



(12) **EUROPEAN PATENT APPLICATION**

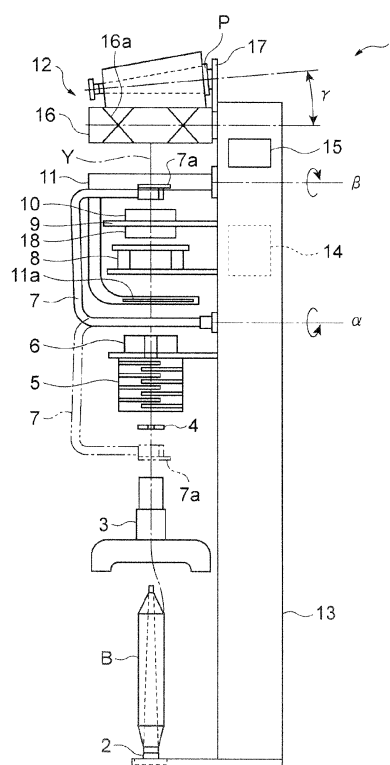
- (43) Date of publication: **29.01.2014 Bulletin 2014/05**
- (51) Int Cl.: **B65H 54/10 (2006.01) B65H 63/00 (2006.01)**
B65H 63/04 (2006.01)
- (21) Application number: **13177801.1**
- (22) Date of filing: **24.07.2013**

- | | |
|---|--|
| <p>(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME</p> <p>(30) Priority: 27.07.2012 JP 2012167283
11.03.2013 JP 2013048113</p> <p>(71) Applicant: Murata Machinery, Ltd.
Minami-ku
Kyoto-shi
Kyoto 601-8326 (JP)</p> | <p>(72) Inventor: Ikkai, Tomoyuki
Kyoto-shi,
Kyoto, 612-8686 (JP)</p> <p>(74) Representative: Stöckeler, Ferdinand
Patentanwälte SCHOPPE, ZIMMERMANN,
STÖCKELER, ZINKLER & PARTNER
P.O. Box 246
82043 Pullach (DE)</p> |
|---|--|

- (54) **Driving state detecting device, winding unit, winding machine, spinning unit, and spinning machine**

(57) A configuration is made which comprises a driving state calculation value calculating section 23 adapted to calculate a calculation value relating to a driving state of a cone-shaped package that rotates by abutting against an outer peripheral surface of a winding drum rotating around an axial line and into which a traversed yarn is wound, and a comparing and detecting section 24 adapted to compare or enable to be compared the calculation value calculated by the driving state calculation value calculating section 23 with a determination reference value.

FIG. 1



Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a driving state detecting device, a winding unit, a winding machine, a spinning unit, and a spinning machine.

2. Description of the Related Art

[0002] Conventionally, there is a method in which a yarn is wound by rotating a cone-shaped package while bringing the package into a contact with a traverse drum where a traverse groove is engraved on an outer surface thereof (see Japanese Unexamined Patent Application Publication No. H4-217557, for example). In an art described in Japanese Unexamined Patent Application Publication No. H4-217557, by displacing a reference drive diameter of the package in an axial direction and immediately changing a rotation speed of the package, a ribbon winding is avoided. This art is based on the condition that there is a contact point (driving point), in which the traverse drum drives the package, on the reference drive diameter (a package average diameter) in proximity of a center in the axial direction.

SUMMARY OF THE INVENTION

[0003] When transmitting drive force of the traverse drum and winding the cone-shaped package, the rotation speed of the package varies according to a position of the driving point in which the traverse drum and the package make contact with each other and the drive force of the traverse drum is transmitted to the package. Thus, even when a rotation speed of the traverse drum is the same, a speed of a wound yarn is different. When a winding condition is different in some of winding units that are arranged next to each other, it is difficult to form packages having the same quality.

[0004] It is an object underlying the invention to provide for driving state detecting devices, a winding unit, a winding machine, a spinning unit and a spinning machine, which permit for improving the quality of a package.

To uniformize quality of the package by equalizing variation tendencies of package drive diameters, which is an outer diameter of the package at the driving point, among a plurality of the winding units, it is required to calculate a package average diameter. Accordingly, embodiments of the present invention provide a driving state detecting device, a winding unit, a winding machine, a spinning unit, and a spinning machine that are capable of calculating the package average diameter.

