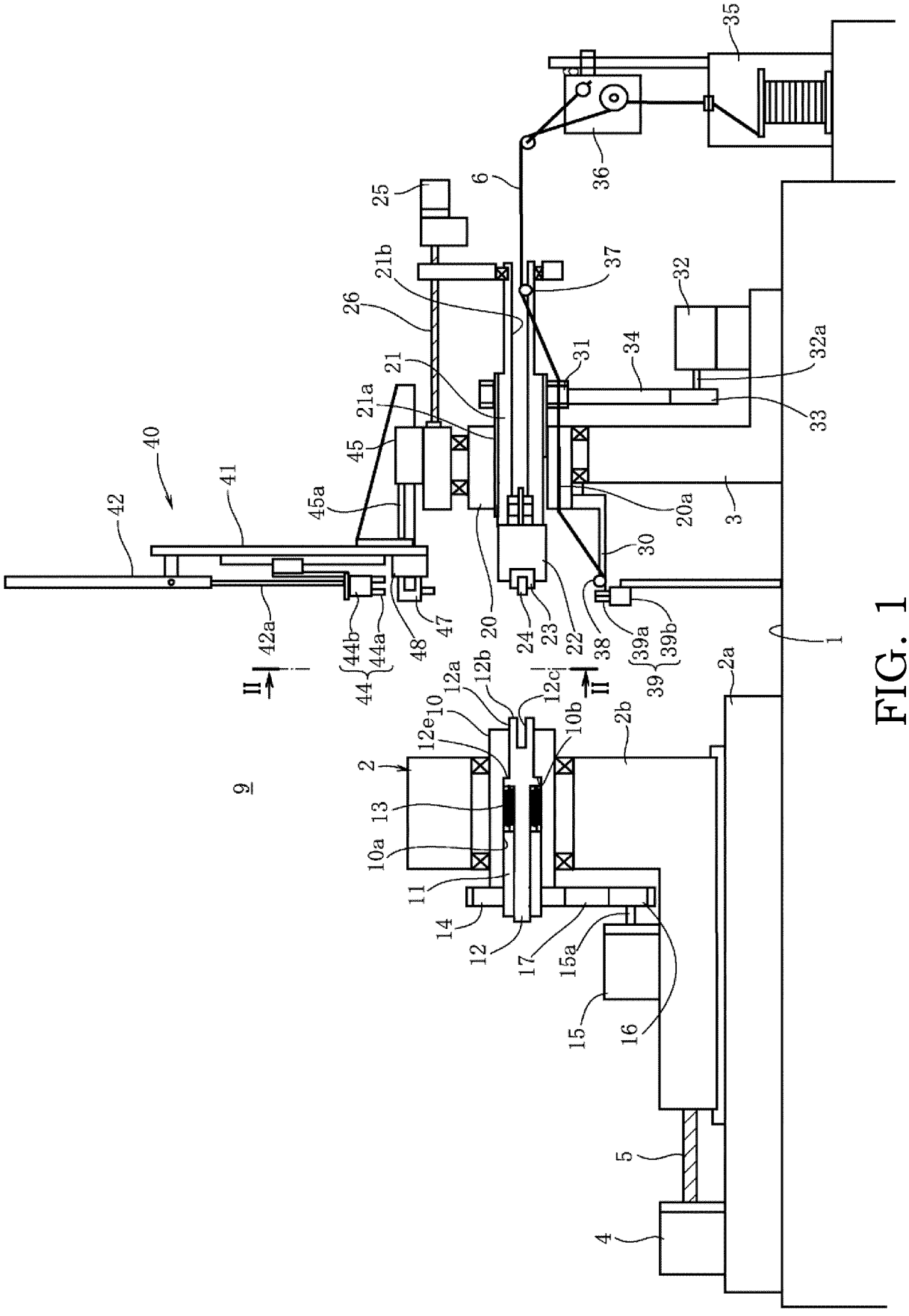
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FIG. 1

