

DESCRIPTION

TITLE OF INVENTION: WIRE ROD DELIVERING DEVICE AND WIRE WINDING
DEVICE PROVIDED WITH THE SAME

TECHNICAL FIELD

[0001] The present invention relates to a wire rod delivering device and a wire winding device provided with the same.

BACKGROUND ART

[0002] Conventionally, there is a known wire winding device for winding a wire rod, which is stored by being wound around a drum, etc., while drawing out the wire rod from the drum, etc. Because a resistance to draw out the wire rod is increased as the cross-sectional area of the wire rod is increased in such a wire winding device, a wire winding device including a wire rod delivering device that sends the wire rod to a wire winding mechanism while drawing out the wire rod from the drum, etc. is known (see JPH10-303055A).

[0003] This wire rod delivering device includes a fixed chuck device that releasably catches the wire rod, a movable chuck device, and an actuator that causes the movable chuck device to approach/move away from the fixed chuck device, and the movable chuck device catching the wire rod is moved by the actuator to approach the fixed chuck device not catching the wire rod, thereby delivering the wire rod from the fixed chuck device side.

SUMMARY OF INVENTION

[0004] With the wire rod delivering device, there is a problem in that the wire rod being delivered is buckled if a delivered amount of the wire rod in a single

cycle is increased. Therefore, with the wire rod delivering device described in JPH10-303055A, as shown in FIG. 11, the tubular wire rod guide 2, which has a length greater than the delivered amount SL, is provided on the movable chuck device 3, and the wire rod guide path 4a, into which the wire rod guide 2 can enter and which has a length greater than the delivered amount SL, is formed on a fixed chuck device 4. By delivering the wire rod 1 in a state in which the wire rod 1 is passed through the wire rod guide 2, it is possible to deliver the thick wire rod 1 without causing it to buckle.

[0005] However, with the above-described wire rod delivering device, in which the tubular wire rod guide 2 is provided on the movable chuck device 3, because the fixed chuck device 4 is formed with the wire rod guide path 4a into which the wire rod guide 2, which has the length greater than the delivered amount SL, can enter, the length that is at least twice as long as the delivered amount SL in a single cycle is required as a space for installing the device, and so, there is a problem in that the size of the device is increased if the delivered amount in a single cycle is to be increased.

[0006] In addition, the wire rod to be wound by the wire winding device is not limited to a round wire having a circular cross section, and there is also a rectangular wire having a square cross section. When a flat rectangular wire having a rectangular cross section is inserted through the tubular wire rod guide having the circular cross section, there is a problem in that the buckling of the flat rectangular wire in the thickness direction cannot be effectively prevented due to the existence of a gap between the wire rod guide and the flat rectangular wire.

[0007] An object of the present invention is to provide a wire rod delivering device capable of, without increasing the size of the device, delivering a wire

rod while preventing buckling of the wire rod even if the wire rod is a flat rectangular wire, as well as to provide a wire winding device employing the wire rod delivering device.

[0008] According to one aspect of the present invention, a wire rod delivering device includes: a fixed chuck device configured to releasably catch a wire rod; a movable chuck device provided movably, the movable chuck device being configured to releasably catch the wire rod; an actuator configured to move the movable chuck device closer to or away from the fixed chuck device; a plurality of support parts provided side by side between the fixed chuck device and the movable chuck device, the plurality of support parts being configured to support the wire rod extending between the fixed chuck device and the movable chuck device; and arrangement means configured to arrange the plurality of support parts at predetermined intervals between the fixed chuck device and the movable chuck device.

BRIEF DESCRIPTION OF DRAWINGS

[0009]

[FIG. 1] FIG. 1 is a plan view showing a wire winding device of an embodiment of the present invention.

[FIG. 2] FIG. 2 is a front view showing the wire winding device of the embodiment of the present invention.

[FIG. 3] FIG. 3 is a diagram showing a state in which a wire rod is delivered by a wire rod delivering device, and is a plan view corresponding to FIG. 1.

[FIG. 4] FIG. 4 is a diagram showing a state in which the wire rod is delivered by the wire rod delivering device, and is a front view corresponding

to FIG. 2.

[FIG. 5] FIG. 5 is a side view of the wire winding device viewed from the wire rod supply side.

[FIG. 6] FIG. 6 is a sectional view along a line A-A in FIG. 2.

[FIG. 7] FIG. 7 is a sectional view along a line B-B in FIG. 2.

[FIG. 8] FIG. 8 is a sectional view along a line C-C in FIG. 1.

[FIG. 9A] FIG. 9A is a diagram showing a procedure of winding an edgewise coil using the wire winding device.

[FIG. 9B] FIG. 9B is a diagram showing the procedure of winding the edgewise coil using the wire winding device.

[FIG. 9C] FIG. 9C is a diagram showing the procedure of winding the edgewise coil using the wire winding device.

[FIG. 10A] FIG. 10A is a diagram showing the procedure of winding the edgewise coil using the wire winding device.

[FIG. 10B] FIG. 10B is a diagram showing the procedure of winding the edgewise coil using the wire winding device.

[FIG. 10C] FIG. 10C is a diagram showing the procedure of winding the edgewise coil using the wire winding device.

[FIG. 11] FIG. 11 is a diagram showing a conventional wire rod delivering device.

