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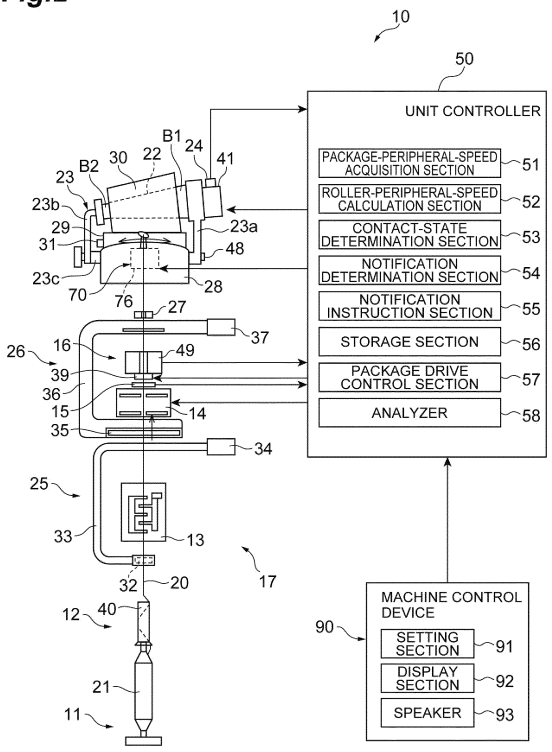
(54) **THREAD WINDING DEVICE**

(57) A yarn winding device configured to wind yarn onto a cone-shaped winding bobbin to form a cone-shaped package, the yarn winding device includes:
a cradle configured to rotatably support the winding bobbin;
a drive motor attached to the cradle and configured to rotate the winding bobbin;
a traverse device configured to traverse the yarn;
a package-peripheral-speed acquisition section configured to acquire, as a first peripheral speed, a peripheral speed of the winding bobbin;
a touch roller configured to be rotated by rotation of the winding bobbin;
a roller-peripheral-speed calculation section configured to calculate, as a second peripheral speed, a peripheral speed of the touch roller; and
a contact-state determination section configured to compare the first peripheral speed acquired by the package-peripheral-speed acquisition section and the second peripheral speed calculated by the roller-peripheral-speed calculation section, thereby determining a contact state of the bobbin that is in contact with the touch roller.

Fig.2



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Description

Technical Field

[0001] The present disclosure relates to a yarn winding device .

Background Art

[0002] For example, Patent Literature 1 describes a yarn winding device configured to wind yarn onto a bobbin to form a package. In this yarn winding device, the shape of the package is arranged, for example, by pressing an outer peripheral surface of the package against a touch roller.

Citation List

Patent Literature

[0003] [Patent Literature 1] Japanese Unexamined Patent Publication No. 2014-108844

Summary of Invention

Technical Problem

[0004] Herein, for example, in order to arrange the shape of the package, for example, the outer peripheral surface of the package needs to be in contact with the touch roller in a predetermined contact state. Thus, in this technical field, it is desired to be able to determine the contact state of the bobbin or the package that is in contact with the touch roller.

[0005] In view of this, the present disclosure describes a yarn winding device capable of determining a contact state of a bobbin or a package that is in contact with a touch roller.

Solution to Problem

[0006] The present disclosure is directed to a yarn winding device configured to wind yarn onto a cone-shaped bobbin to form a cone-shaped package. The yarn winding device includes: a cradle configured to rotatably support the bobbin with a bobbin holding portion configured to hold the bobbin; a driving section attached to the cradle, having a rotation shaft that is coupled to the bobbin holding portion in an integrally rotatable manner, and configured to rotate the bobbin holding portion thereby rotating the bobbin; a traverse device configured to move a yarn guiding section on which the yarn is hooked, thereby traversing the yarn to be wound around the bobbin or the package; a package-peripheral-speed acquisition section configured to acquire, as a first peripheral speed, a peripheral speed of an outer peripheral surface of the bobbin or the package at a predetermined position in a rotational-axis direction of the bobbin; a touch roller configured to come into contact with the outer peripheral surface of the bobbin or the package and to be rotated by rotation of the bobbin or the package; a roller-peripheral-speed calculation section configured to calculate, as a second peripheral speed, a peripheral speed of an outer peripheral surface of the touch roller; and a contact-state determination section configured to compare the first peripheral speed acquired by the package-peripheral-speed acquisition section and the second peripheral speed calculated by the roller-peripheral-speed calculation section, thereby determining a contact state of the bobbin or the package that is in contact with the touch roller.

[0007] Herein, when the bobbin or the package that is rotating is in contact with the touch roller, the peripheral speed of the touch roller is different between when an outer peripheral surface of a base-end portion of the bobbin or the package is in contact with the touch roller and when an outer peripheral surface of a top-end portion of the bobbin or the package is in contact with the touch roller. In this manner, even if the rotational speed of the bobbin or the package is constant, the peripheral speed of the touch roller changes depending on such contact portions of the bobbin or the package that is in contact with the touch roller. Thus, the contact-state determination section compares the first peripheral speed that is the peripheral speed of the outer peripheral surface of the bobbin or the package at the predetermined position and the second peripheral speed that is the peripheral speed of the touch roller, thereby being able to determine which portion of the bobbin or the package is in contact with the touch roller. In other words, the contact-state determination section can determine the contact state of the bobbin or the package. In this manner, the yarn winding device can determine the contact state of the bobbin or the package that is in contact with the touch roller.

[0008] The package-peripheral-speed acquisition section may obtain the first peripheral speed that is the peripheral speed of the outer peripheral surface of the bobbin or the package at the predetermined position by computation based on peripheral-speed calculation information for calculating the peripheral speed. In this case, the package-peripheral-

speed acquisition section can acquire, by computation, the first peripheral speed that is the peripheral speed of the outer peripheral surface of the bobbin or the package at the predetermined position.

[0009] The peripheral-speed calculation information may contain at least one of a shape of the bobbin, a rotational speed of the bobbin, and a yarn speed of the yarn to be wound. In this case, the package-peripheral-speed acquisition section can accurately calculate the first peripheral speed using these values.

[0010] The yarn winding device may further include: a bobbin-information input section into which bobbin information for identifying the shape of the bobbin is input; and a peripheral-speed-information storage section configured to store, for each shape of the bobbin, peripheral-speed information in which the shape of the bobbin is associated with the peripheral speed of the outer peripheral surface of the bobbin at the predetermined position. The package-peripheral-speed acquisition section may acquire, from the peripheral-speed-information storage section, the peripheral speed corresponding to the shape of the bobbin that is identified by the bobbin information input in the bobbin-information input section as the first peripheral speed. In this case, the package-peripheral-speed acquisition section can acquire the peripheral speed from the peripheral-speed-information storage section without performing computation.

[0011] The yarn winding device may further include: a notification determination section configured to determine whether the contact state determined by the contact-state determination section is a predetermined contact state to be notified; and a notification section configured to provide notification when the notification determination section has determined that the contact state determined is the contact state to be notified. In this case, an operator of the yarn winding device can grasp the contact state of the bobbin or the package on the basis of a notification result provided by the notification section. The operator can make operations such as adjusting the contact state of the bobbin or the package or stopping winding of the yarn.

[0012] The yarn winding device further includes a contact-state input section into which the contact state to be notified is input. The notification determination section uses the contact state to be notified input in the contact-state input section as the predetermined contact state to be notified. In this case, the operator of the yarn winding device can use the contact-state input section to set the contact state to be notified. The operator of the yarn winding device can change the contact state to be notified according to the type of yarn to be wound, for example.

[0013] The yarn winding device may further include a yarn-speed detection section configured to detect the yarn speed of the yarn to be wound around the bobbin or the package. The contact-state determination section may further determine the contact state, based on temporal variation in difference between the yarn speed detected by the yarn-speed detection section and the second peripheral speed calculated by the roller-peripheral-speed calculation section. Herein, for example, when the base-end portion of the bobbin is in contact with the touch roller, a layer of yarn (the amount of yarn) between the bobbin and the touch roller increases as the yarn is wound. Because the bobbin and the package each have a cone shape and the peripheral speed is different between on the base-end side and on the top-end side, the outer peripheral surface of the package and the outer peripheral surface of the touch roller are in contact with each other at one point (contact point) . Furthermore, as the layer of yarn increases, the contact point between the outer peripheral surface of the package and the touch roller moves toward the central position (the central position in the rotational-axis direction) of the package outer peripheral surface. The speed of the movement of the contact point changes depending on the speed at which the clearance between the bobbin and the touch roller is filled with the yarn. Specifically, for example, a state is assumed in which the base-end portion of the bobbin is in contact with the touch roller. In this state, when the clearance between the bobbin and the touch roller is wide (when a space between the top-end portion of the bobbin and the touch roller outer peripheral surface is wide), the movement of the contact point is slower than when the clearance between the bobbin and the touch roller is narrow (when the space between the top-end portion of the bobbin and the touch roller outer peripheral surface is narrow) . Because the yarn is wound while being traversed between the base-end portion and the top-end portion of the package, the peripheral speed at the central position of the package outer peripheral surface corresponds to the yarn speed (the average traveling speed of the yarn) . Thus, when the contact point has moved near the central position of the package outer peripheral surface, the peripheral speed of the touch roller becomes substantially the same as the peripheral speed of the package outer peripheral surface at the central position thereof . In other words, the peripheral speed of the touch roller becomes substantially the same as the yarn speed. In this manner, as the yarn is wound around the bobbin, the peripheral speed of the touch roller converges to the yarn speed. The speed at which the peripheral speed of the touch roller converges to the yarn speed changes depending on the clearance size between the bobbin and the touch roller, that is, the state of inclination of the rotation shaft of the bobbin (package) with respect to the rotation shaft of the touch roller. Thus, based on temporal variation in difference between the yarn speed and the second peripheral speed that is the peripheral speed of the touch roller, the contact-state determination section can determine the state of inclination of the bobbin (package) with respect to the touch roller, that is, the contact state of the package with respect to the touch roller.

