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(54) **WINDING DEVICE, MANDREL REPLACEMENT METHOD, AND MANDREL**

(57) A winding device 1 includes a mandrel 3 that rotates around an axis and has a winding drum including a combination of segments 30, a casing 51 to which the mandrel 3 is mounted, a holding hollow shaft 53 that holds the mandrel 3 between the casing 51 and the mandrel 3 and rotates coaxially with the mandrel 3, and an expansion mechanism 20 that changes an outer diameter of the winding drum 30. The mandrel 3 is configured to be insertable into and removable from the holding hollow shaft 53 in its axial direction, integrally with the expansion mechanism 20.

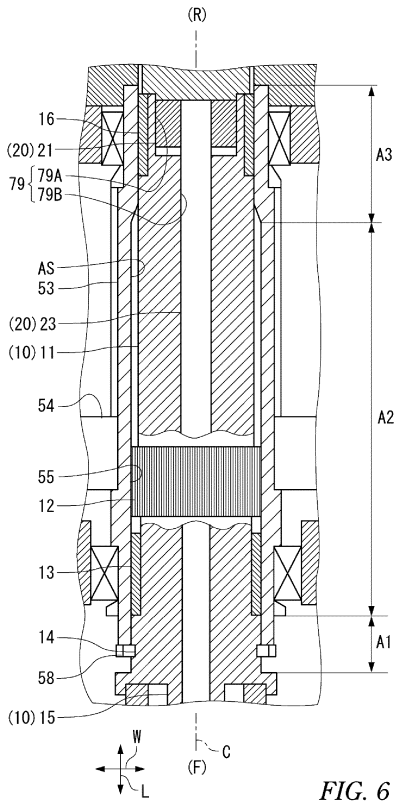

FIG. 6

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Description

Technical Field

[0001] The present disclosure relates to a device for winding a metal strip.

Background Art

[0002] For example, a metal strip obtained through hot rolling and cold rolling is wound by a winding device that is referred to as a carrousel reel, and is conveyed and stored in a form of a coil. In the winding device, a mandrel directly relates to winding of the metal strip. In the mandrel, for example, a winding drum is configured by a plurality of members each referred to as a segment, and the metal strip is wound on the winding drum including the combined segments.

[0003] For example, Patent Literature 1 discloses, as conventional technology, a technique for changing an outer diameter of the winding drum by expanding and collapsing the plurality of segments of the winding device. For example, Patent Literature 2 discloses, as conventional technology, a technique for removing the mandrel when a turntable coiler for winding the metal strip is maintained.

Citation List

Patent Literature

[0004]

Patent Literature 1: KR 102200891 B1
Patent Literature 2: JP 3902292 B2

Summary of Invention

Technical Problem

[0005] The segments of the mandrel are abraded or reduced in surface roughness due to contact with the metal strip. Therefore, a replacement cycle of the segments is, for example, two to three years, which is shorter than a replacement cycle of each of the other members configuring the mandrel. Thus, replacement easiness of the mandrel is required for maintenance.

[0006] However, in the mandrel disclosed in Patent Literature 1, it is interpreted that a main shaft supporting the segments can be removed only in a state where a hydraulic rotating cylinder expanding and reducing a diameter of the winding drum including the segments is separated from the main shaft. Therefore, in the winding device disclosed in Patent Literature 1, it is not easy to remove and replace the mandrel including the cylinder.

[0007] In Patent Literature 2, it is necessary to remove the mandrel after a device on a rear side (innermost side) of the mandrel is removed. Therefore, a work for removing the device is necessary before the mandrel is removed. Thus, also in the winding device disclosed in Patent Literature 2, replacement of the mandrel is not easy.

[0008] Therefore, an object of the present disclosure is to provide a winding device including a mandrel that can be easily replaced.

Solution to Problem

[0009] A winding device according to the present disclosure includes: a mandrel configured to rotate around an axis and including a winding drum; a casing to which the mandrel is mounted; a holding hollow shaft configured to hold the mandrel between the casing and the mandrel and to rotate coaxially with the mandrel; and an expansion mechanism configured to change an outer diameter of the mandrel.

[0010] The mandrel according to the present disclosure is configured to be insertable into and removal from the holding hollow shaft in an axial direction of the mandrel, integrally with the expansion mechanism.

[0011] In the winding device according to the present disclosure, the mandrel preferably includes a main shaft configured to rotate coaxially with the winding drum and extending in the axial direction, and a hydraulic rotating cylinder configured to expand and reduce an outer diameter of the winding drum by movement of a rod in the axial direction. In the expansion mechanism, the hydraulic rotating cylinder including the rod preferably has a dimension in a radial direction falling within a range of an outer diameter of the main shaft.

[0012] According to the winding device, at replacement of the mandrel, the hydraulic rotating cylinder and the rod can be removed together with the mandrel while avoiding interference with the holding hollow shaft. This makes it possible to easily replace the mandrel in a short time.

[0013] In the winding device according to the present disclosure, the hydraulic rotating cylinder including the rod is preferably provided inside the main shaft.

[0014] In the winding device, at replacement of the mandrel, the hydraulic rotating cylinder and the rod can also be removed together with the mandrel while avoiding interference with the holding hollow shaft. This makes it possible to easily replace the mandrel in a short time.

[0015] The winding device according to the present disclosure preferably further includes: a rotational force applying portion configured to transmit rotational force from the holding hollow shaft to the mandrel; and paired bearings provided between the casing and the holding hollow shaft and on both sides of the rotational force applying portion in the axial direction. The main shaft of the mandrel includes a first shaft section, portions of the first shaft section facing the paired bearings each having a cylindrical appearance, and an outer periphery of the first shaft section and an inner periphery of the holding hollow shaft are configured to come into contact

with each other.

[0016] According to the winding device, since the appearance of the first shaft section supported by the bearings is cylindrical, a moment arm to an overturning moment acting on the winding drum of the mandrel is increased, and reaction force acting on the cylindrical first shaft section and surface pressure caused by the reaction force can be reduced. This makes it possible to considerably reduce a risk of wear such as abrasion and settling, of the first shaft section.

[0017] Bushes are preferably replaceably fitted to positions facing the paired bearings, of the first shaft section of the mandrel according to the present disclosure.

[0018] According to the winding device, periodically replacing the bushes, for example, at replacement of the mandrel makes it possible to maintain the winding device 1 at a small maintenance cost without damaging the first shaft section. In particular, the portions facing the bearings receive heavy loads and are easily worn. Therefore, using the replaceable bushes for the portions makes it possible to reduce wear of the mandrel and to improve durability.

[0019] The rotational force applying portion according to the present disclosure preferably includes a spline in which a plurality of inner teeth provided on the inner periphery of the holding hollow shaft and a plurality of outer teeth provided on the outer periphery of the first shaft section of the mandrel mesh with each other.

[0020] According to the winding device, a high transmission torque can be transmitted to the mandrel. In addition, at replacement of the mandrel, the inner teeth of the holding hollow shaft and the outer teeth of the first shaft section can be caused to mesh with each other only by small rotation in a circumferential direction. Therefore, the main shaft can be easily mounted on the holding hollow shaft. In addition, a function sharing system in which the bushes hold a radial load and the spline transmits the torque is adopted, which makes it possible to minimize a gap between the main shaft and the holding hollow shaft.

[0021] The holding hollow shaft according to the present disclosure preferably includes a rotational force receiving section to which the rotational force is transmitted, and the spline is preferably disposed at a position close to the bearing on a side close to the winding drum, out of the paired bearings.

[0022] The winding drum has a considerable weight including a weight of the wound metal strip. Therefore, a considerable torsional force is necessary to rotate the first shaft section. The torsional force is applied to the spline. When the position receiving the torsional force is far from the winding drum, a torsional angle occurring on a second shaft section provided with the winding drum is increased. Therefore, the torsional angle is suppressed by providing the spline at the position close to the winding drum. When the spline is provided at a region of the holding hollow shaft having a large diameter described below, torsional rigidity at the region is large. This makes it possible to suppress torsional stress occurring on the second shaft section.

[0023] In the winding device according to the present disclosure, the mandrel is preferably supported to the holding hollow shaft in the axial direction by fastening a fixing ring having a half-divided structure to the holding hollow shaft.

[0024] According to the winding device, restraint in the axial direction of the mandrel to be maintained is released by unfastening the fixing ring having the half-divided structure. This makes it possible to easily remove the mandrel from the holding hollow shaft. In contrast, when the new mandrel is caused to be held by the holding hollow shaft, the mandrel can be mounted on the holding hollow shaft only by inserting the mandrel into the holding hollow shaft and fastening the keeper plate having the half-divided structure to the holding hollow shaft.

[0025] In the winding device according to the present disclosure, an outer diameter of the first shaft section of the main shaft is preferably configured to be continuously or stepwisely reduced from a front side to a rear side, and an opening diameter of a housing space of the holding hollow shaft for the first shaft section is preferably configured to be continuously or stepwisely reduced from the front side to the rear side, a side from which the mandrel is removed being defined as the front side, a side opposite thereto being defined as the rear side.

[0026] According to the winding device, the outer diameter of the first shaft section 11 and the opening diameter of the housing space are gradually reduced to the rear side. Therefore, the first shaft section of the mandrel is easily inserted into the holding hollow shaft.

[0027] The winding device according to the present disclosure preferably further includes a coil removal assisting mechanism configured to press an end surface of a coil formed of a metal strip wound on the mandrel, from a rear side to a front side along the axial direction of the mandrel, a side from which the mandrel is removed being defined as the front side, a side opposite thereto being defined as the rear side.

[0028] According to the winding device, when the wound coil is removed from the mandrel, the end surface of the coil can be pressed from the rear side to the front side along the axial direction of the mandrel. This makes it possible to prevent the coil from being unwound and becoming a telescopic shape.

[0029] Further, the present disclosure provides a method of replacing a mandrel that rotates around an axis and includes a winding drum, by inserting/removing the mandrel into/from a casing in an axial direction. In this replacement method, the mandrel is inserted into and removed from a holding hollow shaft holding the mandrel between the casing and the mandrel and rotating coaxially with the mandrel. The mandrel is configured to be insertable into and removal from the holding hollow shaft in the axial direction, integrally with an expansion mechanism configured to change an outer diameter of the winding drum.