DESCRIPTION OF EMBODIMENT

[0010] In the following, an embodiment of the present invention will be described with reference to the drawings.

[0011] FIGs. 1 to 4 show a wire winding device 10 including a wire rod delivering device 60 of the embodiment of the present invention. In these figures, the configuration is described by setting mutually orthogonal three axes, X, Y, and Z. The X axis extends in the horizontal front-rear direction, the Y axis extends in the horizontal transverse direction, and the Z axis extends in the vertical direction.

[0012] The wire rod to be wound by the wire winding device 10 is a rectangular wire that has a rectangular cross section and that is formed with an surface insulating film. In this embodiment, a case in which a flat rectangular wire 11 having a wider width relative to the thickness is used as the rectangular wire will be described.

[0013] The flat rectangular wire 11 is wound on a reel (not shown) serving as a wire rod supply source and installed in the vicinity of the wire winding device 10. The wire winding device 10 has the wire rod delivering device 60 that is provided on a table 13 and delivers the flat rectangular wire 11 delivered from the reel in the longitudinal direction and a winding mechanism 30 that is provided on the table 13 so as to be adjacent to the wire rod delivering device 60 and bends and winds the flat rectangular wire 11 that has been delivered from the wire rod delivering device 60.

[0014] As shown in FIGs. 2 and 4, the winding mechanism 30 winds the flat rectangular wire 11 in the width direction. The winding mechanism 30 of this embodiment includes: a shaft 31 having a circular cross section that is provided on a fixing base 29 and that comes into contact with a side surface of the flat rectangular wire 11 on the inner side when the flat rectangular wire 11 is bent; a bender 32 that revolves about the shaft 31 and bends the flat rectangular wire 11 along the shaft 31; and a slew driving mechanism 33 that

slews the bender 32.

[0015] A cylinder portion 29a having a vertical center axis is formed on the fixing base 29, and a roller sleeve 34 is fixed to the cylinder portion 29a with screws 34a in the vertical direction. The shaft 31 is supported by the roller sleeve 34 so as to be rotatable and so as to be movable in the axial direction via bearings 31c.

[0016] The shaft 31 is provided so as to extend in the vertical direction. The shaft 31 has a curving portion 31a around which the flat rectangular wire 11 is curved and a supported portion 31b that is supported by the roller sleeve 34. The curving portion 31a and the supported portion 31b are provided coaxially and continuously.

[0017] The roller sleeve 34 has a support portion 34b that supports the supported portion 31b of the shaft 31 so as to be rotatable and so as to be movable in the axial direction and a surrounding portion 34c that surrounds the curving portion 31a of the shaft 31. The support portion 34b and the surrounding portion 34c are formed coaxially. The support portion 34b is fixed by being embedded in the cylinder portion 29a of the fixing base 29. The surrounding portion 34c projects upwards from a top surface of the fixing base 29 and is formed such that the flat rectangular wire 11, which has been delivered by the wire rod delivering device 60, is placed on its upper edge.

[0018] The slew driving mechanism 33 has: a slew gear 33c that is rotatably supported around the roller sleeve 34 on the top surface of the fixing base 29 via bearings 33b; a drive gear 33d that meshes with the slew gear 33c; and a motor 33e that rotationally drives the drive gear 33d. The bender 32 is attached to the slew gear 33c.

[0019] A controller (not shown) is electrically connected to the motor 33e, and

a control command is output from the controller to the motor 33e. When the motor 33e rotates the drive gear 33d according to the command from the controller, the slew gear 33c that meshes with the drive gear 33d is rotated about the center axis of the shaft 31 as the rotation center, and thereby, the bender 32 is slewed by following an arc-shaped trajectory centered on the shaft 31.

[0020] The bender 32 is slewed together with the slew gear 33c so as to press the flat rectangular wire 11 against the circumference of the shaft 31, thereby bending the flat rectangular wire 11 such that the flat rectangular wire 11 is curved around the circumference of the shaft 31.

[0021] In addition, the winding mechanism 30 includes a press mechanism 40 that press-holds the flat rectangular wire 11, which is being curved around the shaft 31, in the axial direction of the shaft 31 when the flat rectangular wire 11 is bent by the bender 32. The press mechanism 40 has a disc-shaped flange 41 that is formed coaxially on an upper end of the shaft 31, which projects upwards from the surrounding portion 34c of the roller sleeve 34, and an actuator 42 that drives the shaft 31, on which the flange 41 is formed, in the axial direction.

[0022] The actuator 42 includes a main body 42a and a rod 42b that advances and retracts in the Z axis direction relative to the main body 42a. The main body 42a is supported by the fixing base 29 via a support base 42c and the table 13. The lower end of the supported portion 31b of the shaft 31 is rotatably linked to a tip-end portion of the rod 42b via a bearing 42d and a joint 42e.

[0023] A controller (not shown) is electrically connected to the actuator 42, and a control command is output from the controller to the actuator 42.

When the actuator 42 is extended and contracted according to the command from the controller, the flange 41 is lifted and lowered together with the shaft 31, and thereby, a state in which the flat rectangular wire 11 is press-held and a state in which the press-holding of the flat rectangular wire 11 is released are switched.