[0005] Additionally, embodiments of the present invention provide the driving state detecting device, the winding unit, the winding machine, the spinning unit, and the spinning machine that are capable of improving the quality of the package by comparing a calculation value relating to a driving state of the cone-shaped package with a determination reference value and by recognizing the driving state of the cone-shaped package.

[0006] An embodiment of a driving state detecting device of the present invention includes a driving state calculation value calculating section adapted to calculate a calculation value relating to a driving state of a cone-shaped package that rotates by abutting against an outer peripheral surface of a winding drum rotating around an axial line and into which a traversed yarn is wound, and a comparing and detecting section adapted to compare or enable to be compared the calculation value calculated by the driving state calculation value calculating section with a determination reference value.

[0007] Since in the driving state detecting device, the calculation value can be calculated, which relates to the driving state of the cone-shaped package that rotates by abutting against the outer peripheral surface of the winding drum rotating around the axial line and into which the traversed yarn is wound, and the calculated calculation value can be compared or is enabled to be compared with the determination reference value, an operator can recognize the driving state of the cone-shaped package and improve quality of the package. The comparing and detecting section may compare the calculation value with the determination reference value by a unit in which arithmetic processing is performed, or may enable the calculation value and the determination reference value to be compared with each other by the operator by outputting information for comparing the calculated value with the determination reference value.

[0008] An embodiment of a driving state detecting device of the present invention includes a package peripheral speed detecting section adapted to detect a peripheral speed V_P of the cone-shaped package, a package rotation speed detecting section adapted to detect a rotation speed F_P of the package, and an average diameter calculating section adapted to calculate a package average diameter D_{PA} , which is an average outer diameter of the package, as the determination reference value. The driving state calculation value calculating section is a drive diameter calculating section adapted to calculate as the calculation value, a package drive diameter D_P , which is an outer diameter of the package at the driving point in which rotation drive force of a winding drum is transmitted. The comparing and detecting section compares or enables to be compared the package drive diameter D_P with the package average diameter D_{PA} .

[0009] In an embodiment of the driving state detecting device, the package average diameter D_{PA} , which is the average outer diameter of the package, is calculated based on the peripheral speed V_P of the package detected by the package peripheral speed detecting section and the rotation speed F_P detected by the package rotation speed detecting section. Accordingly, the package average diameter D_{PA} can be recognized, and by comparing or enabling to be compared the package average diameter D_{PA} with the determination reference value, an abnormality at the driving point can be detected. By detecting and correcting the abnormality at the driving point, an abnormality in winding, or deviation in the winding among a plurality of winding units can be suppressed.

[0010] An embodiment of the driving state detecting device includes a drum rotation speed detecting section adapted to detect a rotation speed F_1 of the winding drum. The driving state calculation value calculating section may calculate the package drive diameter D_P based on the rotation speed F_1 of the winding drum.

[0011] Since the package drive diameter D_P is calculated by use of the rotation speed F_1 of the winding drum that is detected by the drum rotation speed detecting section, calculation accuracy of the package drive diameter D_P is improved.

[0012] In an embodiment, a package reference value is given as one determination reference value. The package reference value may be a small diameter and/or a large diameter of a winding tube around which the yarn is wound.

[0013] In an embodiment, the package reference value is given as one determination reference value. The package reference value may be an outer diameter of the small diameter and/or an outer diameter of the large diameter of the winding tube that is in a winding operation.

[0014] The comparing and detecting section may enable comparison with the determination reference value by detecting a change in the package drive diameter D_P . By detecting a change in the package drive diameter D_P and recognizing a change in the driving point, a winding state of the package can be detected.

[0015] The average diameter calculating section may calculate the package average diameter D_{PA} , which is the average outer diameter of the package, by the following equation (1).

$$\text{Package average diameter } D_{PA} = \frac{\text{Peripheral speed } V_P \text{ of package } P}{(\text{Rotation speed } F_P \text{ of package } P) \times \pi} \dots (1)$$

[0016] The drive diameter calculating section may calculate the package drive diameter D_P by the following equation (2).
Package drive diameter D_P

$$= \frac{\text{Outer diameter } D_1 \text{ of winding drum} \times \text{Rotation speed } F_1 \text{ of winding drum}}{\text{Rotation speed } F_P \text{ of package } P} \dots (2)$$

[0017] An embodiment of the driving state detecting device includes a notifying section adapted to notify information for instructing adjustment of an inclination of a package supporting section adapted to support the package. The comparing and detecting section compares the package drive diameter D_P with the package average diameter D_{PA} and, when the winding state of the package that has been detected in the comparison by the comparing and detecting section deviates from a predefined state, the notifying section may notify the information for instructing the adjustment of the inclination of the package supporting section. Accordingly, since the operator can adjust the inclination of the package in accordance with instruction contents from the notifying section, the abnormality in the winding of the package can be suppressed (resolved).

