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(54) **WIRE WINDING DEVICE, PRODUCTION FACILITY USING SAME, WIRE WINDING METHOD, AND FINISHED ARTICLE PRODUCTION METHOD**

(57) A winding apparatus (10) includes the plurality of rotatable winding tool holders (12) respectively supported on the base (11), the plurality of rotational drive sources (19) respectively independently coupled to the plurality of winding tool holders (12), and the control means (50) for controlling the plurality of rotational drive sources (19). The control means (50) including the plurality of electrical control devices (52) respectively connected to at least one rotational drive source (19) to drive the rotational drive source (19) in accordance with the control program, the storage device (51) storing the plurality of control programs, and the selection circuit (80) for providing the control programs stored in the storage device (51) to the plurality of electrical control devices (52). The selection circuit (80) is configured to be able to provide different ones of the control programs to different ones of the electrical control devices (52).

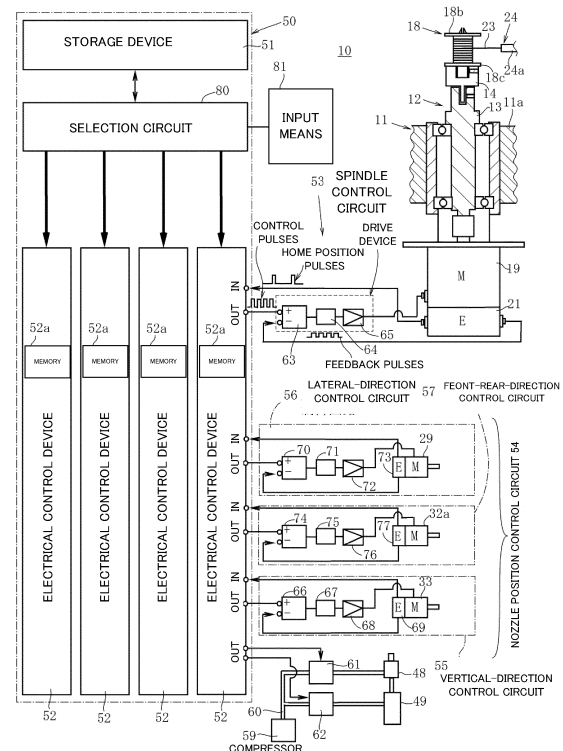


FIG. 1

Description

TECHNICAL FIELD

[0001] The present invention relates to a winding apparatus for winding a wire on an outer peripheral of a rotating winding tool parallel to a rotation axis, a manufacturing facility and a winding method using the same, and a finished product manufacturing method.

BACKGROUND ART

[0002] Conventionally, a wire winding method is known according to which a coil bobbin serving as a winding tool is mounted on a winding tool holder and rotated and a wire fed from a nozzle is rolled up and wound on the coil bobbin. Further, it is known as a method for rotating a winding tool holder to couple a plurality of winding tool holders to a rotary shaft of a single motor via a belt and simultaneously rotate the plurality of winding tool holders in the same direction by the single motor.

[0003] However, if the winding tool holders are coupled to the rotary shaft of the motor via the belt, the belt may be worn or stretched and become slackened due to use. This may cause ridges of the belt to ride over and skip ridges of pulley(s) provided on the rotary shaft of the motor or the winding tool holders and cause a deviation of a rotational position. Further, energy loss at contact parts is large due to there being many mechanical contact parts and there is also a problem of heat generation due to wear.

[0004] To solve this problem, JP2002-43157A discloses a winding apparatus in which a plurality of winding tool holders rotatable with winding tools mounted thereon are pivotally supported on a single base so as to be parallel to each other and rotational drive sources are respectively individually coupled to the plurality of winding tool holders. In this winding apparatus, a controller causes a plurality of the rotational drive sources separately provided on the winding tool holders to rotate in synchronization with each other.

[0005] According to this winding apparatus, a plurality of wound products of the same type can be obtained at one time by rotating the plurality of rotational drive sources in synchronization with each other. Since a belt coupling mechanism is not used in this winding apparatus, deviation of a rotational position due to the wear of a belt is not caused, energy loss is little, and there is no concern for heat generation due to wear.

SUMMARY OF INVENTION

[0006] Here, it has been also required to manufacture wound products in small quantities and large varieties in recent years. Even if the same winding tools and wires are used, a plurality of types of wound products different in the number of windings of the wire, the winding direction, the pull-out position of the wire, and the like may be

assembled into a finished product.

[0007] For example, in the case of obtaining a finished product by assembling two types of wound products, it is conceivable to prepare two winding apparatuses 1, 2 and obtain wound products 3a, 3b separately in the two winding apparatuses 1, 2 as shown in FIG. 8. After two different types of the wound products 3a, 3b are obtained, the two types of the wound products 3a, 3b are conveyed to an assembly machine 6 via an inspection machine 5 by a conveyor 4 and a finished product is obtained by assembling the two types of the wound products 3a, 3b in the assembly machine 6.

[0008] In the case of obtaining the finished product by assembling a plurality of types of the wound products 3a, 3b in this way, wound products 3a, 3b having different specifications are necessary. Thus, as many winding apparatuses 1, 2 as the specifications have to be arranged along the conveyor 4. Further, if as many winding apparatuses 1, 2 as the specifications are arranged along the conveyor 4, cost increases due to the necessity to prepare the plurality of winding apparatuses 1, 2 and a relatively large installation space is necessary since the plurality of winding apparatuses 1, 2 are installed with the space necessary for an operation provided therebetween.

[0009] Further, if a defective product is found by inspection performed by the inspection machine 5, the numbers of good wound products 3a, 3b to be supplied to the assembly machine 6 will no longer match. In this case, it is necessary to discard one lot of the wound products or supply a spare wound product 3a, 3b manually manufactured by a worker in advance onto the conveyor 4, whereby it becomes difficult to improve productivity.

[0010] The present invention aims to provide a winding apparatus capable of simultaneously manufacturing a plurality of types of wound products and a winding method using the same.

[0011] Further, the present invention aims to provide a manufacturing facility and a finished product manufacturing method capable of improving productivity by assembling a plurality of types of wound products without loss.

[0012] According to one aspect of the present invention, a winding apparatus for winding wires around rotating winding tools, includes a plurality of rotatable winding tool holders respectively pivotally supported on a base, the winding tools being mountable on the winding tool holders, a plurality of rotational drive sources respectively independently coupled to the plurality of winding tool holders, and control means for controlling the plurality of rotational drive sources, the control means includes a plurality of electrical control devices connected to at least one of the rotational drive sources, the electrical control devices driving the rotational drive sources in accordance with control programs, a storage device storing a plurality of the control programs, and a selection circuit for providing the plurality of control programs stored in the storage device to the plurality of electrical control devices,

and the selection circuit is configured to be able to provide different ones of the control programs to different ones of the electrical control devices.

[0013] According to other aspect of the present invention, a winding method for respectively mounting and rotating winding tools on a plurality of winding tool holders pivotally supported on a base and respectively winding wires around the rotating winding tools, the plurality of winding tool holders are divided into a plurality of groups and the plurality of winding tool holders are separately and independently rotated for each group.

[0014] According to other aspect of the present invention, finished product manufacturing method for manufacturing a finished product using wound products, includes a winding step of obtaining a plurality of types of wound products by winding, an inspection step of inspecting each of the plurality of types of the wound products, and an assembly step of assembling the plurality of types of the wound products to obtain a finished product, the wound product not satisfying a predetermined requirement is excluded in the inspection step and a shortage signal is sent if the type of the wound product necessary for assembling is in shortage in the assembling step, and the number of the lacking type of the wound products is increased in the winding step after the shortage signal was sent.

BRIEF DESCRIPTION OF DRAWINGS

[0015]

FIG. 1 is an electrical block diagram of control means of a winding apparatus in an embodiment of the present invention,

FIG. 2 is a top view of the winding apparatus in the embodiment of the present invention,

FIG. 3 is a sectional view along line A-A of FIG. 2,

FIG. 4 is a perspective view showing a state where the winding of wires on a plurality of winding tools is started by the winding apparatus in the embodiment of the present invention,

FIG. 5 is a perspective view, corresponding to FIG. 4, showing a state where the wires are actually being wound on the plurality of winding tools in the embodiment of the present invention,

FIG. 6 is a perspective view, corresponding to FIG. 5, showing a state where the wires are wound on the plurality of winding tools in the embodiment of the present invention and wound products are obtained, FIG. 7 is a top view showing a manufacturing facility provided with the winding apparatus in the embodiment of the present invention, and

FIG. 8 is a top view showing a conventional manufacturing facility.

DESCRIPTION OF EMBODIMENT

[0016] Hereinafter, an embodiment of the present in-

vention is described in detail on the basis of the drawings.

[0017] FIGS. 1 to 3 show a winding apparatus 10 according to the embodiment of the present invention. Here, the winding apparatus 10 according to the embodiment is described with three axes of X, Y and Z orthogonal to each other set up, one horizontal direction (width direction) referred to as a Y axis, a front-rear direction orthogonal to the width direction in a horizontal plane referred to as an X axis, and a vertical direction referred to as a Z axis.

[0018] As shown in FIG. 2, the winding apparatus 10 includes a plurality of winding tool holders 12 pivotally supported on a single base 11. Specifically, a supporting tool 11a formed to have an L-shaped cross-section (FIG. 3) extends in a Y-axis direction and is fixed on the base 11. The plurality of winding tool holders 12 extending in the vertical direction and four winding tool holders 12 in the present embodiment are arranged in the Y-axis direction and pivotally supported on the supporting tool 11a.

[0019] Since the plurality of winding tool holders 12 have the same structure, one of these is described as a representative below. As shown in FIG. 3, the winding tool holder 12 includes a spindle 13 supported in the supporting tool 11a, a winding jig 14 mounted on the spindle 13 and a mounting shaft 17 mounted in the winding jig 14.

[0020] The spindle 13 extends in the vertical direction and is supported on the supporting tool 11a by bearings 12a, 12a, rotatably with an axis along the vertical direction serving as a center. A hole 13a is provided in an upper end of the spindle 13. A small diameter part 14a of the winding jig 14 is inserted into the hole 13a and screwed with a set screw 16. A trapezoidal hole 14b is provided in a central part of a large diameter part of the winding jig 14 having a larger outer diameter than the small diameter part 14a. A rear end 17a of the mounting shaft 17 is inserted into the trapezoidal hole 14b and screwed with a set screw 16.