Advantageous Effects of Invention

[0030] According to the winding device of the present disclosure, the expansion mechanism changing the outer diameter of the mandrel and the mandrel are integrally insertable into/removal from the holding hollow shaft in the axial direction of the mandrel. Thus, according to the winding device of the present disclosure, at replacement of the mandrel, the expansion mechanism can also be removed together with the mandrel. This makes it possible to easily replace the mandrel in a short time.

Brief Description of Drawings

[0031]

[FIG. 1] FIG. 1 is a perspective view illustrating a winding device according to an embodiment.
[FIG. 2] FIG. 2 is a front view illustrating the winding device according to the embodiment.
[FIG. 3] FIG. 3 is a perspective view illustrating a single mandrel of the winding device according to the embodiment.
[FIG. 4] FIG. 4 is a cross-sectional plane view of the winding device according to the embodiment.
[FIG. 5] FIG. 5 is a partial enlarged view of FIG. 4.
[FIG. 6] FIG. 6 is a partial enlarged view of FIG. 5 and is a diagram illustrating surroundings of a first shaft section of a main shaft.
[FIG. 7] FIG. 7 is a partial enlarged view of FIG. 5 and is a diagram illustrating surroundings of a second shaft section of the main shaft.
[FIG. 8] FIG. 8 is a cross-sectional plane view illustrating a state where the mandrel is removed from the winding device according to the embodiment.
[FIG. 9] FIG. 9 is a plane view illustrating a fixing ring supporting the mandrel in an axial direction according to the embodiment.

Description of Embodiment

[0032] The present disclosure is described based on a preferred embodiment.

[0033] A winding device 1 according to the embodiment includes two mandrels 3A and 3B. Each of the mandrels 3A and 3B is configured to be insertable and removable integrally with an expansion mechanism 20 that expands or reduces an outer diameter, namely, performs diameter expansion or diameter reduction of a winding drum including a combination of segments 30. The insertable and removal configuration is realized by providing holding hollow shafts 53A and 53B as components of a first rotating mechanism 5, between the first rotating mechanism 5 and the mandrels 3A and 3B. Since the winding device 1 includes the insertable and removal configuration, the mandrels can be easily replaced in a short time. In the following, a configuration of the winding device 1 is described, and then effects achieved by the winding device 1 are described.

[Components Configuring Winding device 1: See FIG. 1, FIG. 2, and FIG. 4]

[0034] Components configuring the winding device 1 are described with reference to FIG. 1, FIG. 2, and FIG. 4.

[0035] The winding device 1 includes paired mandrels 3A and 3B each winding a metal strip SR, the first rotating mechanism 5 supporting and rotating each of the mandrels 3A and 3B in order to wind the metal strip SR, and a second rotating mechanism 6 rotatably supporting the first rotating mechanism 5. The winding device 1 further includes paired gear reducers 7A and 7B transmitting reduced rotational forces to the first rotating mechanism 5, and main driving sources 9A and 9B respectively applying rotational forces to the gear reducers 7A and 7B. In the winding device 1, the rotational forces output from the main driving sources 9A and 9B are respectively decelerated by the gear reducers 7A and 7B, and the reduced rotational forces are transmitted to the first rotating mechanism 5. The rotational forces transmitted to the first rotating mechanism 5 are converted into rotation of the mandrels 3A and 3B necessary for winding the metal strip SR. The above-described components of the winding device 1 are each made of a metal material having characteristics such as necessary mechanical strength.

[0036] The rotation of the mandrels 3A and 3B has been described together above. In a practical example, one mandrel 3A is rotated to wind the metal strip SR while the other mandrel 3B stands by without performing winding. When the winding by the mandrel 3A is finished, the winding of the metal strip SR is performed by the mandrel 3B. In other words, the winding device 1 winds the metal strip SR by alternately using the mandrel 3A and the mandrel 3B.

[0037] Note that a front side (F) and a rear side (R) of the winding device 1 are defined as illustrated in FIG. 1 and other drawings. More specifically, in the winding device 1, a side on which the mandrels 3A and 3B are provided is referred to as the front side (F), and an opposite side on which the main driving sources 9A and 9B are provided is referred to as the rear side (R). The front side (F) corresponds to a side from which a coil CL is removed, and the rear side (R) corresponds to the side opposite thereto. The front side (F) and the rear side (R) have meanings relative to each other. In addition, a length direction (L), a width direction (W), and a height direction (H) in the winding device 1 are defined as illustrated in FIG. 1 and other drawings. The length direction (L) and the width direction (W) extend along a horizontal direction, and the height direction (H) extends along a vertical direction.

[Mandrels 3A and 3B: See FIG. 3, FIG. 5, FIG. 6, and FIG. 7]

[0038] Configurations of the mandrels 3A and 3B are

described with reference to FIG. 3, FIG. 5, FIG. 6, and FIG. 7. The mandrel 3A and the mandrel 3B have the same configuration. Therefore, in the following, both may be collectively referred to as a mandrel 3 and described. As for the holding hollow shafts 53A and 53B and other components, in a case where it is unnecessary to distinguish the two components from each other, the holding hollow shafts 53A and 53B and other components are collectively referred to as a holding hollow shaft 53 or the like in the following description.

[0039] The mandrel 3 includes a main shaft 10 rotated by receiving the rotational force from the first rotating mechanism 5, the expansion mechanism 20 supported by the main shaft 10 and expanding or collapsing the diameter of the segments 30, and the plurality of segments (winding drum) 30 winding the metal strip SR.

[Main Shaft 10: See FIG. 3, FIG. 5, and FIG. 6]

[0040] The main shaft 10 includes a first shaft section 11 supported by the holding hollow shaft 53 as a component of the first rotating mechanism 5, and a second shaft section 15 relating to diameter expansion or diameter collapsing of the segments 30 and supporting the segments 30. The main shaft 10 includes a locking groove 14 into which a fixing ring 58 for positioning the mandrel 3 in a direction of an axis C relative to the first rotating mechanism 5, at a boundary part between the first shaft section 11 and the second shaft section 15. Note that the direction of the axis C is referred to as an axial direction C in some cases. The first shaft section 11 is provided on the rear side (R) of the locking groove 14, and the second shaft section 15 is provided on the front side (F) of the locking groove 14. The main shaft 10 is formed of a cylindrical member including a void around the axis C from the first shaft section 11 to the second shaft section 15. Except for a portion housing a hydraulic rotating cylinder 21, the void is equal in opening diameter from the first shaft section 11 to the second shaft section 15. However, an outer diameter of the main shaft 10 is smaller at the second shaft section 15 than at the first shaft section 11. A rod 23 of the expansion mechanism 20 is inserted into the void. Note that the first shaft section 11 and the second shaft section 15 may be integrally configured from beginning, or may be separately fabricated and then joined and integrated.

[0041] The main shaft 10 is fixed so as not to rotate relative to the holding hollow shaft 53 rotated by the rotational forces of the main driving sources 9A and 9B, and rotates together with the holding hollow shaft 53. By the rotation of the main shaft 10, the metal strip SR is wound on the segments 30 provided on the main shaft 10.

[Stepwise Change in Outer Diameter of First Shaft section 11: See FIG. 5 and FIG. 6]

[0042] The outer diameter of the first shaft section 11 is reduced from the front side (F) to the rear side (R) in a stepwise manner. This is for convenience when the mandrel 3 used so far is removed for maintenance and a new mandrel 3 is inserted. More specifically, as illustrated in FIG. 5 and FIG. 6, the outer diameter of the first shaft section 11 is set to be reduced in a stepwise manner in order of a first section A1 on the front side (F) of a bush 13, a second section A2 on the rear side (R) of the bush 13, and the rear side (R) of the second section A2. Along with change in outer diameter of the first shaft section 11, an opening diameter of a housing space AS of the holding hollow shaft 53 where the first shaft section 11 is disposed is set to be reduced in a stepwise manner from the front side (F) to the rear side (R). Here, the example of stepwise reduction in outer diameter and opening diameter is described; however, continuous reduction in outer diameter and opening diameter may be adopted. Since the outer diameter of the first shaft section 11 is reduced in a stepwise manner as described above, when the first shaft section 11 is mounted on the first rotating mechanism 5, a gap occurs between an outer peripheral surface of the first shaft section 11 and an inner peripheral surface of the holding hollow shaft 53. A portion where the gap occurs is excluded from a management object of a dimension tolerance between the first shaft section 11 and the holding hollow shaft 53.

[Driven-Side Splines 12A and 12B: See FIG. 5 and FIG. 6]

[0043] The first shaft section 11 includes a driven-side spline 12 (12A or 12B) and bushes 13 and 16. In FIG. 5, the driven-side spline corresponding to the mandrel 3A is referred to as the driven-side spline 12A, and the driven-side spline corresponding to the mandrel 3B is referred to as the driven-side spline 12B. However, the driven-side splines 12A and 12B have the same configuration. Thus, each of the driven-side splines 12A and 12B is referred to as the driven-side spline 12 in the following description. Notation of characters A and B is also omitted for the other components in some cases.

[0044] The driven-side spline 12 transmits the rotational force from the holding hollow shaft 53 to the first shaft section 11 of the main shaft 10. The driven-side spline 12 and a driving-side spline 55 of the holding hollow shaft 53 correspond to an example of a rotational force applying portion of the present disclosure in a spline fitting. The driven-side spline 12 includes a plurality of outer teeth provided on an outer periphery thereof, and the driving-side spline 55 includes inner teeth provided on an inner periphery thereof. Sliding in the axial direction C does not occur ideally between the driven-side spline 12 and the driving-side spline 55. Therefore, it is unnecessary to consider service lives of the driven-side spline 12 and the driving-side spline 55 caused by abrasion.

[0045] The driven-side spline 12 is provided adjacent to the bush 13, between the bush 13 and the bush 16 in the direction of the axis C. In other words, the spline 12 is provided at a position close to the segments 30 to which

the metal strip SR is wound. The segments 30 have a considerable weight including a weight of the wound metal strip SR. Therefore, a considerable torsional force is necessary to rotate the first shaft section 11. The torsional force is applied to the driven-side spline 12. When a position receiving the torsional force is far from the segments 30, a torsional angle occurring on the second shaft section 15 provided with the segments 30 is increased. Therefore, the torsional angle is suppressed by providing the spline 12 at a position close to the segments 30. Further, the driven-side spline 12 is provided at a region of the holding hollow shaft 53 having a large diameter as described below. Therefore, torsional rigidity is large. This makes it possible to suppress torsional stress occurring on the second shaft section 15. Note that the bushes 13 and 16 are respectively provided at positions corresponding to bearings BB1 and BB2. Therefore, the spline 12 is disposed at a position close to the bearing BB1 on a side close to the segments 30.

