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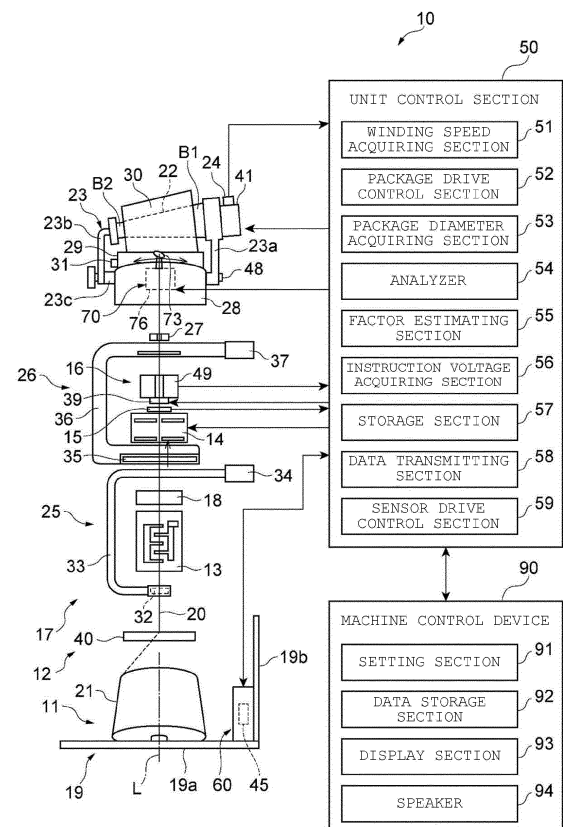
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(54) **YARN WINDING MACHINE**

(57) A winding unit (10) unwinds a yarn (20) from a cross-wound package (21) and winds the yarn (20) into a package (30). The winding unit (10) includes: an optical sensor (45) that is arranged on a side of the cross-wound package (21) and detects a yarn layer of the cross-wound package (21); and a sensor moving device (60) including a drive motor (61) that moves the optical sensor (45) in a predetermined moving direction (D2).

FIG. 2



Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a yarn winding machine.

2. Description of the Related Art

[0002] Conventionally, in a yarn unwinding device for a package, a technique of monitoring a winding diameter of the package by a plurality of optical sensors arranged to face a larger-diameter side end surface of the package is known (see Japanese Unexamined Patent Publication No. H4-85266).

[0003] The plurality of optical sensors are arranged in parallel in a radial direction of the larger-diameter side end surface of the package, and detect a position of an outer peripheral edge of a yarn layer. Thus, the winding diameter of the package is measured. In this device, a balloon length to reduce an unwinding tension is calculated based on the winding diameter of the package, and the balloon length is adjusted.

[0004] When the plurality of optical sensors are arranged aligned in the radial direction as in the conventional device described above, the package diameter can be detected exclusively in a plurality of stages corresponding to the number of sensors, since a position of each optical sensor has been determined. For example, in a configuration in which one inner layer sensor and one outer layer sensor are provided, the package diameter can be detected exclusively in three stages of an outer layer, a middle layer, and an inner layer. Therefore, in changing an unwinding speed (a winding speed) on the basis of the package diameter, three-stage speed change (adjustment) may be performed.

BRIEF SUMMARY OF THE INVENTION

[0005] With a limited number of stages of speed change (adjustment), there is also a limit to increasing a production speed. Therefore, an object of the present invention is to provide a yarn winding machine capable of widening a setting range of a production speed by more flexibly changing a speed.

[0006] The present invention relates to a yarn winding machine for unwinding a yarn from a cross-wound package around which a traversed yarn is wound, and winding the yarn into a wound package. The yarn winding machine includes: a yarn supplying section that holds the cross-wound package; an optical sensor that is arranged on a side of the cross-wound package held by the yarn supplying section and detects a yarn layer of the cross-wound package; and a sensor moving device including a driving source that moves the optical sensor in a radial direction of the cross-wound package held by the yarn

supplying section.

[0007] According to the yarn winding machine, the optical sensor is moved in a moving direction by the driving source of the sensor moving device. The optical sensor can be moved in the radial direction of the cross-wound package held by the yarn supplying section, in accordance with a change in diameter of the cross-wound package. Therefore, a winding speed of the yarn can be more flexibly changed in accordance with a diameter of the cross-wound package. As a result, a setting range of the production speed can be widened.

[0008] The yarn winding machine may further include a sensor drive control section that controls the driving source of the sensor moving device on the basis of detection information of the yarn layer obtained by the optical sensor. In this case, the optical sensor can be moved more accurately and appropriately in response to a change in diameter of the cross-wound package.

[0009] The yarn winding machine may further include: a package diameter acquiring section that acquires a length change in the radial direction of the cross-wound package on the basis of detection information of the yarn layer obtained by the optical sensor; and a storage section that stores a relationship between a length in the radial direction of the cross-wound package acquired by the package diameter acquiring section and an index related to winding of the yarn in the yarn winding machine. In this case, the relationship between the length change of the cross-wound package in the radial direction and the index related to winding of the yarn can be provided or notified to the user, and convenience in production of the yarn winding machine is enhanced.

[0010] The yarn winding machine may further include an instruction voltage acquiring section that acquires an instruction voltage as an index in a tension applying device that applies a tension on the yarn, and the storage section may store a relationship between a diameter of the cross-wound package acquired by the package diameter acquiring section and an instruction voltage in the tension applying device acquired by the instruction voltage acquiring section. In this case, the tension applied on the yarn by the tension applying device can be grasped in accordance with a diameter of the cross-wound package. For example, reference data for a user to determine a tension set value is provided.

[0011] The yarn winding machine may further include a factor estimating section that estimates a yarn breakage factor of the yarn as an index, and the storage section may store a relationship between a diameter of the cross-wound package acquired by the package diameter acquiring section and a yarn breakage factor of the yarn estimated by the factor estimating section. The relationship between the diameter of the cross-wound package and the yarn breakage factor is provided to the user, and any control setting (for example, lot setting and the like) in winding of the yarn becomes possible.

[0012] The yarn winding machine may further include a package diameter acquiring section that acquires a di-

iameter of the cross-wound package on the basis of detection information of a yarn layer obtained by the optical sensor; and a winding speed control section that controls a winding speed of the yarn on the basis of a diameter of the cross-wound package acquired by the package diameter acquiring section. In this case, an unwinding speed (a winding speed) can be flexibly changed on the basis of a diameter of the cross-wound package, and a production speed can be improved.

[0013] The sensor moving device may move the optical sensor in the moving direction orthogonal to a travelling direction of the yarn. The diameter of the cross-wound package changes in a direction orthogonal to the travelling direction of the yarn. Therefore, by the optical sensor being moved by the sensor moving device, the optical sensor can easily follow a change in diameter of the cross-wound package.

[0014] The driving source may be a stepping motor. According to this configuration, a position of the optical sensor can be reliably controlled with a simpler configuration.

[0015] According to the present invention, a setting range of a production speed can be widened by more flexibly changing a winding speed of the yarn.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016]

FIG. 1 is a front view of an automatic winder including a winding unit according to an embodiment of the present invention;

FIG. 2 is a schematic view and a block diagram illustrating a schematic configuration of the winding unit in FIG. 1;

FIG. 3 is a view illustrating a configuration example of an optical sensor installed on a side of a cross-wound package and a sensor moving device;

FIG. 4 is a view for explaining a movement of the optical sensor according to a change in diameter of the cross-wound package;

FIG. 5 is a view illustrating speed control in a unit control section in comparison with conventional speed control;

FIG. 6 is a view illustrating an example of a relationship between a package diameter and an instruction voltage displayed on a display section of a machine control device; and

FIG. 7 is a view illustrating an example of a yarn breakage occurrence tendency with respect to a package diameter displayed on the display section of the machine control device.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0017] An embodiment of the present invention will be hereinafter described with reference to the drawings. In

the description of the drawings, the same reference numerals are given for the same elements, and redundant explanations are omitted.

[0018] With reference to FIG. 1, an overall configuration of an automatic winder 1 including a winding unit (a yarn winding machine) 10 of the present embodiment will be described. In the present specification, "upstream" and "downstream" respectively refer to upstream and downstream in a travelling direction of a yarn at the time of yarn winding.