[0021] The mounting shaft 17 supports a winding tool 18. In the present embodiment, the winding tool 18 is a so-called coil bobbin formed with flanges 18b, 18c on both ends of a winding drum 18a. An upper end of the mounting shaft 17 for supporting the coil bobbin 18 serving as the winding tool is formed to have a smaller width (diameter) toward a tip. A slit 17b is formed in the upper end of the mounting shaft 17 to be open in an outer peripheral surface through a center axis. The upper end of the mounting shaft 17 is formed to have a so-called pen nib shaped cross-section by providing the slit 17b in this way. The upper end of the mounting shaft 17 is fit into the winding drum 18a of the coil bobbin 18 while being elastically deformed to be contracted in a direction to make the width of the slit 17b smaller. In this way, frictional resistance is applied between the upper end of the mounting shaft 17 and the winding drum 18a by an expanding elastic force of the upper end of the mounting shaft 17, thereby preventing the detachment of the coil bobbin 18 from the mounting shaft 17 during wire winding.

[0022] Further, the winding apparatus 10 includes a plurality of rotational drive sources 19 respectively individually coupled to the plurality of winding tool holders 12. In the present embodiment, the rotational drive sources are spindle motors 19. Specifically, the plurality of spindles 13 are provided at predetermined intervals in the Y-axis direction parallel to each other. As many spindle motors 19 as the spindles 13 are mounted on the supporting tool 11a below the respective spindles 13 such that rotary shafts 19a are coaxial with the spindles 13.

[0023] An encoder 21 for digitally outputting a rotational position of the rotary shaft 19a is mounted on each of the plurality of spindle motors 19. The spindle 13 is coupled to the rotary shaft 19a of the spindle motor 19 via a joint 22.

[0024] As shown in FIGS. 2 and 3, the winding apparatus 10 further includes a nozzle means 24 arranged such that tip parts are facing the winding tools 18, configured to supply wires 23 to the winding tools 18, and a nozzle position adjustment means 25 for moving the tip parts of the nozzle means 24. The nozzle means 24 includes a nozzle 24a constituted by a cylindrical tube through which the wire 23 to be wound on the coil bobbin 18 serving as the winding tool is insertable, a mounting tool 24b having the nozzle 24a provided on a tip, and a pulley 24c provided on the mounting tool 24b and configured to turn the wire 23 fed from an unillustrated spool toward the nozzle 24a.

[0025] The nozzle position adjustment means 25 moves the nozzle means 24 in three axis directions. A pair of rails 26 arranged side by side with the plurality of spindles 13 in an X-axis direction and spaced apart at a predetermined distance in the X-axis direction are provided to extend in the Y-axis direction on the upper surface of the base 11 on which the plurality of spindles 13 are arranged in the Y-axis direction. As many movable tables 27 as the spindles 13 are mounted on the pair of rails 26 reciprocally movably in the Y-axis direction to correspond to the respective spindles 13.

[0026] As shown in FIG. 2, as many Y-axis ball screws 28 as the movable tables 27 are provided in parallel to the rails 26 on the upper surface of the base 11. Further, a plurality of Y-axis servo motors 29 for separately rotating each Y-axis ball screw 28 are provided on the upper surface of the base 11.

[0027] As shown in FIG. 3, each of the plurality of movable tables 27 is formed with an internally threaded hole 27a to be threadably engaged with any one of the plurality of Y-axis ball screws 28 and a hole 27b or cutout for allowing the other Y-axis ball screw 28 to idly rotate. Thus, if the Y-axis servo motor 29 is driven to rotate the Y-axis ball screw 28, only the movable table 27 threadably engaged with that Y-axis ball screw 28 moves in the Y-axis direction along the rails 26.

[0028] A supporting column 31 stands on the upper surface of each movable table 27. A vertically movable sliding member 31a is attached to an X-axis actuator 32

by being fit on the supporting column 31. In this way, the X-axis actuator 32 is provided on the supporting column 31 movably upward and downward.

[0029] Further, a Z-axis servo motor 33 is mounted on the upper surface of the movable table 27 so that a rotary shaft 33a thereof extends vertically. A Z-axis ball screw 34 parallel to the supporting column 31 is coaxially mounted on the rotary shaft 33a of the Z-axis servo motor 33 via a joint 33b. The X-axis actuator 32 is provided with an internally threaded member 35 to be threadably engaged with the Z-axis ball screw 34. If the Z-axis servo motor 33 is driven to rotate the Z-axis ball screw 34, the X-axis actuator 32 including the internally threaded member 35 threadably engaged with the Z-axis ball screw 34 moves upward and downward.

[0030] As shown in FIGS. 2 and 3, the X-axis actuator 32 is composed of an X-axis ball screw 32b to be rotationally driven by an X-axis servo motor 32a provided on an end part of a housing 32d long in the X-axis direction, a follower 32c threadably engaged with the X-axis ball screw 32b to move in parallel in a longitudinal direction on the upper surface of the housing 32d, and the like. A base end of the mounting tool 24b in the nozzle means 24 is mounted on the follower 32c.

[0031] As just described, the nozzle position adjustment means 25 is configured to be able to move the nozzle means 24 in the three axis directions by driving each servo motor 29, 32a, 33 of the X, Y, Z axes.

[0032] It should be noted that, although not shown, the wire 23 inserted through the nozzle 24a and supplied is stored by being wound on the spool. At least as many spools storing the wires 23 as the winding tool holders 12 are prepared and arranged behind the base 11. Further, tension applying parts for applying a tension to the wire 23 unwound from each spool are respectively provided behind the base 11.

[0033] The winding apparatus 10 winds the wires 23 inserted through the nozzles 24a and fed around the winding tools 18 rotated together with the winding tool holders 12 by the rotational drive sources 19. The unillustrated tension applying part is configured to apply a suitable tension to the wire 23 while the wire 23 is being wound on the winding tool 18.

[0034] As shown in FIGS. 2 and 3, a clamp 48 to be driven by an air pressure and including wire clamping parts 48a, 48b for clamping an end part of the wire 23 inserted through the nozzle 24a and an elevator 49 for moving the clamp 48 upward and downward are provided for each nozzle means 24 in the winding apparatus 10. The shown elevator 49 is such a fluid pressure cylinder that a rod 49a facing upward is caused to project from and retract into a body part 49b mounted on the supporting tool 11a by a fluid pressure, and the clamp 48 is mounted on the upper end of the rod 49a.

[0035] Further, the winding apparatus 10 includes a control means 50 for controlling the plurality of rotational drive sources 19 and the plurality of nozzle position adjustment means 25 together with the clamps 48 and the

elevators 49.

[0036] The control means 50 is constituted by a micro-computer with a CPU (Central Processing Unit), a ROM (Read Only Memory), a RAM (Random Access Memory) and an I/O interface (Input/Output Interface). The RAM stores data in a process of the CPU, the ROM stores control programs and the like of the CPU in advance, and the I/O interface is used to input and output information to and from connected equipment. The control means 50 may be constituted by a plurality of microcomputers. The control means 50 is programmed so as to at least be able to execute processes necessary for controls according to the embodiment and modifications. It should be noted that the control means 50 may be configured as one device or may be divided into a plurality of devices and configured to process each control in the present embodiment in a distributed manner with the plurality of devices.

[0037] As shown in FIG. 1, the control means 50 in the winding apparatus 10 includes a storage device 51 storing a plurality of control programs for controlling the rotational drive sources 19 and the nozzle position adjustment means 25 (FIG. 3) and electrical control devices 52 for actually controlling the rotational drive sources 19 and the nozzle position adjustment means 25 with any one of the plurality of control programs stored in the storage device 51.

[0038] FIG. 1 shows an electrical block diagram of the control means 50. The storage device 51 in the control means 50 includes an interface to and from which the control programs are input and output via a selection circuit 80 to be described later, and is configured to be able to store a plurality of control programs and output the control programs via the interface.

[0039] The electrical control device 52 is provided with a memory 52a for temporarily storing the control program supplied from the storage device 51. The electrical control device 52 is configured to drive and stop each servo motor 29, 32a, 33 of the X, Y, Z axes in the rotational drive source 19 and the nozzle position adjustment means 25 (FIG. 3) in accordance with the control program stored in the memory 52a. A plurality of the electrical control devices 52, corresponding in number to the rotational drive sources 19 and the nozzle position adjustment means 25 are provided in the present embodiment.

[0040] Since the connecting structures of the plurality of provided electrical control devices 52 in the rotational drive sources 19 and the nozzle position adjustment means 25 (FIG. 3) are identical, one of these is described as a representative below. A spindle control circuit 53 for individually controlling the spindle motor 19 to rotate the spindle 13 provided with the winding tool 18 and a nozzle position control circuit 54 for controlling the position of the nozzle 24a for supplying the wire 23 are connected to the electrical control device 52.

[0041] The spindle control circuit 53 is directly connected to the spindle 13 and controls the spindle motor 19 provided with the encoder 21. The spindle motor 19 is

connected to an output end of the electrical control device 52 via a counter 63, a D/A conversion circuit 64 and an amplifier 65 and starts being rotated by control pulses of the electrical control device 52. Further, the spindle motor 19 is configured to stop when the number of feedback pulses generated by the encoder 21 and the number of the input control pulses match. The encoder 21 is configured to send a home position pulse when the rotary shaft of the spindle motor 19 arrives at a predetermined position during one rotation.

[0042] As just described, the electrical control device 52 outputs the control pulses and rotates the spindle motor 19 until the home position pulse arrives in accordance with the control program stored in the memory 52a. Further, the electrical control device 52 is configured to set the spindle 13 at an initial position by automatically stopping the spindle motor 19 upon the arrival of a feedback pulse when the sending of the control pulses is stopped.

[0043] The nozzle position control circuit 54 is a circuit for controlling the nozzle position adjustment means 25 (FIG. 3). The position of the nozzle 24a is controlled in the vertical direction, lateral direction and front-rear direction by the separate servo motors 29, 32a, 33. The position of the nozzle 24a needs to be moved also in maintenance other than a normal winding operation. The nozzle position control circuit 54 includes a vertical-direction control circuit 55, a lateral-direction control circuit 56 and a front-rear-direction control circuit 57 having a circuit configuration similar to that of the aforementioned spindle control circuit 53.

[0044] Specifically, the vertical-direction control circuit 55 for controlling a vertical-direction position of the nozzle 24a controls the Z-axis servo motor 33

[0045] (FIG. 3) mounted on the upper surface of the movable table 27 such that the rotary shaft 33a extends vertically. The Z-axis servo motor 33 is connected to the output end of the electrical control device 52 via a counter 66, a D/A conversion circuit 67 and an amplifier 68, and starts being rotated by control pulses of the electrical control device 52. The Z-axis servo motor 33 is configured to stop when the number of feedback pulses generated by an encoder 69 directly connected to the Z-axis servo motor 33 and the number of the input control pulses match. Further, the encoder 69 is configured to send a home position pulse when the rotary shaft 33a of the Z-axis motor 33 arrives at a predetermined position during one rotation.