[0014] The yarn winding device may further include a contact-state storage section configured to store identification information for identifying the package and the contact state of the package determined by the contact-state determination section in a manner associated with each other. In this case, even after the package has been formed, the operator or the like of the yarn winding device can check the contact state when the yarn was being wound around the package on

the basis of information stored in the contact-state storage section.

Advantageous Effects of Invention

[0015] According to the present disclosure, the contact state of the bobbin or the package that is in contact with the touch roller can be determined.

Brief Description of Drawings

[0016]

[FIG. 1] FIG. 1 is a front view of an automatic winder including winder units according to an embodiment.
[FIG. 2] FIG. 2 is a schematic diagram and a block diagram illustrating a schematic configuration of each winder unit.
[FIG. 3] FIG. 3 is a left side view illustrating the vicinity of a traverse device of the winder unit in an enlarged manner.
[FIGs. 4] FIG. 4(a) is a schematic diagram illustrating a state in which a base-end portion of a winding bobbin is in contact with a touch roller. FIG. 4 (b) is a schematic diagram illustrating a state in which a central portion of the winding bobbin is in contact with the touch roller. FIG. 4(c) is a schematic diagram illustrating a state in which a top-end portion of the winding bobbin is in contact with the touch roller.
[FIGs. 5] FIG. 5(a) is a schematic diagram illustrating a state in which the base-end portion of the winding bobbin is in contact with the touch roller. FIG. 5(b) is a schematic diagram illustrating a state in which the top-end portion of the winding bobbin is in contact with the touch roller.
[FIG. 6] FIG. 6 is a graph illustrating temporal variation of the peripheral speed of the touch roller.

Description of Embodiments

[0017] An embodiment of the present disclosure will now be described with reference to the drawings. In the description of the drawings, like elements are designated by like reference signs, and duplicate description is omitted.

[0018] Referring to FIG. 1, an overall configuration of an automatic winder 1 including a winder unit (yarn winding device) 10 of the present embodiment will be described. The terms "upstream" and "downstream" herein mean upstream and downstream in a traveling direction of a yarn during winding.

[0019] As illustrated in FIG. 1, the automatic winder 1 includes a plurality of the winder units 10 disposed in parallel, an automatic doffer 80, and a machine control device 90 as main components. Each winder unit 10 winds the yarn 20 unwound from a yarn feeding bobbin 21 onto a winding bobbin 22 (see FIG. 2) while traversing the yarn 20, thereby forming a package 30. The term "traverse" means to cause yarn being wound to reciprocate. The package 30 is a traverse-wound package.

[0020] When a package 30 has been fully wound (has become full) in each winder unit 10, the automatic doffer 80 travels to the position of the corresponding winder unit 10, and discharges the fully wound package 30 from the winder unit 10, and also supplies an empty bobbin to the winder unit 10.

[0021] The machine control device 90 includes a setting section (a bobbin-information input section, a contact-state input section) 91, a display section 92, and a speaker 93. With the setting section 91, an operator can make settings for each winder unit 10 by inputting predetermined set values or selecting an appropriate control method. The predetermined set values that the operator inputs to the setting section 91 include bobbin information for identifying the type (shape) of a winding bobbin 22 around which the yarn 20 is to be wound. Herein, the bobbin information does not necessarily have to be identified by the operator's direct input of the type of a winding bobbin 22 to be used. For example, when the type of the winding bobbin 22 to be used depends on the type of the yarn 20 to be wound, the bobbin information may be identified by the type of the yarn 20 input by the operator.

[0022] Furthermore, the setting section 91 receives input of a contact state to be notified. This contact state to be notified is input by the operator. The setting section 91 sets the contact state to be notified input by the operator for each winder unit 10. The contact state to be notified will be described later. The display section 92 is configured to be capable of displaying a winding status of the yarn 20 of each winder unit 10 and information on a trouble that has occurred, for example. The display section 92 may be configured with a touch panel, and the setting section 91 may be included in the display section 92. The speaker 93 outputs a sound in response to instructions from a notification instruction section 55 described later to notify the operator.

[0023] The following specifically describes a configuration of each winder unit 10 with reference to FIG. 2. As illustrated in FIG. 2, the winder unit 10 includes a winding-unit main body 17 and a unit controller 50 as main components.

[0024] For example, the unit controller 50 includes a CPU, a RAM, a ROM, an I/O port, and a communication port. In the ROM, a program for controlling each component of the winding-unit main body 17 is stored. To the I/O port and the communication port, each component (described later in detail) included in the winding-unit main body 17 and the

machine control device 90 are connected so that communication of control information or the like can be established. With this configuration, the unit controller 50 can control motion of each component included in the winding-unit main body 17.

[0025] The winding-unit main body 17 includes, on a yarn traveling path between the yarn feeding bobbin 21 and a touch roller 29, in the order from the yarn feeding bobbin 21 side: a yarn-unwinding assisting device 12; a tension applying device 13; a yarn joining device 14; a photoelectric length measuring device (yarn-speed detection section) 15; and a yarn monitoring device 16. Below the winding-unit main body 17, a yarn feeding section 11 is provided. The yarn feeding section 11 is configured to be capable of holding a yarn feeding bobbin 21 transported by a bobbin transport system (not illustrated) at a predetermined position.

[0026] The yarn-unwinding assisting device 12 assists unwinding of the yarn 20 from the yarn feeding bobbin 21 by lowering a regulating member 40 covering a core tube of the yarn feeding bobbin 21 in conjunction with the unwinding of the yarn 20 from the yarn feeding bobbin 21. The regulating member 40 comes into contact with a balloon of the yarn 20 that is formed above the yarn feeding bobbin 21 by swinging and centrifugal force of the yarn 20 unwound from the yarn feeding bobbin 21, and controls the balloon of the yarn 20 to an appropriate size, thereby assisting unwinding of the yarn 20. Near the regulating member 40, a sensor (not illustrated) configured to detect a chase portion of the yarn feeding bobbin 21 is provided. When this sensor has detected descent of the chase portion, the yarn-unwinding assisting device 12 follows the descent of the chase portion to lower the regulating member 40 by an air cylinder or the like (not illustrated).

[0027] The tension applying device 13 applies a predetermined tension to the traveling yarn 20. As the tension applying device 13, for example, a gate-type device in which comb teeth movable with respect to fixed comb teeth are disposed may be used. The movable comb teeth are swung by a rotary solenoid so as to be engaged with or released from the fixed comb teeth. As the tension applying device 13, in addition to the above-described gate-type device, for example, a disk-type device may be used.

[0028] For example, when the yarn monitoring device 16 has detected a yarn defect and cuts the yarn, or when the yarn being unwound from the yarn feeding bobbin 21 breaks, the yarn joining device 14 joins the lower yarn from the yarn feeding bobbin 21 and the upper yarn from the package 30. As the yarn joining device configured to join the upper yarn and the lower yarn in this manner, a mechanical knotter, a splicer using fluid such as compressed air, and the like, may be used.

[0029] The photoelectric length measuring device 15 is a length measuring device of a noncontact photoelectric type, and detects a yarn speed that is the traveling speed of the yarn 20 without touching the yarn 20. Specifically, the photoelectric length measuring device 15 projects the yarn 20 onto a photodetector, and processes changes in photoelectric current generated when the projected yarn 20 travels using what is called a spatial filter method, thereby detecting the yarn speed of the yarn 20 to be wound around the winding bobbin (bobbin) 22 or the package 30.

[0030] The yarn monitoring device 16 includes a head 49 in which a sensor (not illustrated) for detecting the thickness of the yarn 20 is disposed and an analyzer 58 configured to process a yarn thickness signal from this sensor. The analyzer 58 is provided in the unit controller 50. The yarn monitoring device 16 detects a yarn defect such as a slub by monitoring the yarn thickness signal from the sensor. Near the head 49, a cutter 39 configured to cut the yarn 20 immediately when the yarn monitoring device 16 has detected a yarn defect is provided.

[0031] Below the yarn joining device 14, a lower-yarn catching member 25 configured to catch a yarn end of the lower yarn and guide the yarn end to the yarn joining device 14 is provided. Above the yarn joining device 14, an upper-yarn catching member 26 configured to catch a yarn end of the upper yarn and guide the yarn end to the yarn joining device 14 is provided. The lower-yarn catching member 25 includes a lower-yarn pipe arm 33 and a lower-yarn suction port 32 formed in the distal end of this 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 in the distal end of this upper-yarn pipe arm 36.

[0032] The lower-yarn pipe arm 33 and the upper-yarn pipe arm 36 are configured to be rotatable around a shaft 34 and a shaft 37, respectively. To each of the lower-yarn pipe arm 33 and the upper-yarn pipe arm 36, an appropriate negative pressure source is connected. The lower-yarn pipe arm 33 is configured to be capable of sucking and catching the yarn end of the lower yarn by generating suction flow in the lower-yarn suction port 32. The upper-yarn pipe arm 36 is configured to be capable of sucking and catching the yarn end of the upper yarn by generating suction flow in the upper-yarn suction port 35. Each of the lower-yarn pipe arm 33 and the upper-yarn pipe arm 36 is provided with a shutter (not illustrated) on its proximal end side. Each shutter is opened and closed in response to signals from the unit controller 50. With this configuration, stoppage and generation of suction flows from the lower-yarn suction port 32 and the upper-yarn suction port 35 are controlled.