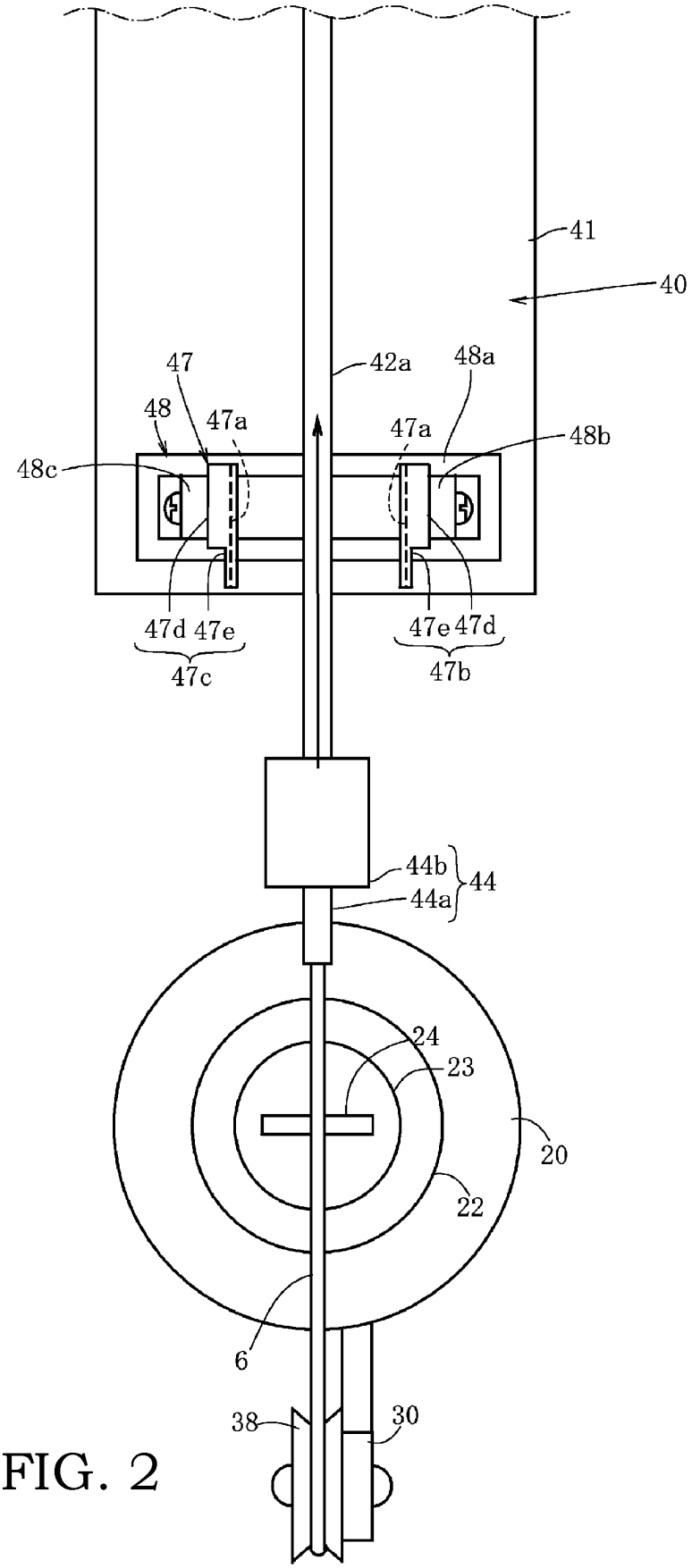
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FIG. 2

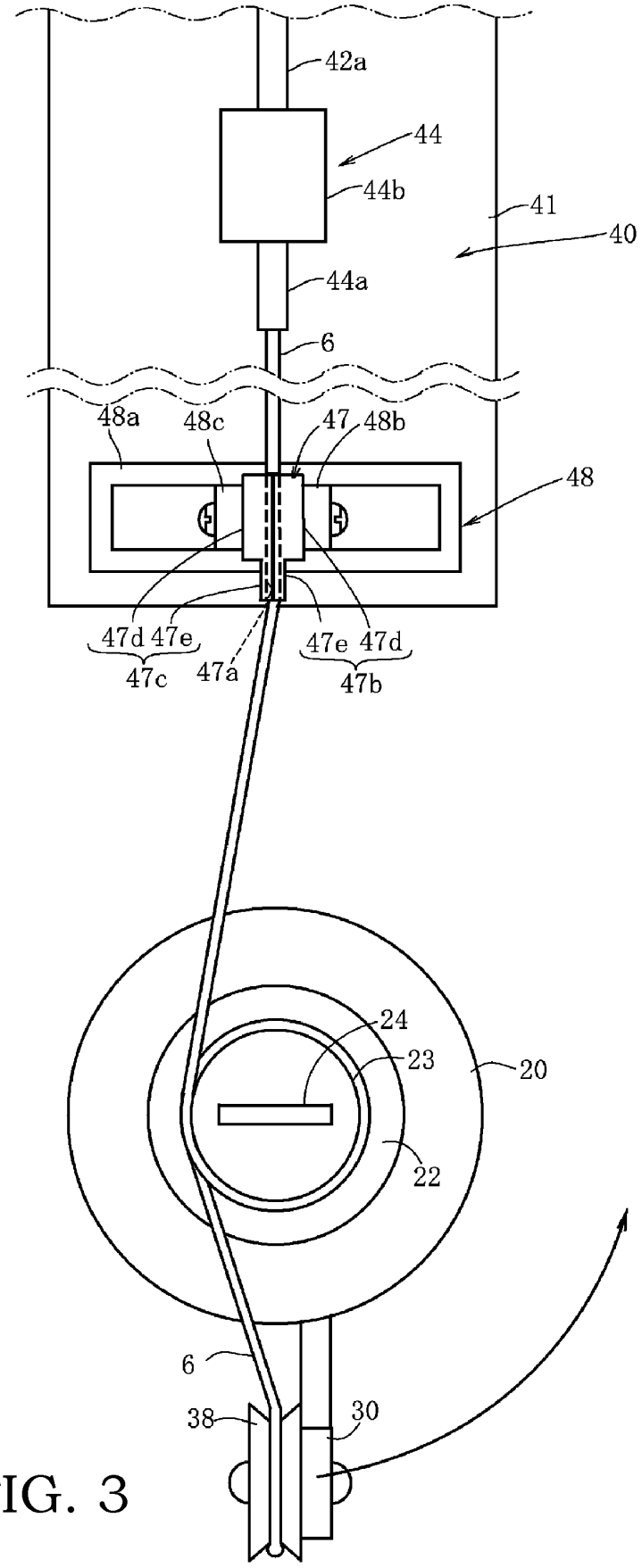
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FIG. 3