[0024] As shown in FIG. 1, a cut-out portion 41a is formed in a part of the flange 41 press-holding the flat rectangular wire 11. The winding mechanism 30 includes a flange moving mechanism 46 that moves the flange 41 such that the flat rectangular wire 11 is not to be press-held at the cut-out portion 41a (see FIG. 2).

[0025] Returning to FIG. 2, the flange moving mechanism 46 has a motor 47 that is provided in parallel with the actuator 42 and a transmission mechanism 48 that transmits the rotation of the motor 47 to the shaft 31. The transmission mechanism 48 includes: a driving pulley 48a that is rotationally driven by the motor 47; a driven pulley 48b that is rotatably attached to a lower end of the cylinder portion 29a of the fixing base 29 and through which the shaft 31 is inserted via a spline so as to be slidable in the axial direction and so as not to be rotatable; and a timing belt 48c that is suspended over pulleys 48a and 48b.

[0026] A controller (not shown) is electrically connected to the motor 47, and a control command is output from the controller to the motor 47. When the motor 47 is driven according to the command from the controller, the driving pulley 48a is rotated, this rotation is transmitted to the driven pulley 48b via the the belt 48c, and the shaft 31 that is spline-coupled to the driven pulley 48b is rotated together with the flange 41.

[0027] As shown in FIGs. 1 to 4, the wire rod delivering device 60 that delivers

the flat rectangular wire 11 to the winding mechanism 30 includes: a fixed chuck device 61 that releasably catches the flat rectangular wire 11 that has been drawn out from the reel and extended straight; a movable chuck device 63 that is provided separately from the fixed chuck device 61 in the Y axis direction so as to be movable in the Y axis direction and that releasably catches the flat rectangular wire 11; and an actuator 62 that moves the movable chuck device 63 closer to or away from the fixed chuck device 61.

[0028] The fixed chuck device 61 is an air cylinder that is attached to the fixing base 29 so as to be adjacent to the winding mechanism 30. The fixed chuck device 61 has a main body 61a that is attached to the fixing base 29 so as to be adjacent to the winding mechanism 30 in the Y axis direction and a pair of clamping pieces 61b and 61c that can be brought into contact with and moved away from each other by an air pressure. The pair of clamping pieces 61b and 61c are provided so as to project out from the main body 61a in the X axis direction and so as to clamp the flat rectangular wire 11 from above and below in the vertical direction.

[0029] When the pair of clamping pieces 61b and 61c are moved closer to each other by the air pressure, as shown in FIG. 2, the pair of clamping pieces 61b and 61c clamp the flat rectangular wire 11 passing between them from above and below in the vertical direction to prohibit the movement of the flat rectangular wire 11. On the other hand, when the pair of clamping pieces 61b and 61c are moved away from each other by the air pressure, as shown in FIG. 4, the pair of clamping pieces 61b and 61c release the clamping of the flat rectangular wire 11 crossing between them to allow the movement of the flat rectangular wire 11 with respect to the fixed chuck device 61.

[0030] As shown in FIG. 2, the fixing base 29, on which the winding

mechanism 30 and the fixed chuck device 61 are provided, is attached to a mount base 14 that is provided on the table 13. The actuator 62 is attached to the table 13.

[0031] The actuator 62 of this embodiment has: a lateral-direction guide 62a that is arranged on the table 13 so as to extend along the Y axis, which is the delivery direction of the flat rectangular wire 11; a lateral-direction rotation shaft 62b that is arranged in parallel with the lateral-direction guide 62a and has a helical external thread on its surface; a lateral-direction moving member 62d that is engaged with the lateral-direction rotation shaft 62b through a ball screw and that can move along the lateral-direction guide 62a with the rotation of the lateral-direction rotation shaft 62b; and a servomotor 62c serving as a lateral-direction driving source that rotationally drives the lateral-direction rotation shaft 62b.

[0032] A controller (not shown) is electrically connected to the servomotor 62c, and a control command is output from the controller to the servomotor 62c. When the servomotor 62c is driven according to the command from the controller, the lateral-direction rotation shaft 62b is rotated and the lateral-direction moving member 62d is moved along the lateral-direction guide 62a. The movable chuck device 63 is attached to the lateral-direction moving member 62d via an angle member 62e.

[0033] As shown in FIGs. 1 to 5, the movable chuck device 63 includes: an attachment plate 64 that is attached to the angle member 62e; a movable wall 66 that is erected on a top surface of the attachment plate 64; and an air cylinder 67 that is attached to a lower surface of the attachment plate 64. A recessed portion 66a, through which the flat rectangular wire 11 can pass through, is formed in a lower part of the movable wall 66 facing the attachment

plate 64. A rod 67a of the air cylinder 67 can enter the recessed portion 66a by penetrating through the attachment plate 64.

[0034] As shown in FIG. 4, as the rod 67a of the air cylinder 67 enters the recessed portion 66a, the rod 67a comes into contact with the flat rectangular wire 11 passing through the recessed portion 66a and presses the flat rectangular wire 11 against the recessed portion 66a, and thereby, the flat rectangular wire 11 is clamped, and the movement of the flat rectangular wire 11 is prohibited. On the other hand, as shown in FIG. 2, as the rod 67a retracts into a main body 67b, the clamping of the flat rectangular wire 11 passing through the recessed portion 66a is released to allow the movement of the flat rectangular wire 11.

