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(54) **WIRE WINDING SYSTEM, TENSION DEVICE, AND WIRE WINDING METHOD**

(57) A winding device 100 which winds a wire 3 around a core 11 includes the core 11, which rotates axially and around which the wire 3 is wound; a roller 21 which rotates axially and feeds the wire 3, which is wound around the roller 21, to the core 11; and a tension device

15 which adjusts a tension of the wire 3 that is supplied to the core 11 from the roller 21. A winding shape and a winding diameter of the wire 3 wound around the roller 21 are substantially identical to a winding shape and a winding diameter of the wire 3 wound around the core 11.

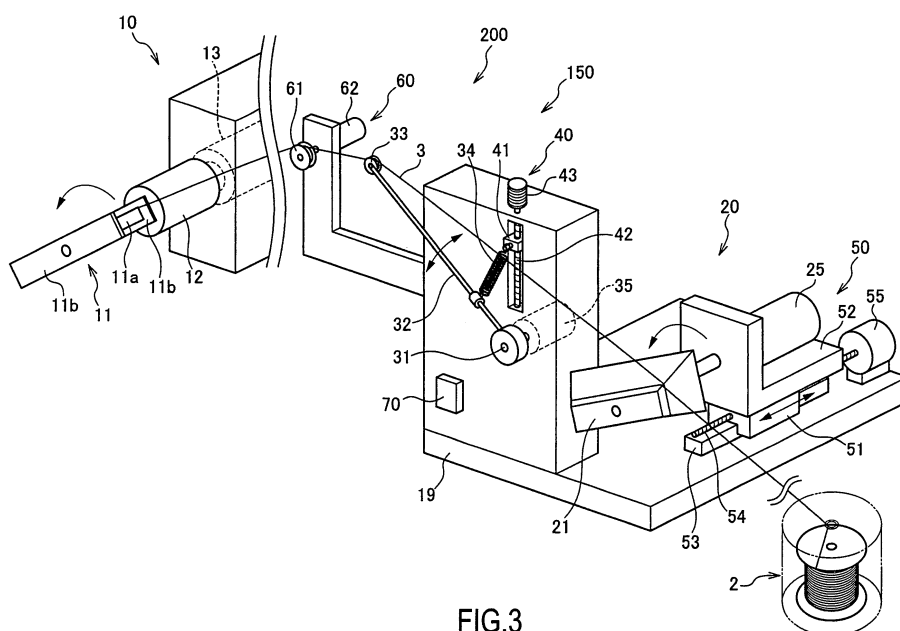


FIG.3

Description

FIELD OF THE INVENTION

[0001] This invention relates to a winding device, a tension device, and a winding method.

BACKGROUND OF THE INVENTION

[0002] In a known conventional tension device provided in a winding device for forming a coil, the tension of a wire supplied to a winder is detected, and the rotation speed of a feeding roller that feeds the wire is controlled in accordance with a resultant detection value such that the tension of the wire is maintained at a constant level (see JP11-222357A and JP2000-128433A).

SUMMARY OF THE INVENTION

[0003] However, when winding is performed around a varying-diameter core having a cross-section with a varying outer diameter, for example a core having a rectangular cross-sectional shape, in this kind of conventional tension device, the tension of the wire varies periodically during a single revolution of the core. It is therefore difficult to maintain the tension of the wire fed to the winder at a constant level.

[0004] This invention has been designed in consideration of the problem described above, and it is an object thereof to provide a winding device, a tension device, and a winding method with which variation in the tension of a wire supplied to a winder can be suppressed.

[0005] In order to achieve above object, this present invention provides a winding device which winds a wire around a core. The winding device comprises a core which rotates axially and around which a wire is wound, a roller which rotates axially and feeds a wire wound around the roller to the core, and a tension device which adjusts a tension of the wire that is supplied to the core from the roller, wherein a winding shape and a winding diameter of the wire wound around the roller are substantially identical to a winding shape and a winding diameter of the wire wound around the core.

[0006] According to this invention, when winding is performed around a core having a cross-section with a varying diameter, a winding shape and a winding diameter of a wire wound around a roller are substantially identical to a winding shape and a winding diameter of a wire wound around the core, and therefore variation in the tension of the wire during a single revolution of the core can be suppressed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007]

FIG. 1 is a perspective view showing a winding device according to a first embodiment of this invention.

FIG. 2A is a sectional view showing a cross-section of a core.

FIG. 2B is a characteristic diagram showing the manner in which the speed of a wire varies.

FIG. 3 is a perspective view showing a winding device according to a second embodiment of this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0008] Embodiments of this invention will be described below with reference to the drawings.

(First Embodiment)

[0009] Referring to FIG. 1, a winding device 100 according to a first embodiment of this invention will be described. FIG. 1 is a perspective view showing the winding device 100.

[0010] The winding device 100 is a device which manufactures a coil by winding a wire 3 supplied from a wire supply source 2 around a core (coil bobbin) 11 that rotates axially.