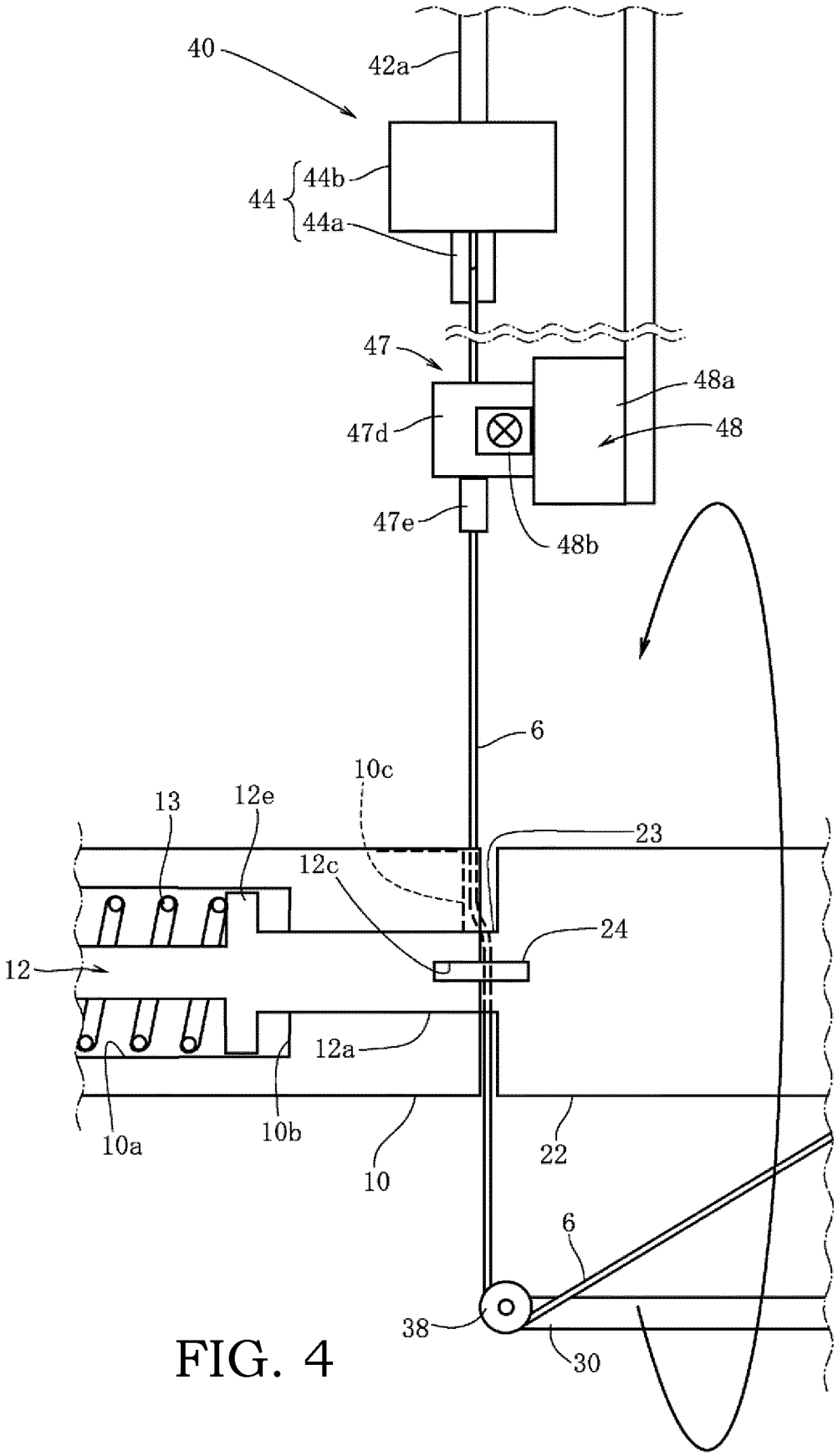
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FIG. 4