[0046] In place of the spline fitting, a key and a key groove can be used; however, the spline fitting is more advantageous for transmission of large rotational force than the key and key groove. In a case of the spline 12 and the driving-side spline 55, 10 or more, furthermore, 20 or more teeth can be provided depending on the diameter. This makes it possible to realize transmission of larger rotational driving force. Presence of many teeth facilitates alignment between the teeth of the spline 12 and the teeth of the driving-side spline 55 in a circumferential direction, at replacement of the mandrel 3. For example, when the number of teeth is 12, the teeth of the spline 12 and the teeth of the driving-side spline 55 can be aligned only by rotating the spline 12 by up to 15 degrees.

[0047] A straight-sided spline and an involute spline can be distinguished based on a cross-sectional shape of the teeth including concavities and convexities. Any form is applicable to the present embodiment; however, the involute spline is advantageous for transmission of larger rotational force, and can reduce backlash in a radial direction or can smoothly rotate even if slight backlash is present.

[Bushes 13 and 16: See FIG. 5 and FIG. 6]

[0048] The bushes 13 and 16 are provided between the first shaft section 11 and the holding hollow shaft 53 by being fitted to the first shaft section 11 of the main shaft 10. The first shaft section 11 is provided with the bushes 13 and 16 at a part on the front side (F) and at a part on the rear side (R), respectively, and both ends of the first shaft section 11 are supported to the holding hollow shaft 53 by the two bushes 13 and 16 in the radial direction.

[0049] Since the first shaft section 11 is not rotatable to the holding hollow shaft 53, the main shaft 10 cannot rotate relative to the holding hollow shaft 53 in principle. However, sliding by a minute distance may occur between the first shaft section 11 and the holding hollow shaft 53 because a gap, namely, backlash of gears is present between the outer teeth of the spline 12 and the inner teeth of the driving-side spline 55 in the circumferential direction. Therefore, the bushes 13 and 16 are provided on the first shaft section 11, and the bushes 13 and 16 and the holding hollow shaft 53 are caused to slide with each other to generate abrasion on the bushes 13 and 16.

[0050] The bushes 13 and 16 are replaceably mounted on the first shaft section 11 by, for example, shrink fitting. Therefore, when the bushes 13 and 16 are removed together with the mandrel 3 from the winding device 1 at replacement of the mandrel 3, the bushes 13 and 16 are replaced with new bushes 13 and 16. The bushes 13 and 16 are used as slide bearings, and are preferably made of a metal material excellent in sliding property, such as a copper alloy and an aluminum alloy, but may be made of a resin material or a ceramic material.

[0051] The bushes 13 and 16 are provided at positions corresponding to the paired bearings BB1 and BB2 supporting the holding hollow shaft 53 (53A or 53B) described below. Note that the winding device 1 includes bearings in addition to the bearings BB1 and BB2; however, illustration of reference numerals of the other bearings is omitted in order to avoid complication of the drawings.

[Second Shaft section 15: See FIG. 5, FIG. 6, and FIG. 7]

[0052] Next, the second shaft section 15 is described.

[0053] The second shaft section 15 is a hollow member that communicates with the first shaft section 11 and extends to the front side (F). Wedges 25 that expands or collapses the diameter of the segments 30 is provided around the second shaft section 15 that has an outer diameter less than the outer diameter of the first shaft section 11. The wedges 25 are slidably fitted to an outer peripheral surface of the second shaft section 15, and are fixed to the rod 23 of the expansion mechanism 20 through a fixing ring 17 on the front side (F) of an end part of the second shaft section 15 on the front side (F).

[0054] The wedges 25 are ones of components of the expansion mechanism 20, and move in the axial direction C with movement of the expansion mechanism 20. The wedges 25 are members each including a plurality of tapered protrusions in the axial direction of the second shaft section 15, and the plurality of wedges 25 are combined in the circumferential direction of the second shaft section 15 to form the hollow member. The wedges 25 and the segments 30 configure a translation cam, and the diameter of the segments 30 as a follower is expanded or collapsed with movement of the wedges 25 as a driver in the axial direction C. The configurations of the wedges 25 are described in detail in description of the expansion mechanism 20. Movement in the axial direction C includes movement from the front side (F) to the rear side (R) and movement from the rear side (R) to the front side (F).

[0055] In the main shaft 10, a cylinder space 19 that is a void where the hydraulic rotating cylinder 21 configuring the expansion mechanism 20 and the rod 23 connecting with the hydraulic rotating cylinder 21 are disposed is provided along the direction of the axis C. The cylinder space 19 includes a cylinder space 19A where the hydraulic rotating cylinder 21 is disposed, and a rod space 19B where the rod 23 is disposed. An end part of the cylinder space 19A on the rear side (R) is closed, whereas an end part on the front side (F) communicates with the rod space 19B. An end part of the rod space 19B on the front side (F) is opened, and an end part of the rod 23 on the front side (F) protrudes. As described above, the hydraulic rotating cylinder 21 and the rod 23 are provided inside the main shaft 10. The hydraulic rotating cylinder 21 is provided inside the first shaft section 11 having a large diameter, and the rod 23 is provided inside the first shaft section 11 and the second shaft section 15 having a small diameter. Accordingly, the hydraulic rotating cylinder 21 including the rod 23 has a dimension in the radial direction falling within a range of the outer diameter of the main shaft 10.

[Expansion Mechanism 20: See FIG. 5, FIG. 6, and FIG. 7]

[0056] Next, the expansion mechanism 20 is described.

[0057] The expansion mechanism 20 includes the hydraulic rotating cylinder 21 as a driving source for moving the wedges 25 in the axial direction C, and the rod 23 moving in the axial direction C relative to the hydraulic rotating cylinder 21. The hydraulic rotating cylinder 21 is housed in the cylinder space 19A, and the rod 23 is inserted into the rod space 19B. The rod 23 protrudes from the end part of the rod space 19B on the front side (F), and a protruding portion of the rod 23 is connected and fixed to the wedges 25 through the fixing ring 17. The hydraulic rotating cylinder 21 operated by oil pressure or air pressure is merely an example of a driving source moving the wedges 25 in the axial direction C, and other driving source moving the wedges 25, for example, a linear electric motor can be used.

[0058] The wedges 25 each include a plurality of cam protrusions 26 communicating in a circumferential direction. The plurality of cam protrusions 26 are provided over the substantially entire length of each of the wedges 25 in the direction of the axis C. For example, each of the wedge shapes 26 has a shape in which a diameter is continuously increased from the rear side (R) to the front side (F), and is steeply reduced from a vertex of the diameter. An outer peripheral surface of a portion where the diameter is enlarged configures a cam surface 27 that comes into contact with and slides with a cam surface 37 of the segments 30 at diameter enlargement or diameter reduction.

[0059] When, for example, hydraulic oil is supplied to the hydraulic rotating cylinder 21 to move the rod 23 to the rear side (R), namely, to retreat the rod 23, the wedges 25 fixed to the end part of the rod 23 on the front side (F) are also retreated. As a result, the cam protrusion 26 pushes up the segments 30 to expand the diameter of the segments 30. When the rod 23 is moved to the front side (F), namely, is advanced from the state where the diameter of the segments 30 is expanded, the diameter of the segments 30 is collapsed.

[Segment 30: See FIG. 3 and FIG. 7]

[0060] The segments 30 are disposed to surround a periphery of the second shaft section 15 with the wedges 25 in between. In the present embodiment, as an example, four segments 30 surround the periphery of the second shaft section 15 to configure the winding drum. A center angle of each of the segments 30 each having an arc-shaped cross-section is 90 degrees. When outer peripheral surfaces of the four segments 30 communicate with each other, a circular cross-section is formed.

[0061] The segments 30 are coupled to the second shaft section 15 of the main shaft 10 so as to be displaceable in the radial direction of the second shaft section 15. When the segments 30 are displaced outward in the radial direction, an outer diameter of the winding drum specified by the outer peripheral surfaces of the segments 30 is expanded, whereas when the segments 30 are displaced inward in the radial direction from those positions, the outer diameter of the winding drum is reduced.

[0062] Outer surfaces 31 of the segments 30 each have an arc surface equal in diameter in the direction of the axis C. On the other hand, inner surfaces 32 are provided with a plurality of cam grooves 36 to which the respective cam protrusions 26 of the wedges 25 enter. For example, each of the wedge grooves 36 has a shape in which a diameter is continuously increased from the rear side (R) to the front side (F), and is steeply reduced from a vertex of the diameter. The inner surface 32 of a portion where the diameter is expanded configures the wedge surface 37 that comes into contact with and slides with the wedge surface 27 of the wedges 25 at diameter expansion or diameter collapsing.

[First Rotating Mechanism 5: See FIG. 1, FIG. 5, and FIG. 6]

[0063] Next, the first rotating mechanism 5 is described.

[0064] The first rotating mechanism 5 holds the mandrels 3A and 3B, and transmits the rotational forces from the main driving sources 9A and 9B to the mandrels 3A and 3B.

[0065] The first rotating mechanism 5 includes a casing 51, the paired holding hollow shafts 53A and 53B provided with an interval in a width direction (W) of the casing 51, and main pinions 54A and 54B respectively provided on the holding hollow shafts 53A and 53B. Each

of the main pinions 54A and 54B is an example of a rotational force receiving section of the present disclosure.

[0066] Main driving shafts 77A and 77B transmitting rotational forces from the gear reducers 7A and 7B are disposed in the casing 51 so as to penetrate the casing 51 in a front-rear direction. The main driving shafts 77A and 77B are disposed at a center part of the casing 51 in the width direction (W), and the holding hollow shafts 53A and 53B are disposed on both sides of the main driving shafts 77A and 77B in the width direction (W). The main driving shafts 77A and 77B are supported by a plurality of bearings so as to be rotatable to the casing 51.

[0067] The holding hollow shaft 53A insertably and removably holds the mandrel 3A, and the holding hollow shaft 53B insertably and removably holds the mandrel 3B. At replacement, the mandrels 3A and 3B are respectively removed from the holding hollow shafts 53A and 53B, and new maintained mandrels 3A and 3B are respectively mounted on the holding hollow shafts 53A and 53B.

[0068] Each of the holding hollow shafts 53A and 53B is supported to the casing 51 in the radial direction by the bearings BB1 and BB2 rotatable to the casing 51. The paired bearings BB1 and BB2 are provided at parts on the front side (F) and the rear side (R), of each of the holding hollow shafts 53A and 53B.