[0046] As just described, the electrical control device 52 outputs the control pulses and rotates the Z-axis servo motor 33 until the home position pulse arrives. Further, the electrical control device 52 can set the X-axis servo motor 32 at an initial position by automatically stopping the Z-axis servo motor 33 upon the arrival of a feedback pulse when the sending of the control pulses is stopped.

[0047] Similarly, the lateral-direction control circuit 56 controls the Y-axis servo motor 29 for moving the movable table 27 in the Y-axis direction. The Y-axis servo motor 29 is connected to the output end of the electrical

control device 52 via a counter 70, a D/A conversion circuit 71 and an amplifier 72, and starts being rotated by control pulses of the electrical control device 52. The Y-axis servo motor 29 is configured to stop when the number of feedback pulses generated by an encoder 73 provided on the Y-axis servo motor 29 and the number of the input control pulses match.

[0048] Similarly, the front-rear-direction control circuit 57 controls the X-axis servo motor 32a in the X-axis actuator 32 having the nozzle means 24 mounted on the follower 32c. The X-axis servo motor 32a is connected to the output end of the electrical control device 52 via a counter 74, a D/A conversion circuit 75 and an amplifier 76, and starts being rotated by control pulses of the electrical control device 52. The X-axis servo motor 32a is configured to stop when the number of feedback pulses generated by an encoder 77 coupled to the X-axis servo motor 32a and the number of the input control pulses match.

[0049] Each of these encoders 69, 73 and 77 is configured to send the home position pulse when the rotary shaft of each servo motor 29, 32a, 33 of the X, Y, Z axes arrives at the predetermined position during one rotation. Thus, the electrical control device 52 outputs the control pulses and rotates each servo motor 29, 32a, 33 of the X, Y, Z axes until the home position pulse arrives. Further, the electrical control device 52 can set the nozzle means 24 at an initial position by automatically stopping each servo motor 29, 32a, 33 of the X, Y, Z axes upon the arrival of the feedback pulses matching in number with the control pulses when the sending of the control pulses is stopped.

[0050] Further, output signal lines to electromagnetic valves 61, 62 for switching air, which is fluid, supplied from an air compressor 59 to the clamp 48 and the elevator 49 through a pipe 60 are connected to the output end of the electrical control device 52 to drive the clamp 48 and the elevator 49 by a fluid pressure.

[0051] The control means 50 is provided with the selection circuit 80 for providing any one of the plurality of control programs stored in the storage device 51 to any one of the plurality of electrical control devices 52, storing the control program in the memory 52a of the electrical control device 52 and driving the electrical control device 52 in accordance with the control program stored in the memory 52a.

[0052] An input means 81 such as a keyboard is connected to the selection circuit 80, which is configured such that an output end of another equipment is connectable to an input end of the input means 81. The selection circuit 80 is configured to determine which one of the plurality of control programs stored in the storage device 51 is to be provided to which one of the plurality of electrical control devices 52 and drive the electrical control device 52 in accordance with the control program, using the input means 81 and output information from the other equipment. That is, the selection circuit 80 determines which one of the control programs stored in the storage

device 51 is to be provided for each of the plurality of electrical control devices 52 and provides the determined control program.

[0053] Thus, for example, if an even number of the winding tool holders 12 are provided, the selection circuit 80 can provide one control program to each rotational drive source 19 in one group formed by equally dividing the even number of the winding tool holders 12 into two, and provide another control program to each rotational drive source 19 in the other divided group. That is, according to the selection circuit 80, different control programs can be provided to different ones of the plurality of electrical control devices 52. According to this, the winding apparatus 10 can simultaneously manufacture two types of wound products despite being a single apparatus.

[0054] Next, a winding method using the above winding apparatus 10 is described.

[0055] In the winding apparatus 10, the plurality of winding tool holders 12 are pivotally supported on the single base 11. Thus, in the winding method by the winding apparatus 10, the winding tool 18 is mounted and rotated on each of the plurality of winding tool holders 12 and the wire 23 is wound on the rotating winding tool 18.

[0056] In a procedure for that, the wires 23 are unwound from the unillustrated spools arranged behind the base 11 and inserted through the nozzles 24a after passing through the unillustrated tension applying parts as a preparation stage. Further, as shown in FIG. 4, the end parts of the wires 23 are clamped by the wire clamping parts 48a, 48b in the clamps 48. Then, the coil bobbin 18 serving as the winding tool for winding the wire 23 is mounted on the mounting shaft 17 of each spindle 13.

[0057] In such a preparatory state, if information to start winding is input after winding conditions are input from the input means 81, the selection circuit 80 selectively supplies the plurality of control programs stored in the storage device 51 to each electrical control device 52 in accordance with the winding conditions input from the input means 81. Each electrical control device 52 temporarily stores the control program supplied via the selection circuit 80 in the memory 52a, moves the nozzle 24a in accordance with the control program, and starts winding by rotating the winding tool holder 12 having the coil bobbin 18 mounted thereon.

[0058] In the present embodiment, the coil bobbin 18 serving as the winding tool includes entwining pins 18d. A winding procedure in this case is described below. As shown in FIG. 4, first, the wire 23 extending from the nozzle 24a to the clamp 48 is wound on the entwining pin 18d by turning the nozzle 24a around the entwining pin 18d to set a winding start wire 23a. Thereafter, the elevator 49 (FIG. 3) separates the clamp 48 from the entwining pin 18d, the wire 23 is torn off near the entwining pin 18d, and the winding start wire 23a is caused to remain on the entwining pin 18d.

[0059] In that state, the electrical control device 52 rotates each winding tool holder 12 together with the coil

bobbin 18 in accordance with the control program selectively supplied from the storage device 51 shown in FIG. 1 by the selection circuit 80 and temporarily stored in the memory 52a. In this way, the wire 23 fed from the nozzle 24a is wound on the winding drum 18a of the coil bobbin 18 as shown in FIG. 5.

[0060] Specifically, the spindle control circuit 53 starts an operation in accordance with the control program selectively supplied from the selection circuit 80 and temporarily stored in the memory 52a, and drives the spindle motor 19 to rotate the coil bobbin 18, whereby winding is performed. Here, if each spindle motor 19 is operated, the coil bobbin 18 rotates a number of times determined by the control program, and the wire 23 fed from the nozzle 24a is wound on the coil bobbin 18 the determined number of times.

[0061] Along with the winding of the wire 23, the electrical control device 52 moves the nozzle means 24 for feeding the wire 23 in accordance with the control program temporarily stored in the memory 52a. In this way, the winding position of the wire 23 is adjusted. Specifically, a distance between the outer periphery of the wire 23 wound on the coil bobbin 18 and the tip of the nozzle 24a is controlled in a predetermined distance by a vertical-direction control circuit 55. The position of the nozzle 24a is controlled to correspond to winding layers of the wire 23 by the lateral-direction control circuit 56. Further, the position of the nozzle 24a is controlled to correspond to the number of windings of the wire 23 by the front-rear-direction control circuit 57.

[0062] If the wire 23 is wound on the coil bobbin 18 a desired number of times, the nozzle 24a is moved by the nozzle position adjustment means 25 and rotated around another entwining pin 18d of each coil bobbin 18 as shown in FIG. 6 in accordance with the control program provided via the selection circuit 80. In this way, the wire 23 extending from the nozzle 24a is entwined around the entwining pin 18d to set a winding end wire 23b.

[0063] Further, the wire 23 extending from the entwining pin 18d to the nozzle 24a is clamped by the wire clamping part 48a, 48b of the clamp 48 in accordance with the control program. Thereafter, the elevator 49 (FIG. 3) separates the clamp 48 from the entwining pin 18d, the wire 23 is torn off near the entwining pin 18d, and the winding end wire 23b is caused to remain on the entwining pin 18d. In this way, a series of winding operations are finished.

[0064] Here, in the winding method using the winding apparatus 10, winding is performed by controlling the plurality of winding tool holders 12 and the plurality of nozzle position adjustment means 25 with each electrical control device 52. Thus, if the same control program is supplied from the selection circuit 80, the same winding can be performed and the same wound products can be obtained. If different control programs are supplied from the selection circuit 80, different windings are performed.

[0065] Thus, in the winding method according to the present embodiment, the plurality of winding tool holders

12 are divided into a plurality of groups, the control program to be provided to the electrical control devices 52 for controlling the winding tool holders 12 belonging to each group is made different for each group. In this way, the plurality of winding tool holders 12 are separately and independently rotated for each group. Further, the tip parts of the nozzle means 24 are also separately and independently moved for each group as the winding tool holders 12 in each group are rotated. That is, the plurality of winding tool holders 12 and the nozzle means 24 corresponding thereto (supplying the wires 23) are independently operated under different conditions for each group. In this way, a plurality of types of wound products can be simultaneously obtained.

[0066] Since four winding tool holders 12 are provided in the present embodiment, an even number of these winding tool holders 12 are equally divided into two. One control program is supplied to each of the electrical control devices 52 for controlling the winding tool holders 12 and the nozzle position adjustment means 25 of one group. Another control program is supplied to each of the electrical control devices 52 for controlling the winding tool holders 12 and the nozzle position adjustment means 25 of the other group. By separately and independently rotating the winding tool holders 12 in one and the other groups in this way, two types of wound products can be simultaneously manufactured in the same number.

[0067] FIGS. 4 to 6 show a case in which the coil bobbins 18 serving as the winding tools include the entwining pins 18d and two types of wound products B, C (FIG. 6) having the wires 23 wound on these entwining pins 18d are simultaneously manufactured in the same number.

[0068] Specifically, in the embodiment shown in FIGS. 4 to 6, the wound products B having the winding start wire 23a and the winding end wire 23b entwined around two entwining pins 18d provided on the flange 18b on one side are manufactured on the coil bobbins 18 mounted on two out of four winding tool holders 12. Further, the wound products C having the winding start wire 23a entwined around the entwining pin 18d provided on the flange 18c on one side and the winding end wire 23b entwined around the entwining pin 18d provided on the other flange 18b are manufactured on the coil bobbins 18 mounted on the other two winding tool holders 12 at the same time as the wound products B.