[0033] The winding-unit main body 17 further includes: a cradle 23 configured to support the winding bobbin 22 in a detachable and rotatable manner; and the touch roller 29 configured to come into contact with an outer peripheral surface of the winding bobbin 22 or an outer peripheral surface of the package 30 and be rotatable. The winding bobbin 22 has a cone-shaped (conical) shape. The winding-unit main body 17 includes an arm-type traverse device 70 configured to traverse the yarn 20 near the cradle 23, and winds the yarn 20 onto the winding bobbin 22 or the package 30 while

traversing the yarn 20 with this traverse device 70. At slightly upstream of this traverse position, a guide plate 28 is provided. The guide plate 28 guides the upstream yarn 20 to the traverse position. At further upstream of the guide plate 28, a ceramic traverse fulcrum 27 is provided. The traverse device 70 traverses the yarn 20 in a direction indicated by an arrow in FIG. 2 with this traverse fulcrum 27 as a fulcrum.

[0034] The winding-unit main body 17 winds the yarn 20 onto the cone-shaped winding bobbin 22 while traversing the yarn 20 with the traverse device 70, thereby forming a cone-shaped package 30.

[0035] Specifically, as illustrated in FIG. 2 and FIG. 3, the traverse device 70 includes a traverse drive motor 76, an output shaft 77, and a traverse arm 74. FIG. 3 is a diagram when viewed from the axial direction of the touch roller 29. Rotation of the package 30 in a winding direction is clockwise in FIG. 3, and rotation of the package 30 in an unwinding direction is counterclockwise in FIG. 3.

[0036] The traverse drive motor 76 is a motor configured to drive the traverse arm 74, and configured with a servomotor, for example. Motion of the traverse drive motor 76 is controlled by the unit controller 50. The traverse drive motor 76 may be another motor such as a step motor or a voice coil motor. In a distal-end portion of the traverse arm 74, a hook-shaped yarn guiding section 73 on which yarn 20 is hooked is formed. The traverse arm 74 can guide the yarn 20 with the yarn guiding section 73. The traverse device 70 swings the traverse arm 74 in a reciprocating manner while the yarn guiding section 73 is guiding the yarn 20 (moves the yarn guiding section 73), thereby being able to traverse the yarn 20 to be wound around the package 30.

[0037] Power of the traverse drive motor 76 is transmitted to a proximal-end portion of the traverse arm 74 via the output shaft 77. When a rotor of the traverse drive motor 76 rotates forward and backward, the traverse arm 74 swings in a reciprocating manner in a direction orthogonal to the plane of FIG. 3 (in a left-right direction (winding width direction of the package 30) in FIG. 2). The traverse arm 74 in FIG. 3 indicates a position at a traverse end portion.

[0038] The touch roller 29 comes into contact with an outer peripheral surface of the winding bobbin 22 or the package 30, and is rotated by rotation of the winding bobbin 22 or the package 30. The touch roller 29 has a cylindrical shape, wherein both end diameters of which are the same. Against the touch roller 29, the outer peripheral surface of the package 30 is pressed. The touch roller 29 has a function of arranging the shape of the package 30. The touch roller 29 also has a function of, while holding the traversed yarn 20 at a position where the yarn 20 is being traversed, causing the package 30 to wind the yarn 20. The touch roller 29 is provided with a rotational speed sensor 31 configured to detect the rotational speed of the touch roller 29. The rotational speed sensor 31 transmits a rotation detection signal corresponding to the rotational speed of the touch roller 29 to the unit controller 50. As the rotational speed sensor 31, various sensors such as a sensor configured to measure magnetic variation of a magnet attached to the touch roller 29 may be used.

[0039] The cradle 23 includes a first cradle arm 23a and a second cradle arm 23b in a pair and a coupling portion 23c coupling 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 around a swinging shaft 48 provided to the coupling portion 23c. When the cradle 23 swings, the cradle 23 absorbs increase in diameter of the package 30 associated with winding of the yarn 20 onto the winding bobbin 22.

[0040] To a distal-end portion of the first cradle arm 23a, a first bobbin holding portion (bobbin holding portion) B1 configured to hold one end portion of the winding bobbin 22 is provided. To a distal-end portion of the second cradle arm 23b, a second bobbin holding portion B2 configured to hold the other end portion of the winding bobbin 22 is provided. Furthermore, to a distal-end portion of the first cradle arm 23a, a package drive motor (driving section) 41 configured with a servomotor is attached. In order to wind the yarn 20 onto the winding bobbin 22, the package drive motor 41 drives and rotates the winding bobbin 22 held by the first bobbin holding portion B1 and the second bobbin holding portion B2. The package drive motor 41 can drive and rotate the package 30 in a manner rotating forward such that the package 30 (winding bobbin 22) is rotated in the winding direction and also in a manner rotating backward such that the package 30 is rotated in the unwinding direction that is opposite to the winding direction. The motor shaft (rotation shaft) of the package drive motor 41 is coupled to the first bobbin holding portion B1 holding the winding bobbin 22 in an integrally rotatable manner. The package drive motor 41 rotates the first bobbin holding portion B1 thereby rotating the winding bobbin 22 (what is called a direct drive system).

[0041] Motion of the package drive motor 41 is controlled by the unit controller 50. As the package drive motor 41, various motors such as a step motor and an induction motor may be used without being limited to the servomotor. The package drive motor 41 is provided with a rotational speed sensor 24 configured to detect the rotational speed of the motor shaft of the package drive motor 41. The rotational speed sensor 24 transmits a rotation detection signal corresponding to the rotational speed of the motor shaft to the unit controller 50.

[0042] The unit controller 50 further includes, in addition to the above-described analyzer 58, a package-peripheral-speed acquisition section 51, a roller-peripheral-speed calculation section 52, a contact-state determination section 53, a notification determination section 54, a notification instruction section 55, a storage section (a peripheral-speed-information storage section, a contact-state storage section) 56, and a package drive control section 57.

[0043] At the time of start of winding the yarn 20, the package-peripheral-speed acquisition section 51 acquires the

peripheral speed (first peripheral speed) of an outer peripheral surface of the winding bobbin 22 at a predetermined position in the rotational-axis direction of the winding bobbin 22. Herein, the expression "at the time of start of winding the yarn 20" indicates a state in which the yarn 20 is not yet accumulated between the winding bobbin 22 and the touch roller 29 and an outer peripheral surface of the winding bobbin 22 is in contact with the touch roller 29. When the package drive motor 41 is attached to the cradle 23, a slight clearance (predetermined clearance) may be formed between the outer peripheral surface of the winding bobbin 22 and the outer peripheral surface of the touch roller 29 at the time of start of winding yarn 20.

[0044] After the start of winding the yarn 20, the package-peripheral-speed acquisition section 51 acquires the peripheral speed (first peripheral speed) of an outer peripheral surface of the package 30 at a predetermined position in the rotational-axis direction of the package 30. Herein, the expression "after the start of winding the yarn 20" indicates a state in which the yarn 20 is being wound around the winding bobbin 22 and the yarn 20 wound around the winding bobbin 22 is in contact with the touch roller 29, that is, a state in which the package 30 is in contact with the touch roller 29.

[0045] In the present embodiment, the package-peripheral-speed acquisition section 51 acquires, as the peripheral speed at the predetermined position in the rotational-axis direction, the respective peripheral speeds of outer peripheral surfaces of the winding bobbin 22 and the package 30 at central positions thereof in the rotational-axis direction. The package-peripheral-speed acquisition section 51 can acquire the respective peripheral speeds of the outer peripheral surfaces of the winding bobbin 22 and the package 30 at the central positions in the rotational-axis direction on the basis of a known method.

[0046] For example, the package-peripheral-speed acquisition section 51 may obtain the peripheral speed of the outer peripheral surface of the winding bobbin 22 or the package 30 at the predetermined position by computation based on peripheral-speed calculation information for calculating the peripheral speed. This peripheral-speed calculation information contains at least one of the shape of the winding bobbin 22, the rotational speed of the winding bobbin 22, and the yarn speed of the yarn 20 to be wound, for example. Herein, the shape of the winding bobbin 22 may include the diameter of the base-end portion of the winding bobbin 22, the length thereof in the rotational-axis direction, and the angle of inclination of the outer peripheral surface thereof with respect to the rotation shaft. The shape of the winding bobbin 22 may include the diameter of the winding bobbin 22 at the central position in the rotational-axis direction. The shape of the winding bobbin 22 is stored in advance in the storage section 56 for each type of the winding bobbin 22. The package-peripheral-speed acquisition section 51 can identify the type of the used winding bobbin 22 on the basis of the bobbin information input in the setting section 91. The package-peripheral-speed acquisition section 51 can acquire the shape of the winding bobbin 22 corresponding to the identified type from the storage section 56. As the rotational speed of the winding bobbin 22, a detection result of the rotational speed sensor 24 may be used. As the yarn speed of yarn to be wound, a detection result of the photoelectric length measuring device 15 may be used.

[0047] As one example, at the time of start of winding the yarn, the package-peripheral-speed acquisition section 51 can calculate the peripheral speed of the outer peripheral surface of the winding bobbin 22 at the central position thereof in the rotational-axis direction on the basis of the shape of the winding bobbin 22 and the rotational speed detected by the rotational speed sensor 24. Specifically, the package-peripheral-speed acquisition section 51 can calculate the peripheral speed of the outer peripheral surface of the winding bobbin 22 at the central position thereof in the rotational-axis direction on the basis of the diameter of the winding bobbin 22 at the central position thereof in the rotational-axis direction that is obtained based on the shape of the winding bobbin 22 and the rotational speed detected by the rotational speed sensor 24.