[0019] As illustrated in FIG. 1, the automatic winder 1 includes a plurality of winding units 10 arranged side by side, an automatic doffing device 80, and a machine control device 90 as main configurations. As a conventional automatic winder, there is a structure of unwinding a yarn of a yarn supplying bobbin on which a yarn spun by a ring spinning machine is wound to be layered sequentially from one side of a bobbin tube, and winding an unwound yarn 20 around a winding bobbin 22 while traversing. There is also an automatic winder of a type in which the yarn 20 unwound from a cross-wound package 21 is rewound around the winding bobbin 22 (see FIG. 2) while being traversed to form a cross-wound package (a wound package) 30 again. The present invention is intended for the latter automatic winder. Each winding unit 10 of the present invention winds the yarn 20 unwound from the cross-wound package 21 around the winding bobbin 22 (see FIG. 2) while traversing the yarn to form the package (the wound package) 30. Note that "Traverse" refers to applying reciprocal motion to the yarn being wound. The package 30 is a cross-wound package. The automatic winder 1 is, for example, a rewinding machine that forms the conical package 30 from the conical cross-wound package 21.

[0020] When the package 30 is fully wound (a full tube) in each winding unit 10, the automatic doffing device 80 travels to a position of the winding unit 10, discharges the fully-wound package 30 from the winding unit 10, and supplies an empty bobbin to the winding unit 10.

[0021] The machine control device 90 includes a setting section 91, a data storage section 92, a display section 93, and a speaker 94. The setting section 91 enables an operator to input a predetermined set value or select an appropriate control method to carry out setting with respect to each winding unit 10. The predetermined set value inputted to the setting section 91 by the operator includes bobbin information for specifying a type (a shape) of the winding bobbin 22 on which the yarn 20 is to be wound. Note that the bobbin information is not limited to being specified by the operator directly inputting the type of the winding bobbin 22 to be used. For example, when the type of the winding bobbin 22 to be used is determined in accordance with a type of the yarn 20 to be wound, the bobbin information may be specified from the type of the yarn 20 inputted by the operator.

[0022] In addition, the setting section 91 receives settings of various control modes to be described later. The various control modes are inputted by the operator. The

setting section 91 sets the control mode inputted by the operator for each winding unit 10. As illustrated in FIG. 2, control by the unit control section 50 is carried out to allow each winding unit 10 to operate in accordance with the set control mode. The data storage section 92 stores, for example, data indicating a relationship between a diameter of the cross-wound package 21 and an index related to winding of the yarn in the winding unit 10. The data stored in the data storage section 92 is notified to the user with use of the display section 93, the speaker 94, or the like. The display section 93 is configured to be able to display winding status of the yarn 20 in each winding unit 10, content of trouble that has occurred, and the like. The display section 93 displays information related to data stored in the data storage section 92, for example, information on a yarn breakage frequency corresponding to a diameter of the cross-wound package 21 and information on an instruction voltage of a tension applying device 13. Note that the display section 93 may be configured by a touch panel, and the setting section 91 may be included in the display section 93. The speaker 94 notifies of, by sound, information related to data displayed on the display section 93, for example, information on a yarn breakage frequency corresponding to a diameter of the cross-wound package 21 and information on an instruction voltage of the tension applying device 13.

[0023] The display section 93 displays, for example, a relationship between a diameter of the cross-wound package 21 and an index related to winding of the yarn in the winding unit 10. A display example of this will be described later with reference to FIGS. 6 and 7. The speaker 94 may notify the user of, for example, a diameter of the cross-wound package 21 in which a yarn breakage is likely to occur, by sound.

[0024] Next, with reference to FIG. 2, a description will be specifically made on a configuration of the winding unit 10. Each winding unit 10 includes a winding unit main body 17 and the unit control section 50 as main configurations, as illustrated in FIG. 2.

[0025] The unit control section 50 includes, for example, a CPU, a RAM, a ROM, an I/O port, and a communication port. The ROM stores a program for controlling each configuration of the winding unit main body 17. To the I/O port and the communication port, each section (details will be described later) of the winding unit main body 17 and the machine control device 90 are connected, and are configured to be able to communicate control information and the like. This allows the unit control section 50 to control an operation of each section of the winding unit main body 17.

[0026] The winding unit main body 17 includes, on a yarn travelling path between the cross-wound package 21 and a touch roller 29, a yarn unwinding assisting device 12, the tension applying device 13, a yarn joining device 14, a photoelectric fixed length device (a yarn speed detecting section) 15, and a yarn monitoring device 16 in this order from the cross-wound package 21 side. A yarn supplying section 11 is arranged at a lower

part of the winding unit main body 17.

[0027] The yarn supplying section 11 is configured to be able to hold, at a predetermined position, the cross-wound package 21 conveyed by an operator or by a bobbin conveyance system (not illustrated). A core member (not illustrated) is arranged upright toward a direction of a central axis L slightly inclined with respect to a horizontal plane, for example, on a mounting plate 19a of a mounting table 19 located at a lower end of the winding unit 10. By inserting the core member into a hole portion at a center of the cross-wound package 21, the cross-wound package 21 maintains a predetermined orientation (see FIGS. 2 and 3). The yarn is unwound by the winding unit 10 while the cross-wound package 21 maintains this orientation.

[0028] The yarn unwinding assisting device 12 includes a regulating member 40 arranged above a core tube of the cross-wound package 21, and assists unwinding of the yarn 20 from the cross-wound package 21 by changing an unwinding tension of the yarn 20 from the cross-wound package 21. The regulating member 40 assists unwinding of the yarn 20 by contacting with a balloon of the yarn 20 formed at an upper part of the cross-wound package 21 by rotation and a centrifugal force of the yarn 20 unwound from the cross-wound package 21, and controlling the balloon of the yarn 20 to an appropriate size. The regulating member 40 is also called a balloon guide. Near the regulating member 40, a kink preventer that inhibits twisting of the yarn 20, a lower yarn sensor that detects a lower yarn, and the like are arranged.

[0029] The tension applying device 13 applies a predetermined tension on the travelling yarn 20. The tension applying device 13 may be a gate-type tension applying device in which movable comb teeth are arranged with respect to fixed comb teeth. The movable comb teeth are swung by a rotary solenoid so that the movable comb teeth are engaged with or released from the fixed comb teeth. Note that a disc-type tension applying device, for example, may be adopted instead of the gate-type tension applying device 13 described above. The unit control section 50 determines an instruction voltage to be transmitted to the tension applying device 13, in consideration of an actual tension measurement value measured by a tension measuring device 18. The instruction voltage to be transmitted to the tension applying device 13 is also transmitted to an instruction voltage acquiring section 56 of the unit control section 50.

[0030] When the yarn monitoring device 16 detects a yarn defect and cuts the yarn, the yarn joining device 14 joins a lower yarn from the cross-wound package 21 and an upper yarn from the package 30 when the yarn being unwound from the cross-wound package 21 breaks, or the like. Such a yarn joining device that joins the upper yarn and the lower yarn may be a mechanical knotter, or may be a splicer using a fluid such as compressed air, or the like. Alternatively, a configuration can be adopted in which the yarn joining device 14 is not provided and the upper yarn and the lower yarn are joined manually

by the operator.

[0031] The photoelectric fixed length device 15 is a fixed length device of a non-contact photoelectric type, and detects a yarn speed, which is a travelling speed of the yarn 20, without touching the yarn 20. Specifically, the photoelectric fixed length device 15 detects the yarn speed of the yarn 20 to be wound around the winding bobbin (the bobbin) 22 or the package 30, by projecting the yarn 20 on a light receiving element and processing a change in photocurrent generated when the projected yarn 20 travels by using a so-called spatial filter principle.

[0032] The yarn monitoring device 16 includes a head 49 arranged with a sensor (not illustrated) for detection of a thickness of the yarn 20, and an analyzer 54 that processes a yarn thickness signal from this sensor. The analyzer 54 is provided in the unit control section 50. The yarn monitoring device 16 detects a yarn defect such as slub by monitoring a yarn thickness signal from the sensor described above. Near the head 49, there is provided a cutter 39 that immediately cuts the yarn 20 when the yarn monitoring device 16 detects a yarn defect.

[0033] A lower yarn catching member 25 adapted to catch a yarn end of the lower yarn and guide the yarn end to the yarn joining device 14 is arranged below the yarn joining device 14. An upper yarn catching member 26 adapted to catch a yarn end of the upper yarn and guide the yarn end to the yarn joining device 14 is arranged above the yarn joining device 14. The lower yarn catching member 25 includes a lower yarn pipe arm 33, and a lower yarn suction port 32 formed at a distal end of the lower yarn pipe arm 33. The upper yarn catching member 26 includes an upper yarn pipe arm 36, and an upper yarn suction port 35 formed at a distal end of the upper yarn pipe arm 36.