[0018] At this point, the calculation value relating to the driving state of the cone-shaped package may be a slip ratio of the package with respect to the winding drum.

[0019] In the driving state detecting device, by comparing the slip ratio of the package with the determination reference value, the driving state of the cone-shaped package can be recognized, and the quality of the package can be improved.

[0020] In an embodiment, the driving state detecting device includes a drum peripheral speed detecting section adapted to detect a peripheral speed V_D of the winding drum, and the package peripheral speed detecting section adapted to detect the peripheral speed V_P of the package. The driving state calculation value calculating section is a package slip ratio calculating section adapted to calculate the slip ratio of the package based on the peripheral speed V_D of the winding drum and the peripheral speed V_P of the package.

[0021] The driving state detecting device may include the notifying section adapted to notify information relating to the slip ratio of the package.

[0022] The driving state detecting device may include the notifying section adapted to notify the calculation value and

the determination reference value that have been enabled by the comparing and detecting section to be compared with each other, or a comparison result from the comparing and detecting section. Accordingly, the operator can easily recognize the winding state of the package based on the information notified by the notifying section and, when there is an abnormality in the winding state, an appropriate countermeasure can be promptly taken. For example, the notifying section may be a display section, a voice output section, or the like. When the notifying section is the display section, the operator can easily recognize the winding state by viewing the display section.

[0023] The notifying section of the driving state detecting device may be the display section in which the comparison result is displayed on a package image. Accordingly, the operator can easily recognize the winding state of the package by visually recognizing the comparison result or data to be compared with each other that are displayed together with the package image that illustrates the package.

[0024] An embodiment of a driving state detecting device (drive diameter calculating device) of the present invention includes a package peripheral speed detecting section adapted to detect a peripheral speed V_P of a cone-shaped package that rotates by abutting against an outer peripheral surface of a winding drum rotating around an axial line and into which the traversed yarn is wound, a package rotation speed detecting section adapted to detect a rotation speed F_P of the package, an average diameter calculating section adapted to calculate a package average diameter D_{PA} , which is an average outer diameter of the package, and a notifying section adapted to notify a calculation result from the average diameter calculating section.

[0025] An embodiment of a winding unit of the present invention includes the winding drum adapted to rotate around the axial line, the package supporting section adapted to support the cone-shaped package that rotates in response to driving force from the winding drum by abutting against the outer peripheral surface of the winding drum rotating around the axial line and into which the traversed yarn is wound, a yarn speed detecting section adapted to detect a yarn travelling speed of the yarn travelling between a yarn supplying section adapted to supply the yarn and the package, and the above-described driving state detecting device.

[0026] Since the winding unit includes the above-described driving state detecting device, the package average diameter D_{PA} , which is the average outer diameter of the package, is calculated based on the rotation speed F_1 of the winding drum detected by the drum rotation speed detecting section and the rotation speed F_P of the package detected by the package rotation speed detecting section. Accordingly, the package average diameter D_{PA} can be recognized, and by comparing the package average diameter D_{PA} with the package reference value, the abnormality at the driving point can be detected. By detecting and correcting the abnormality at the driving point, the abnormality in winding or the deviation in the winding among the plurality of the winding units can be suppressed.

[0027] The winding unit may include the package peripheral speed detecting section adapted to detect the peripheral speed V_P of the package by the following equation (3).

$$\begin{aligned} & \text{Peripheral speed } V_P \text{ of package } P \\ & = \text{Yarn travelling speed } V_0 \times \cos (\text{Traverse angle } \theta) \dots (3) \end{aligned}$$

[0028] The winding unit may include a contact pressure adjustment mechanism adapted to adjust a contact state of the package with respect to the winding drum. The contact pressure adjustment mechanism may include a cylinder or a motor that are connected to the package supporting section. The contact state of the package with respect to the winding drum may be a contact pressure of the package with respect to the winding drum, balance of the contact pressure in an axial direction of the package, or the like. A winding machine of the present invention includes a plurality of the winding units.