[0048] As one example, after the start of winding the yarn, the package-peripheral-speed acquisition section 51 calculates the diameter of the package 30 at the central position thereof in the rotational-axis direction on the basis of the yarn speed detected by the photoelectric length measuring device 15 and the rotational speed detected by the rotational speed sensor 24. The package-peripheral-speed acquisition section 51 may calculate the peripheral speed of the outer peripheral surface of the package 30 at the central position thereof on the basis of the diameter of the package 30 thus calculated. As another example, after the start of winding the yarn, the package-peripheral-speed acquisition section 51 may use the yarn speed of the yarn 20 detected by the photoelectric length measuring device 15 as the peripheral speed of the outer peripheral surface of the package 30 at the central position thereof in the rotational-axis direction. In the present embodiment, the package 30 has a cone shape, and the average yarn speed of yarn 20 traversed by the traverse device 70 is detected by the photoelectric length measuring device 15. Thus, the average yarn speed of yarn 20 detected by the photoelectric length measuring device 15 corresponds to the peripheral speed of the outer peripheral surface of the package 30 at the central position thereof in the rotational-axis direction.

[0049] The package-peripheral-speed acquisition section 51 may acquire the peripheral speed of the outer peripheral surface of the winding bobbin 22 at the predetermined position without computation using the peripheral-speed calculation information. Herein, the storage section 56 may store, for each shape of the winding bobbin 22, peripheral-speed information in which the shape of the winding bobbin 22 is associated with the peripheral speed of the outer peripheral surface of the winding bobbin 22 at the predetermined position. Inthiscase, the package-peripheral-speed acquisition section 51 can acquire the peripheral speed corresponding to the shape of a bobbin identified by the bobbin information

input in the setting section 91 from the storage section 56.

[0050] Hereinafter, the peripheral speed of the outer peripheral surface of the winding bobbin 22 at the central position thereof in the rotational-axis direction and the peripheral speed of the outer peripheral surface of the package 30 at the central position thereof in the rotational-axis direction are referred to collectively as "package-center-diameter peripheral speed (first peripheral speed)".

[0051] The package drive control section 57 controls the rotational speed of the package drive motor 41 such that the yarn speed of the yarn 20 to be wound around the winding bobbin 22 or the package 30 becomes a predetermined yarn speed. For example, based on the diameter of the winding bobbin 22 or the package 30 at the central position thereof in the rotational-axis direction, the package drive control section 57 can calculate the rotational speed of the package drive motor 41 for achieving the predetermined yarn speed. The package drive control section 57 can calculate the diameter of the winding bobbin 22 or the package 30 at the central position in the rotational-axis direction on the basis of a known method.

[0052] As one example, at the time of start of winding the yarn 20, the package drive control section 57 may calculate the diameter of the winding bobbin 22 at the central position in the rotational-axis direction on the basis of information that identifies the shape of the winding bobbin 22 set in advance in the package-peripheral-speed acquisition section 51. As one example, after the start of winding the yarn 20, the package drive control section 57 may calculate the diameter of the package 30 on the basis of the yarn speed detected by the photoelectric length measuring device 15 and the rotational speed detected by the rotational speed sensor 24. When using the yarn speed detected by the photoelectric length measuring device 15 to calculate the diameter of the package 30, the package drive control section 57 can perform control of adjusting the rotational speed of the package drive motor 41 on the basis of the actual yarn speed of the yarn 20 (what is called feedback control).

[0053] The roller-peripheral-speed calculation section 52 calculates the peripheral speed (second peripheral speed) of the outer peripheral surface of the touch roller 29. As one example, the roller-peripheral-speed calculation section 52 can calculate the peripheral speed of the outer peripheral surface of the roller-peripheral-speed calculation section 52 on the basis of the diameter of the touch roller 29 and the rotational speed detected by the rotational speed sensor 31. The diameter of the touch roller 29 is set in advance in the roller-peripheral-speed calculation section 52. Hereinafter, the peripheral speed of the outer peripheral surface of the touch roller 29 is referred to as "touch-roller peripheral speed (second peripheral speed)".

[0054] The contact-state determination section 53 compares the package-center-diameter peripheral speed acquired by the package-peripheral-speed acquisition section 51 and the touch-roller peripheral speed calculated by the roller-peripheral-speed calculation section 52, thereby determining the contact state of the winding bobbin 22 or the package 30 that is in contact with the touch roller 29. Herein, the contact-state determination section 53 determines, as the contact state, whether the base-end portion of the winding bobbin 22 or the package 30 is in contact with the touch roller 29, whether the top-end portion is in contact with the touch roller 29, and whether a central portion between the base-end portion and the top-end portion is in contact with the touch roller 29.

[0055] Herein, if the winding bobbin 22 or the package 30 that is rotating is in contact with the touch roller 29, the touch-roller peripheral speed is different between when the outer peripheral surface of the base-end portion of the winding bobbin 22 or the package 30 is in contact with the touch roller 29 and when the outer peripheral surface of the top-end portion of the winding bobbin 22 or the package 30 is in contact with the touch roller 29. In this manner, even if the rotational speed of the winding bobbin 22 or the package 30 is constant, the touch-roller peripheral speed changes depending on such contact portions of the winding bobbin 22 or the package 30 that is in contact with the touch roller 29. Thus, the contact-state determination section 53 compares the package-center-diameter peripheral speed and the touch-roller peripheral speed, thereby being able to determine which portion of the winding bobbin 22 or the package 30 is in contact with the touch roller 29, that is, the contact state of the winding bobbin 22 or the package 30.

[0056] Specifically, at the time of start of winding the yarn 20, if the touch-roller peripheral speed and the package-center-diameter peripheral speed satisfy Formula (1) below, the contact-state determination section 53 determines that the base-end portion 22a of the winding bobbin 22 is in contact with the touch roller 29 as illustrated in FIG. 4(a). Similarly, after the start of winding the yarn 20, if the touch-roller peripheral speed and the package-center-diameter peripheral speed satisfy Formula (1) below, the contact-state determination section 53 determines that the base-end portion of the package 30 is in contact with the touch roller 29.

$$\text{Touch-roller peripheral speed} \;/\; \text{Package-center-diameter peripheral speed} > 1 \quad \ldots(1)$$

[0057] At the time of start of winding yarn 20, if the touch-roller peripheral speed and the package-center-diameter peripheral speed satisfy Formula (2) below, the contact-state determination section 53 determines that the outer peripheral surface of the winding bobbin 22 at the central position thereof in the rotational-axis direction is in contact with the

touch roller 29 as illustrated in FIG. 4(b). Similarly, after the start of winding yarn 20, if the touch-roller peripheral speed and the package-center-diameter peripheral speed satisfy Formula (2) below, the contact-state determination section 53 determines that the outer peripheral surface of the package 30 at the central position thereof in the rotational-axis direction is in contact with the touch roller 29.

$$\text{Touch-roller peripheral speed} / \text{Package-center-diameter peripheral speed} = 1 \quad \ldots(2)$$

[0058] At the time of start of winding yarn 20, if the touch-roller peripheral speed and the package-center-diameter peripheral speed satisfy Formula (3) below, the contact-state determination section 53 determines that the top-end portion 22b of the winding bobbin 22 is in contact with the touch roller 29 as illustrated in FIG. 4 (c). Similarly, after the start of winding yarn 20, if the touch-roller peripheral speed and the package-center-diameter peripheral speed satisfy Formula (3) below, the contact-state determination section 53 determines that the top-end portion of the package 30 is in contact with the touch roller 29.

$$\text{Touch-roller peripheral speed} / \text{Package-center-diameter peripheral speed} < 1 \quad \ldots(3)$$

[0059] The contact-state determination section 53 further determines the contact state on the basis of temporal variation in difference between the yarn speed of the yarn 20 detected by the photoelectric length measuring device 15 and the touch-roller peripheral speed calculated by the roller-peripheral-speed calculation section 52. Herein, the contact-state determination section 53 determines, as the contact state, whether the clearance between the top-end portion of the package 30 and the touch roller 29 is wide or narrow in a state in which the base-end portion thereof is in contact with the touch roller 29. Similarly, the contact-state determination section 53 determines, as the contact state, whether the clearance between the base-end portion of the package 30 and the touch roller 29 is wide or narrow in a state in which the top-end portion thereof is in contact with the touch roller 29.

[0060] Herein, for example, as illustrated in FIGs. 5, when the base-end portion 22a of the winding bobbin 22 is in contact with the touch roller 29, a layer of yarn 20 (the amount of yarn) between the winding bobbin 22 and the touch roller 29 increases as the yarn 20 is wound. Because the winding bobbin 22 and the package 30 each have a cone shape and the peripheral speed is different between on the base-end side and on the top-end side, the outer peripheral surface of the package 30 and the outer peripheral surface of the touch roller 29 are in contact with each other at one point (contact point). Furthermore, as the layer of yarn 20 increases, the contact point between the outer peripheral surface of the package 30 and the touch roller 29 moves toward the central position (central position in the rotational-axis direction) of the outer peripheral surface of the package 30. The speed of the movement of the contact point changes depending on the speed at which the clearance between the winding bobbin 22 and the touch roller 29 is filled with the yarn.