[0035] As indicated by a solid arrow in FIG. 4, as the movable chuck device 63 catching the flat rectangular wire 11 is moved towards the fixed chuck device 61 by the actuator 62, in which the movable chuck device 63 is attached to the lateral-direction moving member 62d via the angle member 62e, the flat rectangular wire 11 caught by the movable chuck device 63 is moved in the Y axis direction. At this time, if the fixed chuck device 61 is being opened to release the flat rectangular wire 11, the flat rectangular wire 11 is delivered from the fixed chuck device 61 in the longitudinal direction (in the Y axis direction) towards the winding mechanism 30.

[0036] Subsequently, as the fixed chuck device 61 catches the flat rectangular wire 11, the delivery of the flat rectangular wire 11 is stopped. In this state, as indicated by a broken line arrow in FIG. 2, as the movable chuck device 63 is opened to release the flat rectangular wire 11, the movable chuck device 63 can be moved away from the fixed chuck device 61 by the actuator 62.

[0037] When the movable chuck device 63 is moved away from the fixed chuck

device 61, in other words, when the movable chuck device 63 is returned to the reel side, by catching the flat rectangular wire 11 by the fixed chuck device 61, the flat rectangular wire 11 that has delivered towards the winding mechanism 30 side is prevented from returning by being moved together with the movable chuck device 63.

[0038] The flat rectangular wire 11 can be delivered again by, as shown in FIG. 4, moving the movable chuck device 63 again towards the fixed chuck device 61 in a state in which the flat rectangular wire 11 is caught again by the movable chuck device 63, which has been moved to the reel side, and in which the fixed chuck device 61 is opened. By repeating the series of operations of the movable chuck device 63 and the fixed chuck device 61 described above, it is possible to deliver the flat rectangular wire 11 sequentially.

[0039] As shown in FIGs. 1 and 2, in the wire rod delivering device 60, a plurality of support parts 71, which support the flat rectangular wire 11 extending between the fixed chuck device 61 and the movable chuck device 63 in a straight state, are provided side by side between the fixed chuck device 61 and the movable chuck device 63. Support rods 68 are provided over a range from the fixed chuck device 61 to the movable chuck device 63 by penetrating through the movable chuck device 63. This embodiment shows a configuration in which a pair of support rods 68 are provided, and the plurality of support parts 71 are movably provided on the pair of support rods 68. Only a single support rod 68 may be provided, or three or more support rods 68 may also be provided.

[0040] As shown in FIG. 6, a fixed wall 69 is provided on the fixing base 29, to which the fixed chuck device 61 is attached, so as to oppose to the movable wall 66 and so as to be adjacent to the fixed chuck device 61. A recessed

portion 69a, through which the flat rectangular wire 11 can pass through, is formed in a lower part of the fixed wall 69 facing the fixing base 29. The pair of support rods 68 are provided on the fixed wall 69 with a predetermined clearance in the X axis direction so as to sandwich the recessed portion 69a from both sides in the X axis direction, and at the same time, the pair of support rods 68 are provided so as to extend in the Y axis direction in parallel with each other by penetrating the movable wall 66.

[0041] As shown in FIG. 5, the movable wall 66 is formed with holes 66b, through which the pair of support rods 68 penetrate respectively. Sleeves 66c for ensuring smooth movement of the pair of support rods 68 are respectively installed in the holes 66b.

[0042] As shown in FIG. 7, each of the support parts 71 supporting the flat rectangular wire 11 includes a movable guide 72 that has a rectangular plate shape extending in the X axis direction and a hold plate 73 that is attached to the movable guide 72. The movable guide 72 has a pair of insertion holes 72a formed on both sides in the X axis direction, through which the pair of support rods 68 are respectively inserted. On the further outside of the pair of insertion holes 72a, attachment holes 72b penetrating the movable guide 72 in the Z axis direction are respectively formed.

[0043] In a lower surface of the movable guide 72, a recessed groove 72c having a cross section slightly larger than the cross sectional shape of the flat rectangular wire 11 is formed so as to extend in the Y axis direction. In a state in which the flat rectangular wire 11 extending in the Y axis direction is received in the recessed groove 72c, the hold plate 73 is attached to the lower surface of the movable guide 72. Female screw holes 73a are formed in the hold plate 73 so as to respectively oppose to the attachment holes 72b, and

the hold plate 73 is attached to the movable guide 72 by screwing male screws 74 respectively inserted into the attachment holes 72b.

[0044] Returning to FIGs. 1 to 4, the plurality of movable guides 72 are provided for the pair of support rods 68 between the fixed chuck device 61 and the movable chuck device 63. The wire rod delivering device 60 includes arrangement means for arranging the plurality of support parts 71 at predetermined intervals between the fixed chuck device 61 and the movable chuck device 63.