[0011] The winding device 100 comprises a winder 10 that drives the core 11 to rotate axially, a wire feeder 20 that supplies the wire 3 supplied from the wire supply source 2 to the core 11, a tension device 15 that adjusts the tension of the wire 3 supplied to the winder 10 from the wire feeder 20, and a controller 70 that controls a winding operation.

[0012] The core 11 is constituted by a drum portion 11a around which the wire 3 is wound, and a collar portion 11b provided on both ends face of the drum portion 11a to restrict a winding width of the coil.

[0013] FIG. 2A shows a cross-section of the drum portion 11a perpendicular to a rotary central axis. As shown in FIG. 2A, a cross-sectional shape of the drum portion 11a is formed with a varying diameter that varies according to site such that outer diameters a, b, c, which represent dimensions from a rotary center O to an outer edge, are not constant, in contrast to a circle. This embodiment illustrates a case in which the cross-sectional shape of the drum portion 11a is rectangular, as shown in FIG. 2A.

[0014] The winder 10 comprises a spindle 12 provided on one end portion thereof to support the core 11, and a winding motor 13, an output shaft of which is connected to the other end of the spindle 12. When the winding motor 13 is driven to rotate, the core 11 rotates axially.

[0015] The winder 10 also includes a guide mechanism (not shown) that feeds the wire 3 to be wound around the core 11 in a rotary axis direction. By performing winding using the guide mechanism, the wire 3 can be wound regularly around the core 11 in multiple layers. The core 11 has a rectangular cross-sectional shape, and therefore, by winding the wire 3 around the core 11, a rectangular coil is manufactured.

[0016] The wire feeder 20 comprises a roller 21 around

which the wire 3 supplied to the winder 10 from the wire supply source 2 is wound, and a feeding motor 25 that drives the roller 21 to rotate. The wire 3 is wound once around the roller 21, and by driving the feeding motor 25 to rotate, the roller 21 rotates axially such that the wire 3 wound around the roller 21 is fed to the core 11. It should be noted that the rotary axes of the core 11 and the roller 21 are formed to be parallel.

[0017] The operations of the winding motor 13 that drives the core 11 to rotate and the feeding motor 25 that drives the roller 21 to rotate are controlled by the controller 70 such that the rotation speeds of the two motors 13, 25 are identical at all times during winding, and the rotation phases of the two motors 13, 25 are identical at all times during winding.

[0018] The tension device 15 comprises a pulley 16 around which the wire fed from the roller 21 is wound, a wire speed modifying motor 17 that drives the pulley 16 to rotate and is capable of modifying the rotation speed of the pulley 16, a tension arm 32, a base end portion of which is supported rotatably, a tension pulley 33 provided on a rotary tip end portion of the tension arm 32 and around which the wire 3 is wound, a tension spring 34 that biases the tension arm 32 in a direction heading away from the core 11 and applies tension to the wire 3, and an encoder 35 that is provided on the base end portion of the tension arm 32 and detects a rotation angle of the tension arm 32.

[0019] The tension arm 32 is supported in a rotation position where the tension of the wire 3 and a biasing force of the tension spring 34 are counterbalanced. When the tension of the wire 3 exceeds a predetermined value, the tension arm 32 rotates in a direction (downward in the drawing) approaching the core 11 against the tension spring 34, and when the tension of the wire 3 falls below a predetermined value, the tension arm 32 is rotated in a direction (upward in the drawing) heading away from the core 11 by the biasing force of the tension spring 34.

[0020] The biasing force applied to the tension arm 32 by the tension spring 34 is adjusted by a tension adjustment mechanism 40.

[0021] The tension adjustment mechanism 40 comprises a ball screw 42 provided on a pedestal 19, an adjustment knob 43 for rotating the ball screw 42, and a movable body 41 that is screwed to the ball screw 42 and moves along the ball screw 42. One end portion of the tension spring 34 is connected to the tension arm 32, and the other end portion is connected to the movable body 41.

[0022] The tension of the tension spring 34 is adjusted by rotating the adjustment knob 43 to rotate the ball screw 42 such that the movable body 41 rises and falls. It should be noted that the tension adjustment mechanism 40 adjusts the tension of the tension spring 34 as initial setting before the start of winding, and not during winding.

[0023] The rotary base end portion of the tension arm 32 is connected to a rotation detection shaft 31 of the encoder 35, and the encoder 35 outputs a signal corre-

sponding to the rotation angle of the tension arm 32 to the controller 70. The controller 70 calculates the tension of the wire 3 on the basis of the rotation angle of the tension arm 32 input from the encoder 35, and feedback-controls the rotation speed of the wire speed modifying motor 17 such that the calculated tension of the wire 3 approaches a preset predetermined value (target value). By controlling the rotation speed of the wire speed modifying motor 17, the wire speed of the wire 3 fed from the pulley 16 is modified, and as a result, the tension of the wire 3 is adjusted to the target value.

[0024] A CPU that controls the winding operation performed by the winding device 100, ROM storing maps and the like required during a processing operation of the CPU, RAM that stores data read from the ROM, data read by various instruments, and so on temporarily, and so on are housed in the controller 70.