[0061] Specifically, for example, a state is assumed in which the base-end portion 22a of the winding bobbin 22 is in contact with the touch roller 29. In this state, when the clearance between the winding bobbin 22 and the touch roller 29 is wide (when a space between the top-end portion 22b of the winding bobbin 22 and the outer peripheral surface of the touch roller 29 is wide), the movement of the contact point is slower than when the clearance between the winding bobbin 22 and the touch roller 29 is narrow (the space between the top-end portion 22b and the outer peripheral surface of the touch roller 29 is narrow) . Specifically, when the clearance between the winding bobbin 22 and the touch roller 29 is wide as illustrated in FIG. 5(a), the speed at which the clearance is filled with the yarn 20 is slower than when the clearance between the winding bobbin 22 and the touch roller 29 is narrow as illustrated in FIG. 4(a), and accordingly the movement of the contact point is slower.

[0062] Similarly, a state is assumed in which the top-end portion 22b of the winding bobbin 22 is in contact with the touch roller 29. In this state, when the clearance between the winding bobbin 22 and the touch roller 29 is wide (when a space between the base-end portion 22a of the winding bobbin 22 and the outer peripheral surface of the touch roller 29 is wide), the movement of the contact point is slower than when the clearance between the winding bobbin 22 and the touch roller 29 is narrow (when the space between the base-end portion 22a and the outer peripheral surface of the touch roller 29 is narrow) . Specifically, when the clearance between the winding bobbin 22 and the touch roller 29 is wide as illustrated in FIG. 5(b), the speed at which the clearance is filled with the yarn 20 is slower than when the clearance between the winding bobbin 22 and the touch roller 29 is narrow as illustrated in FIG. 4 (c), and accordingly the movement of the contact point is slower.

[0063] Because the yarn 20 is wound while being traversed between the base-end portion and the top-end portion of

the package 30, the package-center-diameter peripheral speed corresponds to the average yarn speed of the yarn 20 (the average traveling speed of the yarn 20). Thus, when the contact point has moved near the central position of the outer peripheral surface of the package 30, the touch-roller peripheral speed becomes substantially the same as the package-center-diameter peripheral speed. In other words, the touch-roller peripheral speed becomes substantially the same as the average yarn speed of the yarn 20. It should be noted that the touch-roller peripheral speed and the package-center-diameter peripheral speed do not become the same technically due to occurrence of slippage between the package 30 and the touch roller 29, for example.

[0064] In this manner, as the yarn 20 is wound around the winding bobbin 22, the touch-roller peripheral speed converges to the yarn speed of the yarn 20. The speed at which the touch-roller peripheral speed converges to the yarn speed of the yarn 20 changes depending on the clearance size between the winding bobbin 22 and the touch roller 29, that is, the state of inclination of the rotation shaft of the winding bobbin 22 (package 30) with respect to the rotation shaft of the touch roller 29.

[0065] Herein, FIG. 6 illustrates variation in touch-roller peripheral speed when the yarn 20 is wound in the states illustrated in FIG. 4(a), FIG. 4(c), FIG. 5(a), and FIG. 5(b). The curve L1 given in FIG. 6 represents variation in peripheral speed when yarn 20 is wound in the state illustrated in FIG. 5(a). The curve L2 given in FIG. 6 represents variation in peripheral speed when yarn 20 is wound in the state illustrated in FIG. 4(a). The curve S1 given in FIG. 6 represents variation in peripheral speed when yarn 20 is wound in the state illustrated in FIG. 5(b). The curve S2 given in FIG. 6 represents variation in peripheral speed when yarn 20 is wound in the state illustrated in FIG. 4(c).

[0066] As described above, for example, even if the base-end portion of the package 30 is in contact with the touch roller 29, depending on the state of inclination of the winding bobbin 22 (package 30) with respect to the touch roller 29, time required for the touch-roller peripheral speed to converge to the average yarn speed of the yarn is different as indicated by the curves L1 and L2 in FIG. 6. Similarly, even if the top-end portion of the package 30 is in contact with the touch roller 29, depending on the state of inclination of the winding bobbin 22 (package 30) with respect to the touch roller 29, time required for the touch-roller peripheral speed to converge to the average yarn speed of the yarn is different as indicated by the curves S1 and S2 in FIG. 6.

[0067] Thus, based on how much closer the touch-roller peripheral speed has converged to the yarn speed of yarn 20 after a lapse of a predetermined period of time from the start of the winding of the yarn 20, the contact-state determination section 53 can determine the state of inclination of the winding bobbin 22 (package 30) with respect to the touch roller 29, that is, the contact state. Herein, the contact-state determination section 53 can also determine which of the base-end portion and the top-end portion of the package 30 is in contact with the touch roller 29 on the basis of whether the touch-roller peripheral speed after a lapse of a predetermined period of time from the start of winding yarn 20 is higher or lower than the yarn speed of yarn 20. Specifically, if the touch-roller peripheral speed is higher than the yarn speed of yarn 20, the contact-state determination section 53 determines that the base-end portion of the package 30 is in contact therewith. If the touch-roller peripheral speed is lower than the yarn speed of yarn 20, the contact-state determination section 53 determines that the top-end portion of the package 30 is in contact therewith.

[0068] As described above, the contact-state determination section 53 compares the touch-roller peripheral speed and the package-center-diameter peripheral speed, thereby determining, as the contact state, which of the base-end-portion, the top-endportion, and the central position of the winding bobbin 22 or the package 30 is in contact with the touch roller 29. The contact-state determination section 53 can make this determination in both cases of at the time of start of winding the yarn 20 and after the start of winding the yarn 20. The contact-state determination section 53 determines, as the contact state, the state of inclination of the winding bobbin 22 (package 30) with respect to the touch roller 29 on the basis of temporal variation in difference between the average yarn speed of the yarn 20 and the touch-roller peripheral speed. The contact-state determination section 53 can make this determination after a lapse of a predetermined period of time from the start of winding the yarn 20.

[0069] The notification determination section 54 determines whether the contact state determined by the contact-state determination section 53 is a predetermined contact state to be notified. The notification determination section 54 uses, as the predetermined contact state to be notified, a contact state to be notified set in the setting section 91. The contact state to be notified includes at least either one of the base-end portion, the top-end portion, and the central position of the winding bobbin 22 or the package 30 is in contact with the touch roller 29 and the state of inclination of the winding bobbin 22 (package 30) with respect to the touch roller 29.

[0070] In the present embodiment, as one example of the contact state to be notified, the state in which the top-end portion of the winding bobbin 22 or the package 30 is in contact with the touch roller 29 and the state in which a central portion of the winding bobbin 22 or the package 30 is in contact with the touch roller 29 are set. Furthermore, as one example of the contact state to be notified, the state of inclination of the package 30 is set in which the base-end portion of the package 30 is in contact with the touch roller 29 and the clearance between the top-end portion of the package 30 and the outer peripheral surface of the touch roller 29 is equal to or larger than a predetermined value.

[0071] The notification instruction section 55 provides notification by activating the speaker 93 when the notification determination section 54 has determined that the contact state of the winding bobbin 22 or the package 30 is the contact

state to be notified. In this manner, the notification instruction section 55 and the speaker 93 function as a notification section configured to provide notification when the notification determination section 54 has determined that the contact state thereof is the contact state to be notified.

[0072] The storage section 56 stores identification information for identifying the package 30 and the contact state of the package 30 determined by the contact-state determination section 53 in a manner associated with each other. The storage section 56 can use, as the identification information for the package 30, identification information provided by a known method, such as identification information provided by the unit controller 50 for managing eachpackage 30. As described above, the storage section 56 stores in advance the shape of the winding bobbin 22 for each type of the winding bobbin 22. As described above, the storage section 56 may store, for each shape of the winding bobbin 22, peripheral-speed information in which the shape of the winding bobbin 22 is associated with the peripheral speed of the outer peripheral surface of the winding bobbin 22 at a predetermined position.

[0073] The unit controller 50 controls motion of the traverse drive motor 76 in addition to the above-described determination of the contact state and the like. The unit controller 50 further controls catching motion of the lower-yarn catching member 25 and the upper-yarn catching member 26 (swinging of the lower-yarn pipe arm 33 and the upper-yarn pipe arm 36). The unit controller 50 controls opening and closing of the shutters provided to the lower-yarn pipe arm 33 and the upper-yarn pipe arm 36 to control stoppage and generation of suction flows from the lower-yarn suction port 32 and the upper-yarn suction port 35.

[0074] As described in the foregoing, in each winder unit 10 of the present embodiment, the contact-state determination section 53 compares the package-center-diameter peripheral speed and the touch-roller peripheral speed, thereby being able to determine which portion of the winding bobbin 22 or the package 30 is in contact with the touch roller 29, that is, the contact state of the winding bobbin 22 or the package 30. In this manner, the winder unit 10 can determine the contact state of the winding bobbin 22 or the package 30 that is in contact with the touch roller 29.

[0075] The package-peripheral-speed acquisition section 51 can obtain the peripheral speed of the outer peripheral surface of the winding bobbin 22 or the package 30 at the predetermined position on the basis of the peripheral-speed calculation information for calculating the peripheral speed. In this case, the package-peripheral-speed acquisition section 51 can acquire, by computation, the peripheral speed of the outer peripheral surface of the winding bobbin 22 or the package 30 at the predetermined position.

[0076] The peripheral-speed calculation information may contain at least one of the shape of the winding bobbin 22, the rotational speed of the winding bobbin 22, and the average yarn speed of the yarn 20 to be wound. In this case, the package-peripheral-speed acquisition section 51 can accurately calculate the peripheral speed using these values.

[0077] The package-peripheral-speed acquisition section 51 may acquire, from the storage section 56, the peripheral speed corresponding to the shape of the bobbin that is identified by the bobbin information input in the setting section 91. In this case, the package-peripheral-speed acquisition section 51 can acquire the peripheral speed from the storage section 56 without performing computation.