[0069] As just described, in the winding method using the winding apparatus 10, the number of rotations of the coil bobbins 18 serving as the winding tools and movements of the nozzles 24a are determined by the control programs provided via the selection circuit 80. Specifically, in the winding apparatus according to the present embodiment, the plurality of winding tool holders 12 are divided into the plurality of groups, and the plurality of winding tool holders 12 are separately and independently rotated for each group. Thus, the plurality of types of the wound products B, C can be simultaneously manufactured despite using the single winding apparatus 10.

[0070] Particularly, the tip part of the nozzle means 24

arranged to face the tip part of the winding tool 18 and configured to supply the wire 23 to be wound around the winding tool 18 is also separately and independently moved for each group as the winding tool holder 12 in each group rotates. In this way, not only the number of windings of the wire 23, but also the pull-out position of the wire 23 and the like can also be made different for each type of the wound products B, C.

[0071] Next, a winding facility 100 provided with the winding apparatus 10 is described.

[0072] As described above, the winding apparatus 10 can simultaneously manufacture the plurality of types of the wound products B, C and the winding facility 100 provided with the winding apparatus 10 includes, as shown in FIG. 7, a conveyor 110 for conveying the plurality of types of the wound products B, C wound in the winding apparatus 10 to a downstream side, an inspection machine 120 provided downstream of the winding apparatus 10 to inspect the plurality of types of the wound products B, C, and an assembly machine 130 provided downstream of the inspection machine 120 to assemble the plurality of types of the wound products B, C.

[0073] The inspection machine 120 inspects whether or not the wound products B, C are wound in accordance with a desired specification and satisfy a predetermined requirement before the wound products B, C conveyed from the winding apparatus 10 by the conveyor 110 are assembled by the assembly machine 130. In this way, the occurrence of defective products is prevented. Specifically, the inspection machine 120 is provided with an exclusion means 121 for prohibiting the conveyance of the wound product B, C not satisfying the requirement to a further downstream side by the conveyor 110 by excluding the wound product B, C determined not to satisfy the predetermined requirement as a result of inspection. The exclusion means 121 in the diagram is a robot including a grip part 121a for gripping a defective product.

[0074] The assembly machine 130 assembles the plurality of types of the wound products B, C to obtain a finished product. The assembly machine 130 is provided with a detector 131 for detecting a state of conveyance of the wound products B, C conveyed by the conveyor 110 since the wound products B, C may be excluded in the inspection machine 120 in a preceding process. Thus, the assembly machine 130 is configured to assemble the plurality of types of the wound products B, C, whose state of conveyance was confirmed by the detector 131.

[0075] In the assembly machine 130, if the wound product B, C was excluded in the inspection machine 120 in the preceding process and the state of conveyance of the planned wound product B, C could not be confirmed by the detector 131, assembling is postponed until that wound product B, C is conveyed next. Thus, the assembly machine 130 is provided with a keeping mechanism 132 for keeping an excess wound product B, C if the planned wound product B, C was not conveyed and another type of the wound product B, C was conveyed.

[0076] Further, the assembly machine 130 is configured to bring the excess wound product B, C and assemble the excess wound product B, C together with the newly conveyed wound product B, C when the lacking wound product B, C is newly conveyed in a state where the excess wound product B, C is kept.

[0077] Thus, the assembly machine 130 is provided with a signal generator 131a for sending a shortage signal when the state of conveyance of the planned wound product B, C cannot be confirmed by the detector 131 and the type of the wound product B, C necessary for assembling is in shortage. A signal of the signal generator 131a is connected to the control means 50 (FIG. 1) of the winding apparatus 10.

[0078] The winding apparatus 10 is configured to increase the electrical control devices 52, to which the control program for obtaining the lacking type of the wound products B, C upon receiving a shortage signal of the wound product B, C by means of a signal output of the signal generator 131a in the assembly machine 130 is supplied. That is, the winding apparatus 10 is configured to increase the number of the rotational drive sources 19 controlled to wind the lacking wound products B, C.

[0079] Specifically, it is, for example, assumed that one control program is supplied to each electrical control device 52 for controlling two out of four winding tool holders 12 and the nozzle position adjustment means 25 facing these winding tool holders 12, and another control program is supplied to each electrical control device 52 for controlling the other two winding tool holders 12 and the nozzle position adjustment means 25 facing these winding tool holders 12. That is, the winding apparatus 10 is assumed to manufacture the two types of the wound products B, C two by two.

[0080] Further, in this case, it is assumed that the control means 50 receives a signal representing that one wound product B is in shortage. In such a case, the selection circuit 80 in the winding apparatus 10 supplies one control program supplied to each electrical control device 52 for controlling the two winding tool holders 12 manufacturing the wound products B to one or both of the two electrical control devices 52 for controlling the other two winding tool holders 12. That is, the selection circuit 80 supplies the control program for manufacturing the lacking wound products B to one or both of the two electrical control devices 52, to which the control program for manufacturing the wound products C was supplied in the previous winding.

[0081] In this way, three out of the four winding tool holders 12 or all the winding tool holders 12 and the nozzle position adjustment means 25 facing these winding tool holders 12 are respectively controlled by each electrical control device 52 to which the one control program (control program for obtaining the wound products B) was supplied. Thus, three or four lacking wound products B can be manufactured at one time. If one winding tool holder 12 remains (if three wound products B are manufactured at one time), the remaining one winding tool

holder 12 and the nozzle position adjustment means 25 facing this winding tool holder 12 are controlled by the electrical control device 52 to which the other control program (control program for obtaining the wound products C) was supplied, and the other type of the wound products C are manufactured in a reduced quantity.

[0082] A method for manufacturing a finished product in such a manufacturing facility 100 includes a winding step of obtaining the plurality of types of the wound products B, C by winding using the winding apparatus 10, an inspection step of inspecting each of the plurality of types of the wound products B, C and an assembly step of assembling the plurality of types of the wound products B, C to obtain a finished product as shown in FIG. 7.

[0083] In the inspection step, the wound product B, C not satisfying the predetermined requirement is excluded. In the assembly step, a shortage signal is sent when the type of the wound product B, C necessary for assembling is in shortage. In the winding step after the shortage signal was sent, the wound products B, C of the lacking type are increased.

[0084] In the event of a situation in which the wound product B, C detected as a defective product is excluded in the inspection step and the type of the wound product B, C necessary for assembling is in shortage, the assembling is postponed and the other type of an excess wound product B, C is kept until the lacking wound product is conveyed next.

[0085] In the winding apparatus 10, the manufacturing of the lacking wound products B, C is increased in response to the shortage signal sent when the type of the wound product B, C necessary for assembling is in shortage. When the increased wound products B, C are conveyed to the assembly machine 130 by the conveyor 110, the excess wound product B, C is brought and assembled together with the newly conveyed lacking wound product B, C.

[0086] Accordingly, in the manufacturing facility 100 provided with the winding apparatus 10, even if the wound product B, C manufactured in the winding apparatus 10 is excluded in the inspection machine 120, the numbers of the wound products B, C manufactured in the winding apparatus 10 thereafter are adjusted. Thus, the generation of a plurality of excess wound products B, C can be avoided and the plurality of types of the wound products B, C are assembled without loss, whereby productivity can be improved.

[0087] Further, the winding apparatus 10 can simultaneously wind the plurality of types of the wound products B, C. In the manufacturing facility 100, the single winding apparatus 10 is provided along the conveyor 110 and the winding step of obtaining the plurality of types of the wound products B, C is performed by the single winding apparatus 10, whereby the wound products B, C simultaneously wound by the single winding apparatus 10 and having different specifications are assembled. In this way, a cost increase can be avoided and the installation space of the manufacturing facility 100 can be made

smaller as compared to the conventional case requiring a plurality of winding apparatuses shown in FIG. 8.

[0088] It should be noted that, in the aforementioned embodiment, the nozzle position adjustment means 25 moves the nozzle means 24 with each servo motor 29, 32a, 33 of the X, Y, Z axes. However, this is an example and the nozzle position adjustment means 25 is not limited to this as long as the tip part of the nozzle means 24 can be moved. For example, the nozzle position adjustment means may move the tip part of the nozzle means 24 by means of a fluid pressure.

[0089] Further, in the above embodiment, the winding tool 18 is the so-called coil bobbin having the flanges 18b, 18c formed on both ends of the winding drum 18a. However, this is an example and the winding tool 18 is not limited to this as long as the wire 23 can be wound therearound. For example, the winding tool 18 may be formed without flanges on both ends of a winding drum.

[0090] Further, in the aforementioned embodiment, the signal generator 131a sends a shortage signal when the wound products B, C conveyed by the conveyor 110 are inspected and the type of the wound product B, C necessary for assembling is in shortage in the assembly step. However, the signal generator 131a may send a shortage signal representing the shortage of the type of the wound product necessary for assembling in the assembly machine 130 when the wound product not satisfying the predetermined requirement is excluded by the exclusion means 121 as long as the inspection machine 120 includes the exclusion means 121.

[0091] Further, in the aforementioned embodiment, the method according to which the winding apparatus 10 includes four winding tool holders 12 and winding is performed with the four winding tool holders divided into two groups has been described. However, this is an example and the number of the winding tool holders 12 provided on the base 11 may be two or three to be less than four or may be five or more (e.g. six, eight or ten) to be more than four. That is, the number of the winding tool holders 12 may be an odd number or an even number as long as this number is two or more. Further, the number of the groups into which the plurality of winding tool holders 12 are divided is also not limited to two, and the winding tool holders 12 may be divided into three or more groups.

[0092] Furthermore, in the aforementioned embodiment, the control means 50 includes as many electrical control devices 52 as the winding tool holders 12 and the electrical control devices 52 separately and independently rotate the winding tool holders 12. That is, in the above embodiment, one electrical control device 52 is configured to rotate one winding tool holder 12 by driving one rotational drive source 19. In contrast, the number of the winding tool holders 12 controlled by the single electrical control device 52 may be two constituting the group, or may be three, four or more as long as a plurality of electrical control devices 52 are provided and a plurality of winding tool holders 12 can be divided into a plurality of groups, in other words, the plurality of winding

tool holders 12 are configured to be rotated by the plurality of electrical control devices 52. That is, each electrical control device 52 only has to be configured to drive at least one rotational drive source 19. In this case, a plurality of the winding tool holders 12 constituting the group and the nozzle position adjustment means 25 are rotated in synchronization and controlled to move by the single electrical control device 52, and the same type of the wound products B, C are manufactured in that group.

[0093] The configuration, functions and effects of the embodiment of the present invention are summarized.