[0029] An embodiment of a spinning unit of the present invention includes a draft roller adapted to draft a fiber bundle, a spinning section adapted to spin the fiber bundle, which has been drafted by the draft roller, by whirling airflow and to generate the yarn, a winding drum adapted to rotate around the axial line, the package supporting section adapted to support the cone-shaped package that rotates in response to the drive force from the winding drum by abutting against the outer peripheral surface of the winding drum and into which the traversed yarn is wound, and the above-described driving state detecting device.

[0030] Since the spinning unit includes the above-described driving state detecting device, the package average diameter D_{PA} , which is the average outer diameter of the package, is calculated based on the rotation speed F_1 of the winding drum detected by the drum rotation speed detecting section and the rotation speed F_P of the package detected by the package rotation speed detecting section. Accordingly, the package average diameter D_{PA} can be recognized, and by comparing the package average diameter D_{PA} with the package reference value, the abnormality at a driving point can be detected. By detecting and correcting the abnormality at the driving point, the abnormality in winding can be suppressed.

[0031] In an embodiment, the spinning unit spins the yarn at a preset constant yarn travelling speed, and the driving state detecting device may calculate the package average diameter D_{PA} , which is the average outer diameter of the package, by employing the preset constant yarn travelling speed.

[0032] The spinning unit may include the contact pressure adjustment mechanism adapted to adjust the contact pressure of the package with respect to the winding drum. The contact pressure adjustment mechanism may include the cylinder that is connected to the package supporting section. A spinning machine of the present invention includes a plurality of the spinning units.

[0033] According to the present invention, the package average diameter D_{PA} can be calculated. According to the present invention, the driving state detecting device, the winding unit, the winding machine, the spinning unit, and the spinning machine in which by comparing or enabling to be compared the calculation value relating to the driving state of the cone-shaped package with the determination reference value, the driving state of the cone-shaped package can be recognized and the quality of the package can be improved.

BRIEF DESCRIPTION OF THE DRAWINGS

[0034]

FIG. 1 is a front view of a winding unit provided in a winding machine according to a first embodiment of the present invention.

FIG.2 is a block diagram of a unit controller.

FIG.3 is a front view of a package.

FIG.4 is a front view illustrating the package and a winding drum.

FIG.5 is a flowchart illustrating a procedure for calculating a package drive diameter.

FIG. 6 is a front view of a spinning machine according to a second embodiment of the present invention.

FIG. 7 is a vertical sectional view of the spinning machine illustrated in FIG. 6.

FIG.8 is a plan view illustrating a package and a cradle.

FIG.9 is a block diagram of a unit controller of a spinning machine according to a third embodiment of the present invention.

FIG.10 is a schematic view illustrating a package image displayed in a display section.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0035] FIG. 1 is a front view of a winding unit provided in a winding machine according to a first embodiment of the present invention. As illustrated in FIG. 1, a winding unit 1 is a device adapted to wind a yarn Y into a package P, and by arranging a plurality of winding units 1 next to each other, for example, an automatic winder serving as the winding machine is configured. The winding unit 1 is provided with a bobbin supporting section 2, which is a yarn supplying section, a yarn unwinding assisting device 3, a preclearer 4, a gate-type tension control member 5, a tension sensor 6, a lower yarn catching device 7, a splicer (yarn joining device) 8, a yarn speed sensor (yarn speed detecting section) 18, a cutter 9, a yarn clearer capable of detecting a defect of the yarn Y (yarn defect detecting device) 10, an upper yarn catching device 11, and a yarn winding section 12 in this order from upstream (a lower part herein) along a traveling path of the yarn Y (that is, a yarn path). Each of such components is mounted on a machine base 13. Furthermore, the winding unit 1 is provided with a unit controller (driving state detecting device) 14, and a display (display section) 15, which is a notifying section.