[0034] The lower yarn pipe arm 33 and the upper yarn pipe arm 36 are configured to be swingable about a shaft 34 and a shaft 37, respectively. An appropriate negative pressure source is connected to the lower yarn pipe arm 33 and the upper yarn pipe arm 36. The lower yarn pipe arm 33 is configured to generate a suction flow at the lower yarn suction port 32 to suck and catch the yarn end of the lower yarn. The upper yarn pipe arm 36 is configured to generate a suction flow at the upper yarn suction port 35 to suck and catch the yarn end of the upper yarn. A shutter (not illustrated) is respectively arranged at each of a basal end side of the lower yarn pipe arm 33 and a basal end side of the upper yarn pipe arm 36. Each shutter is opened/closed in accordance with a signal from the unit control section 50. Stop and generation of the suction flow from the lower yarn suction port 32 and the upper yarn suction port 35 are thereby controlled.

[0035] The winding unit main body 17 further includes a cradle 23 that removably and rotationally holds the winding bobbin 22, and the touch roller 29 rotatable while making contact with an outer peripheral surface of the winding bobbin 22 or an outer peripheral surface of the package 30. The winding bobbin 22 has a conical (a truncated cone) shape having different diameters at both

ends. The winding unit main body 17 includes an arm-type traverse device 70 adapted to traverse the yarn 20 near the cradle 23, and winds the yarn 20 into the winding bobbin 22 or the package 30 while traversing the yarn 20 with the traverse device 70. A guide plate 28 is arranged slightly upstream of a traverse area. The guide plate 28 guides the yarn 20 located upstream to the traverse area. A traverse fulcrum 27 made of ceramics is arranged further upstream of the guide plate 28. The traverse device 70 traverses the yarn 20 in a direction indicated with an arrow in FIG. 2 with this traverse fulcrum 27 as a center.

[0036] The winding unit main body 17 forms the conical package 30 by winding the yarn 20 around the conical winding bobbin 22 while traversing the yarn 20 with the traverse device 70.

[0037] The traverse device 70 includes a traverse drive motor 76 that reciprocates a traverse arm (not illustrated). The traverse drive motor 76 is configured by, for example, a servo motor or the like. An operation of the traverse drive motor 76 is controlled by the unit control section 50. The traverse drive motor 76 may be other motors such as a step motor or a voice coil motor. A hook-shaped yarn guide section 73 is formed at a distal end of the traverse arm. The traverse device 70 can traverse the yarn 20 to be wound around the package 30 by reciprocating the traverse arm (moving the yarn guide section 73) with the yarn guide section 73 guiding the yarn 20.

[0038] The touch roller 29 comes into contact with an outer peripheral surface of the winding bobbin 22 or the package 30, and is driven to rotate with rotation of the winding bobbin 22 or the package 30. The touch roller 29 has a cylindrical shape having the same diameter at both ends. An outer peripheral surface of the package 30 is pressed against the touch roller 29. The touch roller 29 has a function of adjusting a shape of the package 30. Further, the touch roller 29 has a function of holding the traversed yarn 20 at a traversed position and winding the yarn into the package 30. The touch roller 29 is provided with a rotation speed sensor 31 that detects a rotation speed of the touch roller 29. The rotation speed sensor 31 transmits a rotation detection signal corresponding to the rotation speed of the touch roller 29, to the unit control section 50. As the rotation speed sensor 31, various sensors such as a sensor that measures a change in magnetism of a magnet attached to the touch roller 29 can be used.

[0039] The cradle 23 includes a pair of a first cradle arm 23a and a second cradle arm 23b, and a connecting section 23c that connects a proximal end portion of the first cradle arm 23a and a proximal end portion of the second cradle arm 23b. The cradle 23 is configured to be swingable about a swing shaft 48 provided in the connecting section 23c. An increase in diameter of the package 30 accompanying winding of the yarn 20 around the winding bobbin 22 can be absorbed by the swinging of the cradle 23.

[0040] At a distal end portion of the first cradle arm

23a, a first bobbin holding section B1 that holds one end portion of the winding bobbin 22 is arranged. At a distal end portion of the second cradle arm 23b, a second bobbin holding section B2 that holds another end portion of the winding bobbin 22 is arranged. Further, to the distal end portion of the first cradle arm 23a, a package drive motor 41 configured by a servo motor is attached. The package drive motor 41 rotatably drives the winding bobbin 22 held by the first bobbin holding section B1 and the second bobbin holding section B2, to wind the yarn 20 around the winding bobbin 22. The package drive motor 41 rotatably drives the package 30 in forward rotation of rotating the package 30 (the winding bobbin 22) in a winding direction and in reverse rotation of rotating the package 30 in an unwinding direction, which is a direction opposite to the winding direction. A motor shaft (a rotational axis) of the package drive motor 41 is connected to the first bobbin holding section B1 that holds the winding bobbin 22 so as to be relatively non-rotatable. The package drive motor 41 rotates the winding bobbin 22 by rotating the first bobbin holding section B1 (a so-called direct drive system).

[0041] The operation of the package drive motor 41 is controlled by a package drive control section 52 of the unit control section 50. The package drive motor 41 is not limited to the servo motor, and various types of motors such as a step motor and an induction motor can be adopted. The package drive motor 41 is provided with a rotation speed sensor 24 that detects a rotation speed of the motor shaft of the package drive motor 41. The rotation speed sensor 24 transmits a rotation detection signal corresponding to the rotation speed of the motor shaft, to a winding speed acquiring section 51 of the unit control section 50.

[0042] Each winding unit 10 includes one optical sensor 45 arranged on a side of the cross-wound package 21 to detect a yarn layer of the cross-wound package 21, and a sensor moving device 60 that holds the optical sensor 45 and moves the optical sensor 45 in a moving direction D2. FIG. 3 is a view illustrating a configuration example of the optical sensor 45 installed on a side of the cross-wound package 21 and the sensor moving device 60. As illustrated in FIG. 3, the optical sensor 45 includes a light projecting/receiving section 45a that faces an outer peripheral surface of the cross-wound package 21. The optical sensor 45 detects absence of the yarn layer of the cross-wound package 21 by detecting reflected light from the cross-wound package 21 with the light projecting/receiving section 45a. The optical sensor 45 detects presence of the yarn layer of the cross-wound package 21 on an optical path of the light projecting/receiving section 45a, by detecting reflected light from the cross-wound package 21 with the light projecting/receiving section 45a.

[0043] The sensor moving device 60 is configured to move the optical sensor 45 in the moving direction D2 orthogonal to a travelling direction D1 of the yarn 20. The travelling direction D1 of the yarn 20 may be, for example,

parallel to the central axis L of the cross-wound package 21. The moving direction D2 of the optical sensor 45 by the sensor moving device 60 may be parallel to a radial direction of the cross-wound package 21 attached to the mounting table 19. That is, the moving direction D2 of the optical sensor 45 is parallel to the radial direction of the cross-wound package 21.

[0044] The sensor moving device 60 is configured to move the optical sensor 45 by, for example, a ball screw structure. As an example, the sensor moving device 60 includes: a housing 62 fixed to the mounting plate 19a and/or a side plate 19b of the mounting table 19; a threaded shaft 63 fixed in the housing 62 and extending in the moving direction D2; and a moving section 64 that includes a nut section 64a to be meshed with the threaded shaft 63 and is movable in the moving direction D2 with rotation of the threaded shaft 63. For example, the optical sensor 45 is fixed on the moving section 64. The moving section 64 is arranged downstream (above) of the optical sensor 45 in the travelling direction D1 of the yarn 20, and a sliding plate section 67 is arranged upstream (below) of the optical sensor 45 in the travelling direction D1 of the yarn 20. In other words, the optical sensor 45 is provided between the moving section 64 and the sliding plate section 67. The sliding plate section 67 is, for example, an L-shaped plate-shaped member, and is slidable along a corner portion of a rectangular guide section 65 extending in the moving direction D2. A guide bar insertion section 68 is fixed to the sliding plate section 67, and a guide bar 66 is inserted into the guide bar insertion section 68. The threaded shaft 63 and the guide bar 66 extend in parallel (in the moving direction D2), and a linear movement region of the optical sensor 45 is located between the threaded shaft 63 and the guide bar 66. The moving section 64, the sliding plate section 67, and the guide bar insertion section 68 are guided by the threaded shaft 63, the guide section 65, and the guide bar 66, to move in the moving direction D2 while holding the optical sensor 45.