[0025] Next, the roller 21 and a mechanism for adjusting a winding diameter of the wire 3 wound around the roller 21 in the wire feeder 20 will be described.

[0026] In the following description, a winding shape of the wire 3 indicates a loop shape of the wire 3 wound around the core 11 and the roller 21, while a winding diameter of the wire 3 indicates an inner diameter of the loop.

[0027] The roller 21 is formed in a tapered shape having a similar cross-sectional shape to the cross-sectional shape of the core 11 and a roller diameter, i.e. the magnitude of the cross-section, which varies continuously in a rotary axis direction.

[0028] The site of the roller 21 around which the wire 3 is wound can be modified by moving the roller 21 in the rotary axis direction using a roller diameter adjustment mechanism 50. More specifically, the roller 21 is formed such that the cross-sectional area thereof increases gradually toward the rear of the rotary axis, and therefore, by moving the roller 21 toward the front of the rotary axis, the roller diameter of the roller 21 in the site around which the wire 3 is wound increases, leading to an increase in the winding diameter of the wound wire 3.

[0029] Further, the cross-sectional shape of the roller 21 is similar to the cross-sectional shape of the core 11, and therefore the cross-sectional shape of the site of the roller 21 around which the wire 3 is wound and the cross-sectional shape of the core 11 remain identical at all times, even when the roller 21 is moved in the rotary axis direction.

[0030] As described above, by moving the roller 21 in the rotary axis direction, the winding shape and winding diameter of the wire 3 wound around the roller 21 can be made identical to the winding shape and winding diameter of the wire 3 wound around the core 11.

[0031] The roller diameter adjustment mechanism 50 comprises a motor base 52 carrying the feeding motor 25, a rail 53 disposed on the pedestal 19 so as to extend parallel to the rotary axis of the feeding motor 25, a follower 51 that is joined to the motor base 52 to be free to move along the rail 53, a ball screw 54 that is screwed

to the follower 51 and extends parallel to the rotary axis of the feeding motor 25, and a roller moving motor 55 that drives the ball screw 54 to rotate.

[0032] By driving the roller moving motor 55, the motor base 52 moves along the rail 53, and as a result, the feeding motor 25 placed on the motor base 52 moves in a rotary axis direction thereof. By driving the roller moving motor 55 in this manner, the roller 21 can be moved in the rotary axis direction, and thus the roller diameter adjustment mechanism 50 modifies the roller diameter of the roller 21 in the site where the wire 3 is wound.

[0033] The roller diameter adjustment mechanism 50 further comprises a guide mechanism (not shown) for preventing the wire 3 wound around the roller 21 from moving together with the roller when the roller 21 moves in the rotary axis direction. When the guide mechanism is used, the wire 3 is guided along a predetermined path, and therefore, when the roller 21 is moved in the rotary axis direction, the winding diameter of the wire 3 wound around the roller 21 is modified smoothly in accordance with the movement of the roller 21.

[0034] A speed detector 60 that detects the speed of the wire 3 supplied to the core 11 from the roller 21 is provided between the tension pulley 33 on the rotary tip end portion of the tension arm 32 and the core 11.

[0035] The speed detector 60 comprises a pulley 61 around which the wire 3 is wound, and an encoder 62 that detects a rotation angle of the pulley 61. The rotation angle of the pulley 61 detected by the encoder 62 is input into the controller 70, and the controller 70 calculates the speed of the wire 3 supplied to the core 11 on the basis of the input rotation angle.

[0036] When the wire 3 is wound a plurality of times around the core 11 such that the number of wound layers increases, the length of wire 3 required to perform a single revolution around the core 11 increases, and therefore the speed of the wire 3 increases. A first map defining a relationship between the speed of the wire 3 and the number of wound layers is stored in the controller 70, and the controller 70 uses this map to determine the current number of layers of the wire 3 from the calculated speed of the wire 3 and calculate the current winding diameter wound around the core 11 from the determined number of wound layers.

[0037] The controller 70 also stores a second map defining a relationship between a movement amount of the roller 21 in the rotary axis direction and the roller diameter of the roller 21 in the site where the wire 3 is wound. This map is defined by a taper angle and so on of the roller 21. The controller 70 uses the map to control the movement amount of the roller 21 in the rotary axis direction such that the roller diameter of the roller 21 in the site where the wire 3 is wound matches the calculated winding diameter of the core 11.

[0038] Next, the winding operation of the winding device 100, which is controlled by the controller 70, will be described.

(1) Pre-winding preparation

[0039] The wire 3 extracted from the wire supply source 2 is wound once around the roller 21, and then wound around the pulley 16, the tension pulley 33, and the pulley 61. A tip end portion of the wire 3 is then tied to a terminal (not shown) of the core 11 by a robot hand (not shown).

[0040] Further, the roller diameter adjustment mechanism 50 adjusts an initial rotary axis direction position of the roller 21 such that the cross-sectional size of the site of the roller 21 around which the wire 3 is wound matches the cross-sectional size of the drum portion 11a of the core 11.