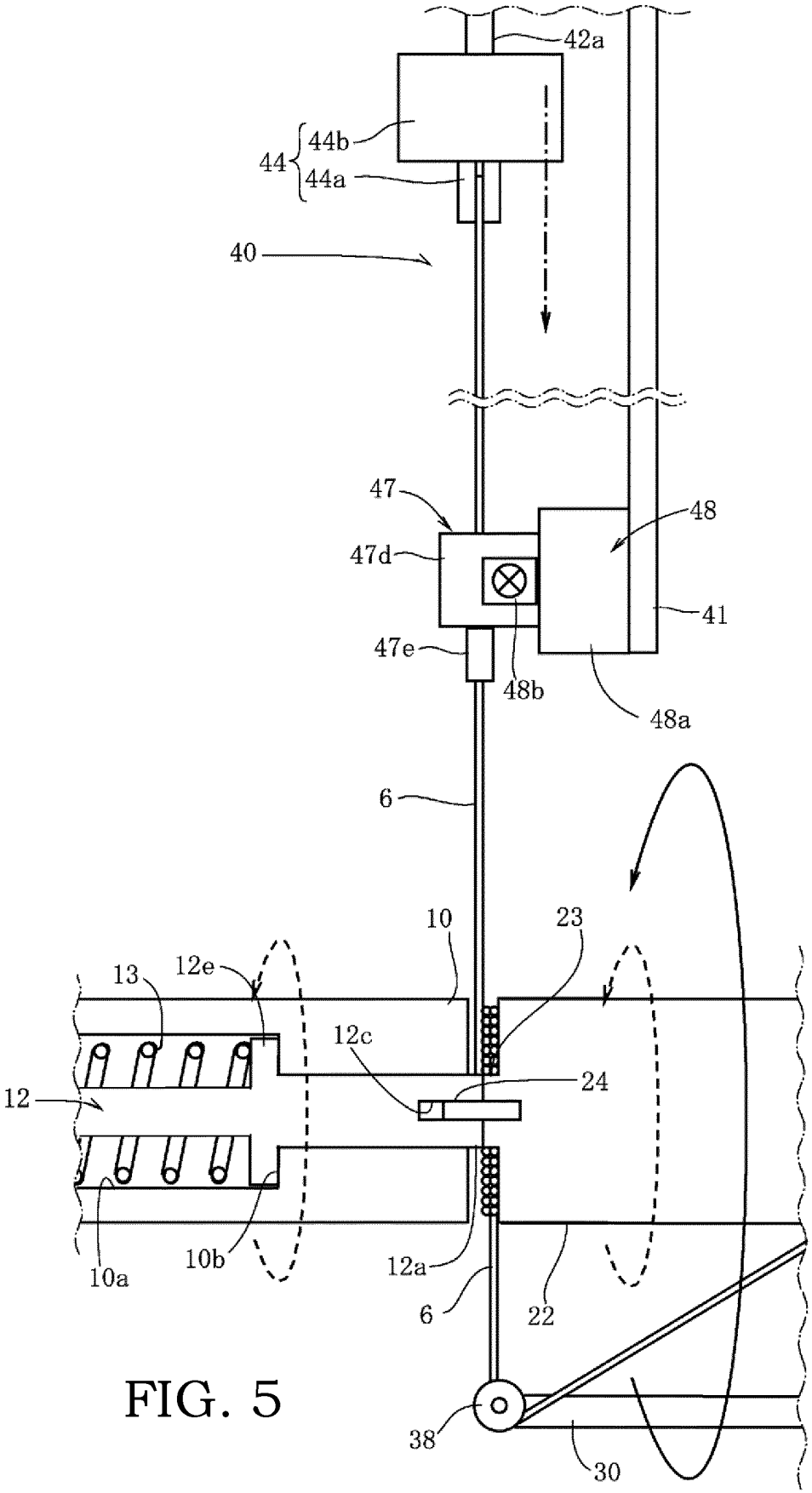
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FIG. 5

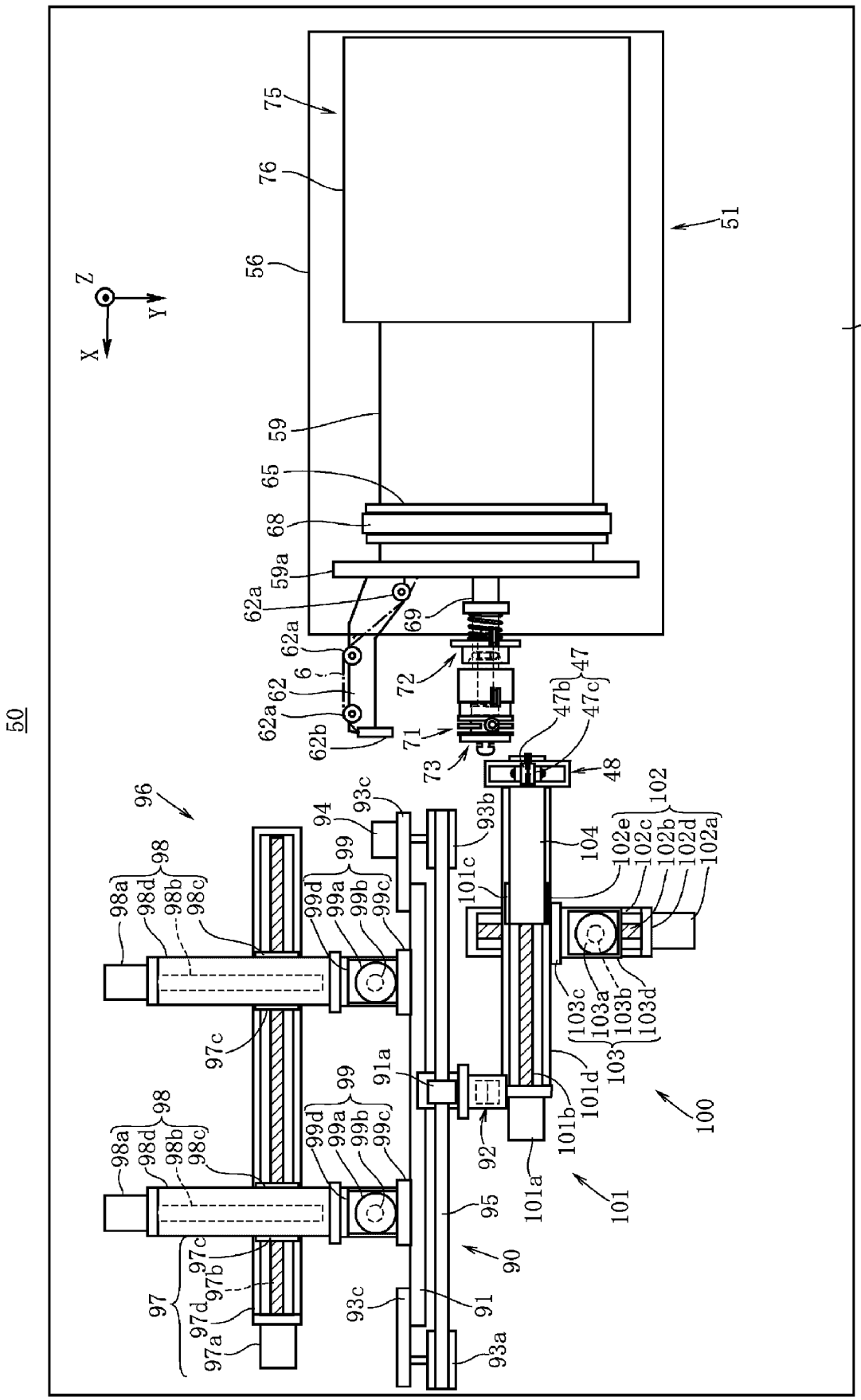
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FIG. 6