[0094] The winding apparatus 10 for winding the wires 23 around the rotating winding tools 18 includes the plurality of rotatable winding tool holders 12 respectively supported on the base 11, the winding tools 18 being mountable on the winding tool holders 12, the plurality of rotational drive sources 19 respectively independently coupled to the plurality of winding tool holders 12 and the control means 50 for controlling the plurality of rotational drive sources 19, the control means 50 including the plurality of electrical control devices 52 connected to at least one rotational drive source 19 to drive the rotational drive source 19 in accordance with the control program, the storage device 51 storing the plurality of control programs, and the selection circuit 80 for providing the control programs stored in the storage device 51 to the plurality of electrical control devices 52; and the selection circuit 80 is configured to be able to provide different ones of the control programs to different ones of the electrical control devices 52.

[0095] The winding apparatus further includes the plurality of nozzle means 24 arranged such that the tip parts are facing the winding tools 18, the nozzle means 24 supplying the wires 23 to the winding tools 18, and the nozzle position adjustment means 25 for moving the tip parts of the plurality of nozzle means 24; and the plurality of electrical control devices 52 drive the nozzle position adjustment means 25 in accordance with the control programs provided by the selection circuit 80.

[0096] Further, in the winding method of the present embodiment for respectively mounting and rotating the winding tools 18 on the plurality of winding tool holders 12 pivotally supported on the single base 11 and respectively winding the wires 23 around the rotating winding tools 18, the plurality of winding tool holders 12 are divided into the plurality of groups and the plurality of winding tool holders 12 are separately and independently rotated for each group.

[0097] Further, in the winding method according to the present embodiment, the wires 23 to be wound around the rotating winding tools 18 are supplied by the plurality of nozzle means 24 arranged such that the tip parts are facing the winding tools 18, and the tip parts of the plurality of nozzle means 24 separately and independently move for each group as the winding tool holders 12 in each group are rotated.

[0098] Further, the manufacturing facility 100 for manufacturing a finished product using wound products in-

cludes the above winding apparatus 10, the conveyor 110 for conveying the plurality of types of the wound products B, C wound in the winding apparatus 10 to the downstream side, the inspection machine 120 provided downstream of the winding apparatus 10 to inspect the plurality of types of the wound products B, C, the assembly machine 130 provided downstream of the inspection machine 120 to assemble the plurality of types of the wound products B, C, the exclusion means 121 provided in the inspection machine 120 to prohibit the conveyance of the wound product B, C not satisfying the predetermined requirement to a further downstream side by excluding the wound product B, C not satisfying the predetermined requirement, and the signal generator 131a for sending a shortage signal when the type of the wound product B, C necessary for assembling in the assembly machine 130 is in shortage; and the control means 50 of the winding apparatus 10 is configured to increase the number of the rotational drive sources 19 controlled by the control program for obtaining the lacking type of the wound products B, C when receiving the shortage signal.

[0099] Further, the finished product manufacturing method according to the present embodiment for manufacturing a finished product using wound products includes the winding step of obtaining the plurality of types of the wound products B, C by winding, the inspection step of inspecting each of the plurality of types of the wound products B, C and the assembly step of assembling the plurality of types of the wound products B, C to obtain a finished product; and the wound product B, C not satisfying the predetermined requirement is excluded in the inspection step, a shortage signal is sent when the type of the wound product B, C necessary for assembling is in shortage in the assembling step, and the number of the wound products B, C of the lacking type is increased in the winding step after the shortage signal was sent.

[0100] Further, in the finished product manufacturing method according to the present embodiment, winding is performed to obtain the same number of the plurality of types of the wound products B, C in one winding step, and winding is performed by increasing the number of the lacking type of the wound products B, C and reducing the number of the other type of the wound products B, C in the winding step after the shortage signal was sent.

[0101] In the winding apparatus 10 and the winding method using the winding apparatus 10, the number of rotations of the winding tools 18 and movements of the nozzle means 24 are determined by the control programs provided via the selection circuit 80. The plurality of winding tool holders 12 are divided into the plurality of groups and different control programs are provided to the electrical control devices 52 for controlling the rotational drive sources 19 in different groups, whereby the plurality of winding tool holders 12 can be separately and independently rotated for each group. Thus, the plurality of types of the wound products B, C can be simultaneously manufactured by the single winding apparatus 10.

[0102] Further, in the winding apparatus 10 and the

winding method according to the present embodiment, the tip parts of the nozzle means 24 for supplying the wires 23 to be wound around the rotating winding tools 18 are also separately and independently moved for each group by the electrical control devices 52, to which the different control programs were provided, as the winding tool holders 12 in each group are rotated. In this way, not only the number of windings of the wires 23, but also the pull-out positions of the wires 23 and the like can be made different for each type of the wound products B, C.

[0103] Further, in the manufacturing facility 100 provided with the winding apparatus 10 and the finished product manufacturing method, even if the wound product B, C manufactured in the winding apparatus 10 is excluded in the inspection machine 120, the generation of a plurality of excess wound products B, C can be avoided by adjusting the numbers of the wound products B, C manufactured thereafter in the winding apparatus 10. Thus, the plurality of types of the wound products B, C can be assembled without loss and productivity can be improved.

[0104] Further, the winding apparatus 10 can simultaneously wind the plurality of types of the wound products B, C. In the manufacturing facility 100, the single winding apparatus 10 is provided along the conveyor 110 and the winding step of obtaining the plurality of types of the wound products B, C is performed by the single winding apparatus 10, whereby the wound products B, C simultaneously wound by the single winding apparatus 10 and having different specifications are assembled. Thus, according to the manufacturing facility 100 of the present embodiment, a cost increase can be avoided and the installation space of the manufacturing facility 100 can be made smaller as compared to the conventional case requiring a plurality of winding apparatuses.

[0105] 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.

Claims

1. A winding apparatus for winding wires (23) around rotating winding tools (18), comprising:

a plurality of rotatable winding tool holders (12) respectively pivotally supported on a base (11), the winding tools (18) being mountable on the winding tool holders (12);
a plurality of rotational drive sources (19) respectively independently coupled to the plurality of winding tool holders (12); and
control means (50) configured to control the plurality of rotational drive sources (19),
wherein:

the control means (50) includes:

a plurality of electrical control devices (52) connected to at least one of the rotational drive sources (19), the electrical control devices (52) driving the rotational drive sources (19) in accordance with control programs;
a storage device (51) storing a plurality of the control programs; and
a selection circuit (80) configured to provide the plurality of control programs stored in the storage device (51) to the plurality of electrical control devices (52), and

the selection circuit (80) is configured to be able to provide different ones of the control programs to different ones of the electrical control devices (52).

2. The winding apparatus according to claim 1, further comprising:

a plurality of nozzle means (24) arranged such that tip parts are facing the winding tools (18), the nozzle means (24) supplying the wires (23) to the winding tools (18); and
nozzle position adjustment means (25) for moving the tip parts of the plurality of nozzle means (24),
wherein the plurality of electrical control devices (52) drive the nozzle position adjustment means (25) in accordance with the control programs provided by the selection circuit (80).

3. A winding method for respectively mounting and rotating winding tools (18) on a plurality of winding tool holders (12) pivotally supported on a base (11) and respectively winding wires (23) around the rotating winding tools (18), wherein:
the plurality of winding tool holders (12) are divided into a plurality of groups and the plurality of winding tool holders (12) are separately and independently rotated for each group.

4. The winding method according to claim 3, wherein:

the wires (23) to be wound around the rotating winding tools (18) are supplied by a plurality of nozzle means (24) respectively arranged such that tip parts are facing the winding tools (18), and
the tip parts of the plurality of nozzle means (24) separately and independently move for each group as the winding tool holders (12) in each group are rotated.

5. A manufacturing facility for manufacturing a finished product using wound products, comprising:

the winding apparatus (10) according to claim 1 or 2;
 a conveyor (110) for conveying a plurality of types of wound products (B, C) wound in the winding apparatus (10) to a downstream side;
 an inspection machine (120) provided downstream of the winding apparatus (10) to inspect the plurality of types of the wound products (B, C);
 an assembly machine (130) provided downstream of the inspection machine (120) to assemble the plurality of types of the wound products (B, C);
 exclusion means (121) provided in the inspection machine (120), the exclusion means (121) prohibiting the wound product (B, C) not satisfying a predetermined requirement from being conveyed to a further downstream side by the conveyor (110) by excluding the wound product (B, C) not satisfying the predetermined requirement; and
 a signal generator (131a) for sending a shortage signal when the type of the wound product (B, C) necessary for assembling in the assembly machine (130) is in shortage,
 the control means (50) of the winding apparatus (10) being configured to increase the number of the rotational drive sources (19) controlled by the control program for obtaining the lacking type of the wound products (B, C) when the shortage signal is received.

6. A finished product manufacturing method for manufacturing a finished product using wound products, comprising:

a winding step of obtaining a plurality of types of wound products (B, C) by winding;
 an inspection step of inspecting each of the plurality of types of the wound products (B, C); and
 an assembly step of assembling the plurality of types of the wound products (B, C) to obtain a finished product,
 wherein:

the wound product (B, C) not satisfying a predetermined requirement is excluded in the inspection step and a shortage signal is sent when the type of the wound product (B, C) necessary for assembling is in shortage in the assembling step, and
 the number of the lacking type of the wound products (B, C) is increased in the winding step after the shortage signal was sent.

7. The finished product manufacturing method according to claim 6, wherein:

winding is performed to obtain the same number of the plurality of types of the wound products (B, C) in one winding step, and
 winding is performed by increasing the number of the lacking type of the wound products (B, C) and reducing the number of the other type of the wound products (B, C) in the winding step after the shortage signal was sent.