[0045] The sensor moving device 60 includes a drive motor 61 connected to any one end portion of the threaded shaft 63. The drive motor 61 is, for example, a stepping motor. The drive motor 61 is fixed to the housing 62, and is controlled by a sensor drive control section 59 of the unit control section 50 to rotate the threaded shaft 63. The drive motor 61 is a driving source that moves the optical sensor 45 in the moving direction D2. The drive motor 61 may be a stepping motor, a servo motor, or the like.

[0046] Returning to FIG. 2, in addition to the analyzer 54 described above, the unit control section 50 further includes the winding speed acquiring section 51, the package drive control section 52, a package diameter acquiring section 53, a factor estimating section 55, the instruction voltage acquiring section 56, a storage section 57, a data transmitting section 58, and the sensor drive control section 59.

[0047] The winding speed acquiring section 51 ac-

quires a winding speed of the yarn 20 by acquiring a signal transmitted from the rotation speed sensor 24 of the package drive motor 41. In the winding unit 10, the winding speed of the yarn 20 is equal to an unwinding speed of the yarn 20 from the cross-wound package 21.

[0048] The package drive control section (the winding speed control section) 52 controls the package drive motor 41 on the basis of a diameter of the cross-wound package 21 acquired by the package diameter acquiring section 53, to control the winding speed of the yarn 20. The package drive control section 52 controls the package drive motor 41 such that the winding speed of the yarn 20 is adjusted to a speed indicated in a predetermined control mode in accordance with the diameter of the cross-wound package 21. Alternatively, the package drive control section 52 may store an appropriate winding speed in advance, on the basis of a diameter of the cross-wound package 21 or an unwinding tension estimated on the basis of a diameter of the cross-wound package 21. The package drive control section 52 may control the package drive motor 41 such that the winding speed of the yarn 20 is adjusted to an appropriate winding speed.

[0049] The package diameter acquiring section 53 acquires a diameter of the cross-wound package 21 on the basis of detection information of a yarn layer of the cross-wound package 21 obtained by the optical sensor 45. The optical sensor 45 may be subjected to movement control to repeatedly stop and slightly move by, for example, the sensor drive control section 59, and acquire a diameter of the cross-wound package 21 when absence of the yarn layer is detected by the optical sensor 45, by not detecting reflected light from the cross-wound package 21 with the light projecting/receiving section 45a.

[0050] When a yarn breakage occurs, the factor estimating section 55 estimates whether a factor of the yarn breakage is caused by a yarn defect (a weak yarn, yarn unevenness, or the like) or an unwinding defect (sloughing or the like), for example, on the basis of a signal outputted from the yarn monitoring device 16. The factor estimating section 55 estimates and stores the yarn breakage factor in correspondence with a diameter of the cross-wound package 21 acquired by the package diameter acquiring section 53.

[0051] The instruction voltage acquiring section 56 acquires an instruction voltage in the tension applying device 13. The instruction voltage in the tension applying device 13 is stored in correspondence with a diameter of the cross-wound package 21 acquired by the package diameter acquiring section 53.

[0052] The storage section 57 generates and stores data indicating a relationship between a diameter of the cross-wound package 21 and an index related to winding of the yarn in the winding unit 10, in accordance with the control mode described above. The data transmitting section 58 transmits the data stored in the storage section 57 to the machine control device 90, and causes the data storage section 92 to store the data.

[0053] The sensor drive control section 59 controls the drive motor 61 of the sensor moving device 60 on the basis of detection information obtained by the optical sensor 45. The sensor drive control section 59 controls the drive motor 61 to perform movement control of the optical sensor 45 such that the optical sensor 45 repeats slight movement and stop. More specifically, the sensor drive control section 59 may control the optical sensor 45 to slightly move when absence of a yarn layer is detected by the optical sensor 45. The sensor drive control section 59 may gradually move the optical sensor 45 when the yarn layer of the cross-wound package 21 is no longer detected. As illustrated in FIG. 4, the optical sensor 45 is located at a position corresponding to a yarn layer position Pa of an outermost layer in a cross-wound package 21A when a diameter is large at an initial stage of unwinding, but the cross-wound package 21 becomes thinner as unwinding of the yarn 20 proceeds. Since the cross-wound package 21 is a cross-wound package, the diameter thereof decreases while the conical shape is maintained. When the optical sensor 45 no longer detects the yarn layer position Pa, the optical sensor 45 is controlled to approach the central axis L in a side view. The optical sensor 45 is moved to a position corresponding to a yarn layer position Pb of an outermost layer in a cross-wound package 21B when a diameter is small.

[0054] According to the winding unit 10 of the present embodiment, the optical sensor 45 is moved in the moving direction D2 by the drive motor 61 of the sensor moving device 60. The optical sensor 45 can be moved in accordance with a change in diameter of the cross-wound package 21. Therefore, a winding speed of the yarn 20 can be more flexibly changed in accordance with the diameter of the cross-wound package 21. As a result, a setting range of the production speed can be widened.

[0055] The winding unit 10 further includes: the package diameter acquiring section 53 that acquires a diameter of the cross-wound package 21 on the basis of detection information of a yarn layer obtained by the optical sensor 45; and the package drive control section 52 that controls a winding speed of the yarn 20 on the basis of a diameter of the cross-wound package 21 acquired by the package diameter acquiring section 53. Therefore, an unwinding speed (a winding speed) can be flexibly changed on the basis of a diameter of the cross-wound package 21, and a production speed can be improved. Accordingly, a setting range of the production speed can be widened.

[0056] A specific example of the winding speed will be described with reference to FIG. 5. In FIG. 5, speed control in a conventional unit control section is indicated by a thick broken line, and speed control in the unit control section 50 of the present embodiment is indicated by a thick solid line. Conventionally, for example, when two optical sensors fixed at positions of two locations in a radial direction are used, control to switch a winding speed has been performed at two points of a timing (time T₁ in the figure) at which an outer layer sensor switches

from on to off and a timing (time T_2 in the figure) at which an inner layer sensor switches from on to off. Note that, unwinding is performed at a low speed V_0 until time T_0 . That is, unwinding has been performed at a relatively low speed V_1 as an outer layer speed from the time T_0 to the time T_1 , unwinding has been performed at a high speed V_2 as an intermediate layer speed from the time T_1 to the time T_2 , and unwinding has been performed at a relatively low speed V_3 as an outer layer speed from the time T_2 until approaching an end of unwinding. Whereas, in the present embodiment, as indicated by a solid line in the figure, a speed can be changed more flexibly than the three-stage speed control. More specifically, unwinding is performed at a winding speed similar to the conventional winding speed at a timing of the conventional switching control (Time T_0 , T_1 , and T_2), but unwinding is performed at a higher winding speed than the conventional winding speed in a time zone between these timings. As a result, a production speed is improved.

[0057] The winding unit 10 further includes the sensor drive control section 59 that controls the drive motor 61 of the sensor moving device 60 on the basis of detection information of a yarn layer obtained by the optical sensor 45. This allows the optical sensor 45 to be moved more accurately and appropriately in response to a change in diameter of the cross-wound package 21.

[0058] The winding unit 10 further includes the storage section 57 that stores a relationship between a diameter of the cross-wound package 21 acquired by the package diameter acquiring section 53 and an index related to winding of the yarn 20 in the winding unit 10. This enables provision or notification of a relationship between the diameter of the cross-wound package 21 and the index related to winding of the yarn 20 to the user, and convenience in the production of the winding unit 10 is enhanced.

[0059] More specifically, the winding unit 10 further includes the instruction voltage acquiring section 56 that acquires an instruction voltage as an index in the tension applying device 13, and the storage section 57 stores a relationship between a diameter of the cross-wound package 21 and the instruction voltage in the tension applying device 13. The winding unit 10 further includes the factor estimating section 55 that estimates a yarn breakage factor of the yarn as an index, and the storage section 57 stores a relationship between a diameter of the cross-wound package 21 and the yarn breakage factor.