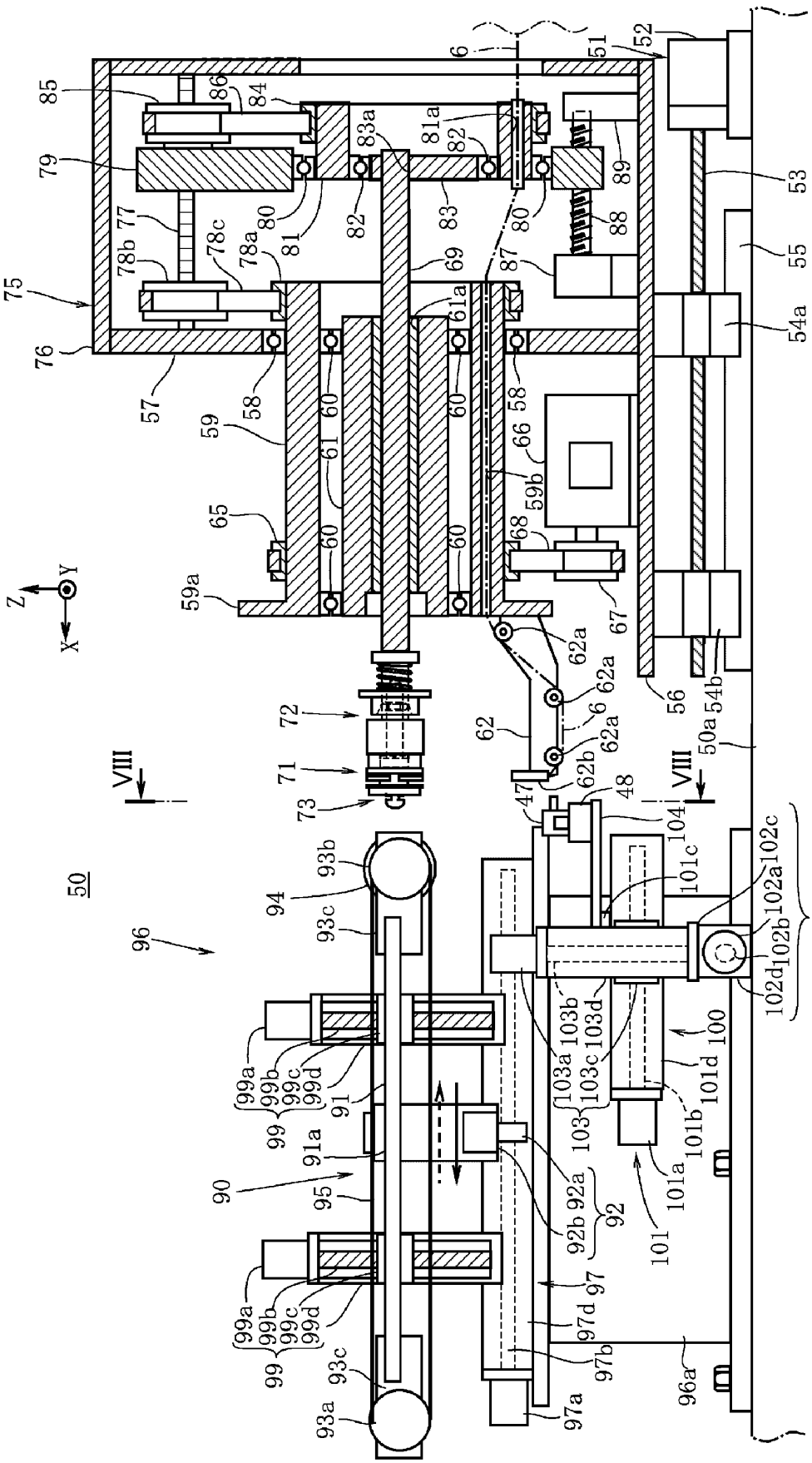
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FIG. 7