[0045] As shown in FIGs. 1 and 3, the arrangement means in this embodiment is each of elastic members respectively interposed between the plurality of support parts 71, and specifically, the arrangement means is each of coil springs 76. The coil springs 76 are respectively interposed between the fixed wall 69 and the support part 71 as well as between the movable wall 66 and the support part 71. The space between adjacent support parts 71 is set by the natural length and the spring constant of the coil spring 76. In this embodiment, all of the plurality of coil springs 76 interposed between the support parts 71 are identical. As the plurality of coil springs 76 force to increase the intervals between adjacent support parts 71 by a uniform biasing force, the plurality of support parts 71 are evenly distributed between the fixed chuck device 61 and the movable chuck device 63. In other words, between the fixed chuck device 61 and the movable chuck device 63, the intervals between the adjacent support parts 71 are the same with each other. Specifically, in a state in which the movable chuck device 63 is most separated from the fixed chuck device 61, the plurality of support parts 71 are evenly distributed. If the plurality of support parts 71 are evenly distributed, the movable chuck device 63 can move smoothly with respect to the fixed chuck

device 61. In addition, when the respective interposed coil springs 76 are the same, it is possible to reduce the cost because the coil springs 76 of the same specification can be employed.

[0046] Each of both surfaces of the support parts 71 is formed with, at the center thereof, a counterbored hole 72d into which an end portion of the coil spring 76 can enter. As shown in FIG. 3, when the adjacent support parts 71 come close to each other, the compressed coil spring 76 is received between the counterbored holes 72d of the adjacent support parts 71.

[0047] A reinforcing rod 77 is further provided on the fixed wall 69 that is attached to the fixing base 29 so as to be adjacent to the fixed chuck device 61. The reinforcing rod 77 is provided between the fixed chuck device 61 and the movable chuck device 63 by penetrating the movable chuck device 63. The reinforcing rod 77 has a larger diameter than the pair of support rods 68. The movable wall 66 is formed with a hole 66d through which the reinforcing rod 77 penetrates. A cylinder sleeve 66e for ensuring smooth movement of the reinforcing rod 77 is installed in the hole 66d.

[0048] As shown in FIGs. 1 to 4 and 8, the fixing base 29 includes a support member 54 that prevents the flat rectangular wire 11, which has been delivered in the Y axis direction by the wire rod delivering device 60, from swinging in the X axis direction.

[0049] The support member 54 is attached to the fixing base 29 so as to oppose to the fixed chuck device 61. A horizontal recessed groove 54a into which the flat rectangular wire 11, which has been delivered in the Y axis direction, enters and a vertical recessed groove 54b that receives the pair of clamping pieces 61b and 61c, which clamp the flat rectangular wire 11, are respectively formed at parts of the support member 54 opposing to the fixed chuck device

61.

[0050] As the flat rectangular wire 11 extending in the Y axis direction enters and received in the horizontal recessed groove 54a, the movement of the flat rectangular wire 11 in the X axis direction that is the width direction is prevented while allowing the delivery of the flat rectangular wire 11 in the Y axis direction that is the longitudinal direction.

[0051] As shown in FIGs. 1 to 4, a guide member 55 is provided on the fixing base 29. The guide member 55 comes into sliding contact with a leading edge of the flat rectangular wire 11. In this embodiment, the guide member 55 has a sliding contact portion 55a having a wedge-shaped cross section. In the sliding contact portion 55a, a surface (a top surface) is formed so as to incline relative to the horizontal plane, and this surface comes into sliding contact with a leading edge 11c of the flat rectangular wire 11, which has been bent first (see FIG. 9C).

[0052] As the leading edge of the flat rectangular wire 11 comes into sliding contact with the surface of the sliding contact portion 55a, the flat rectangular wire 11 becomes inclined relative to the horizontal plane, and therefore, the bent part of the flat rectangular wire 11 is prevented from interfering with the flat rectangular wire 11 that has been delivered.

[0053] Next, operation of the wire winding device 10 will be described.

[0054] In this embodiment, a description will be given of a case in which the wire rod is the flat rectangular wire 11 having a wider width relative to its thickness, and an edgewise coil 16 having a running-track shape is obtained by winding the flat rectangular wire 11 in the width direction (see FIGs. 9 and 10).

[0055] A winding of the edgewise coil having the running-track shape using

the wire winding device 10 is performed by repeating, after a preparation step, a wire rod bending step in which the flat rectangular wire 11 is bent into a U-shape by the winding mechanism 30 by curving it around the circumference of the shaft 31 and a wire rod delivering step in which the flat rectangular wire 11 is delivered by the wire rod delivering device 60.

[0056] These operations will be described below.

[0057] <Winding Preparation Step>

First, both of the fixed chuck device 61 and the movable chuck device 63 are opened, and the flat rectangular wire 11 delivered from the reel is allowed to pass through the fixed chuck device 61 and the movable chuck device 63.

[0058] Specifically, as shown in FIG. 2, in the movable chuck device 63, the rod 67a of the air cylinder 67 is retracted into the main body 67b, and the flat rectangular wire 11 is passed through the recessed portion 66a of the movable wall 66. The flat rectangular wire 11 that has passed through the movable chuck device 63 is then sequentially inserted into the recessed grooves 72c of the plurality of support parts 71 (see FIG. 7), and the flat rectangular wire 11 extending from the movable chuck device 63 towards the fixed chuck device 61 is sequentially supported by the plurality of support parts 71.