[0069] The end parts of the mandrels 3A and 3B on the rear side (R) in the axial direction C are restrained in the front-rear direction by cylindrical fixing rings 57 fixed to the casing 51, and the end parts of the mandrels 3A and 3B on the front side (F) in the axial direction C are restrained in the front-rear direction by cylindrical fixing rings 58 insertable into / removable from the casing 51. As described above, movement of the mandrels 3A and 3B are restrained in the front-rear direction by the fixing rings 57 and the fixing rings 58. The fixing rings 58 each having a half-divided structure as illustrated in FIG. 9 are fixed to the end parts of the holding hollow shafts 53A and 53B on the front side (F) by fastening means BL such as bolts while being inserted into the locking grooves 14. At replacement, the fastening means BL and the fixing rings 58 are removed. As a result, restraint of the mandrels 3A and 3B to the front side (F) is released, which makes it possible to remove the mandrels 3A and 3B.

[0070] The main pinion 54A is fitted to the holding hollow shaft 53A, and the main pinion 54B is fitted to the holding hollow shaft 53B. The main pinion 54A meshes with a main gear 81A fitted to the main driving shaft 77A on the rear side (R), and the main pinion 54B meshes with a main gear 81B fitted to the main driving shaft 77B on the front side (F). In addition, a driving-side spline 55A meshing with the driven-side spline 12A is provided on the holding hollow shaft 53A, and a driving-side spline 55B meshing with the driven-side spline 12B is provided on the holding hollow shaft 53B.

[0071] Along with rotation of the main driving shafts 77A and 77B, the holding hollow shaft 53A is rotated through the main pinion 54A and the main gear 81A or the holding hollow shaft 53B is rotated through the main pinion 54B and the main gear 81B. Rotating the holding hollow shaft 53A rotates the mandrel 3A through the driving-side spline 55A and the driven-side spline 12A, and rotating the holding hollow shaft 53B rotates the mandrel 3B through the driving-side spline 55B and the driven-side spline 12B.

[0072] The main pinions 54A and 54B of the holding hollow shafts 53A and 53B receive the rotational forces from the main driving shafts 77A and 77B. Each of the driven-side splines 12A and 12B is disposed at a position close to the bearing BB1 on a side close to the winding drum including the segments 30 separated from a corresponding one of the main pinions 54A and 54B, out of the paired bearings BB1 and BB2 supporting a corresponding one of the holding hollow shafts 53A and 53B. The position corresponds to a region where the diameters of the first shaft section 11 and the holding hollow shaft 53 are large.

[Second Rotating Mechanism 6: See FIG. 1 and FIG. 2]

[0073] Next, the second rotating mechanism 6 is described.

[0074] The second rotating mechanism 6 rotatably supports the first rotating mechanism 5. When winding of a predetermined amount of metal strip SR by the one mandrel 3A is completed, the second rotating mechanism 6 rotates the first rotating mechanism 5 to enable start of winding of the metal strip SR by the other mandrel 3B. More specifically, the second rotating mechanism 6 rotates the first rotating mechanism 5 by 180 degrees such that, in FIG. 1, the mandrel 3A reaches the position of the mandrel 3B and the mandrel 3B reaches the position of the mandrel 3A.

[0075] The second rotating mechanism 6 includes a base 61, and a driving gear 63 and an idling roller 65 provided with an interval in the width direction (W) on the base 61. A driven gear 59 of the first rotating mechanism 5 is placed on the driving gear 63 and the idling roller 65.

[0076] The driving gear 63 rotates, for example, in a clockwise direction by an unillustrated electric motor. The driving gear 63 includes a plurality of teeth on an outer peripheral surface, and the teeth of the driving gear 63 mesh with teeth of the driven gear 59. The idling roller 65 is rotatably supported by the base 61 through unillustrated bearings. The idling roller 65 has a flat outer peripheral surface.

[0077] When winding of the metal strip SR by the mandrel 3A is completed and the driving gear 63 is rotated, the first rotating mechanism 5 is rotated through the driven gear 59 meshing with the driving gear 63. At this time, the idling roller 65 is rotated with rotation of the driven gear 59. When the mandrel 3B reaches the previous position of the mandrel 3A, rotation of the driving gear 63 is stopped.

[Gear reducers 7A and 7B: See FIG. 1 and FIG. 4]

[0078] Next, the gear reducers 7A and 7B are described.

[0079] The gear reducer 7A reduces rotation of the main driving source 9A and transmits the reduced rotation to the holding hollow shaft 53A, and the gear reducer 7B reduces rotation of the main driving source 9B and transmits the reduced rotation to the holding hollow shaft 53B.

[0080] The gear reducer 7A includes a gear case 71A, a first gear 73A rotatably supported by the gear case 71A through bearings, a second gear 74A rotatably supported by the gear case 71A through bearings, and a third gear 75A rotatably supported by the gear case 71 through bearings. The first gear 73A meshes with the second gear 74A, and the second gear 74A meshes with the third gear 75A. A drive coupling 91A of the main driving source 9A is coaxially fixed to the first gear 73A, and the main driving shaft 77A extending up to the first rotating mechanism 5 is coaxially fixed to the third gear 75A. The main pinion 54A is coaxially fixed to the main driving shaft 77A as described above.

[0081] The gear reducer 7B includes a gear case 71B, a first gear 73B rotatably supported by the gear case 71B through bearings, and a second gear 74B rotatably supported by the gear case 71 through bearings. The first gear 73B meshes with the second gear 74B. A drive coupling 91B of the main driving source 9B is coaxially fixed to the first gear 73B, and the main driving shaft 77B extending up to the first rotating mechanism 5 is coaxially fixed to the second gear 74B. The main pinion 54B is coaxially fixed to the main driving shaft 77B as described above.

[0082] Each of the main driving shaft 77A and the main driving shaft 77B has a cylindrical form, and the main driving shaft 77A is provided in a void inside the main driving shaft 77B. A supporting shaft 79 in which both ends are fixed and supported is provided in a void inside the main driving shaft 77A. The main driving shaft 77B is rotatable around the supporting shaft 79, and the main driving shaft 77A is rotatable around the main driving shaft 77B.

[Main Driving Sources 9A and 9B: See FIG. 1 and FIG. 4]

[0083] When the metal strip SR is wound on the mandrel 3A, the main driving source 9A is driven, and rotational force of the main driving source 9A is transmitted to the gear reducer 7A through the drive coupling 91A. The rotational force transmitted to the gear reducer 7A is transmitted to the main driving shaft 77A, and further rotates the mandrel 3A through the main pinion 54A and the driving-side spline 55A. At this time, operation of the main driving source 9B is stopped.

[0084] When the metal strip SR is wound on the mandrel 3B, the main driving source 9B is driven, and rotational force of the main driving source 9B is transmitted to the gear reducer 7B through the driving shaft 91B. The rotational force transmitted to the gear reducer 7B is transmitted to the main driving shaft 77B, and further rotates the mandrel 3B through the main pinion 54B and the driving-side spline 55B. At this time, operation of the main driving source 9A is stopped.

[Work for Replacing Mandrel 3: See FIG. 6]

[0085] Next, a work for replacing the mandrel 3 is described.

[0086] To replace, for example, the mandrel 3B for maintenance, the fixing ring 58 is first removed. When the fixing ring 58 is removed, restraint of the mandrel 3B to the front side (F) is released. Therefore, the mandrel 3B can be removed from the holding hollow shaft 53B of the first rotating mechanism 5 by being moved to the front side (F). After a new mandrel 3B for replacement is inserted into the holding hollow shaft 53B of the first rotating mechanism 5, the fixing ring 58 is fixed to the holding hollow shaft 53B by the fastening means. The work for replacing the mandrel 3B is thus finished. The removed mandrel 3B is subjected to maintenance such as replacement of the segments 30.

[Removal of Coil CL from Mandrel 3: See FIG. 4 and FIG. 5]

[0087] The coil CL formed by winding the metal strip SR by the mandrel 3 is removed from the mandrel 3.

[0088] To remove the coil CL from the mandrel 3, as an example, an unillustrated carriage is used. More specifically, the carriage is moved to the mandrel 3 to receive the coil CL. After the mandrel 3 is reduced in diameter to release restraint of the coil CL, the carriage is moved to remove the coil CL from the mandrel 3. At the removal, it is necessary to prevent the coil CL from becoming a telescopic shape, and the coil CL is not easily removed from the mandrel 3 in some cases. To cope with such defects, the winding device 1 includes a removal assisting mechanism 100. The removal assisting mechanism 100 includes a stripper plate 101 that comes into contact with a part of the coil CL on the rear side (R) to press the coil CL, and a driving source 103 that moves the stripper plate 101 from a standby position illustrated by a solid line to a removal position illustrated by an alternate long and short dash line.

[0089] When the coil CL is removed from the mandrel 3, the removal assisting mechanism 100 operates the driving source 103 and advances the stripper plate 101 from the standby position to the removal position. In this way, the removal assisting mechanism 100 copes with the defects when the coil CL is removed from the mandrel 3.

[Effects Achieved by Winding device 1]

[0090] According to the winding device 1, the expansion mechanism 20 changing the outer diameter of the mandrel 3 and the mandrel 3 are integrally insertable into and removal from the holding hollow shaft 53 in the axial direction of the mandrel. Thus, according to the winding device 1 of the present disclosure, at replacement of the mandrel 3, the expansion mechanism 20 can also be removed together with the mandrel. This makes it possible to easily replace the mandrel 3 in a short time.

[0091] According to the winding device 1, the hydraulic rotating cylinder 21 including the rod 23 has the dimension in the radial direction falling within the range of the outer diameter of the main shaft 10. In addition, the hydraulic rotating cylinder 21 including the rod 23 is provided inside the main shaft 10. Therefore, according to the winding device 1, at replacement of the mandrel 3, the hydraulic rotating cylinder 21 and the rod 23 can be removed together with the mandrel 3 while avoiding interference with the holding hollow shaft 53. This makes it possible to easily replace the mandrel in a short time.

[0092] According to the winding device 1, the first shaft section 11 supported by the bearings BB1 and BB2 through the holding hollow shaft 53 has the cylindrical appearance. Therefore, according to the winding device 1, a moment arm of an overturning moment acting on the winding drum including the segments 30 of the mandrel 3 is increased, and reaction force acting on the cylindrical first shaft section 11 and surface pressure generated by the reaction force can be reduced. This makes it possible to considerably reduce a risk of wear such as abrasion and settling, of the first shaft section 11.