[0078] When the notification determination section 54 has determined that the contact state is the contact state to be notified, the notification instruction section 55 provides notification by outputting a sound from the speaker 93. In this case, the operator of the winder unit 10 can grasp the contact state of the winding bobbin 22 or the package 30 on the basis of the sound output from the speaker 93. The operator can make operations such as adjusting the contact state of the winding bobbin 22 or the package 30 or stopping winding of the yarn 20.

[0079] The winder unit 10 includes the setting section 91 for inputting the contact state to be notified. In this case, the operator of the winder unit 10 can use the setting section 91 to set the contact state to be notified. The operator of the winder unit 10 can change the contact state to be notified according to the type of the yarn 20 to be wound, for example.

[0080] Depending on the state of inclination of the winding bobbin 22 with respect to the touch roller 29, the speed of movement of the contact point that moves toward the central position of the outer peripheral surface of the package 30 changes . In other words, the speed when the touch-roller peripheral speed converges to the yarn speed of yarn 20 is different. Thus, based on temporal variation in difference between the yarn speed and the touch-roller peripheral speed, the contact-state determination section 53 can determine the state of inclination of the winding bobbin 22 with respect to the touch roller 29, that is, the contact state of the package 30 with respect to the touch roller 29.

[0081] The storage section 56 stores identification information of the package 30 and the contact state of the package 30 determined by the contact-state determination section 53 in a manner associated with each other. In this case, even after the package 30 has been formed, the operator or the like of the winder unit 10 can check the contact state when the yarn 20 was being wound around the package 30 on the basis of information stored in the storage section 56.

[0082] Although the embodiment of the present disclosure and modifications thereof have been described above, the present disclosure is not limited to the embodiment and the modifications. The present disclosure may be modified within the scope not changing the gist described in each claim. The embodiment and the modifications may be used in combination as appropriate.

[0083] For example, there are occasions in which the central axis defined by the outer peripheral surface of the winding bobbin 22 and the rotation shaft of the winding bobbin 22 are displaced from each other due to, for example, distortion

of the winding bobbin 22. In this case, the outer peripheral surface of the winding bobbin 22 intermittently comes into contact with the outer peripheral surface of the touch roller 29, and the peripheral speed of the touch roller 29 does not increase. Thus, if touch-roller peripheral speed does not become equal to or higher than the predetermined value even after a lapse of the predetermined period of time, the contact-state determination section 53 may determine that the winding bobbin 22 is distorted.

[0084] The traverse device 70 does not necessarily have to be configured to traverse the yarn 20 by swinging the traverse arm 74 in a reciprocating manner. For example, the traverse device 70 may be configured to traverse the yarn 20 by reciprocating the yarn guiding section 73 by belt driving.

[0085] When the notification determination section 54 has determined that the contact state is the contact state to be notified, the package drive control section 57 may stop winding the yarn 20. The notification instruction section 55 may provide notification by changing a display mode of the display section 92 in addition to the speaker 93 or instead of the speaker 93.

[0086] The cradle 23 may have a mechanism of, based on the contact state determined by the contact-state determination section 53, changing the angle of the winding bobbin 22 such that it becomes a predetermined contact state.

[0087] Herein, the winder unit 10 does not necessarily have to provide notification based on a determination result of the contact state. The winder unit 10 may only determine the contact state, or may only store the determined contact state and the identification information of the package 30 in a manner associated with each other. The contact state to be notified that the notification determination section 54 uses in determination does not have to be changeable by the setting section 91. In this case, the notification determination section 54 may use the predetermined contact state as the contact state to be notified. The contact-state determination section 53 does not have to determine the contact state on the basis of temporal variation in difference between the yarn speed of the yarn 20 and the touch-roller peripheral speed. The winder unit 10 does not have to include the storage section 56 configured to store identification information of the package 30 and the contact state thereof in a manner associated with each other.

[0088] The package-peripheral-speed acquisition section 51 acquires, as the peripheral speeds of the winding bobbin 22 and the package 30 at the predetermined positions in the rotational-axis direction, the respective peripheral speeds of the outer peripheral surfaces thereof at central positions in the rotational-axis direction. Without being limited to this, the package-peripheral-speed acquisition section 51 may acquire, as the peripheral speeds of the winding bobbin 22 and the package 30 at the predetermined positions in the rotational-axis direction, the respective peripheral speeds (first peripheral speed) of the outer peripheral surfaces thereof at predetermined positions between the base-end portion and the top-end portion.

Reference Signs List

[0089] 10... winder unit (yarn winding device), 15... photoelectric length measuring device (yarn-speed detection section), 20... yarn, 22... winding bobbin (bobbin), 29... touch roller, 30... package, 41... package drive motor (driving section), 51... package-peripheral-speed acquisition section, 52... roller-peripheral-speed calculation section, 53... contact-state determination section, 54... notification determination section, 55... notification instruction section (notification section), 56... storage section (peripheral-speed-information storage section, contact-state storage section), 70... traverse device, 73... yarn guiding section, 91... setting section (bobbin-information input section, contact-state input section), 93... speaker (notification section), B1... first bobbin holding portion (bobbin holding portion)

Claims

1. A yarn winding device configured to wind yarn onto a cone-shaped bobbin to form a cone-shaped package, the yarn winding device comprising:

   a cradle configured to rotatably support the bobbin with a bobbin holding portion configured to hold the bobbin;
   a driving section attached to the cradle, having a rotation shaft that is coupled to the bobbin holding portion in an integrally rotatable manner, and configured to rotate the bobbin holding portion thereby rotating the bobbin;
   a traverse device configured to move a yarn guiding section on which the yarn is hooked, thereby traversing the yarn to be wound around the bobbin or the package;
   a package-peripheral-speed acquisition section configured to acquire, as a first peripheral speed, a peripheral speed of an outer peripheral surface of the bobbin or the package at a predetermined position in a rotational-axis direction of the bobbin;
   a touch roller configured to come into contact with the outer peripheral surface of the bobbin or the package and to be rotated by rotation of the bobbin or the package;
   a roller-peripheral-speed calculation section configured to calculate, as a second peripheral speed, a peripheral

speed of an outer peripheral surface of the touch roller; and
a contact-state determination section configured to compare the first peripheral speed acquired by the package-peripheral-speed acquisition section and the second peripheral speed calculated by the roller-peripheral-speed calculation section, thereby determining a contact state of the bobbin or the package that is in contact with the touch roller.

2. The yarn winding device according to claim 1, wherein the package-peripheral-speed acquisition section obtains the first peripheral speed that is the peripheral speed of the outer peripheral surface of the bobbin or the package at the predetermined position by computation based on peripheral-speed calculation information for calculating the peripheral speed.

3. The yarn winding device according to claim 2, wherein the peripheral-speed calculation information contains at least one of a shape of the bobbin, a rotational speed of the bobbin, and a yarn speed of the yarn to be wound.

4. The yarn winding device according to claim 1, further comprising:

a bobbin-information input section into which bobbin information for identifying the shape of the bobbin is input; and
a peripheral-speed-information storage section configured to store, for each shape of the bobbin, peripheral-speed information in which the shape of the bobbin is associated with the peripheral speed of the outer peripheral surface of the bobbin at the predetermined position, wherein
the package-peripheral-speed acquisition section acquires, from the peripheral-speed-information storage section, the peripheral speed corresponding to the shape of the bobbin that is identified by the bobbin information input in the bobbin-information input section as the first peripheral speed.

5. The yarn winding device according to any one of claims 1 to 4, further comprising:

a notification determination section configured to determine whether the contact state determined by the contact-state determination section is a predetermined contact state to be notified; and
a notification section configured to provide notification when the notification determination section has determined that the contact state determined is the contact state to be notified.

6. The yarn winding device according to claim 5, further comprising a contact-state input section into which the contact state to be notified is input, wherein
the notification determination section uses the contact state to be notified input in the contact-state input section as the predetermined contact state to be notified.

7. The yarn winding device according to any one of claims 1 to 6, further comprises a yarn-speed detection section configured to detect the yarn speed of the yarn to be wound around the bobbin or the package, wherein
the contact-state determination section further determines the contact state, based on temporal variation in difference between the yarn speed detected by the yarn-speed detection section and the second peripheral speed calculated by the roller-peripheral-speed calculation section.

8. The yarn winding device according to any one of claims 1 to 7, further comprising a contact-state storage section configured to store identification information for identifying the package and the contact state of the package determined by the contact-state determination section in a manner associated with each other.