[0059] The flat rectangular wire 11 that has passed through the last support parts 71 on the fixed wall 69 side is then passed through the recessed portion 69a of the fixed wall 69 (see FIG. 6), and as shown in FIG. 8, the flat rectangular wire 11 is passed through the horizontal recessed groove 54a of the support member 54. At this time, as shown in FIG. 4, the pair of clamping pieces 61b and 61c of the fixed chuck device 61 are separated from each other, and so, the flat rectangular wire 11 is allowed to move through between the pair of

clamping pieces 61b and 61c. As shown in FIG. 1, the flat rectangular wire 11 that has passed through the support member 54 is then inserted into a gap between the shaft 31 and the bender 32 in the winding mechanism 30.

[0060] In this state, the pair of clamping pieces 61b and 61c of the fixed chuck device 61 are moved closer to each other to clamp the flat rectangular wire 11 extending therebetween from above and below in the vertical direction, and thereby, the movement of the flat rectangular wire 11 is prohibited.

[0061] After the flat rectangular wire 11 is caught by the fixed chuck device 61, the movable chuck device 63 is moved away from the fixed chuck device 61 by the actuator 62 of the wire rod delivering device 60. In a state in which the movable chuck device 63 is separated from the fixed chuck device 61, the movable chuck device 63 causes the rod 67a of the air cylinder 67 to enter the recessed portion 66a, catches the flat rectangular wire 11 to prohibit the movement of the flat rectangular wire 11, and prepares for next delivery of the flat rectangular wire 11.

[0062] <First Wire Rod Bending Step>

From this state, the bending of the flat rectangular wire 11 is started. First, together with the slew gear 33c, the bender 32 is revolved by 180 degrees by the slew driving mechanism 33 of the winding mechanism 30, and as shown in FIG. 9A, the flat rectangular wire 11 is bent so as to be curved around the shaft 31. At this time, the press mechanism 40 (see FIG. 2) press-holds the flat rectangular wire 11, which is being bent along the shaft 31, from the thickness direction using the flange 41.

[0063] At this time, the flange 41 is oriented such that the cut-out portion 41a is positioned on the wire rod delivering device 60 side. In other words, the cut-out portion 41a is positioned at an opening portion of the flat

rectangular wire 11 that is bent to the U-shape. As a result, the entire part of the flat rectangular wire 11 that is being bent into the U-shape is press-held by the flange 41, and so, in the flat rectangular wire 11, the bulging caused by the bending and the bending wrinkles due to the bending at the part being curved around the shaft 31 are prevented.

[0064] After the bending is completed, the bender 32 is returned to the initial position by being revolved by 180 degrees in the reverse direction by the slew driving mechanism 33. Simultaneously with, or before or after the operation of returning the bender 32, the press-holding of the flat rectangular wire 11 by the flange 41 is released by the press mechanism 40.

[0065] <Wire Rod Delivering Step>

Next, as shown in FIG. 9B, the flat rectangular wire 11 is delivered in the longitudinal direction by the wire rod delivering device 60, and the newly delivered flat rectangular wire 11 is inserted through a gap between the shaft 31 and the bender 32, thereby moving the first bent portion 11a in the Y axis direction such that it is moved away from the shaft 31. The amount of the flat rectangular wire 11 delivered at this time is half of the amount required for one complete winding of the edgewise coil to be obtained.

[0066] The delivery of the flat rectangular wire 11 by the wire rod delivering device 60 is performed by releasing the catching of the flat rectangular wire 11 by opening the fixed chuck device 61 as shown in FIGs. 1 and 2, and by moving the movable chuck device 63 catching the flat rectangular wire 11 towards the fixed chuck device 61 by the actuator 62 as shown in FIGs. 3 and 4. The amount of the flat rectangular wire 11, which is equal to the moved distance of the movable chuck device 63, is delivered from the fixed chuck device 61 towards the winding mechanism 30.

[0067] In the above, the delivered amount of the flat rectangular wire 11 in a single cycle is equal to the distance by which the movable chuck device 63 is moved closer to the fixed chuck device 61. If this delivered amount in a single cycle is increased, the distance between the movable chuck device 63 and the fixed chuck device 61 is also increased, and thereby, the possibility of buckling of the flat rectangular wire 11 during the delivery is increased.

[0068] However, in the wire rod delivering device 60 of this embodiment, the plurality of support parts 71 that support the flat rectangular wire 11 extending between the movable chuck device 63 and the fixed chuck device 61 are provided at equal intervals. Therefore, the flat rectangular wire 11 extending between the movable chuck device 63 and the fixed chuck device 61 is supported by the plurality of support parts 71, and so, even if the delivered amount of the flat rectangular wire 11 is increased, the buckling of the flat rectangular wire 11 is not caused.

[0069] After the required amount of the flat rectangular wire 11 is delivered, the pair of clamping pieces 61b and 61c of the fixed chuck device 61 are moved closer to each other to clamp the flat rectangular wire 11 extending therebetween to prohibit the movement of the flat rectangular wire 11.

[0070] At the same time, the catching of the flat rectangular wire 11 is released in the movable chuck device 63, and the movable chuck device 63 is moved away from the fixed chuck device 61 by the actuator 62. In a state in which the movable chuck device 63 is separated from the fixed chuck device 61, the movable chuck device 63 catches the flat rectangular wire 11 to prohibit the movement thereof, and prepares for next delivery of the flat rectangular wire 11.