[0060] These pieces of data are utilized in, for example, "optimum speed control setting" and "package density priority setting" as the control modes. In the "optimum speed control setting", a winding speed of the yarn 20 is automatically adjusted by the package drive control section 52. The storage section 57 stores diameter data of the cross-wound package 21 when a yarn breakage occurs, and the data is stored in the data storage section 92 of the machine control device 90. On the basis of data collected in the data storage section 92, for example, if

a yarn breakage or the like frequently occurs at a position of a diameter of 130 mm, control is automatically performed to wind the yarn 20 with a lowered unwinding speed at a position of 130 mm $\pm$ 3 mm. In contrast, for example, at a location (a diameter) where no yarn breakage has occurred but the instruction voltage of the tension applying device 13 is high, the yarn can be wound at high speed without change of the tension of the yarn by automatically setting the unwinding speed high and lowering the instruction voltage of the tension applying device 13. As a result, the unwinding speed (the winding speed) can be increased without causing fluctuation in the unwinding tension. According to this "optimum speed control", a yarn breakage is reduced, and productivity is improved.

[0061] In the "package density priority setting", for example, the setting can be made optimum for a user who uses the winding unit 10 in dyeing winding. By making it possible to grasp the instruction voltage of the tension applying device 13 for each package diameter, adjustment can be performed so as to lower the unwinding speed at a location (a diameter) with a high unwinding tension value, which is not able to be lowered by adjustment of the tension applying device 13. This allows winding to be performed with substantially the same tension from the beginning to the end of the unwinding operation. For example, in the dyeing winding, a density needs to be lowered to facilitate dyeing of the package 30 by the user, and the yarn 20 needs to be wound with the same tension. Such a control mode of tension equalization brings advantages to the user.

[0062] Note that an instruction voltage of the tension applying device 13 or an occurrence tendency of the yarn breakage may be displayed on the display section 93 of the machine control device 90 in correspondence with a diameter of the cross-wound package 21. In the example illustrated in FIG. 6, a change in instruction voltage of the tension applying device 13 is displayed in correspondence with a diameter of the cross-wound package 21. According to such display (notification), a load applied to the yarn 20 by the tension applying device 13 can be visually grasped, which can be used as a reference when the user determines a set value in the tension applying device 13.

[0063] In the example illustrated in FIG. 7, a location (a diameter) where a yarn breakage is likely to occur is indicated in correspondence with a diameter of the cross-wound package 21. In this example, a tendency is displayed in which a yarn breakage or the like frequently occurs at a position of a diameter of 180 mm, and a tendency is indicated in which a yarn breakage or the like may occur at a position of a diameter of 140 mm. As illustrated in FIG. 7, a numerical value of a location (a diameter) where a yarn breakage may occur is illustrated together with a size of a circle indicating an occurrence frequency. In addition, a bar graph may be illustrated in addition to the graph of the circle. Both the graph of the circle and the bar graph may be displayed together, or

may be displayed as separate graphs.

[0064] Through the above control, collected data is stored in the machine control device 90, and it is possible to check a transition of the package diameter and an instruction voltage and a tendency of yarn breakage at any location (diameter) for each spindle or table. The tension applied on the yarn by the tension applying device 13 can be grasped in accordance with a diameter of the cross-wound package 21. For example, reference data for a user to determine a tension set value is provided. Furthermore, a relationship between the diameter of the cross-wound package 21 and the yarn breakage factor is provided to the user, and any control setting (for example, lot setting and the like) in winding of the yarn becomes possible. A plurality of types of setting such as the "optimum speed control setting" and the "package density priority setting" can be prepared as lot setting.

[0065] The sensor moving device 60 moves the optical sensor 45 in the moving direction D2 orthogonal to the travelling direction D1 of the yarn 20. A diameter of the cross-wound package 21 changes in a direction orthogonal to the travelling direction D1 of the yarn 20. Therefore, by the optical sensor 45 being moved by the sensor moving device 60, the optical sensor 45 can easily follow a change in diameter of the cross-wound package 21. Furthermore, a configuration can also be adopted in which the optical sensor 45 can be moved from a position irradiating a surface of the cross-wound package 21 to a position irradiating a surface of awinding bobbin of the cross-wound package 21, as a movement range. In this configuration, since a radius of the cross-wound package 21 can be detected, a diameter can be calculated from a size (a length) of the radius.

[0066] The drive motor 61 is a stepping motor. Therefore, a position of the optical sensor 45 can be reliably controlled with a simpler configuration.

[0067] An embodiment of the present invention has been described above, but the present invention is not limited to the above-described embodiment. For example, the optical sensor 45 is not limited to the case of being arranged to face the outer peripheral surface of the cross-wound package 21, and may be arranged to face an end surface on a larger-diameter side or an end surface on a smaller-diameter side of the cross-wound package 21.

[0068] The sensor moving device is not limited to an aspect (a ball screw structure) illustrated in FIG. 3. For example, an electric cylinder mechanism, an air cylinder mechanism, or a solenoid mechanism may be adopted as the sensor moving device. In these cases, the optical sensor 45 is attached to a distal end of the electric cylinder, the air cylinder, or the solenoid. Alternatively, a crank slider mechanism that converts a rotational motion of a crank into a reciprocating linear motion of the slider may be adopted, and the optical sensor 45 may be attached to a distal end of the slider. Alternatively, a traverse mechanism (a belt traverse mechanism) using a belt may be adopted, and a roller conveyor mechanism

using a motor roller may be adopted. Alternatively, the optical sensor 45 may be attached onto a linear guide, and the optical sensor 45 may be moved by blowing a fluid such as compressed air or water. A mechanism that vibrates like a part feeder may be provided, and the optical sensor 45 may be moved using the vibration.

[0069] The storage section is not limited to an aspect of storing a relationship between a diameter of the cross-wound package acquired by the package diameter acquiring section and an instruction voltage in the tension applying device and a yarn breakage factor. The storage section may store a relationship between a diameter of the cross-wound package acquired by the package diameter acquiring section and another index related to winding of the yarn in the yarn winding machine. Examples of another index include a ribbon diameter, an unwinding speed, and the like.

[0070] In the unit control section 50, the sensor drive control section 59 may be omitted. In the sensor moving device 60, the optical sensor 45 may move in accordance with a predetermined movement schedule. In this case, the movement schedule is, for example, a position in a radial direction of the optical sensor according to elapsed time after a start of winding. Alternatively, a moving speed of the optical sensor 45 in the radial direction may be set to be constant or variable in accordance with elapsed time after a start of winding.

[0071] In addition to the control modes described above, various modes may be adopted. For example, a mode of manually setting a speed may be adopted. Assuming that a yarn breakage frequently occurs at a position of 130 mm, a configuration may be adopted in which, when a position of a package diameter at which the unwinding speed is desired to be decreased is manually inputted as, for example, 130 mm in the machine control device 90, the unwinding speed of the yarn layer of about $130 \pm$ several mm can be set to be decreased.

[0072] Further, as "contact pressure setting mode", a package contact pressure corresponding to an unwound yarn length (a current diameter of the cross-wound package 21) may be set. This can secure an optimum contact pressure without actually measuring the diameter of the cross-wound package 21.

[0073] The present invention may be applied to a yarn winding machine of a type different from the above-described embodiment. For example, the present invention is not limited to a case where the cross-wound package is manually installed at a lower end of the device, and the present invention may be applied to a yarn winding machine of a type in which a cross-wound package to be unwound is installed at one end of a swing arm having a horizontal rotational axis, and a cross-wound package to be unwound next is installed at another end of the swing arm. When the swing arm rotates, the next cross-wound package is installed at a predetermined unwinding position. Further, the present invention may be applied to a simple yarn winding machine in which the splicer is omitted.

[0074] A winding unit (10) unwinds a yarn (20) from a cross-wound package (21) and winds the yarn (20) into a package (30). The winding unit (10) includes: an optical sensor (45) that is arranged on a side of the cross-wound package (21) and detects a yarn layer of the cross-wound package (21); and a sensor moving device (60) including a drive motor (61) that moves the optical sensor (45) in a predetermined moving direction (D2).

Claims

1. A yarn winding machine (10) for unwinding a yarn (20) from a cross-wound package (21) around which a traversed yarn (20) is wound and winding the yarn (20) into a wound package (30), the yarn winding machine (10) comprising:

a yarn supplying section (11) adapted to hold the cross-wound package (21);
 an optical sensor (45) arranged on a side of the cross-wound package (21) held by the yarn supplying section (11) and adapted to detect a yarn layer of the cross-wound package (21); and
 a sensor moving device (60) including a driving source (61) adapted to move the optical sensor (45) parallel to a radial direction of the cross-wound package (21) held by the yarn supplying section (11).