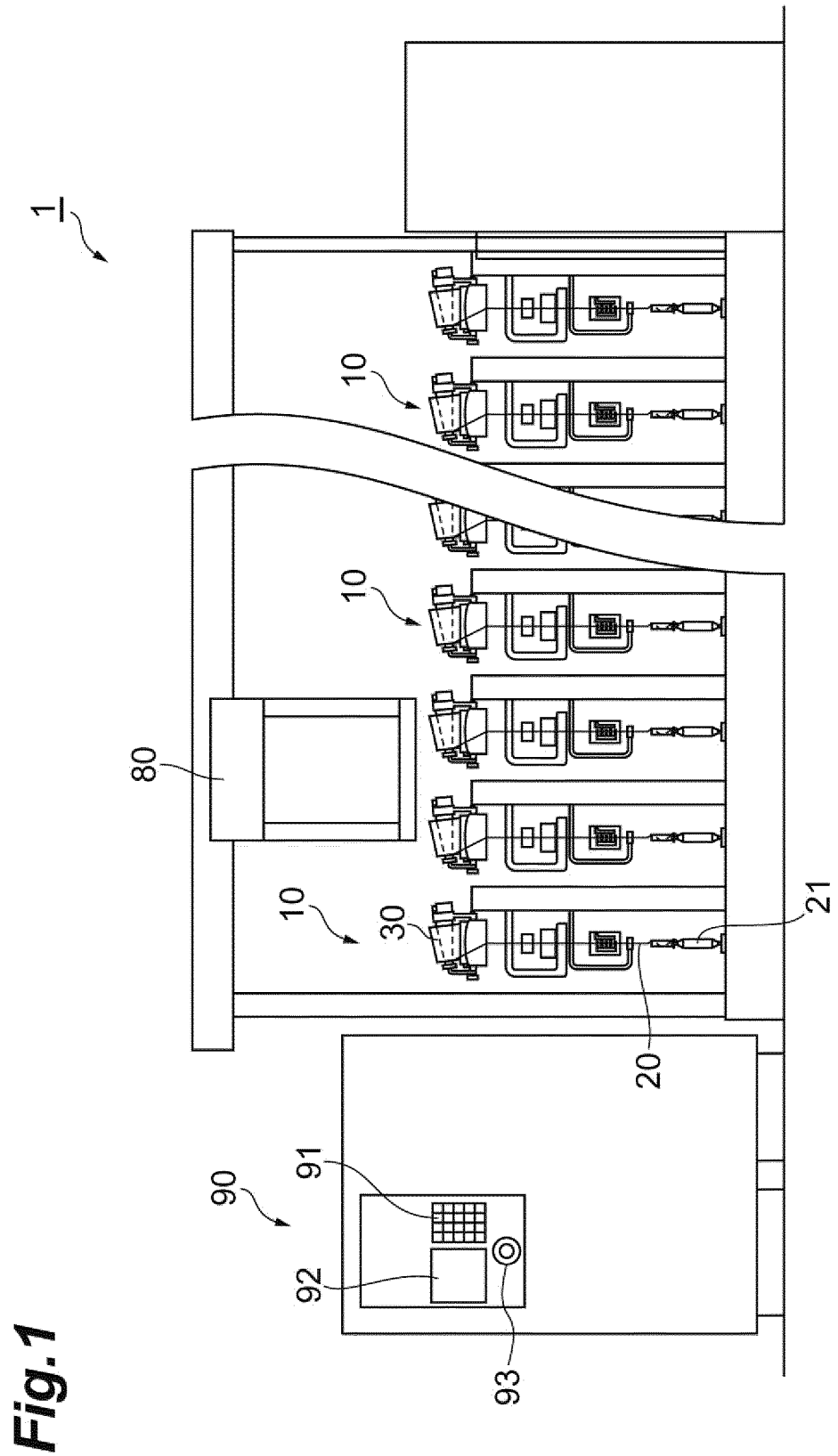
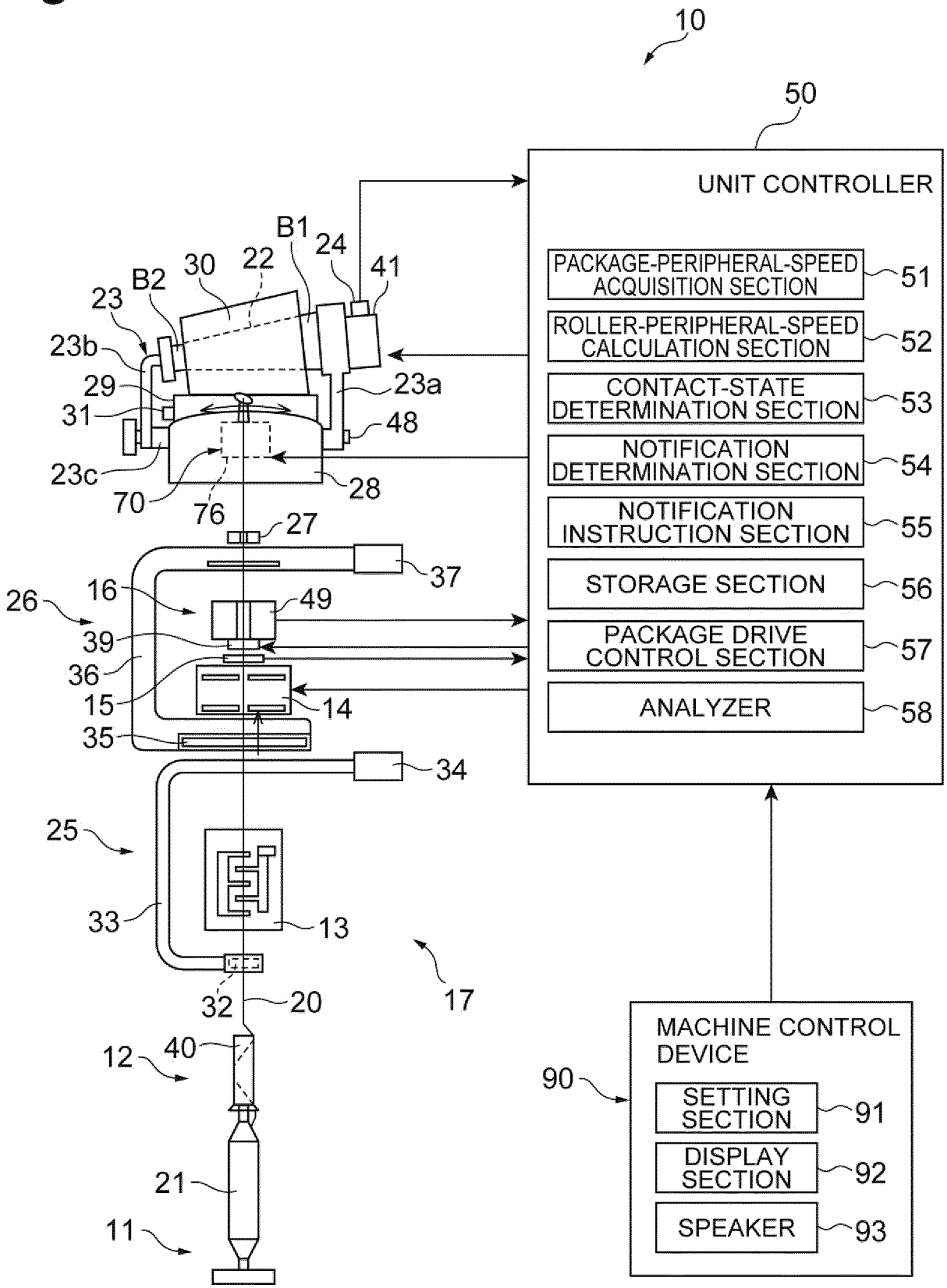


Fig.1

Fig.2


10
50
UNIT CONTROLLER
PACKAGE-PERIPHERAL-SPEED ACQUISITION SECTION
51
ROLLER-PERIPHERAL-SPEED CALCULATION SECTION
52
CONTACT-STATE DETERMINATION SECTION
53
NOTIFICATION DETERMINATION SECTION
54
NOTIFICATION INSTRUCTION SECTION
55
STORAGE SECTION
56
PACKAGE DRIVE CONTROL SECTION
57
ANALYZER
58
B1
24
41
30
22
B2
23
23b
29
31
23a
48
23c
70
76
28
27
37
26
16
49
39
36
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13
17
32
20
12
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21
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MACHINE CONTROL DEVICE
90
SETTING SECTION
91
DISPLAY SECTION
92
SPEAKER
93