[0071] <Wire Rod Bending Step>

After the flat rectangular wire 11 is newly delivered, as shown in FIG. 9C, the bender 32 is revolved again by the slew driving mechanism 33, and the flat rectangular wire 11 is bent so as to be curved around the shaft 31. At this time, the press mechanism 40 press-holds the flat rectangular wire 11, which is being bent along the shaft 31, from the thickness direction using the flange 41.

[0072] When the bender 32 is revolved again, a portion 11b on the leading end side of the portion 11a, which has been bent into the U-shape, is lifted by the guide member 55 and is passed through the cut-out portion 41a. As a result, the portion 11b is disengaged from the shaft 31, and so, the portion 11b crosses with the newly delivered flat rectangular wire 11 without interference.

[0073] After the bending is completed, the bender 32 is returned to the initial position by being revolved by 180 degrees in the reverse direction by the slew driving mechanism 33. Simultaneously with, or before or after the operation of returning the bender 32, the press-holding of the flat rectangular wire 11 by the flange 41 is released by the press mechanism 40.

[0074] <Flange Moving Step>

Next, as shown in FIG. 10A, the flange 41 is moved such that the cut-out portion 41a formed in the flange 41 is moved to the position corresponding to a straight portion 11e of the flat rectangular wire 11 that is on the leading end side of a newly bent portion 11d, in other words, the position orthogonal to the delivery direction of the flat rectangular wire 11.

[0075] The flange 41 is moved by the flange moving mechanism 46 (see FIG. 2). Specifically, by driving the motor 47 in accordance with the command from the controller, the driving pulley 48a is rotated to rotate the driven pulley 48b via the belt 48c, and thereby, the shaft 31, which is spline-coupled to the

driven pulley 48b, is rotated together with the flange 41 as indicated by a one-dot chain line arrow.

[0076] As a result, the cut-out portion 41a, which was facing the wire rod delivering device 60 side at the time of the wire rod bending step, is rotated about 90 degrees, and the cut-out portion 41a is now arranged at the position orthogonal to the delivery direction of the flat rectangular wire 11.

[0077] <Wire Rod Delivering Step>

Next, as shown in FIG. 10B, the flat rectangular wire 11 is delivered by the wire rod delivering device 60 in the longitudinal direction, and the newly delivered flat rectangular wire 11 is inserted into a gap between the shaft 31 and the bender 32.

[0078] Upon the delivery of the flat rectangular wire 11, the straight portion 11e of the flat rectangular wire 11 is passed through the cut-out portion 41a to be disengaged from the circumference of the shaft 31.

[0079] As a result, the edgewise coil 16 having the running-track shape, which has been wound once, is moved away from the shaft 31 in the Y axis direction. The amount of the flat rectangular wire 11 delivered at this time is half of the amount required for one complete winding of the edgewise coil to be obtained.

[0080] As described above, the delivery of the flat rectangular wire 11 is performed by releasing the catching of the flat rectangular wire 11 by the fixed chuck device 61, and by moving the movable chuck device 63 catching the flat rectangular wire 11 by the actuator 62 towards the fixed chuck device 61. At this time, the plurality of support parts 71, which are provided at equal intervals between the movable chuck device 63 and the fixed chuck device 61, support the flat rectangular wire 11 extending between the movable chuck device 63 and the fixed chuck device 61 and prevent the buckling of the flat

rectangular wire 11.

[0081] After the required amount of the flat rectangular wire 11 is delivered, the fixed chuck device 61 catches the flat rectangular wire 11 again to prohibit the movement of the flat rectangular wire 11. At the same time, the movable chuck device 63, which has released the catching of the flat rectangular wire 11, is moved away from the fixed chuck device 61 by the actuator 62. In a state in which the movable chuck device 63 is separated from the fixed chuck device 61, the movable chuck device 63 then catches the flat rectangular wire 11 to prohibit the movement thereof, and prepares for the next the delivery of the flat rectangular wire 11.

[0082] <Bending Step of Further Wire Rod>

After the flat rectangular wire 11 is newly delivered, as indicated by a one-dot chain line arrow in FIG. 10C, the bender 32 is revolved again by the slew driving mechanism 33, and the flat rectangular wire 11 is bent so as to be curved around the shaft 31. At this time, the press mechanism 40 again press-holds the flat rectangular wire 11, which is being bent along the shaft 31, from the thickness direction using the flange 41.

[0083] As a result, it is possible to bend the newly delivered flat rectangular wire 11 to the U-shape. At this time, the flange 41 press-holds the entire part of the flat rectangular wire 11 that is being bent into the U-shape, and so, in the flat rectangular wire 11, the bulging caused by the bending and the bending wrinkles due to the bending at the part being curved around the shaft 31 are prevented.

[0084] After the bending is completed, the bender 32 is returned to the initial position by being revolved by 180 degrees in the reverse direction by the slew driving mechanism 33. Simultaneously with, or before or after this, the

press-holding of the flat rectangular wire 11 by the flange 41 is released by the press mechanism 40.

[0085] Subsequently, by sequentially repeating the steps from <Flange Moving Step> to <Bending Step of Further Wire Rod> as described above, the flat rectangular wire 11 is regular wound to perform the winding to achieve the specified width and specified layers. As a result, the edgewise coil 16 extending in the Z axis direction is formed on a top surface of the flange 41.