(2) Winding process

[0041] The winding motor 13 and feeding motor 25 are driven to rotate synchronously at an identical rotation speed and an identical rotary phase. By driving the winding motor 13 and feeding motor 25 to rotate synchronously in this manner, the respective rotation positions of the core 11 and the roller 21 are maintained in identical positions.

[0042] When the winding motor 13 and feeding motor 25 are driven to rotate, the wire 3 fed from the roller 21 is wound regularly around an outer periphery of the drum portion 11a of the core 11. When a single layer has been wound around the drum portion 11a, a second layer is wound around the outer periphery of the first layer of the wire 3, and when winding of the second layer is complete, a third layer is wound around the outer periphery of the second layer of the wire 3. The wire 3 is thus wound around the drum portion 11a in multiple layers such that the winding diameter of the wire 3 wound around the drum portion 11a increases every time the number of layers increases.

[0043] The winding diameter of the wire 3 is calculated by the controller 70. More specifically, the current number of layers is determined from the speed of the wire 3, detected by the speed detector 60, and the first map. The current winding diameter wound around the core 11 is calculated from the determined number of wound layers.

[0044] Then, every time the winding diameter of the wire 3 wound around the drum portion 11a increases, the controller 70 controls an advancing movement amount of the roller 21 in the rotary axis direction using the second map such that the winding diameter matches the roller diameter of the roller 21 in the site where the wire 3 is wound.

[0045] Thus, the roller diameter of the roller 21 in the winding site of the wire 3 is modified to match the winding diameter of the wire 3 wound around the drum portion 11a, and since the cross-sectional shape of the roller 21 is similar to the cross-sectional shape of the core 11, the winding diameter and winding shape of the wire 3 wound around the roller 21 are respectively identical to the winding diameter and winding shape of the wire 3 wound

around the drum portion 11a.

[0046] Hence, during winding, the winding diameter and winding shape of the wire 3 wound around the roller 21 are controlled to be respectively identical to the winding diameter and winding shape of the wire 3 wound around the drum portion 11a, while the winding motor 13 and feeding motor 25 are synchronously controlled such that the respective rotation speeds and rotation phases thereof are identical. Therefore, even when the wire 3 is wound around a core 11 having a cross-sectional shape with a varying diameter such that the speed of the wire 3 varies, the speed of the wire 3 fed from the roller 21 varies in an identical manner to the speed variation thereof. As a result, variation in the tension of the wire 3 between the core 11 and the roller 21 can be suppressed, and an oscillation angle of the tension arm 32 can be suppressed.

[0047] This point will now be described in further detail with reference to FIG. 2. FIG. 2A is a sectional view showing the cross-section of the core 11, and FIG. 2B is a characteristic diagram showing the manner in which the speed of the wire 3 varies.

[0048] As shown in FIG. 2A, on the cross-section of the core 11 having a rectangular cross-section, a length from the rotation center O to a long side 11A is set as a, a length from the rotation center O to a short side 11B is set as b, and a length from the rotation center O to a corner portion 11C is set as c. In this case, when the rotary angular velocity of the core 11 is maintained at a constant value ω , the speed (vertical axis) of the wire 3 wound around the core 11 varies such that inflection points $a\omega$, $c\omega$, $b\omega$, $c\omega$, $a\omega$, ... occur relative to the rotation angle (horizontal axis) of the core 11, as shown in FIG. 2B.

[0049] In a case where the cross-section of the roller 11 takes a conventional circular shape, the tension arm 32 oscillates periodically when the wire 3 is wound around the core 11, and therefore the rotary angular velocity of the wire speed modifying motor 17 must be controlled in accordance with the speed of the wire 3 shown in FIG. 2B. Accordingly, it is difficult to control the tension of the wire 3 supplied to the core 11 to a constant level, and when a fine wire 3 is used, the wire 3 may be break due to variation in the tension thereof.

[0050] In this embodiment, on the other hand, the winding diameter and winding shape of the wire 3 wound around the roller 21 are controlled to be identical to the winding diameter and winding shape of the wire 3 wound around the drum portion 11a, and therefore the rotary angular velocity of the roller 21 is maintained at the same constant value ω as the core 11. As a result, the speed of the wire 3 fed from the roller 21 varies in an identical manner to the speed of the wire 3 wound around the core 11, i.e. as shown in FIG. 2B. Hence, variation in the tension of the wire 3 between the core 11 and the roller 21 can be suppressed, and periodic oscillation of the tension arm 32 can be suppressed. As a result, the tension of the wire 3 supplied to the core 11 can be maintained at

a constant level with a high degree of precision, and a high-quality coil can be manufactured.

[0051] As described above, variation in the tension of the wire 3 between the core 11 and the roller 21 is suppressed by modifying the roller diameter of the roller 21 in the site where the wire 3 is wound. However, the tension of the wire 3 between the core 11 and the roller 21 may vary temporarily due to a delay in the roller diameter modification control or the like, causing the tension arm 32 to oscillate. In this case, the wire speed modifying motor 17 is operated to modify the speed of the wire 3 fed from the pulley 16, thereby controlling (adjusting) the tension of the wire 3 to a target value. Hence, the wire speed modifying motor 17 is operated to complement the roller diameter modification control performed by the roller diameter adjustment mechanism 50.