[0093] According to the winding device 1, in the first shaft section 11 of the mandrel 3, the bushes 13 and 16 are insertably and removably fitted at the positions facing the paired bearings BB1 and BB2. Therefore, according to the winding device 1, periodically replacing the bushes 13 and 16, for example, at replacement of the mandrel 3 makes it possible to maintain the winding device 1 at a small maintenance cost without damaging the first shaft section 11. In particular, the portions facing the bearings BB1 and BB2 receive heavy loads and are easily worn. Therefore, using the replaceable bushes 13 and 16 for the portions makes it possible to reduce wear of the mandrel 3 and to improve durability.

[0094] According to the winding device 1, as the rotational force applying portion, the spline including the driven-side spline 12 and the driving-side spline 55 is adopted. The spline is high in transmission torque. In addition, at replacement of the mandrel 3, the inner teeth of the holding hollow shaft 53 and the outer teeth of the first shaft section 11 can be caused to mesh with each other only by small rotation in the circumferential direction. Therefore, the main shaft 10 can be easily mounted on the holding hollow shaft 53. Further, a function sharing system in which the bushes 13 and 16 hold a radial load and the spline transmits the torque is adopted, which makes it possible to minimize the gap between the first shaft section 11 of the main shaft 10 and the holding hollow shaft 53.

[0095] According to the winding device 1, the holding hollow shaft 53 includes the main pinion 54 as the rotational force receiving section to which the rotational force is transmitted, and the driven-side spline 12 is disposed at the position close to the bearing BB1 on the side close to the winding drum including the segments 30, out of the paired bearings BB1 and BB2.

[0096] The segments (winding drum) 30 have the considerable weight including the weight of the wound metal strip SR. Therefore, the considerable torsional force is necessary to rotate the first shaft section 11. The torsional force is applied to the driven-side spline 12. When the position receiving the torsional force is far from the segments 30, the torsional angle occurring on the second shaft section 15 provided with the segments 30 is increased. Therefore, in the winding device 1, the torsional angle is suppressed by providing the driven-side spline 12 at the position close to the segments 30. Further, the driven-side spline 12 is provided at the region of the holding hollow shaft 53 having the large diameter. Therefore, torsional rigidity is large.

[0097] According to the winding device 1, the outer diameter of the first shaft section 11 and the opening diameter of the housing space AS is gradually reduced to the rear side (R). Therefore, at replacement of the mandrel 3, the first shaft section 11 of the mandrel 3 is easily inserted into the holding hollow shaft 53.

[0098] According to the winding device 1, the coil removal assisting mechanism 100 pressing the end surface of the coil CL is provided. Therefore, at removal of the coil CL from the mandrel 3, it is possible to prevent the coil CL from being unwound and becoming a telescopic shape, and to prevent the coil CL from becoming difficult to be removed.

[Substitution of Configuration and Others]

[0099] Although the preferred embodiment of the present disclosure is described above, the configurations described in the above-described embodiment can be selected or substituted with other configurations without departing from the spirit of the present disclosure.

[0100] For example, in the expansion mechanism 20, the hydraulic rotating cylinder 21 is used as the driving source for expanding or collapsing the diameter of the segments 30. In the present disclosure, however, the driving source is not limited as long as the driving source can expand or collapse the diameter of the segments 30, and other driving source such as a linear electric motor can be used.

[0101] Further, in the winding device 1, the gear reducers 7A and 7B are interposed between the main driving sources 9A and 9B and the first rotating mechanism 5; however, a driving source having functions corresponding to the gear reducers 7A and 7B can be used.

Reference Signs List

[0102]

1 Winding device
3, 3A, 3B Mandrel
5 First rotating mechanism
6 Second rotating mechanism
7A, 7B Gear reducer
9A, 9B Main driving source
10 Main shaft
11 First shaft section
12 Driven-side spline
13, 16 Bush
14 Locking groove
15 Second shaft section
17 Fixing ring
19 Cylinder space
19A Cylinder space
19B Rod space
20 Expansion mechanism
21 Hydraulic rotating cylinder
23 Rod
25 Wedge
26 Cam protrusion
27 Can surface
30 Segment
31 Outer surface
32 Inner surface
36 Cam groove
37 Cam surface
51 Casing
53, 53A, 53B Holding hollow shaft
54A, 54B Main pinion
55A, 55B Driving-side spline
57, 58 Fixing ring
59 Driven gear
61 Base
63 Driving gear
65 Idling roller
71, 71A, 71B Gear case
73A, 73B First gear
74A, 74B Second gear
75A Third gear
77A, 77B Main driving shaft
79 Supporting shaft
81A, 81B Main gear
91A, 91B Drive coupling
100 Removal assisting mechanism
101 Stripper plate
103 Driving source
A1 First section
A2 Second section
A3 Third section
BB1, BB2 Bearing
C Axis
F Front side
R Rear side
H Height direction
L Length direction
W Width direction
SR Metal strip
CL Coil

Claims

1. A winding device comprising:

a mandrel configured to rotate around an axis and including a winding drum and an expansion mechanism configured to change an outer diameter of the winding drum;
a casing to which the mandrel is mounted; and
a holding hollow shaft configured to hold the mandrel between the casing and the mandrel and to rotate coaxially with the mandrel, wherein
the mandrel is configured to be insertable into and removal from the holding hollow shaft in an axial direction of the mandrel, integrally with the expansion mechanism.

2. The winding device according to claim 1, wherein

the mandrel includes a main shaft configured to rotate coaxially with the winding drum and extending in the axial direction,
the expansion mechanism includes a hydraulic rotating cylinder configured to expand or reduce the outer diameter of the winding drum by movement of a rod in the axial direction, and
the hydraulic rotating cylinder including the rod has a dimension in a radial direction falling within a range of an outer diameter of the main shaft.

3. The winding device according to claim 2, wherein the hydraulic rotating cylinder including the rod is provided inside the main shaft.

4. The winding device according to claim 2 or 3, further comprising:

a rotational force applying portion configured to transmit rotational force from the holding hollow shaft to the mandrel; and
paired bearings provided between the casing and the holding hollow shaft and on both sides of the rotational force applying portion in the axial direction, wherein
the main shaft of the mandrel includes a first shaft section, portions of the first shaft section facing the paired bearings each having a cylindrical appearance, and
an outer periphery of the first shaft section and an inner periphery of the holding hollow shaft are configured to come into contact with each other.

5. The winding device according to claim 4, wherein bushes (13 and 16) are replaceably fitted to positions facing the paired bearings, of the first shaft section of the mandrel.

6. The winding device according to claim 4 or 5, wherein the rotational force applying portion includes a spline in which a plurality of inner teeth provided on the inner periphery of the holding hollow shaft and a plurality of outer teeth provided on the outer periphery of the first shaft section of the mandrel mesh with each other.

7. The winding device according to claim 6, wherein

the holding hollow shaft includes a rotational force receiving section to which the rotational force is transmitted, and
the spline is disposed at a position close to the bearing on a side close to the winding drum, out of the paired bearings.

8. The winding device according to any one of claims 1 to 7, wherein the mandrel is supported to the holding hollow shaft in the axial direction by fastening a fixing ring having a half-divided structure to the holding hollow shaft.

9. The winding device according to any one of claims 4 to 7, wherein

an outer diameter of the first shaft section of the main shaft is configured to be continuously or stepwisely reduced from a front side to a rear side, and
an opening diameter of a housing space of the holding hollow shaft for the first shaft section is configured to be continuously or stepwisely reduced from the front side to the rear side, a side from which the mandrel is removed being defined as the front side, a side opposite thereto being defined as the rear side.

10. The winding device according to any one of claims 1 to 9, further comprising a coil removal assisting mechanism configured to press an end surface of a coil formed of a metal strip wound on the mandrel, from a rear side to a front side along the axial direction of the mandrel, a side from which the mandrel is removed being defined as the front side, a side opposite thereto being defined as the rear side.

11. A method of replacing a mandrel by inserting/ removing the mandrel into/from a casing in an axial direction, the mandrel configured to rotate around an axis and including a winding drum, the method comprising inserting/removing the mandrel into/from a holding hollow shaft holding the mandrel between the casing and the mandrel and rotating coaxially with the mandrel, wherein
the mandrel is configured to be insertable into and removal from the holding hollow shaft in the axial direction of the mandrel, integrally with an expansion mechanism configured to change an outer diameter of the winding drum.

12. A mandrel rotating around an axis and including a winding drum, the mandrel comprising:

an expansion mechanism including a hydraulic rotating cylinder configured to expand or reduce an outer diameter of the winding drum by movement of a rod in an axial direction; and
a main shaft configured to rotate coaxially with the winding drum and extending in the axial direction, wherein
the hydraulic rotating cylinder including the rod has a dimension in a radial direction falling within a range of an outer diameter of the main shaft.