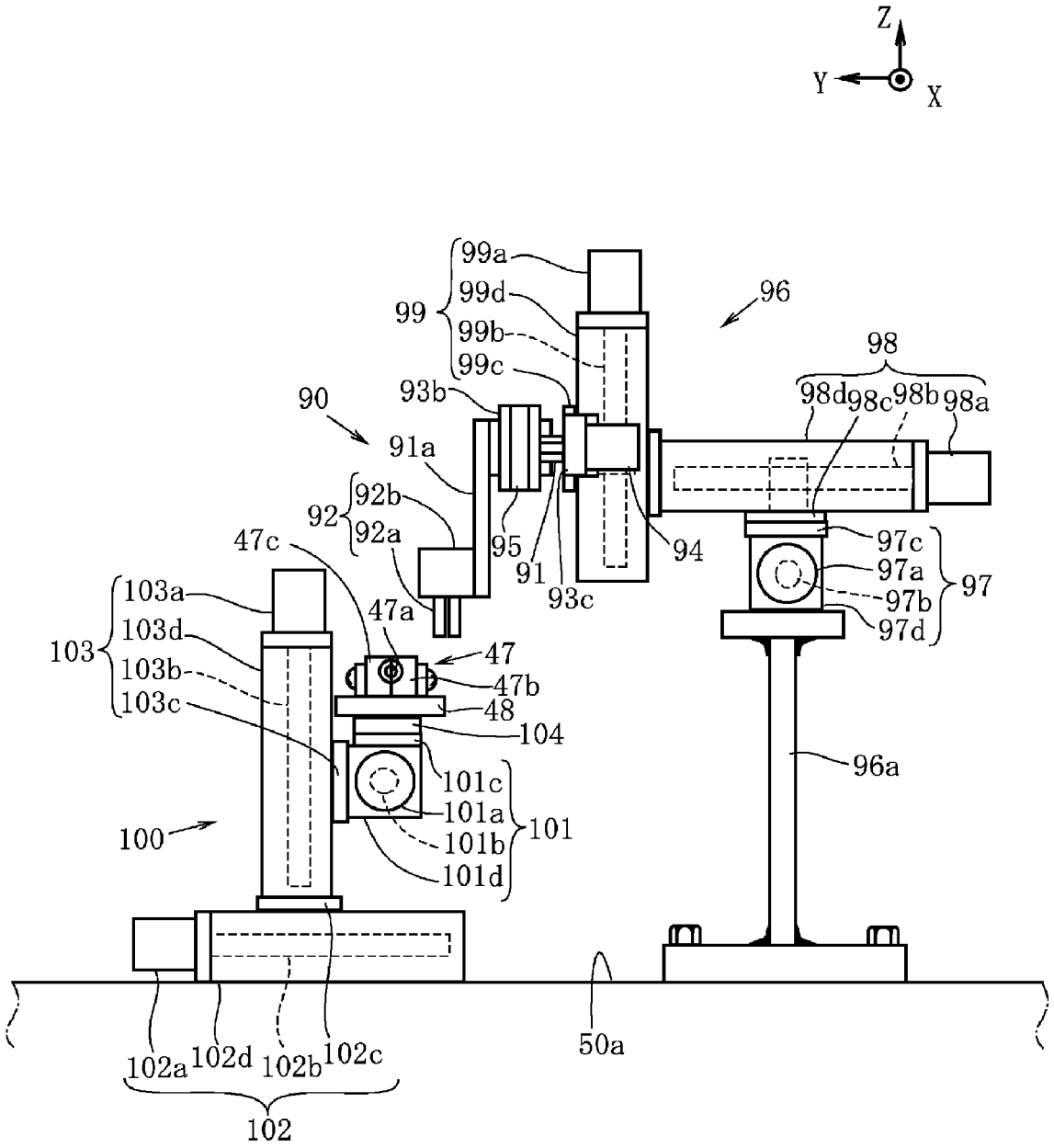
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FIG. 8

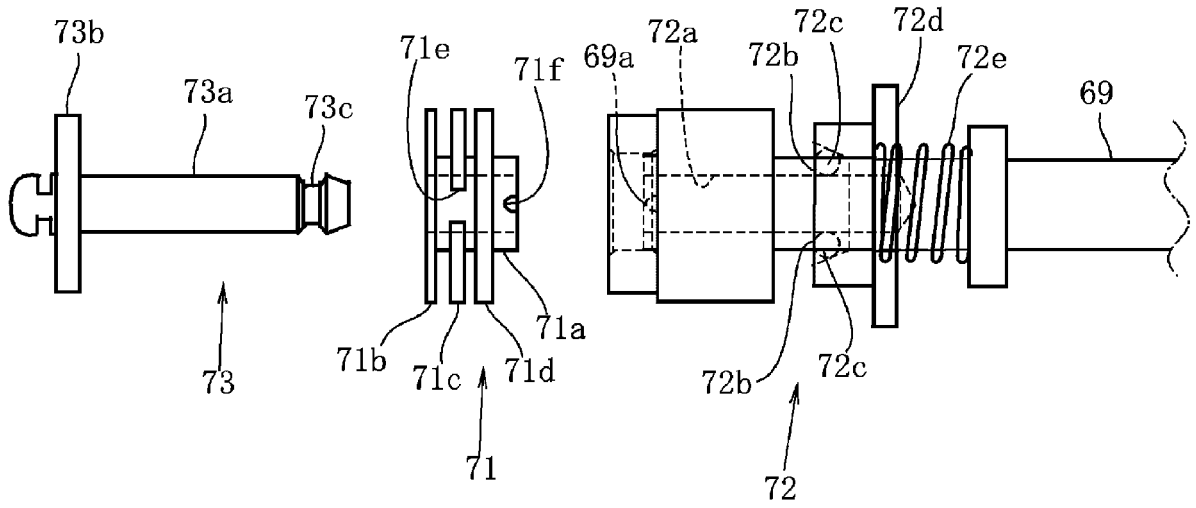
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FIG. 9