(3) Post-winding process

[0052] When the desired number of layers has been wound, the wire 3 is cut by the robot hand, and the terminal end portion of the wire 3 is tied to a terminal (not shown) of the core 11. The core 11 is then removed from the spindle 12, and a new core 11 is attached to the spindle 12. Thus, a coil is manufactured.

[0053] In this embodiment, the roller 21 is formed in a block shape, but this invention is not limited thereto, and instead, the roller 21 may be formed in the shape of a frame around which the wire 3 is wound and the size of the frame may be modified by an actuator or the like. In other words, the shape and size of the site of the roller 21 around which the wire 3 is wound may be modified to achieve the desired winding shape and winding diameter in the wound wire 3.

[0054] The following effects are obtained by the embodiment described above.

[0055] When the wire 3 is wound around the core 11 having a cross-sectional shape with a varying diameter, the winding shape and winding diameter of the wire 3 wound around the roller 21 are controlled to be identical to the winding shape and winding diameter of the wire 3 wound around the core 11. Therefore, the tension of the wire 3 wound around the core 11 can be controlled with a high degree of precision, and variation in the tension can be suppressed. As a result, the quality of the manufactured varying-diameter coil is improved.

[0056] Further, the roller 21 has a similar cross-sectional shape to the cross-sectional shape of the core 11 and is formed in a tapered form such that the roller diameter thereof varies continuously in the rotary axis direction. Therefore, the roller diameter of the roller 21 in the site where the wire 3 is wound can be modified to a desired diameter by employing the roller diameter adjustment mechanism 50 to move the roller 21 in the rotary axis direction. Moreover, even when the roller 21 is moved in the rotary axis direction, the cross-sectional shape of the roller 21 in the site where the wire 3 is wound remains identical to the cross-sectional shape of the core

11 at all times. By forming the roller 21 in the similar shape to the cross-sectional shape of the core 11 and forming the roller 21 in the tapered shape in the rotary axis direction, the winding shape and winding diameter of the wire 3 wound around the roller 21 can be made identical to the winding shape and winding diameter of the wire 3 wound around the core 11 simply by moving the roller 21 in the rotary axis direction.

(Second Embodiment)

[0057] Referring to FIG. 3, a winding device 200 according to a second embodiment of this invention will be described. FIG. 3 is a perspective view showing the winding device 200.

[0058] Constitutions of the winding device 200 according to this embodiment which are similar to those of the winding device 100 according to the first embodiment described above have been allocated identical reference symbols, and description thereof has been omitted. The following description centers on differences with the winding device 100.

[0059] The winding device 200 differs from the winding device 100 according to the first embodiment in a part of the constitution of the tension device 15.

[0060] In the tension device 15 of the winding device 100 according to the first embodiment, the tension of the wire 3 supplied to the core 11 from the roller 21 is adjusted by controlling the rotation speed of the wire speed modifying motor 17 to modify the wire speed of the wire 3 fed from the pulley 16.

[0061] In a tension device 150 according to the winding device 200, on the other hand, the pulley 16 and the wire speed modifying motor 17 are not provided, and the tension of the wire 3 supplied to the core 11 from the roller 21 is adjusted by varying the rotation speed of the feeding motor 25.

[0062] In the winding device 200, variation in the tension of the wire 3 between the core 11 and the roller 21 is controlled by modifying the roller diameter of the roller 21 in the site where the wire 3 is wound, similarly to the first embodiment. However, when the tension of the wire 3 between the core 11 and the roller 21 varies due to a delay in the roller diameter modification control or the like such that the tension arm 32 oscillates, the tension of the wire 3 is controlled (adjusted) by operating the feeding motor 25. Hence, in the winding device 200, the feeding motor 25 is operated to complement the roller diameter modification control performed by the roller diameter adjustment mechanism 50.

[0063] When the feeding motor 25 is operated to complement the roller diameter modification control, the rotary phases of the feeding motor 25 and the winding motor 13 deviate from each other as a result of the increase or decrease in the rotation speed of the feeding motor 25. However, this phase deviation is temporary, and as long as the roller diameter modification control performed by the roller diameter adjustment mechanism 50 is sta-

ble, the rotation speeds and rotation phases of the feeding motor 25 and winding motor 13 become identical again.

[0064] The following effects are obtained by the embodiment described above.

[0065] There is no need to provide special facilities to adjust the tension of the wire 3 between the core 11 and the roller 21, and therefore similar actions and effects to those of the first embodiment can be obtained with a simple structure.