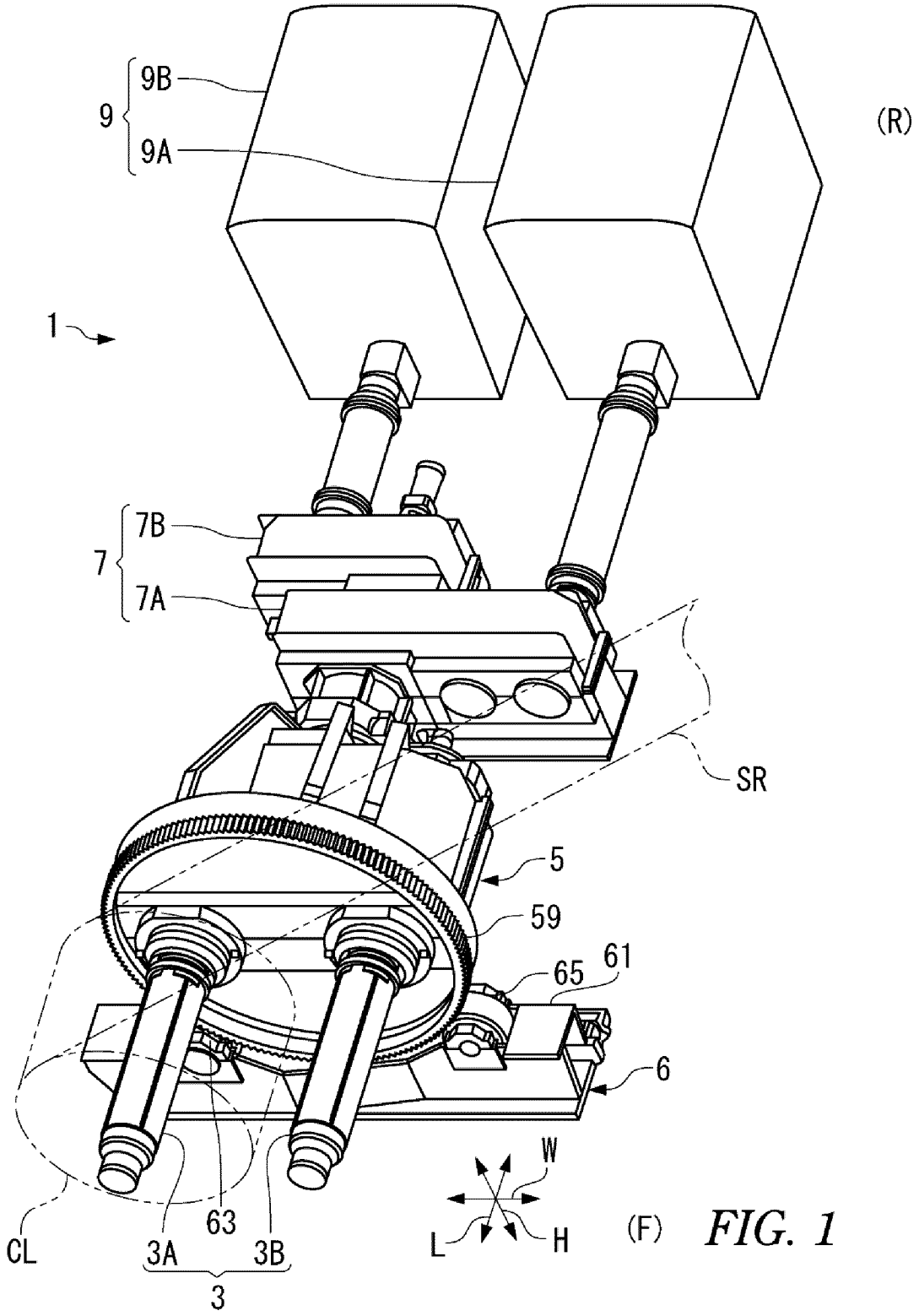


FIG. 1

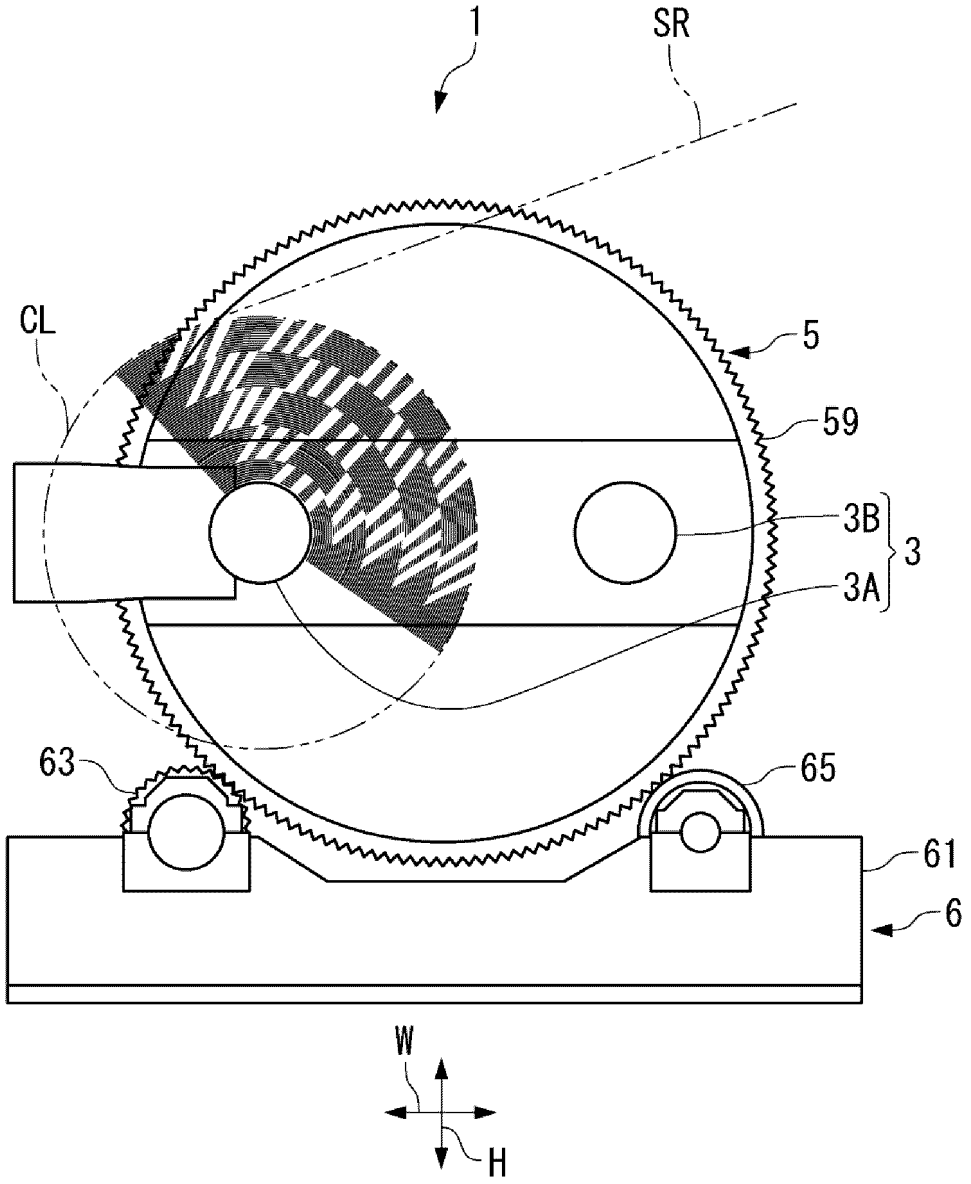


FIG. 2

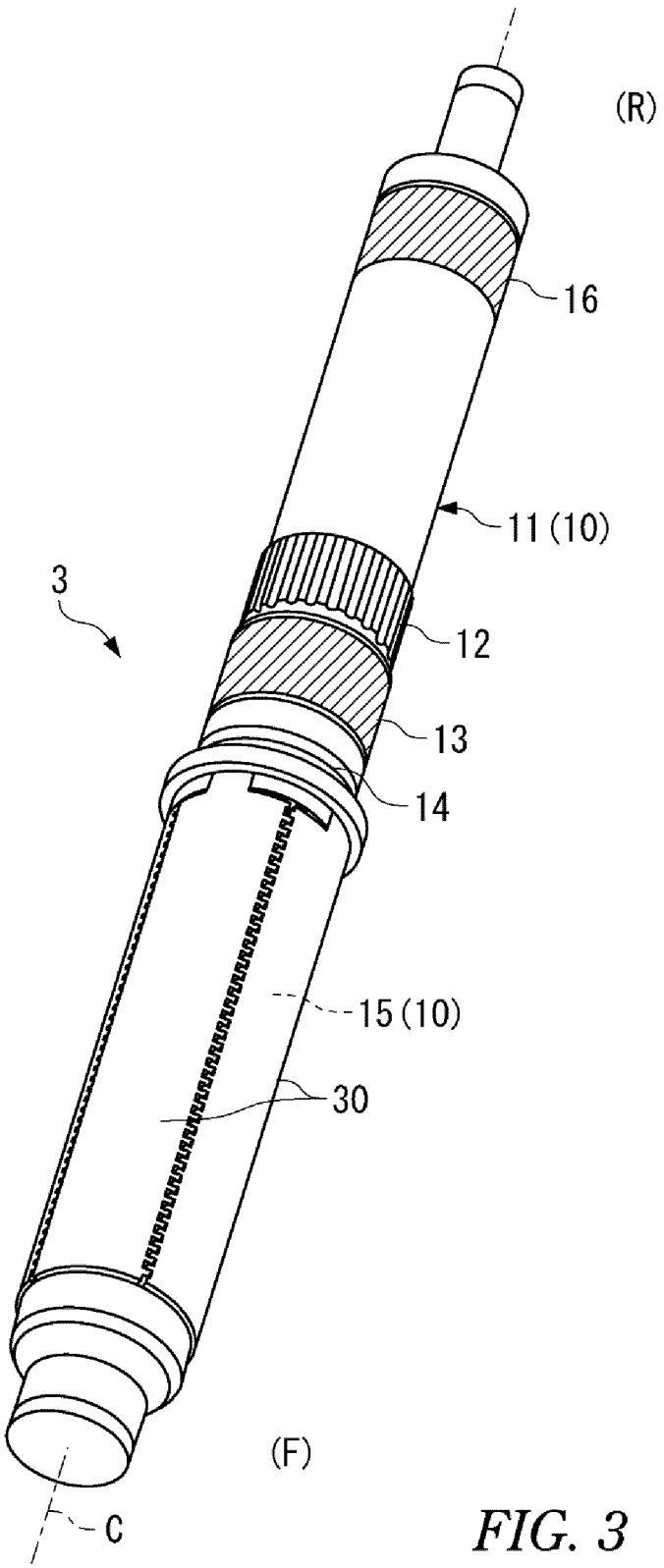
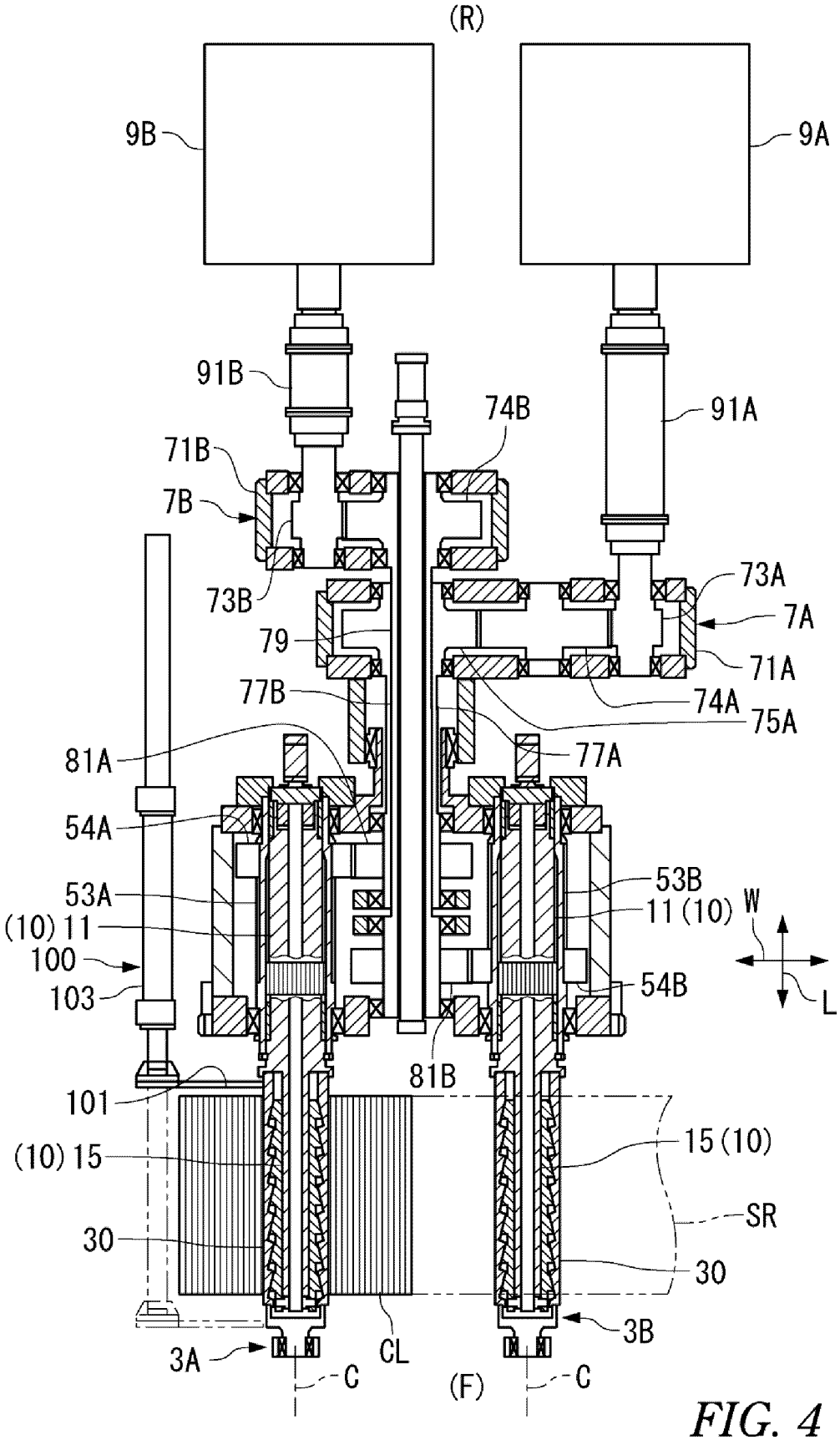