[0086] After the desired edgewise coil 16 is formed as described above, the flat rectangular wire 11 is cut using a cutter device (not shown), and the edgewise coil 16 is removed. Thereby, a series of winding operations are completed.

[0087] In the wire winding device 10, it is possible to easily change the size and the shape of the edgewise coil 16 by varying the amount of the flat rectangular wire 11 delivered by the wire rod delivering device 60, a radius of curvature of the shaft 31, and so forth.

[0088] In particular, the change in the delivered amount of the flat rectangular wire 11 by the wire rod delivering device 60 is easily achieved because it only requires changing the moved distance of the movable chuck device 63 by the actuator 62. Even in a case in which the delivered amount of the flat rectangular wire 11 is large, because the flat rectangular wire 11 to be delivered is supported by the plurality of support parts 71, it is possible to deliver the flat rectangular wire 11 while preventing occurrence of the buckling thereof.

[0089] In addition, because the plurality of support parts 71 are arranged at predetermined intervals and the adjacent support parts 71 can be brought into contact with and moved away from each other, the increase in the size of the wire rod delivering device 60 is prevented. In addition, when the delivered

amount of the flat rectangular wire 11 is to be increased or decreased, this can be addressed by increasing or decreasing the number of the support parts 71, and so, it is possible to effectively prevent the buckling of the flat rectangular wire 11.

[0090] Because the plurality of support parts 71 are movably provided on the support rods 68, it is possible to arrange the plurality of support parts 71 in a straight line with ease, and also to increase or decrease the number of the support parts 71 with ease. On the other hand, while it is conceivable that the support rods 68 may be bent as the number of the support parts 71 is increased, because the reinforcing rod 77 is provided between the fixed chuck device 61 and the movable chuck device 63 and so as to penetrate through the movable chuck device 63, the plurality of support parts 71 are prevented from being provided in a bent manner. If there is no risk that the support rods 68 are bent, the reinforcing rod 77 is not required.

[0091] With the wire winding device 10 including the wire rod delivering device 60 and the winding mechanism 30, the flat rectangular wire 11 is accurately delivered by the wire rod delivering device 60 without causing the buckling, and so, it is possible to obtain a coil, for example, the edgewise coil, of the desired size.

[0092] In the above-mentioned embodiment, a description has been given of the configuration in which the wire rod is the flat rectangular wire 11 having a wider width relative to its thickness. However, this is only an example, and the wire rod may not be the flat rectangular wire. For example, the wire rod may be a rectangular wire having a square cross section, or it may also be a round wire having a circular cross section.

[0093] In this case, although it is necessary to change the support parts 71 for

supporting the wire rod according to the cross sectional shape of the wire rod as needed, because the plurality of support parts 71 are movably provided on the support rods 68, it is also easy to change the support parts 71.

[0094] In addition, in the above-mentioned embodiment, a description has been given of the configuration in which the edgewise coil is obtained by winding the flat rectangular wire 11 in the width direction. However, this is only an example, and it may be possible to employ a configuration for obtaining a square coil and a circular coil.

[0095] Furthermore, in the above-mentioned embodiment, a description has been given of the configuration in which the arrangement means is each of the coil springs 76 interposed between the plurality of support parts 71. However, this is only an example, and the arrangement means may also be other elastic members than the coil springs 76.

[0096] 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.

[0097] This application claims priority based on Japanese Patent Application No.2022-142029 filed with the Japan Patent Office on September 7, 2022, the entire contents of which are incorporated into this specification.

SCOPE OF CLAIMS

Claim 1. A wire rod delivering device comprising:
a fixed chuck device configured to releasably catch a wire rod;
a movable chuck device provided movably, the movable chuck device being configured to releasably catch the wire rod;
an actuator configured to move the movable chuck device closer to or away from the fixed chuck device;
a plurality of support parts provided side by side between the fixed chuck device and the movable chuck device, the plurality of support parts being configured to support the wire rod extending between the fixed chuck device and the movable chuck device; and
arrangement means configured to arrange the plurality of support parts at predetermined intervals between the fixed chuck device and the movable chuck device.

Claim 2. The wire rod delivering device according to claim 1, wherein

the arrangement means is configured to arrange the plurality of support parts such that the plurality of support parts are evenly distributed between the fixed chuck device and the movable chuck device.

Claim 3. The wire rod delivering device according to claim 1 or 2, wherein

the arrangement means is an elastic member interposed between the plurality of support parts.

Claim 4. The wire rod delivering device according to claim 3, wherein

the elastic member is a coil spring.

Claim 5. The wire rod delivering device according to claim 1 or 2, further comprising

a support rod provided between the fixed chuck device and the movable chuck device so as to penetrate through the movable chuck device, and the plurality of support parts being movably provided on the support rod.

Claim 6. The wire rod delivering device according to claim 5, further comprising

a reinforcing rod provided between the fixed chuck device and the movable chuck device so as to penetrate through the movable chuck device.

Claim 7. A wire winding device comprising: the wire rod delivering device according to claim 1; and a winding mechanism configured to wind the wire rod delivered from the wire rod delivering device.