[0066] Further, if it is considered that the roller diameter adjustment mechanism 50 is applied to a device that controls the tension of the wire 3 supplied to the core 11 from the roller 21 by varying the rotation speed of the feeding motor 25, then variation in the rotation speed of the feeding motor 25 can be suppressed by the roller diameter modification control performed by the roller diameter adjustment mechanism 50 when winding is performed around the core 11 having the varying diameter cross-section, and as a result, the tension of the wire 3 wound around the core 11 can be controlled with a high degree of precision.

[0067] This invention is not limited to the embodiments described above, and may be subjected to various modifications within the scope of the technical spirit thereof.

INDUSTRIAL APPLICABILITY

[0068] This invention may be applied to a winding device that winds a wire around a rotating core.

Claims

1. A winding device which winds a wire around a core, comprising:

a core which rotates axially and around which a wire is wound;
a roller which rotates axially and feeds a wire wound around the roller to the core; and
a tension device which adjusts a tension of the wire that is supplied to the core from the roller, wherein a winding shape and a winding diameter of the wire wound around the roller are substantially identical to a winding shape and a winding diameter of the wire wound around the core.

2. The winding device as defined in Claim 1, further comprising a controller which controls a winding operation, wherein a shape and a size of a site of the roller around which the wire is wound can be modified such that the winding shape and the winding diameter of the wound wire are as desired; and the controller sets the shape and the size of the site of the roller around which the wire is wound such that the winding shape and the winding diameter of

the wire wound around the roller are substantially identical to the winding shape and the winding diameter of the wire wound around the core.

3. The winding device as defined in Claim 2, further comprising a roller moving mechanism which moves the roller in a rotary axis direction, wherein the roller has a similar cross-sectional shape to a cross-sectional shape of the core, and is formed in a tapered form such that a cross-sectional size thereof varies continuously in the rotary axis direction, and the controller controls a movement amount of the roller using the roller moving mechanism such that the winding diameter of the wire wound around the roller is substantially identical to the winding diameter of the wire wound around the core.

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4. The winding device as defined in Claim 3, further comprising a speed detector which detects a speed of the wire supplied to the core from the roller, and the controller:

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calculates the winding diameter of the wire wound around the core on the basis of the speed of the wire detected by the speed detector; and controls the movement amount of the roller using the roller moving mechanism such that the cross-sectional size of the site of the roller around which the wire is wound is substantially identical to the calculated winding diameter of the wire.

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5. A tension device which adjusts a tension of a wire in a winding device which winds the wire around a core that rotates axially, comprising a roller which rotates axially and feeds a wire wound around the roller to the core, wherein a winding shape and a winding diameter of the wire wound around the roller are substantially identical to a winding shape and a winding diameter of the wire wound around the core.

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6. A winding method for winding a wire around a core, comprising the steps of:

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feeding a wire wound around a roller to the core by causing the roller to rotate axially; winding the wire fed from the roller around the axially rotating core; and adjusting a tension of the wire that is supplied to the core from the roller, wherein winding is performed in a state where a winding shape and a winding diameter of the wire wound around the roller are substantially identical to a winding shape and a winding diameter of the wire wound around the core.

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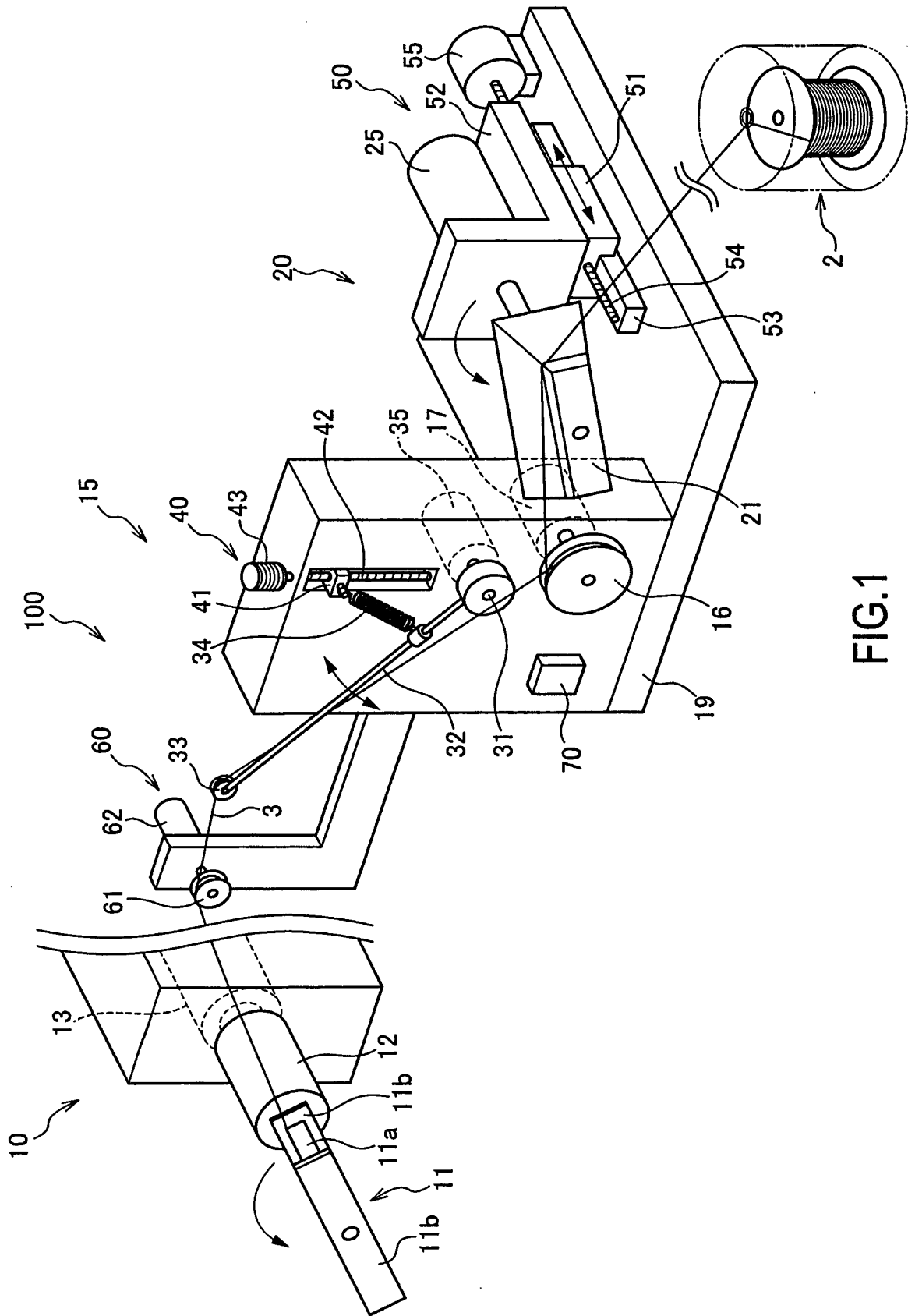