FIG. 3


(R)
9B
9A
91B
91A
74B
71B
7B
73B
73A
7A
79
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74A
75A
81A
77A
54A
53A
53B
(10) 11
11 (10)
W
100
54B
103
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81B
101
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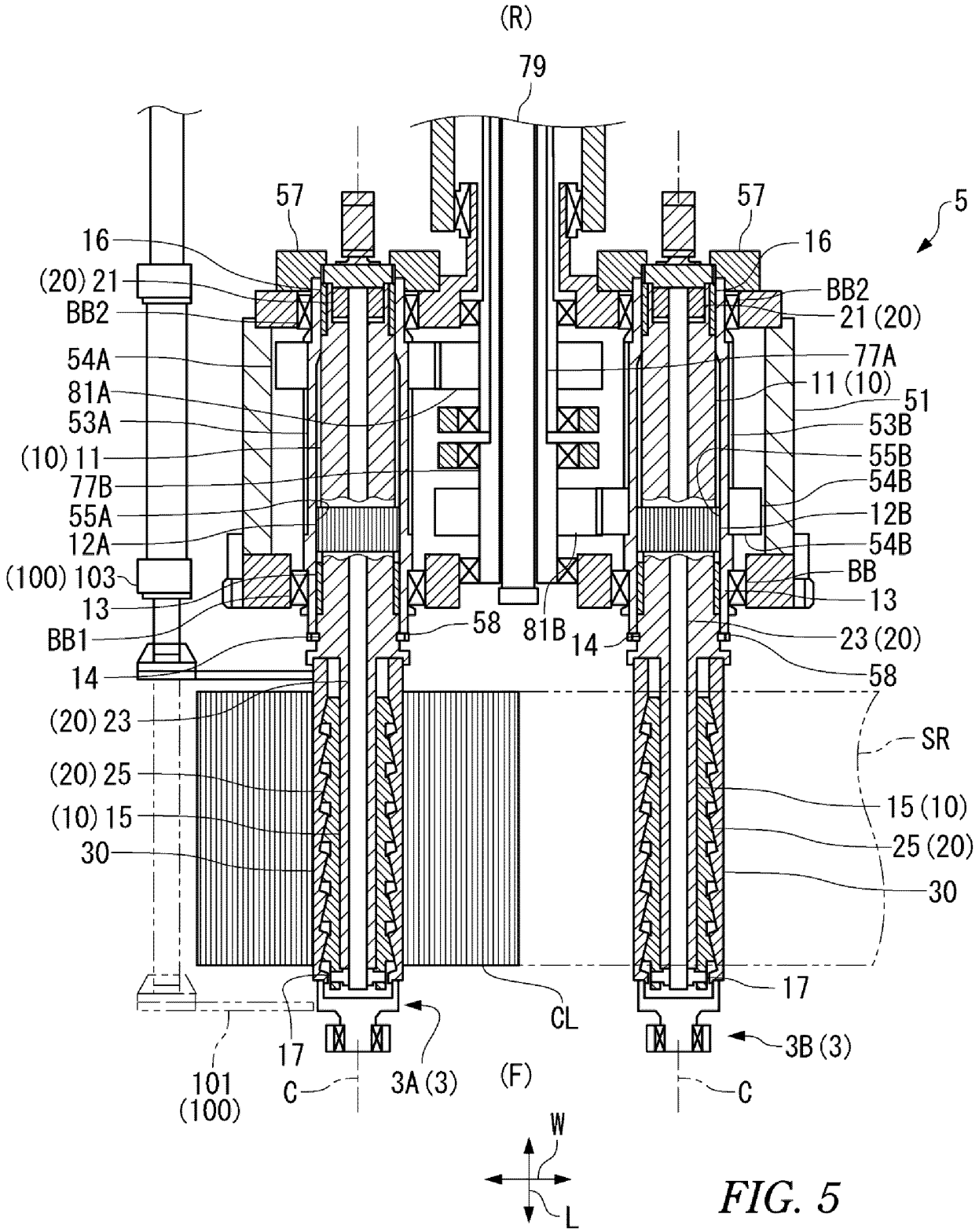
SR
30
30
3B
3A
CL
C
(F)
C

FIG. 4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57
57
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16
16
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BB2
BB2
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77A
81A
11 (10)
51
53A
53B
(10) 11
55B
77B
54B
55A
12B
12A
54B
(100) 103
BB
13
13
BB1
58
81B
14
23 (20)
14
58
(20) 23
SR
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15 (10)
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25 (20)
30
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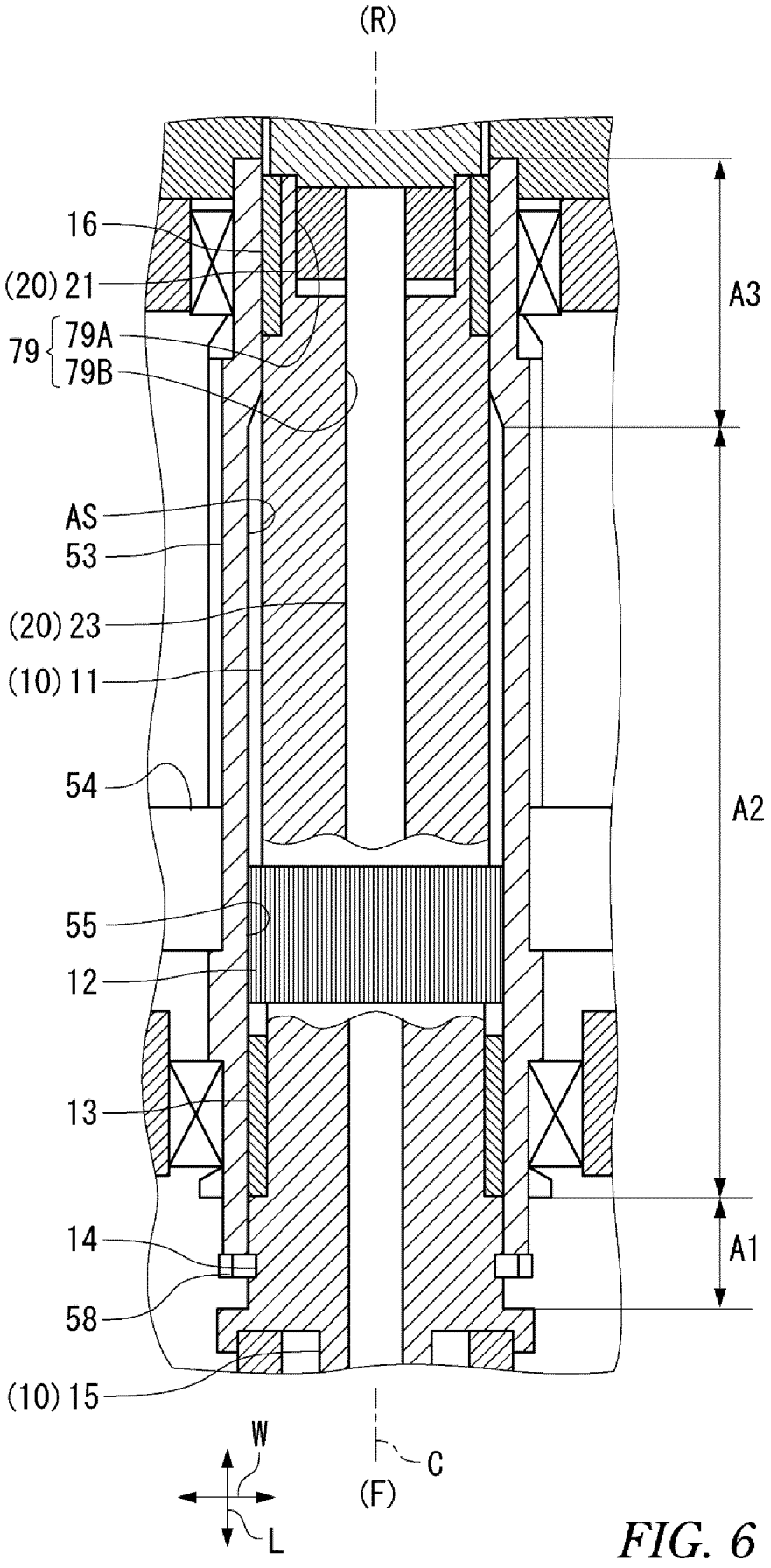
(100)
C
3A (3)
(F)
C
W
L