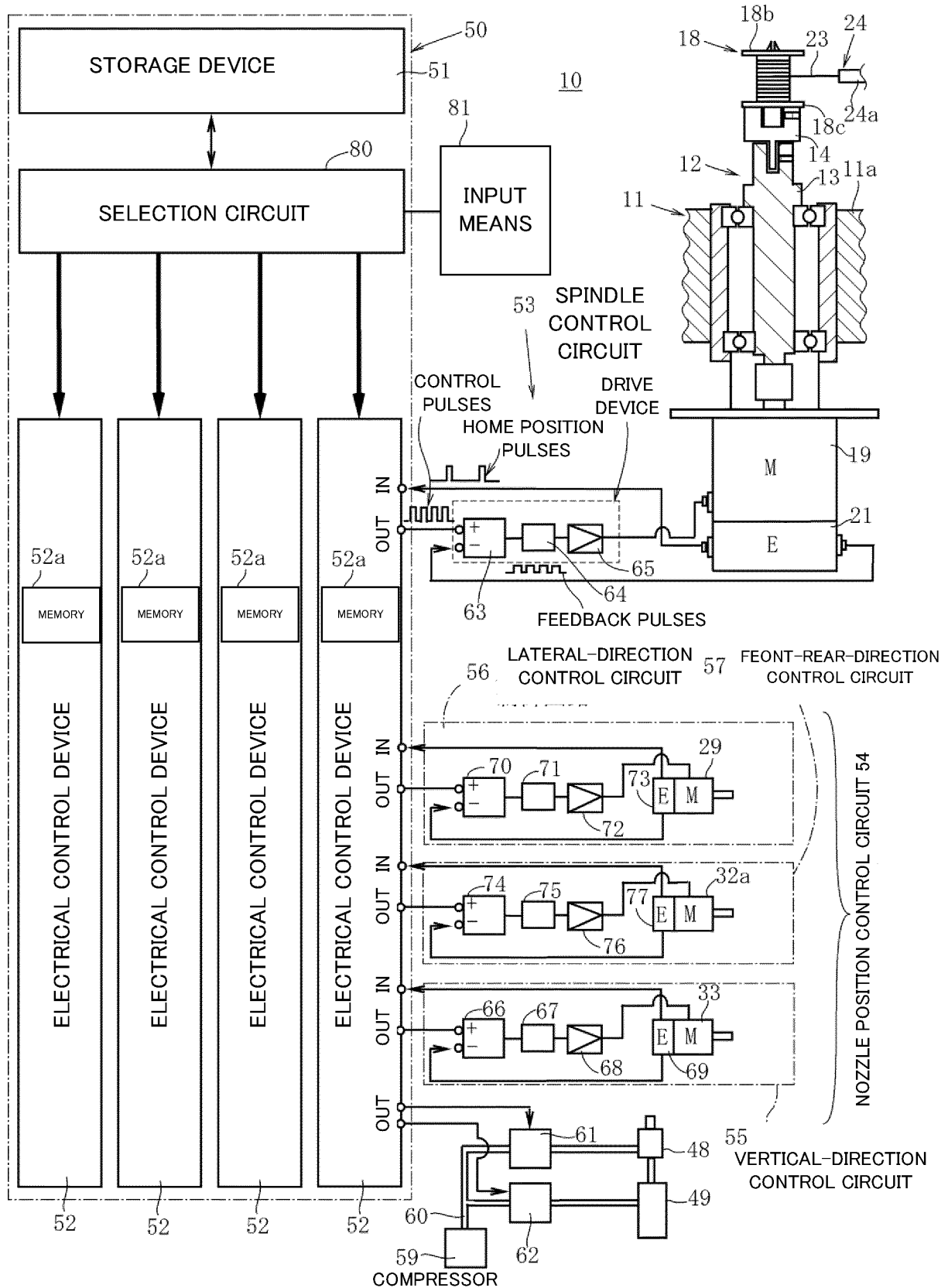
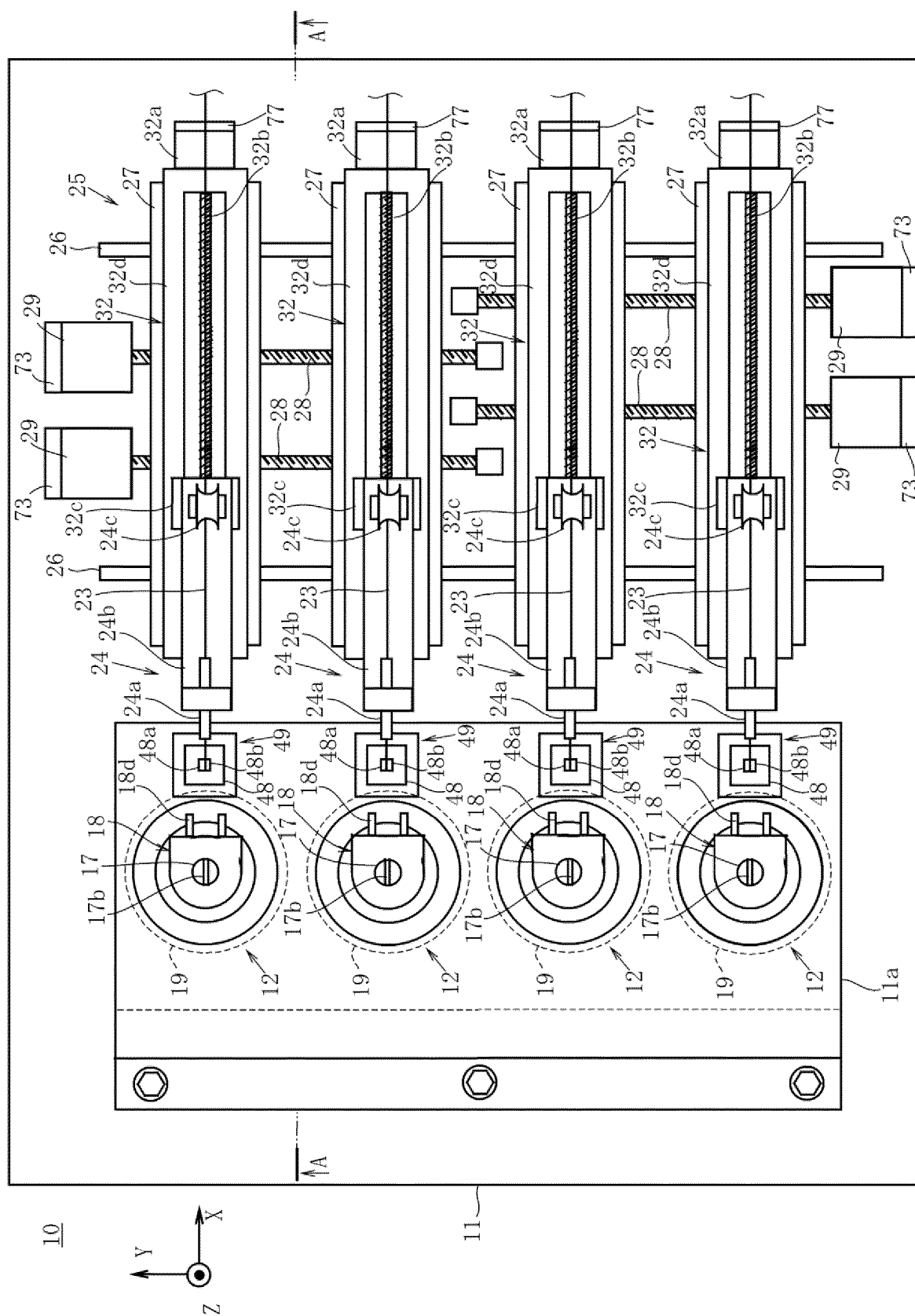
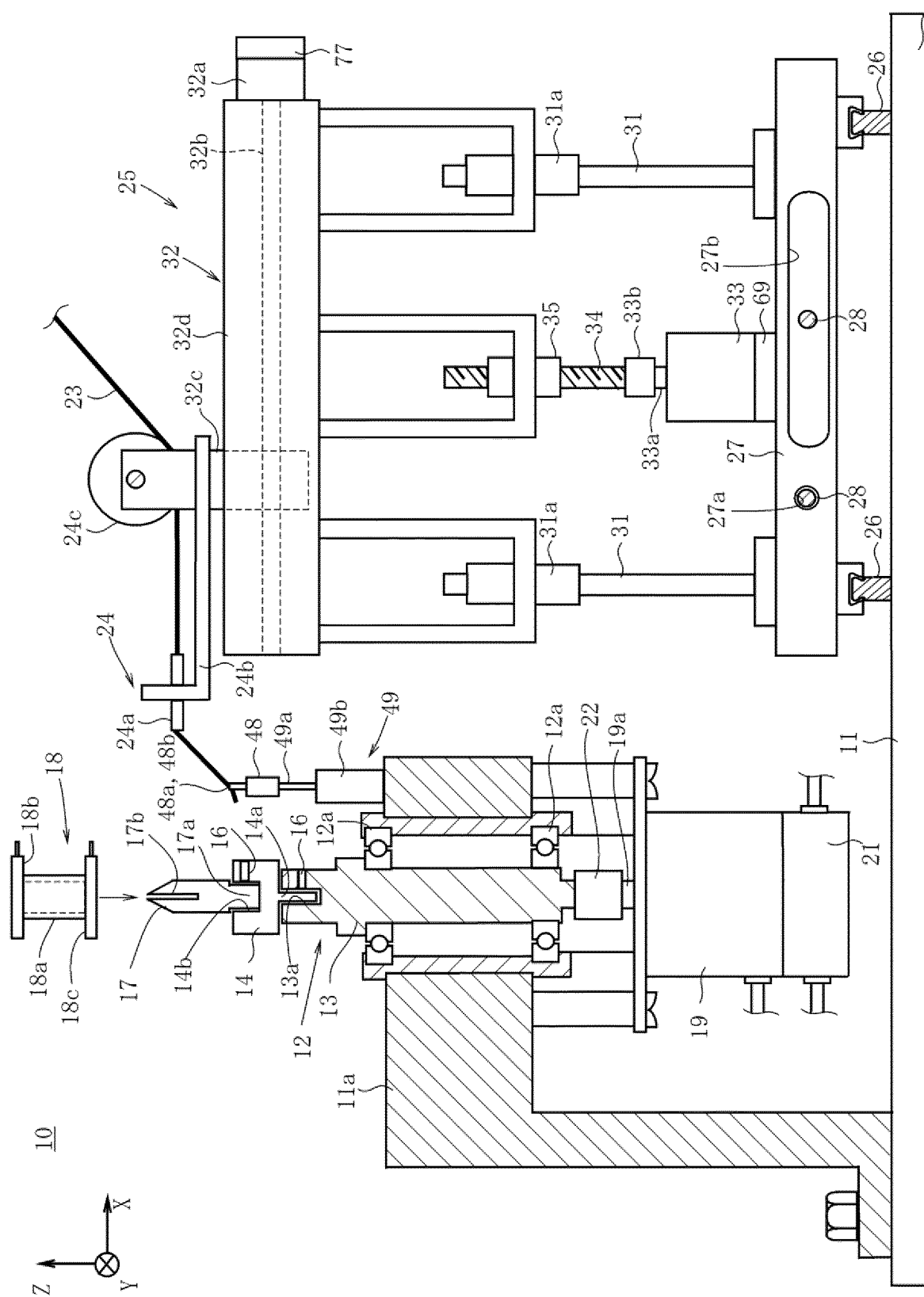