FIG.1

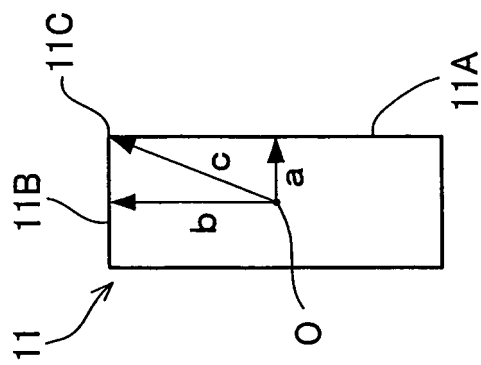


FIG. 2A

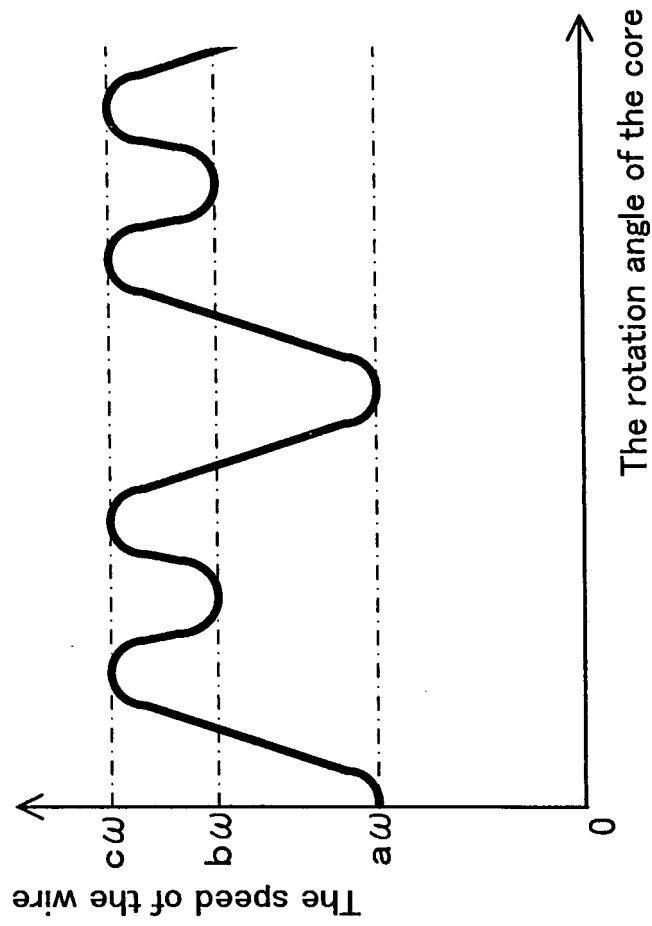


FIG. 2B

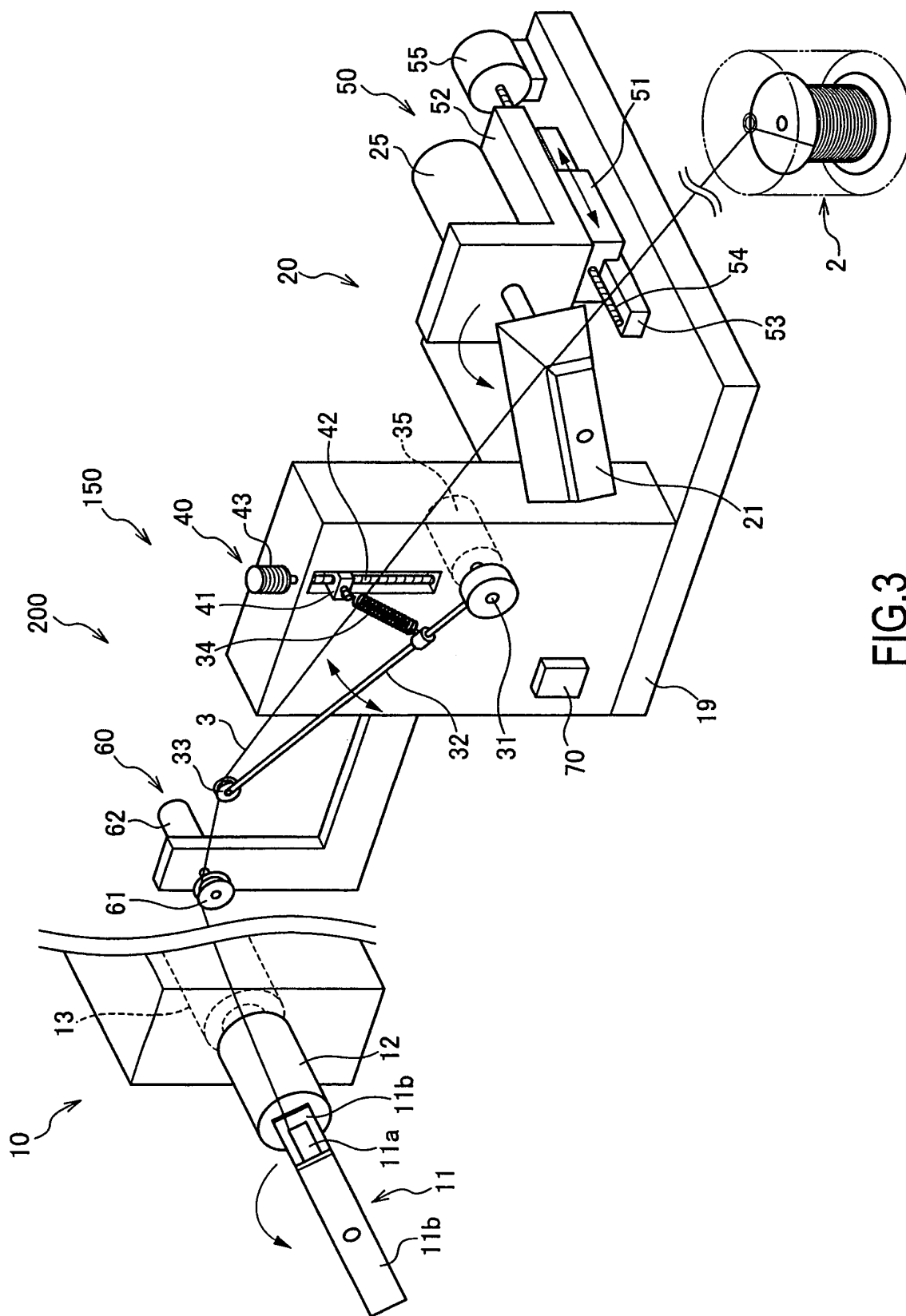


FIG.3

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2007/060080

A. CLASSIFICATION OF SUBJECT MATTER

H01F41/06(2006.01) i, B65H59/36(2006.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H01F41/06

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

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2007

Kokai Jitsuyo Shinan Koho 1971-2007 Toroku Jitsuyo Shinan Koho 1994-2007

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 2000-223344 A (Toshiba Corp.), 11 August, 2000 (11.08.00), Claims 1 to 5; Par. Nos. [0007], [0018] to [0033]; Figs. 1 to 5 (Family: none)	1-6
Y	JP 2000-128433 A (Nittoku Engineering Co., Ltd.), 09 May, 2000 (09.05.00), Par. Nos. [0020] to [0033]; Figs. 1 to 2 (Family: none)	1-6
Y	JP 11-222357 A (Nittoku Engineering Co., Ltd.), 17 August, 1999 (17.08.99), Par. Nos. [0054] to [0056]; Fig. 4 & EP 926090 A2	1-6

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

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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14 August, 2007 (14.08.07)Date of mailing of the international search report
28 August, 2007 (28.08.07)Name and mailing address of the ISA/
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INTERNATIONAL SEARCH REPORT

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 57-107016 A (Kabushiki Kaisha Suwa Seikosha), 03 July, 1982 (03.07.82), Claims; page 1, lower left column, line 14 to page 2, upper left column, line 20; Figs. 2 to 5 (Family: none)	1-6

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REFERENCES CITED IN THE DESCRIPTION

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- JP 11222357 A [0002]
- JP 2000128433 A [0002]