FIG. 5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(20) 21
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79B
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(20) 23
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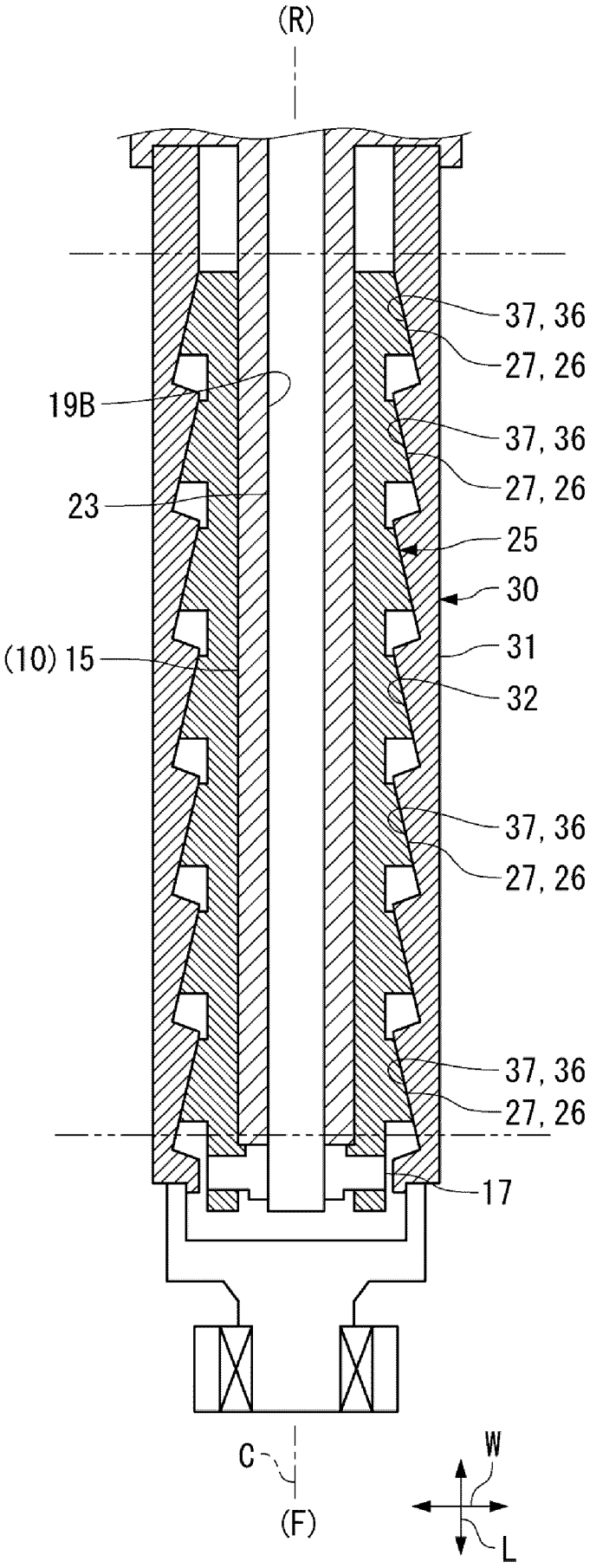
A2
A1
W
L
C
(F)

FIG. 6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17
C
(F)
W
L

FIG. 7

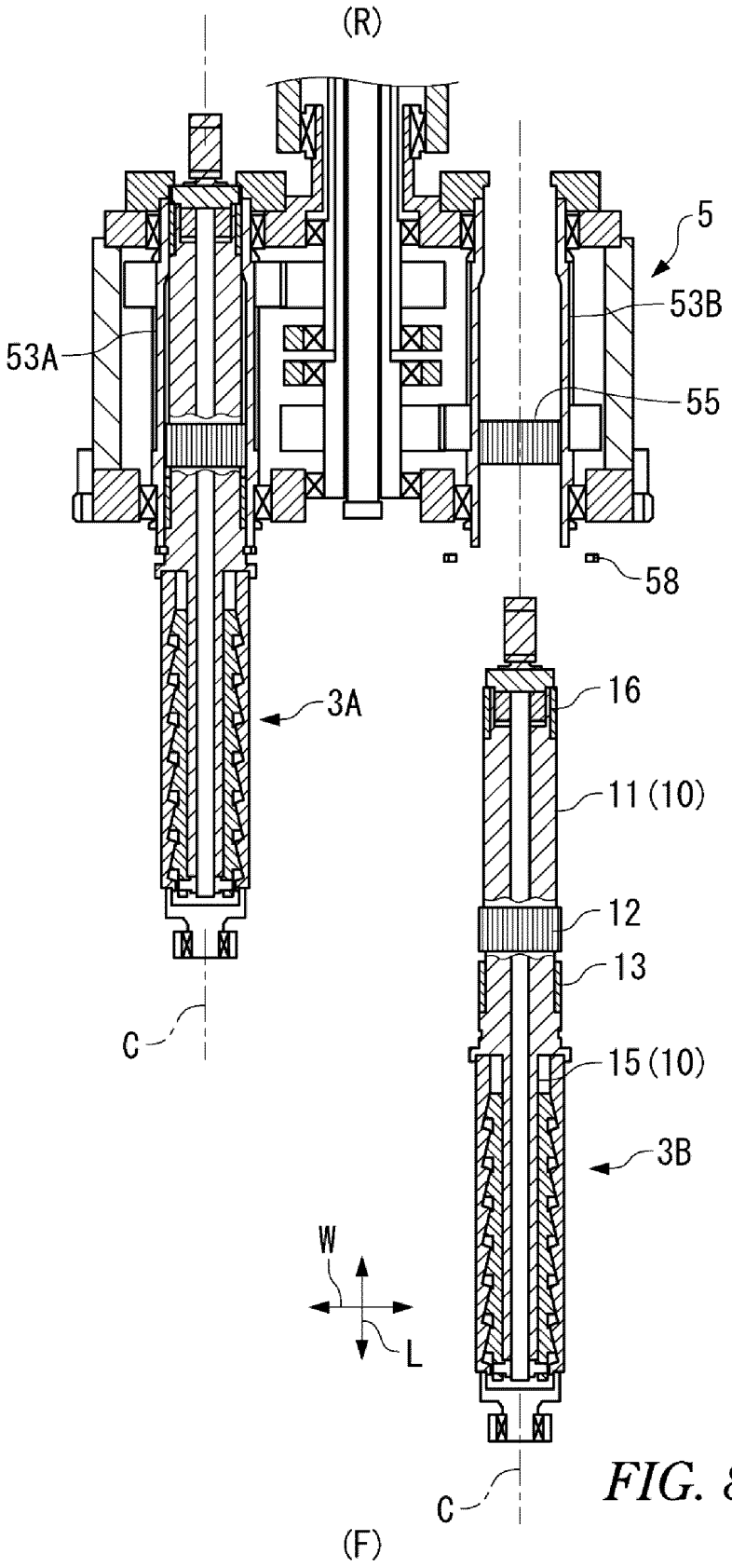

FIG. 8

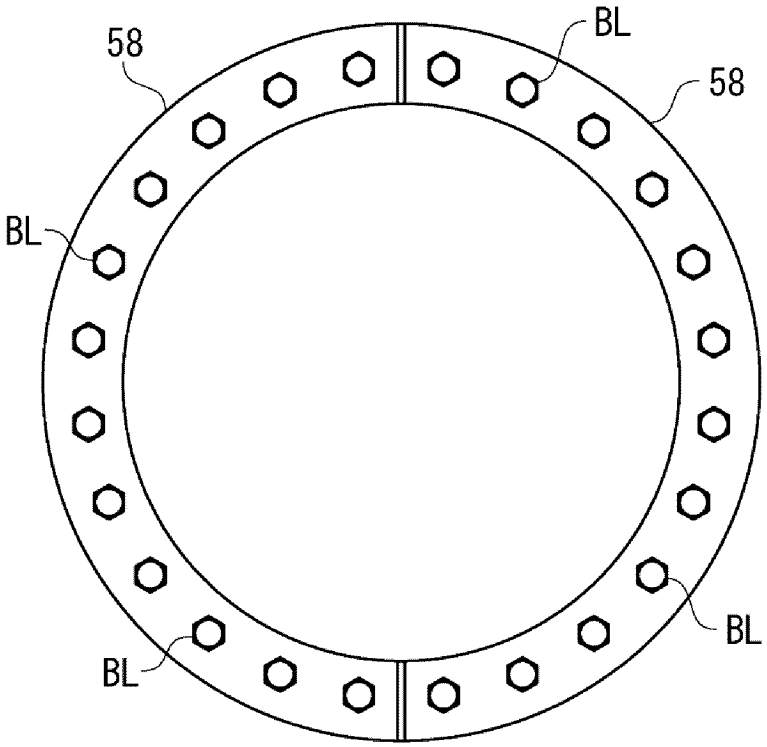

FIG. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2022/020961

A. CLASSIFICATION OF SUBJECT MATTER

B65H 18/04(2006.01)i
FI: B65H18/04

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)

B65H18/00-18/28

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 1971-2022
Registered utility model specifications of Japan 1996-2022
Published registered utility model applications of Japan 1994-2022

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 60-061116 A (MITSUBISHI HEAVY INDUSTRIES, LTD.) 08 April 1985 (1985-04-08) p. 1, lower left column, line 20 to p. 2, upper right column, line 2, fig. 1	12
A		1-11
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 039992/1990 (Laid-open No. 130261/1991) (KUSAKABE ELECTRIC & MACHINERY CO., LTD.) 27 December 1991 (1991-12-27), fig. 2	12
A		1-11
Y	JP 2007-191301 A (PABOT GIKEN K.K.) 02 August 2007 (2007-08-02) fig. 7	12
A		1-11

☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
08 June 2022	**21 June 2022**

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

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

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2022/020961

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REFERENCES CITED IN THE DESCRIPTION

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