2. The yarn winding machine (10) according to claim 1, further comprising a sensor drive control section (59) adapted to control the driving source (61) of the sensor moving device (60) based on detection information of the yarn layer obtained by the optical sensor (45).

3. The yarn winding machine (10) according to claim 1 or 2, further comprising:

a package diameter acquiring section (53) adapted to acquire a diameter change of the cross-wound package (21) based on detection information of the yarn layer obtained by the optical sensor (45); and
 a storage section (57) adapted to store a relationship between a diameter of the cross-wound package (21) acquired by the package diameter acquiring section (53) and an index related to winding of the yarn (20) in the yarn winding machine (10).

4. The yarn winding machine (10) according to claim 3, further comprising an instruction voltage acquiring section (56) adapted to acquire an instruction voltage as the index in a tension applying device (13) adapted to apply tension on the yarn (20), wherein the storage section (57) stores a relationship be-

tween the diameter of the cross-wound package (21) acquired by the package diameter acquiring section (53) and the instruction voltage in the tension applying device (13) acquired by the instruction voltage acquiring section (56).

5. The yarn winding machine (10) according to claim 3 or 4, further comprising a factor estimating section (55) adapted to estimate a yarn breakage factor of the yarn (20) as the index, wherein the storage section (57) stores a relationship between the diameter of the cross-wound package (21) acquired by the package diameter acquiring section (53) and the yarn breakage factor of the yarn (20) estimated by the factor estimating section (55).

6. The yarn winding machine (10) according to any one of claims 1 to 5, further comprising:

a package diameter acquiring section (53) adapted to acquire a diameter of the cross-wound package (21) based on detection information of the yarn layer obtained by the optical sensor (45); and
 a winding speed control section adapted to control a winding speed of the yarn (20) based on the diameter of the cross-wound package (21) acquired by the package diameter acquiring section (53).

7. The yarn winding machine (10) according to any one of claims 1 to 6, wherein the sensor moving device (60) moves the optical sensor (45) in the moving direction orthogonal to a travelling direction of the yarn (20).

8. The yarn winding machine (10) according to any one of claims 1 to 7, wherein the driving source (61) is a stepping motor.