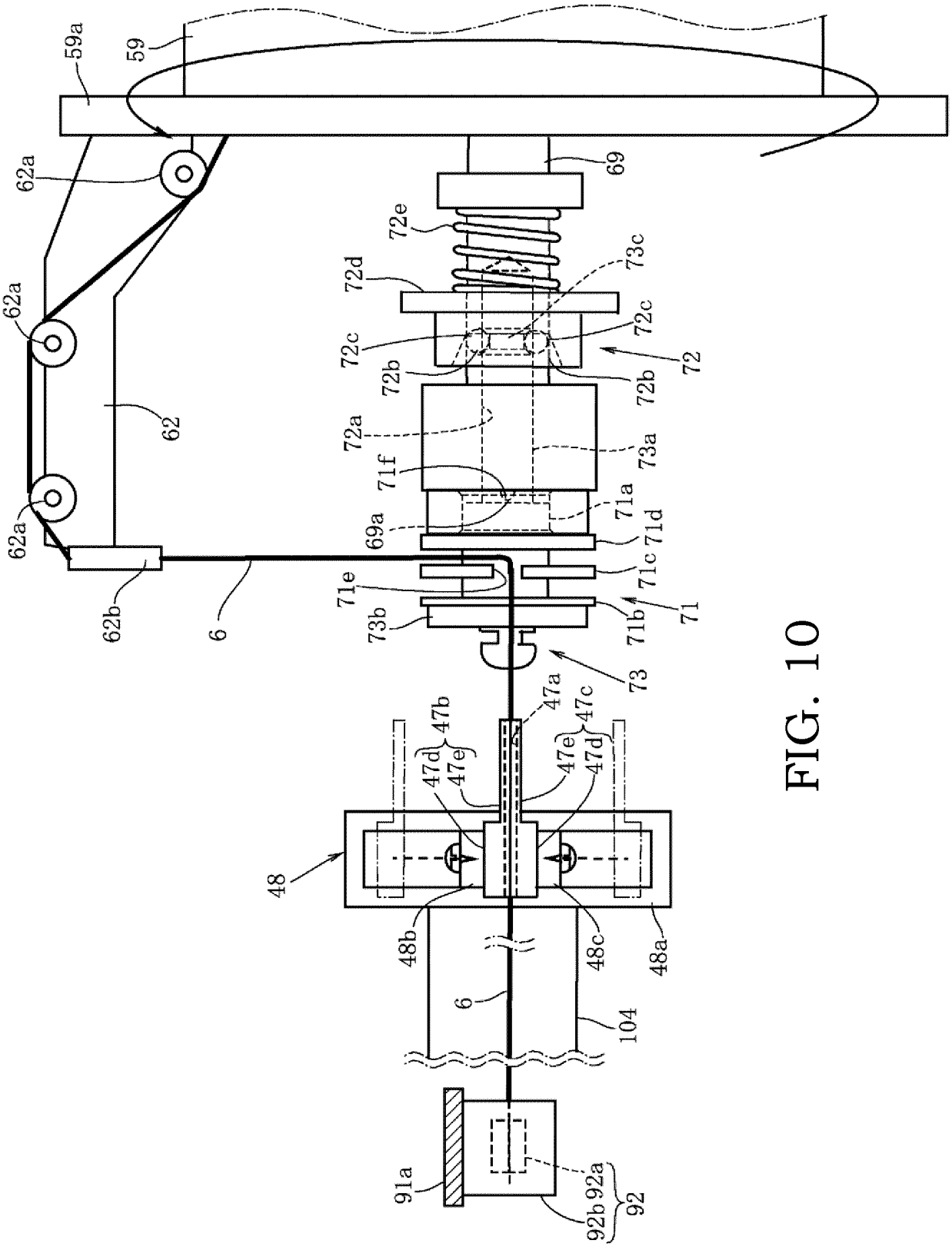
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FIG. 10