Fig.3

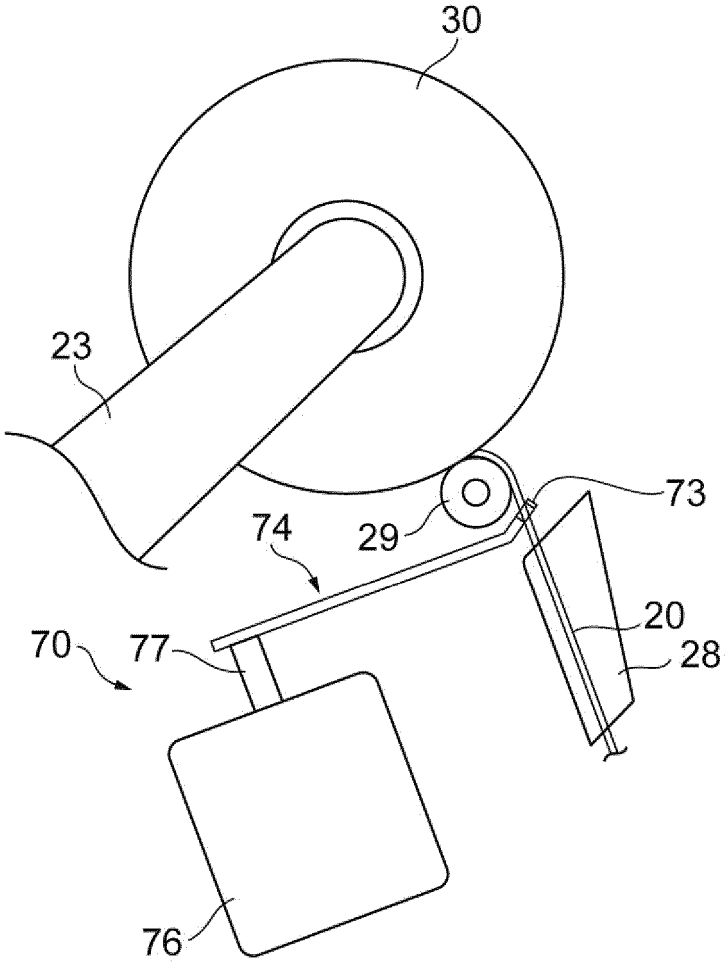


Fig.4

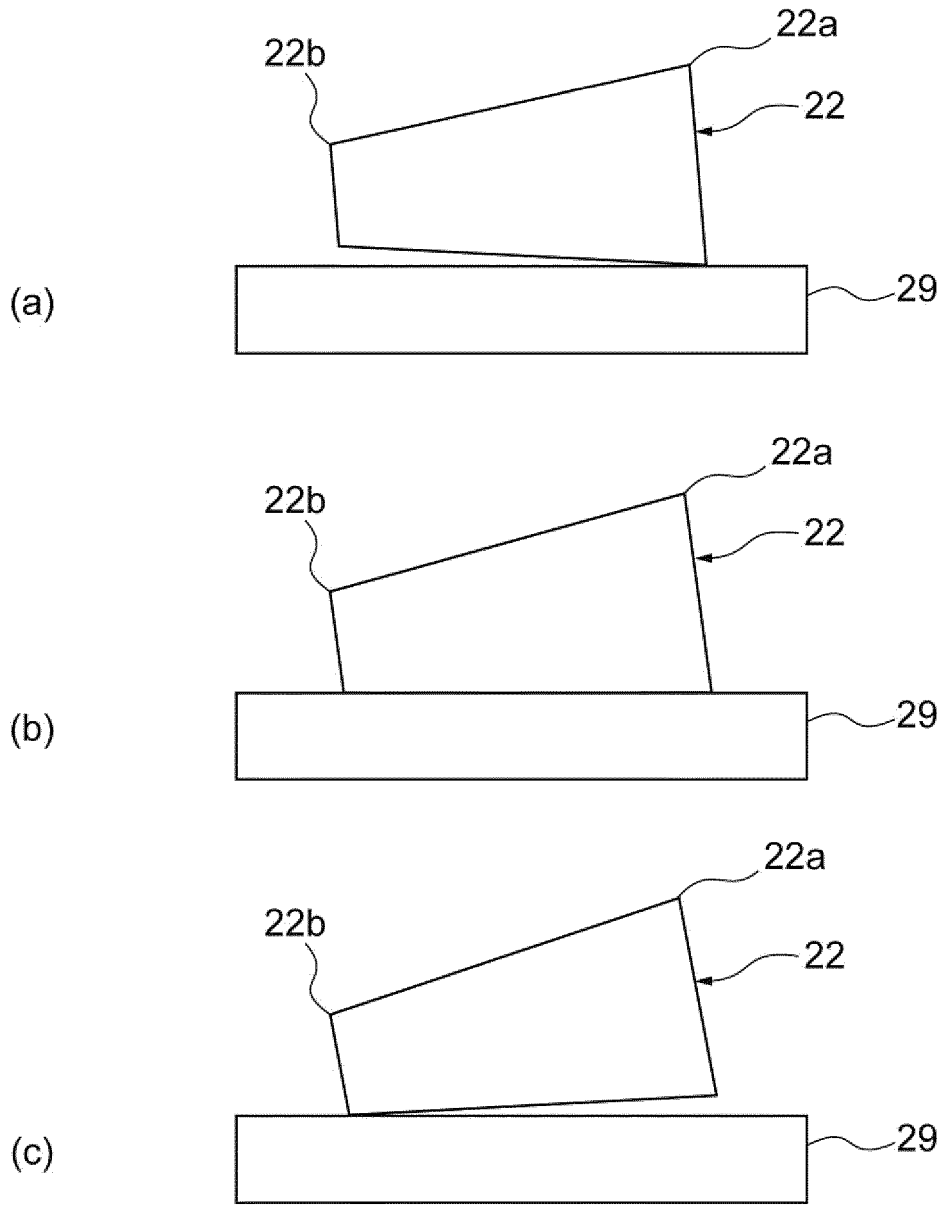
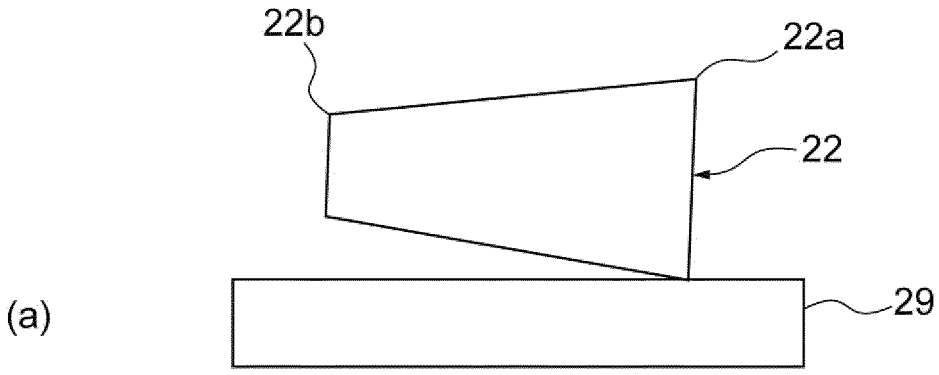


Fig.5



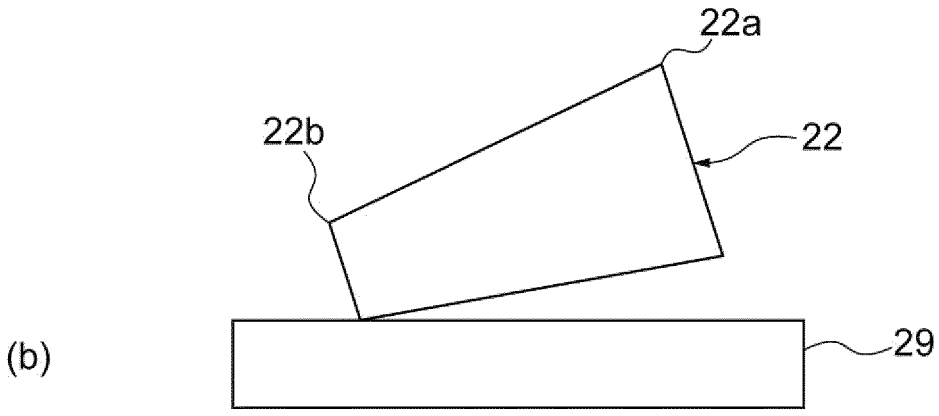
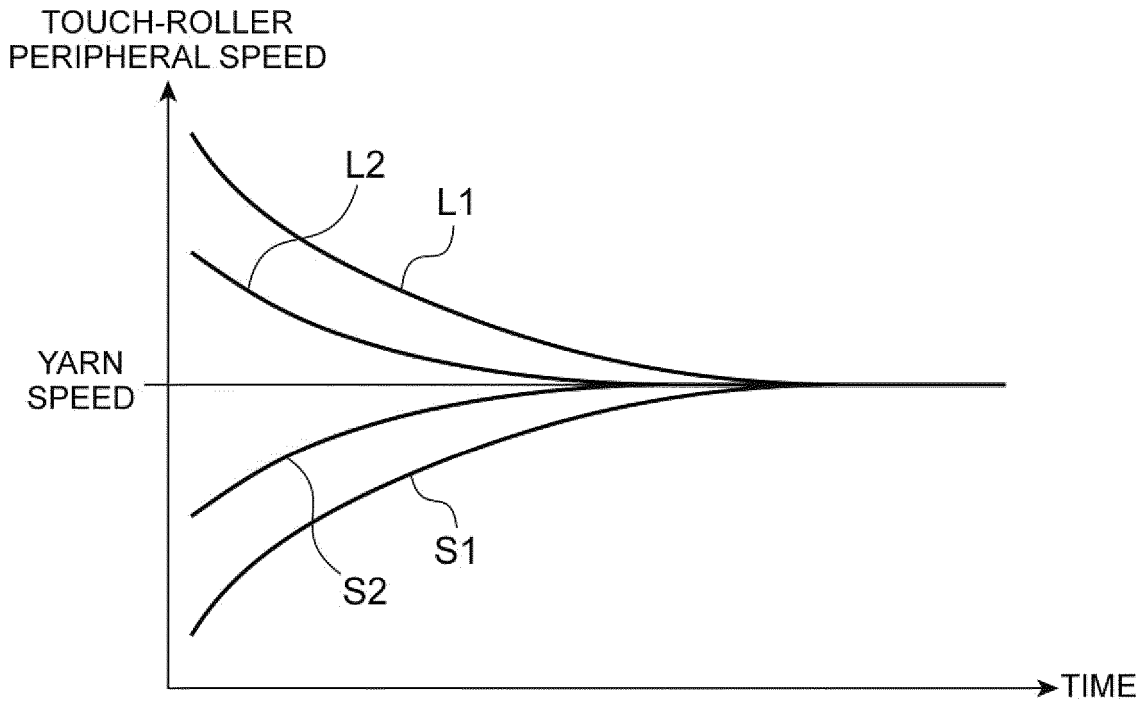


Fig.6



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2018/032615

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl. B65H54/02(2006.01)i, B65H63/00(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int. Cl. B65H54/02, B65H61/00-63/08

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 1971-2018
Registered utility model specifications of Japan 1996-2018
Published registered utility model applications of Japan 1994-2018

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.
A	JP 2013-199339 A (MURATA MACHINERY LTD.) 03 October 2013 & EP 2641859 A1 & CN 103318706 A	1-8
A	JP 2012-224436 A (MURATA MACHINERY LTD.) 15 November 2012 & EP 2514699 A2 & CN 102745545 A	1-8
A	JP 61-221061 A (TEIJIN SEIKI CO., LTD.) 01 October 1986 & US 4685629 A & EP 196090 A2	1-8

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"P" document published prior to the international filing date but later than the priority date claimed
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26.09.2018	09.10.2018

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

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

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2014108844 A **[0003]**