FIG. 1

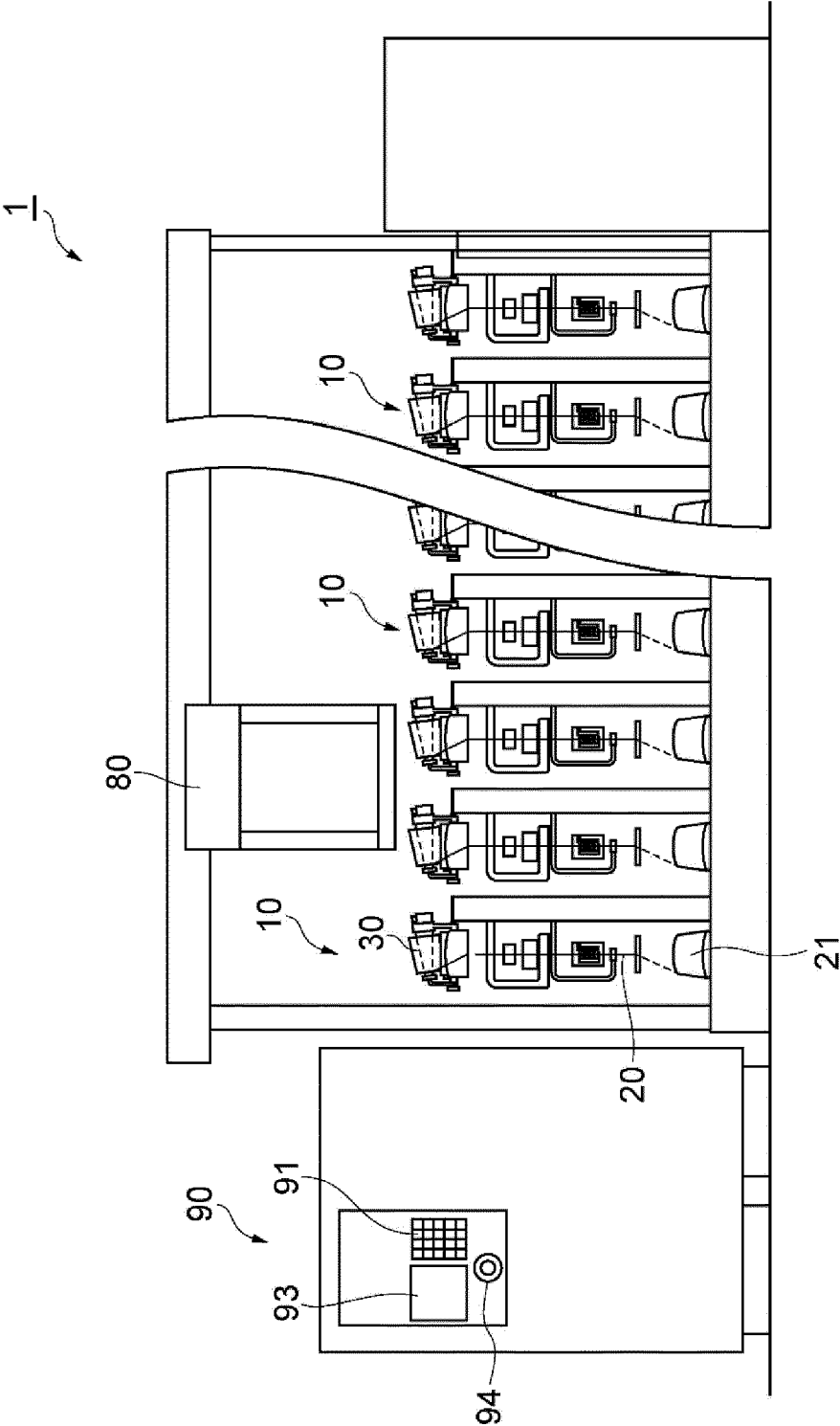


FIG. 2

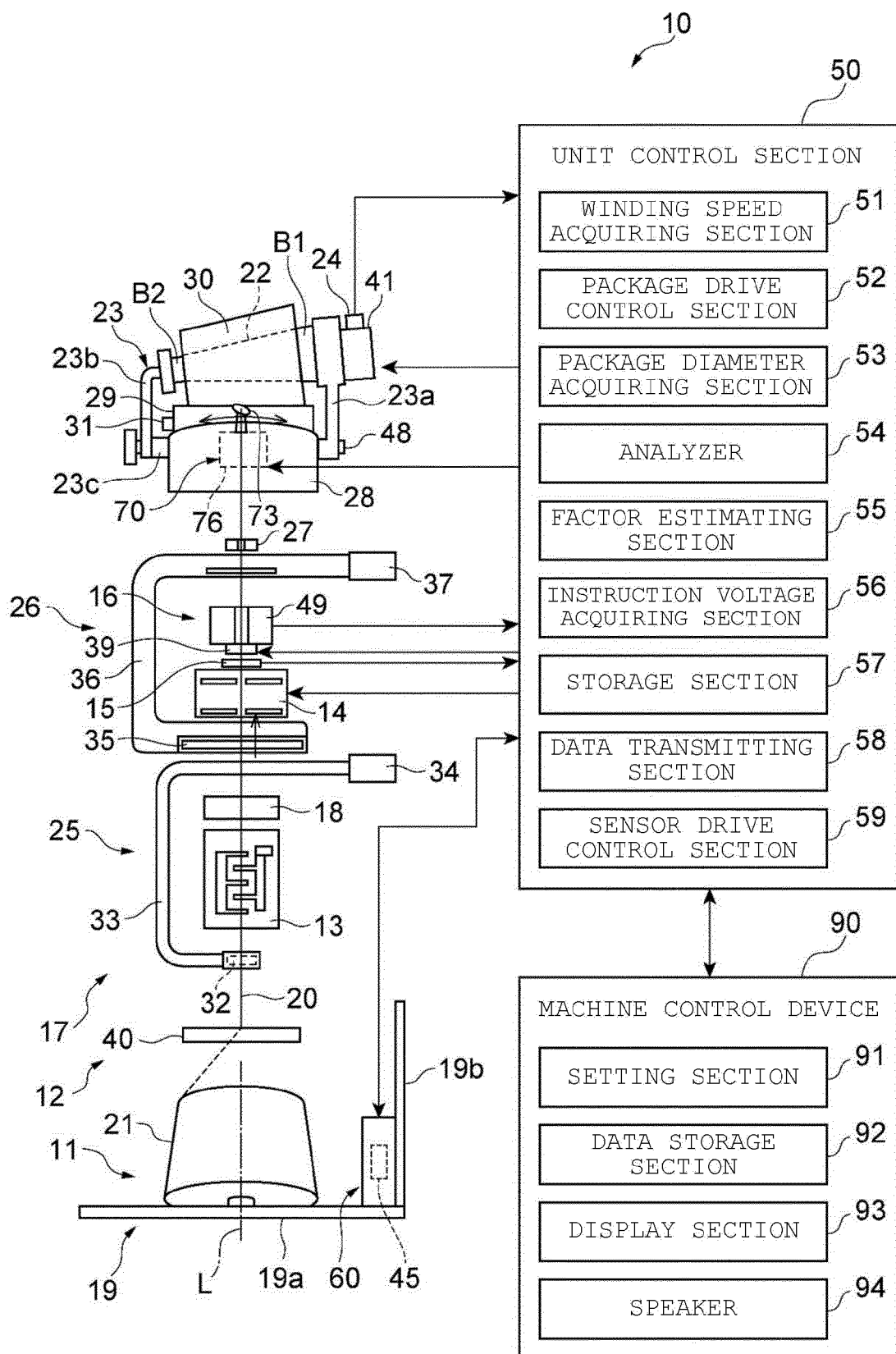


FIG. 3

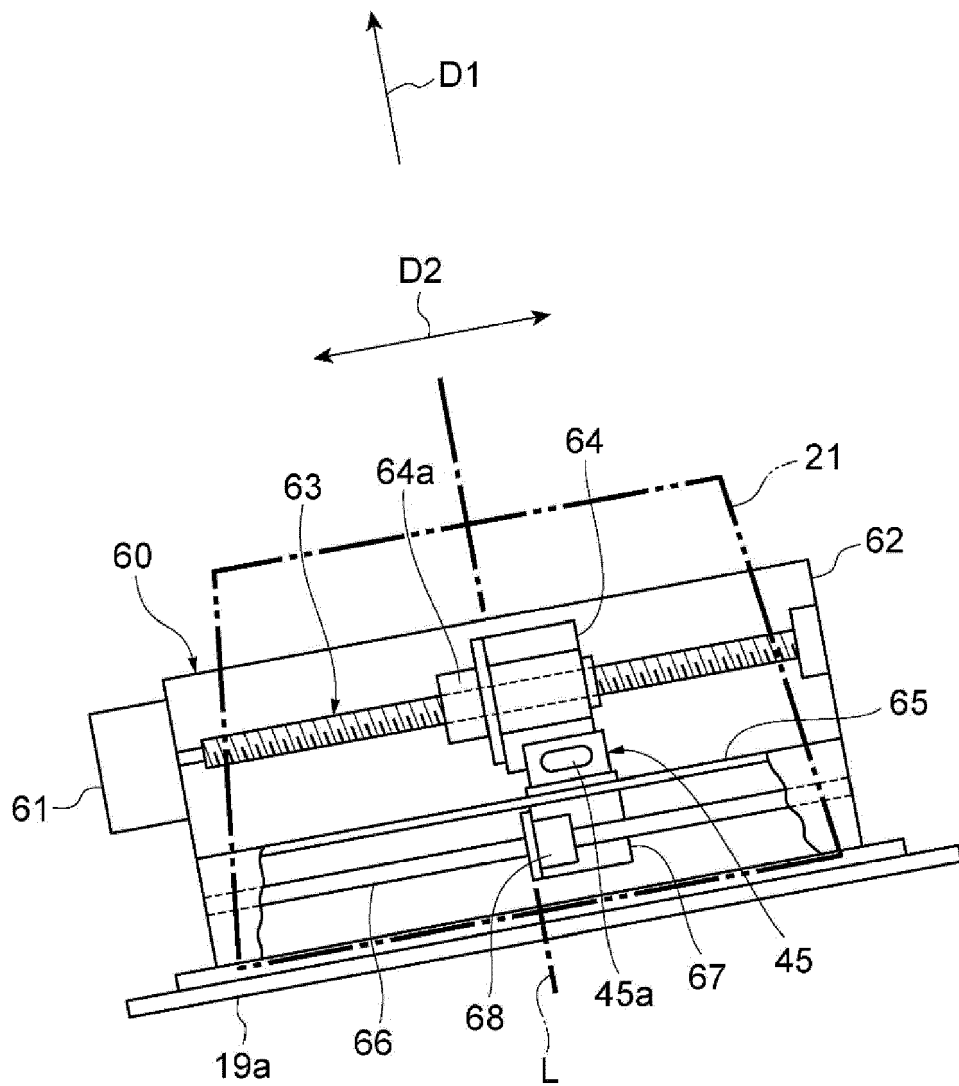


FIG. 4

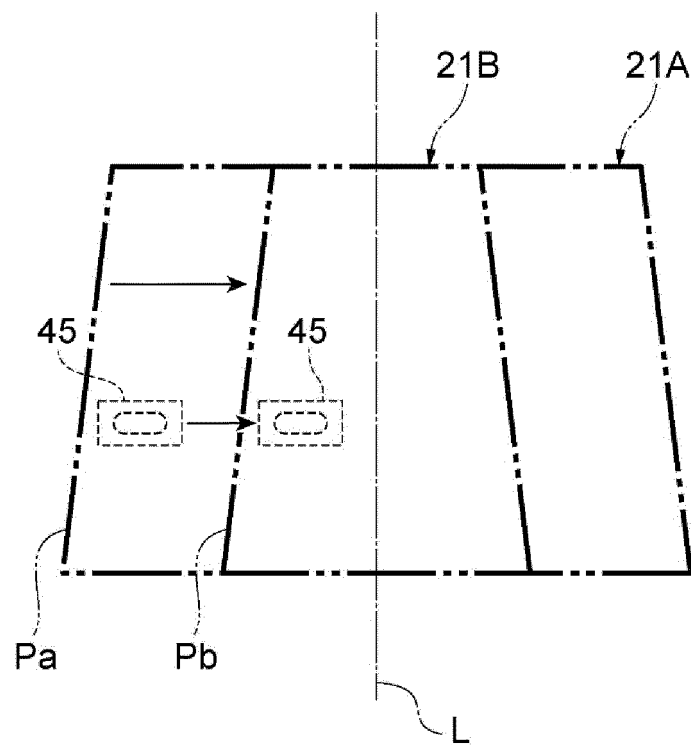


FIG. 5

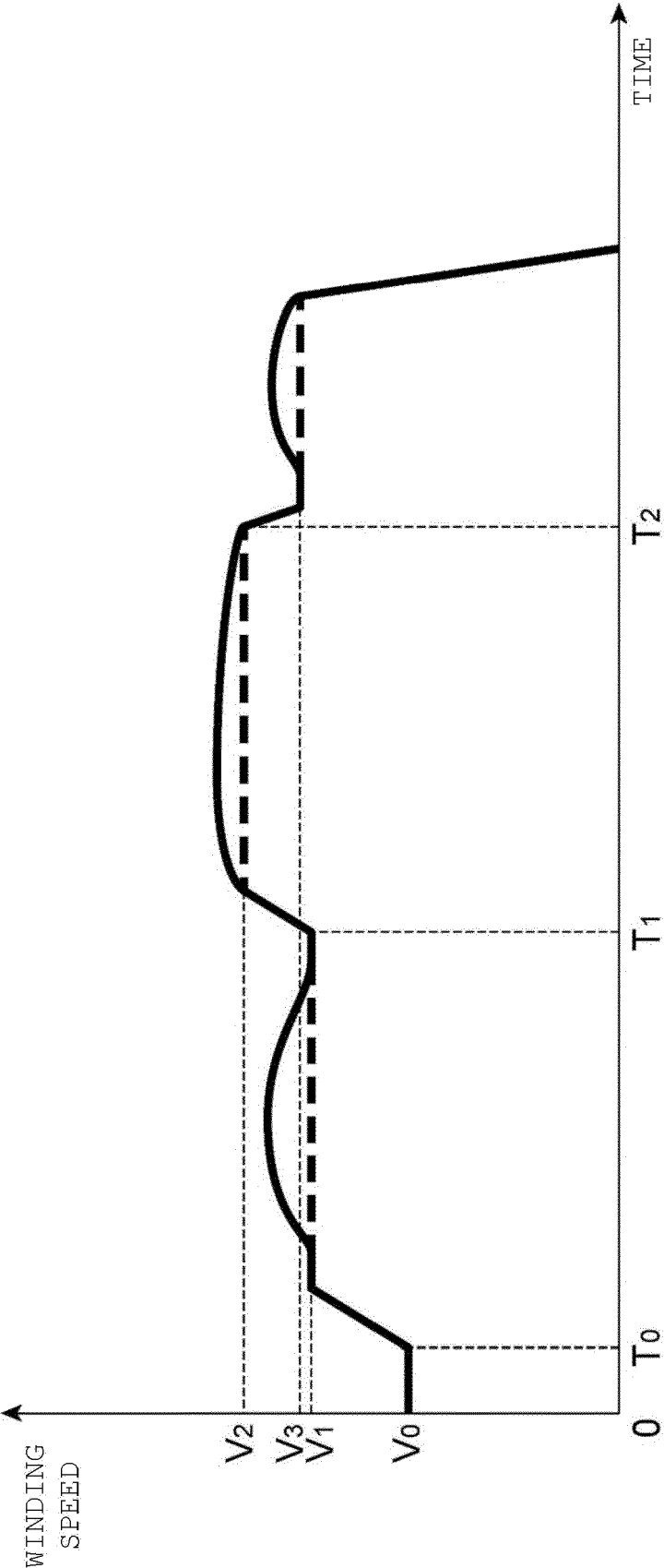


FIG. 6

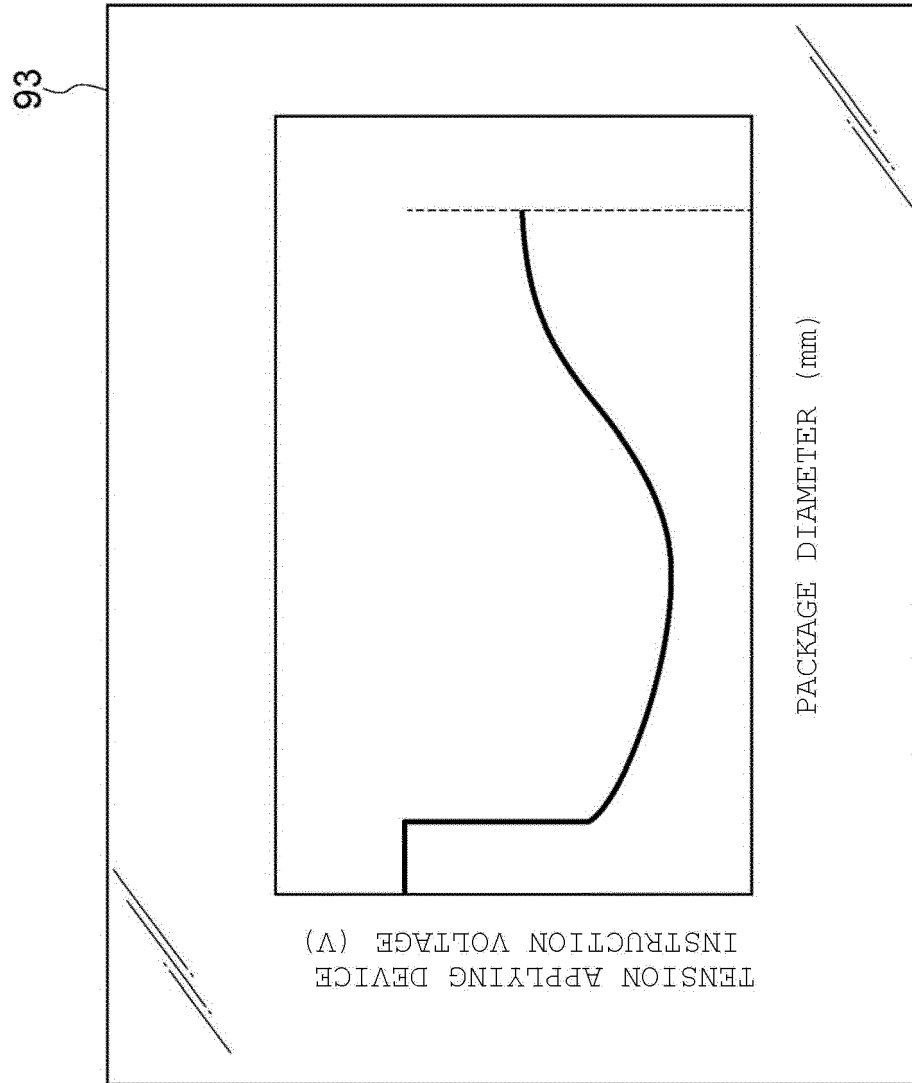
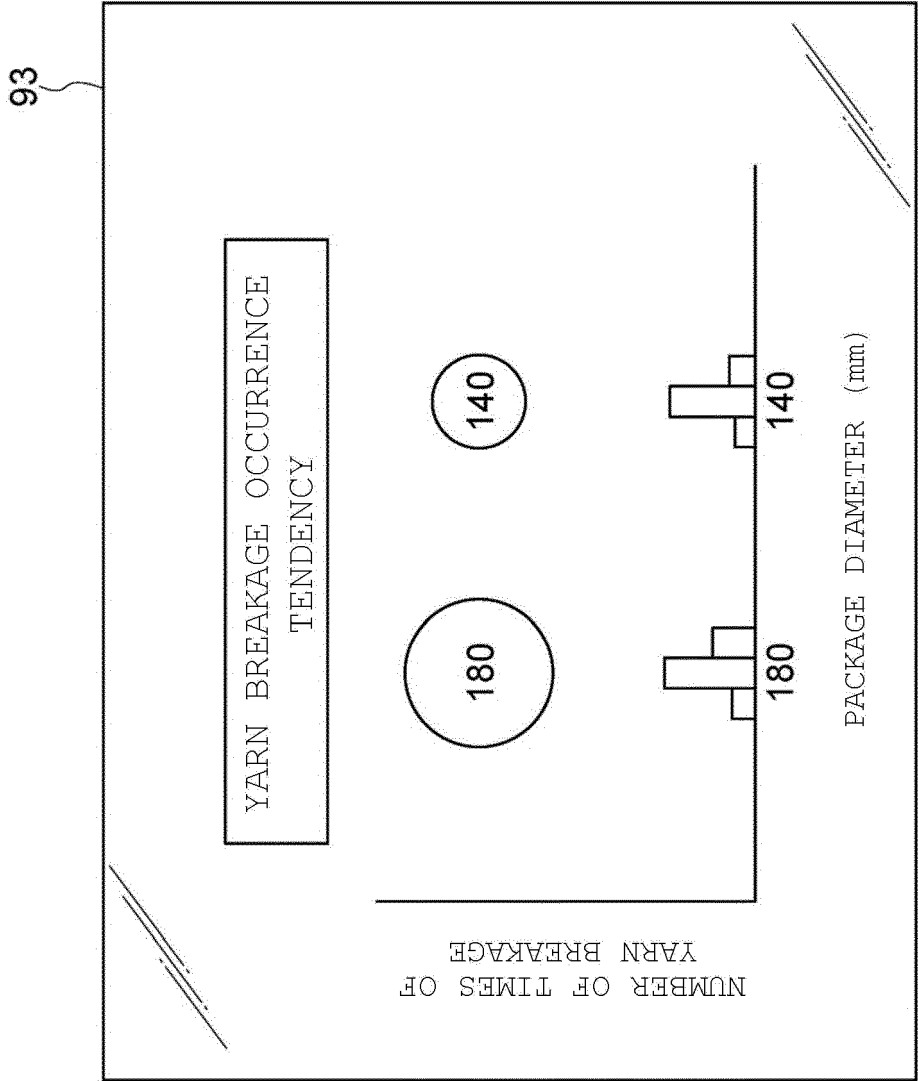


FIG. 7





EUROPEAN SEARCH REPORT

Application Number

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Place of search The Hague		Date of completion of the search 24 April 2023	Examiner Pussemier, Bart
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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