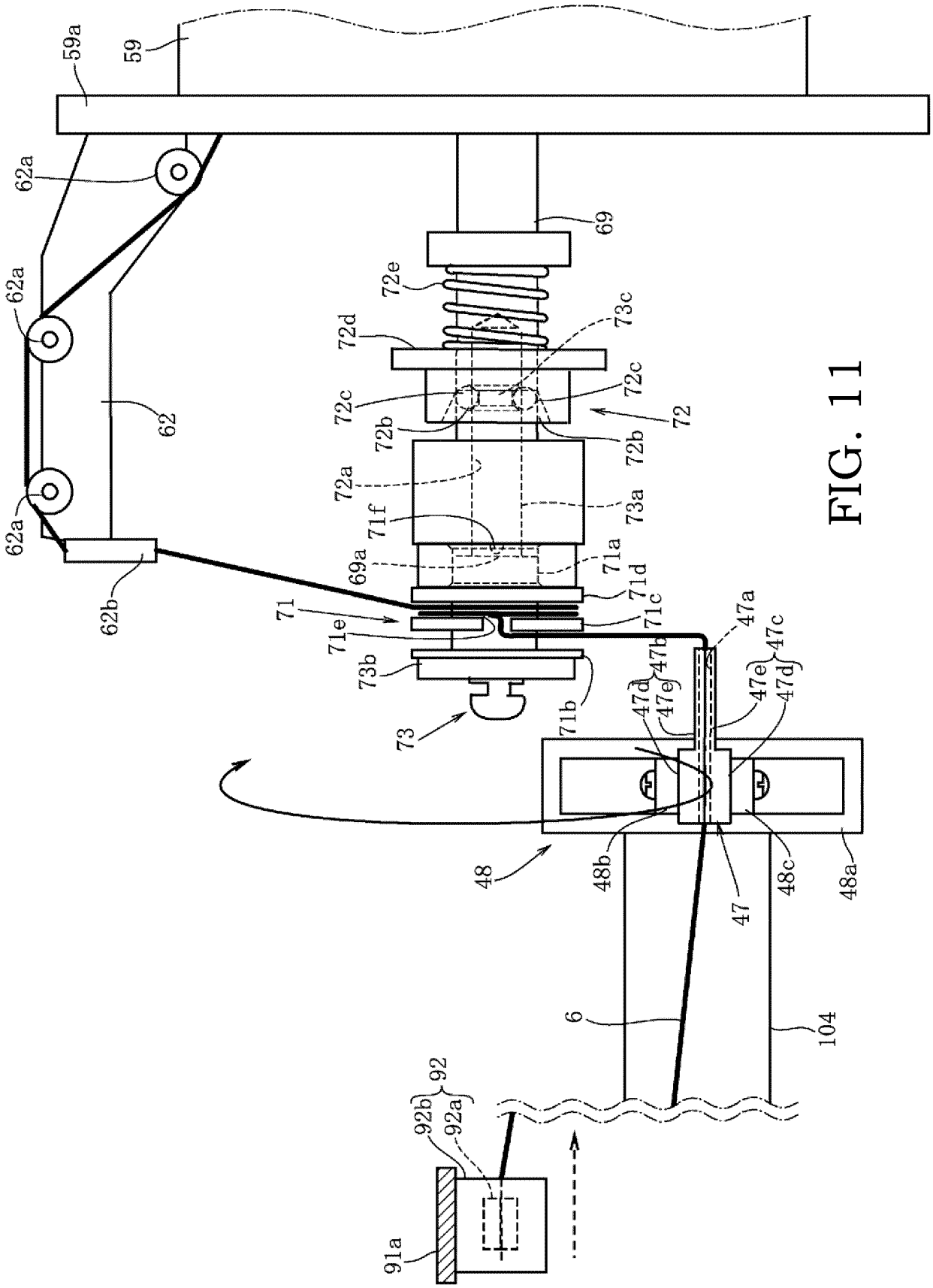
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FIG. 11

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2019/026143

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl. H01F41/088(2016.01)i
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl. H01F41/06-41/098

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2019
Registered utility model specifications of Japan	1996-2019
Published registered utility model applications of Japan	1994-2019

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 62-118735 A (MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.) 30 May 1987, page 2, lower left column, lines 3-19, fig. 3 (Family: none)	1-9
Y	JP 62-269308 A (MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.) 21 November 1987, page 3, upper left column, line 12 to page 5, upper left column, line 16, fig. 1-7 (Family: none)	1-2, 5-7, 9
Y	JP 2013-197563 A (NITTOKU ENGINEERING CO., LTD.) 30 September 2013, paragraphs [0027]-[0028], [0040], [0044], fig. 6, 15 (Family: none)	1-9
Y	JP 11-297559 A (NITTOKU ENGINEERING CO., LTD.) 29 October 1999, paragraphs [0048]-[0057], fig. 1, 4-6 (Family: none)	2-5, 7-9
A	JP 2016-178149 A (NITTOKU ENGINEERING CO., LTD.) 06 October 2016, paragraphs [0027]-[0029], [0045]-[0047], [0050]-[0058], fig. 1, 6-8 & US 2018/0053599 A1, paragraphs [0033]-[0036], [0052]-[0054], [0057]-[0066], fig. 1, 6-8 & WO 2016/147745 A1 & DE 112016001277 T5 & KR 10-2017-0109245 A	1-9

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Date of the actual completion of the international search	Date of mailing of the international search report
30 August 2019 (30.08.2019)	10 September 2019 (10.09.2019)

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

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Patent documents cited in the description

- JP 2018135687 A **[0113]**