FIG. 1





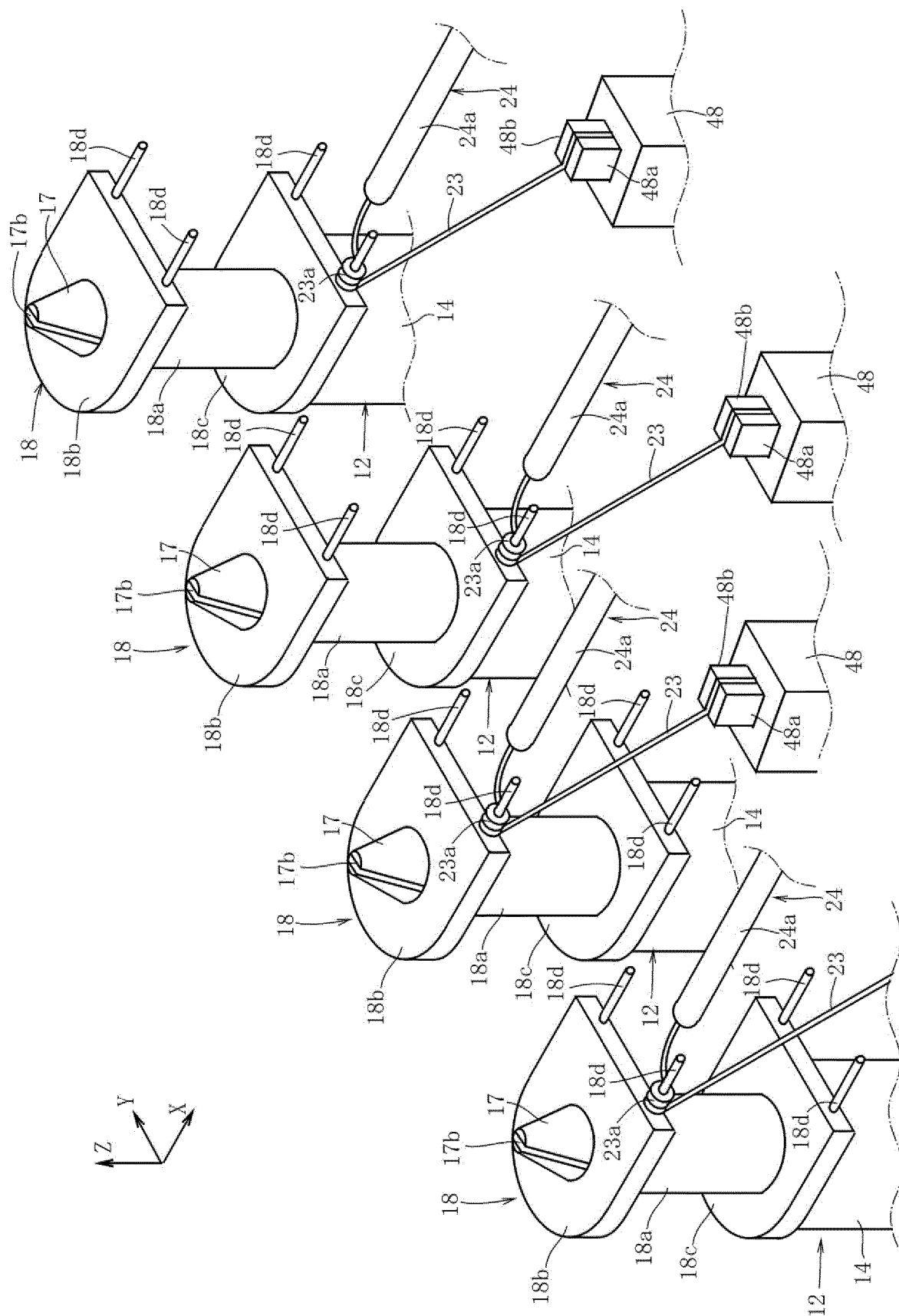


FIG. 4

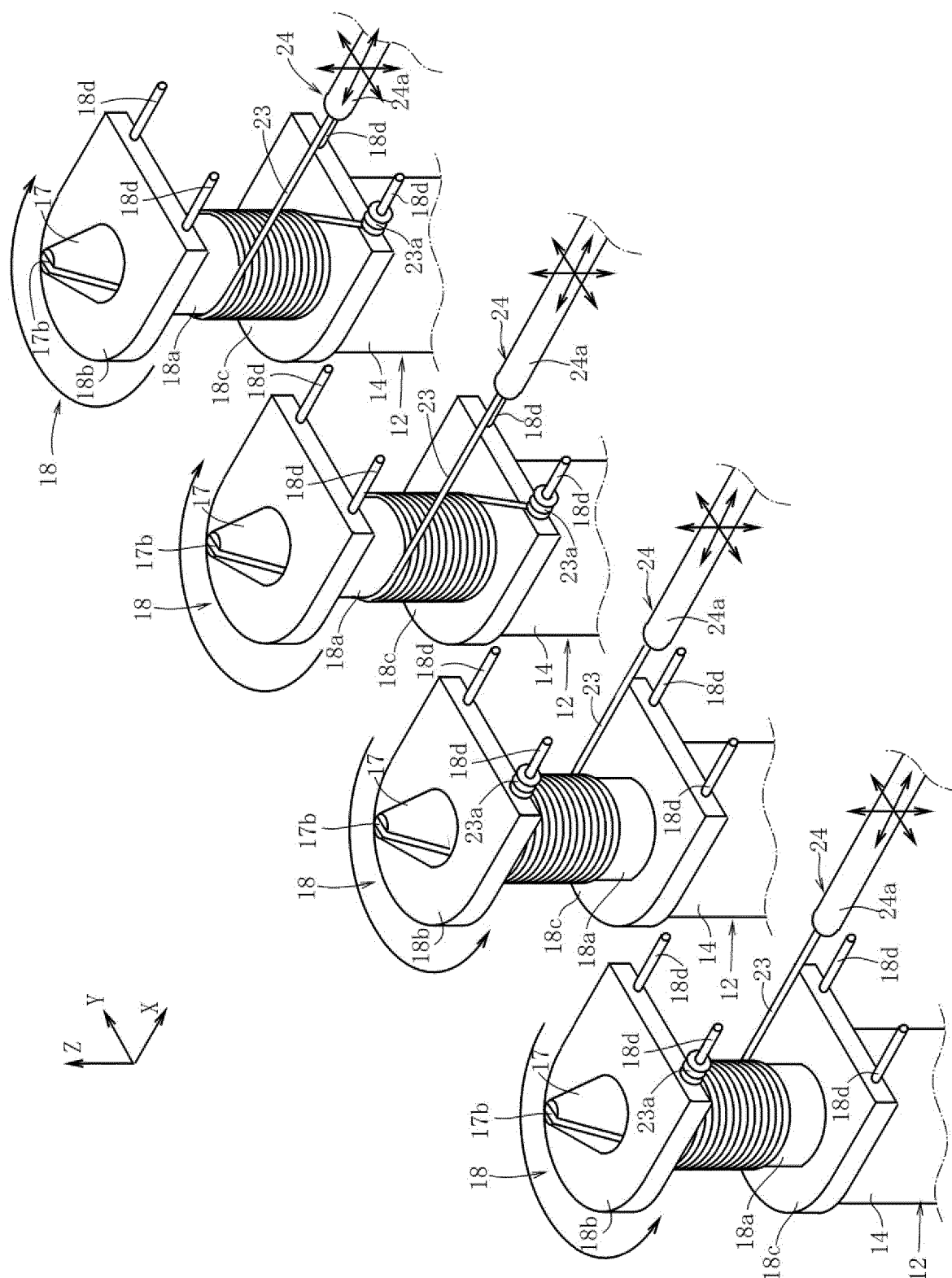


FIG. 5

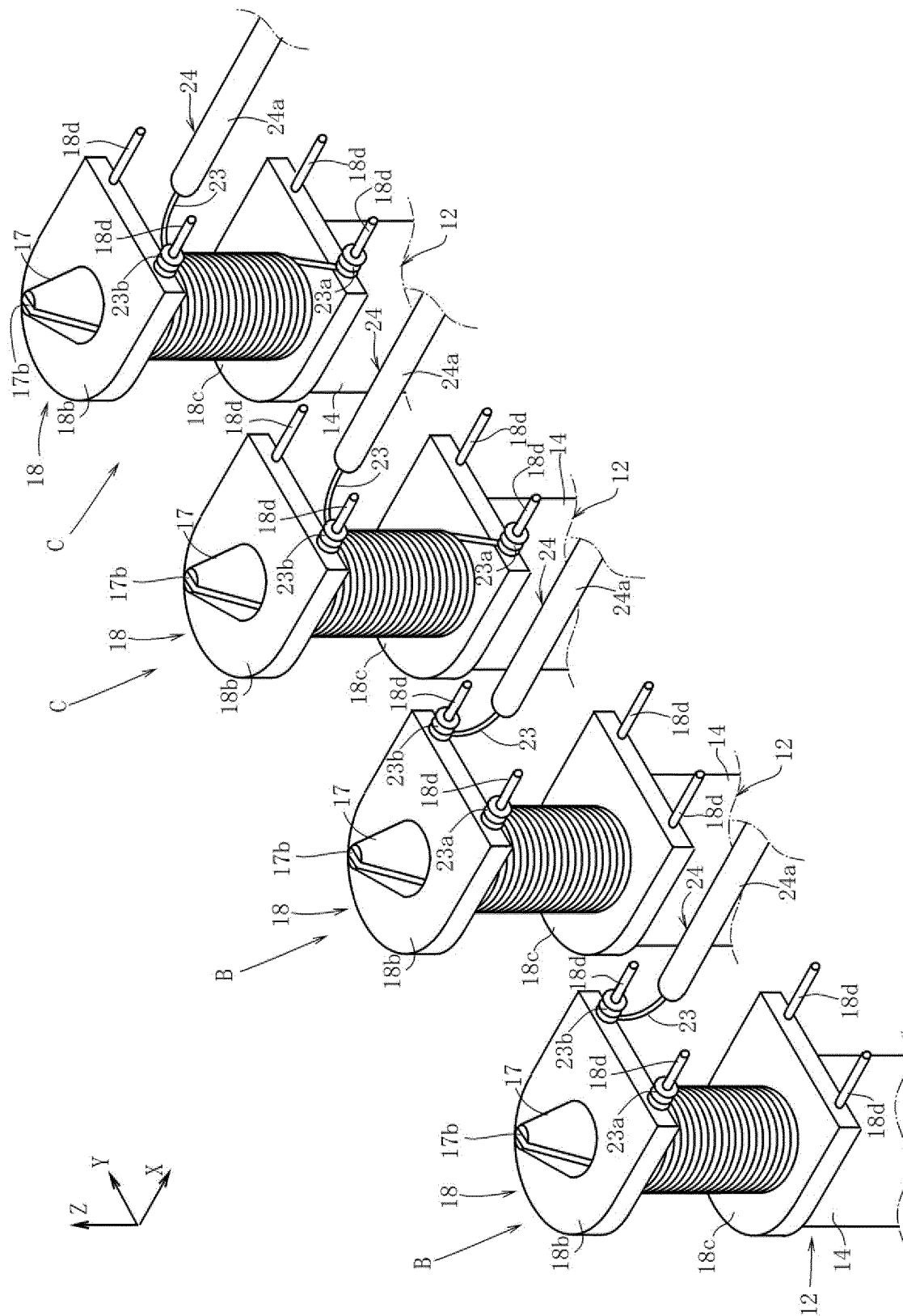


FIG. 6

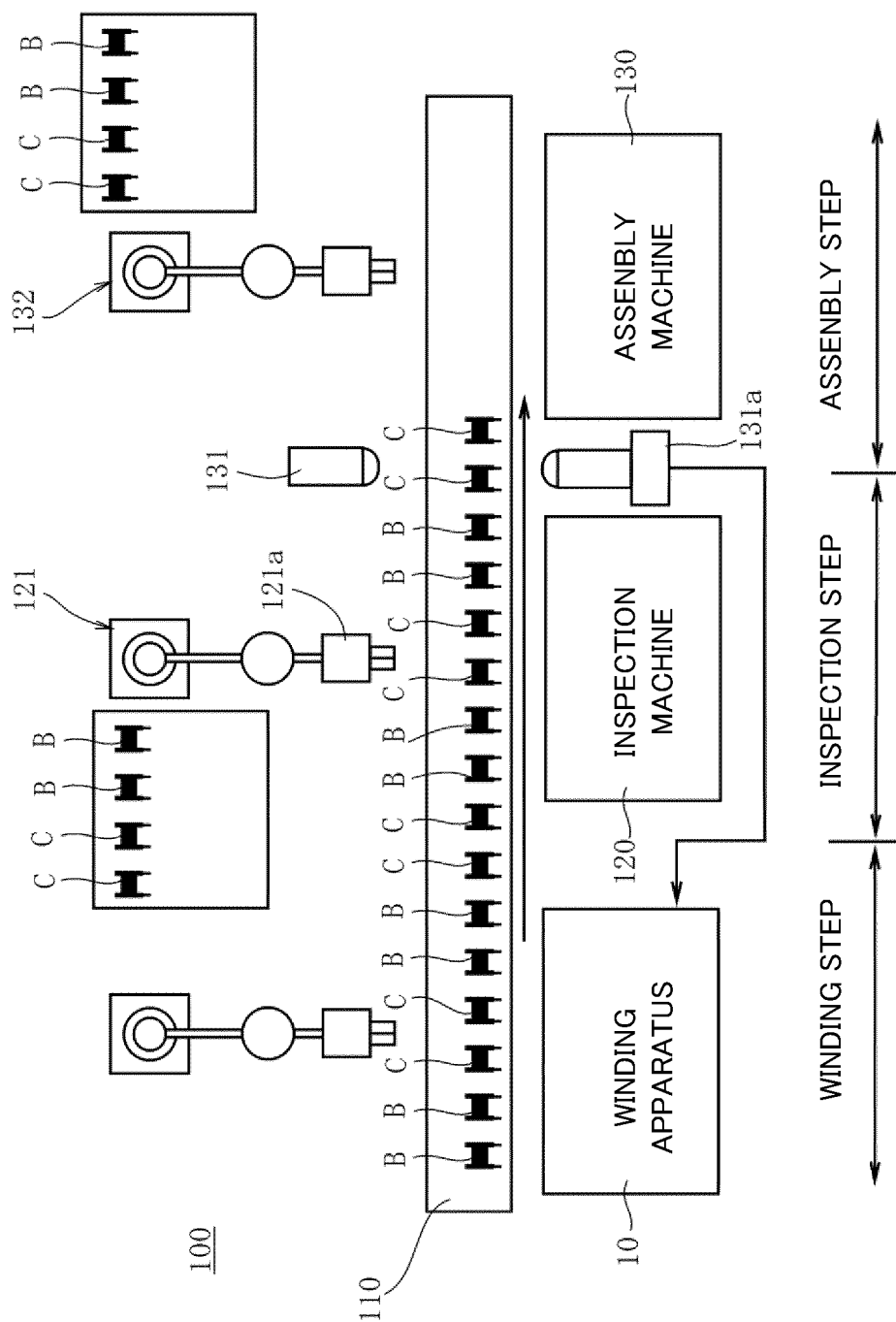


FIG. 7

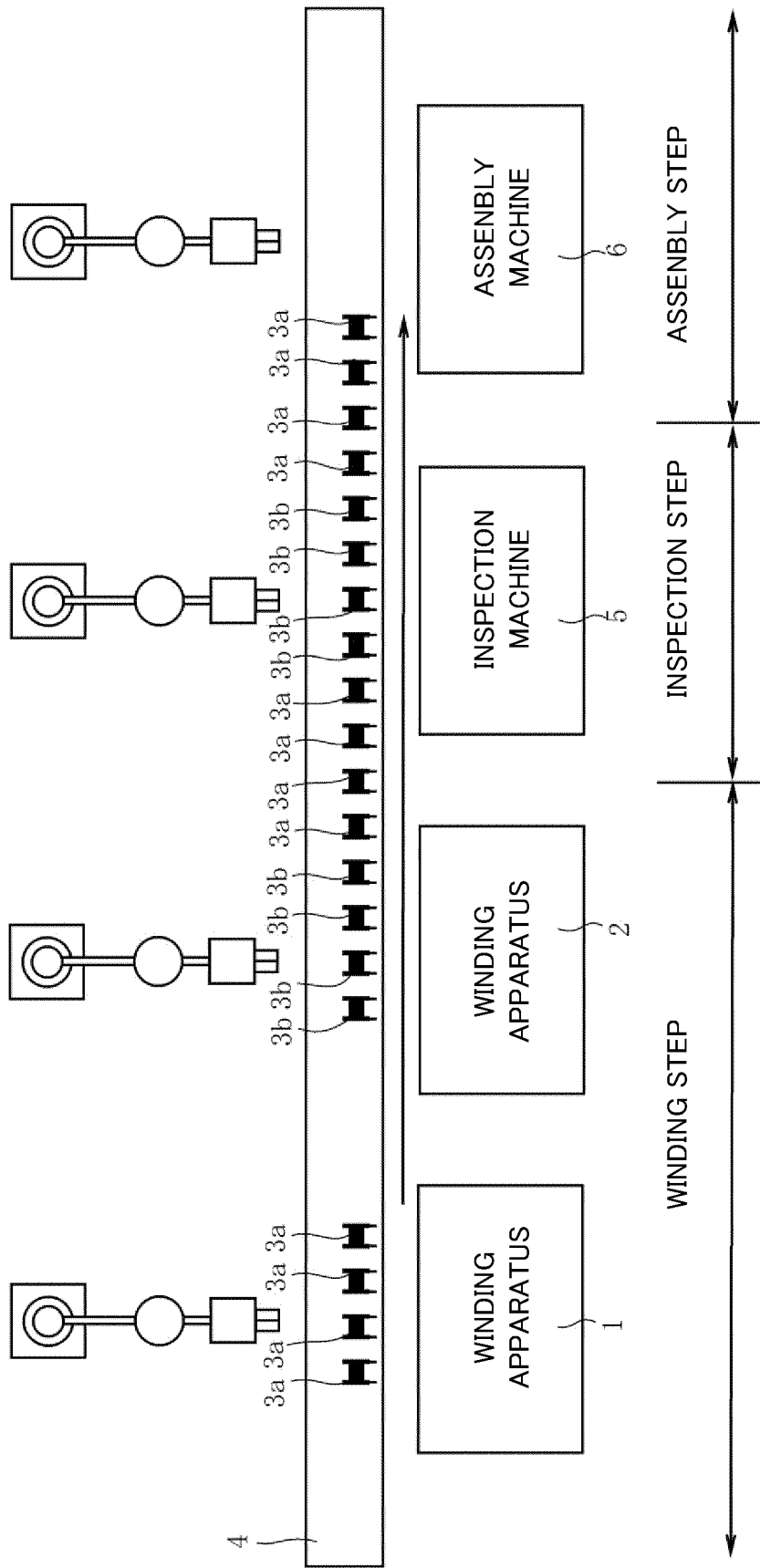


FIG.8

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2019/005912

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl. H01F41/04 (2006.01) i, B65H54/02 (2006.01) i, B65H54/32 (2006.01) i,
B65H54/34 (2006.01) i, B65H54/547 (2006.01) i, H01F41/06 (2016.01) i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int.Cl. H01F41/04, B65H54/02, B65H54/32, B65H54/34, B65H54/547, H01F41/06

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

Published examined utility model applications of Japan 1922-1996

Published unexamined utility model applications of Japan 1971-2019

Registered utility model specifications of Japan 1996-2019

Published registered utility model applications of Japan 1994-2019

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2001-230140 A (TDK CORPORATION) 24 August 2001, paragraphs [0005]-[0064], fig. 1-10 (Family: none)	6-7
Y		1-5
Y	JP 2002-43157 A (NITTOKU ENGINEERING CO., LTD.) 08 February 2002, paragraphs [0008]-[0104], fig. 1-15 & US 2002/0030134 A1, paragraphs [0015]-[0206], fig. 1-15 & EP 1174889 A2 & TW 530314 B & KR 10-2002-0008071 A & CN 1335630 A	1-5
Y	JP 2012-204414 A (MURATA MANUFACTURING CO., LTD.) 22 October 2012, paragraphs [0020]-[0029], fig. 1-2 & CN 102693833 A	1-5
Y	JP 55-128814 A (BROTHER INDUSTRIES, LTD.) 06 October 1980, page 4, upper left column, line 6 to page 5, upper right column, line 4, fig. 4-5 (Family: none)	1-2, 5



Further documents are listed in the continuation of Box C.



See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"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
29 March 2019 (29.03.2019)

Date of mailing of the international search report
09 April 2019 (09.04.2019)

Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2002043157 A [0004]