[0036] The bobbin supporting section 2, which is a portion to supply the yarn Y, supports a yarn supplying bobbin B upright. The yarn supplying bobbin B is formed by a ring spinning machine in a preceding processing, and is transported from the ring spinning machine in a state of being set in a tray, for example. The yarn unwinding assisting device 3 controls, by use of a tubular member arranged in a part above the yarn supplying bobbin B, a balloon of the yarn Y unwound from the yarn supplying bobbin B. The gate-type tension control member 5 applies a predetermined tension on the travelling yarn Y by holding the yarn Y in a zig-zag manner by a pair of comb teeth-shaped gates, one of which is fixed and the other of which is movable. The tension sensor 6 is a device for measuring a tension of the yarn Y travelling along the yarn path. The unit controller 14 performs feedback control of the gate-type tension control member 5 in accordance with the tension of the yarn Y measured by the tension sensor 6 such that the predetermined tension is applied on the travelling yarn Y.

[0037] The preclearer 4 pre-regulates passage of a yarn defect that is greater than a predefined value, by a pair of regulating members arranged at a predetermined interval with the yarn path therebetween.

[0038] The yarn clearer 10 detects the yarn defect during an winding operation of the yarn Y. The yarn clearer 10 detects a thickness of the yarn Y that passes through, and determines presence/absence of the defect of the yarn Y in accordance with the thickness of the detected yarn Y. The yarn speed sensor 18 detects a yarn travelling speed of the

yarn Y travelling between the bobbin supporting section 2 and the yarn winding section 12. The yarn speed sensor 18 transmits to the unit controller 14 a pulse-like signal corresponding to a length of the passage every time the yarn Y passes through a predetermined length. The pulse-like signal output by the yarn speed sensor 18 is referred to as a yarn speed pulse signal.

[0039] The cutter 9 cuts the yarn Y when the yarn defect is detected by the yarn clearer 10 and yarn joining is instructed by the unit controller 14. The splicer 8 joins a yarn end from the yarn supplying bobbin B and a yarn end from the package P at the time of cutting the yarn Y by the cutter 9 or yarn breakage of the yarn Y.

[0040] The lower yarn catching device 7 is configured capable of vertically swinging with an axial line α as a center, and a suction mouth 7a is arranged at a swinging end thereof. The sucking mouth 7a is swung between a part above the splicer 8 and a part below the preclearer 4. The upper yarn catching device 11 is configured capable of vertically swinging with an axial line β as a center, and a sucking mouth 11a is arranged at a swinging end thereof. The sucking mouth 11a is swung between a part below the splicer 8 and the yarn winding section 12. Accordingly, the lower yarn catching device 7 swings downward and sucks the yarn end from the yarn supplying bobbin B with the sucking mouth 7a. Subsequently, the lower yarn catching device 7 swings upward and delivers the yarn end from the yarn supplying bobbin B to the splicer 8. On the other hand, the upper yarn catching device 11 swings upward and sucks the yarn end from the package P with the sucking mouth 11a. Subsequently, the upper yarn catching device 11 swings downward and delivers the yarn end from the package P to the splicer 8.

[0041] The yarn winding section 12 winds the yarn Y unwound from the yarn supplying bobbin B into the cone-shaped package P and forms a full package P while traversing the yarn from side to side (an axial direction of a winding drum 16). The yarn winding section 12 includes the winding drum 16 and a cradle 17, which is a package supporting section.

[0042] The winding drum 16 rotates the package P being in contact with the package P, and winds the yarn Y into the package P. The winding drum 16 has a drum groove formed over, along which the traversing is performed.

[0043] A rotation sensor 31 is mounted on the winding drum 16. The rotation sensor 31 is electrically connected to the unit controller 14, the yarn clearer 10, or the like. The rotation sensor 31 is configured as a rotary encoder, for example, and is adapted to transmit a pulse-like signal to an analyzer of the yarn clearer 10 every time the winding drum 16 rotates a predetermined angle. The pulse-like signal output by the rotation sensor 31 is referred to as a rotation pulse signal.

[0044] As illustrated in FIG. 2, the winding unit 1 includes a drum driving motor 32 adapted to drive the winding drum 16 and a motor control section 33 adapted to control the drum driving motor 32. The drum driving motor 32, the motor control section 33, and the unit controller 14 are electrically connected to each other. The drum driving motor 32 operates in accordance with an instruction signal from the motor control section 33. Accordingly, the winding drum 16 is controlled to rotate and to stop.

[0045] The cradle 17 rotatably supports the package P. In the cradle 17, an angle γ that is formed by an axial line of the winding drum 16 and an axial line of the package P can be adjusted, and by adjusting the angle γ , a position of a contact point (hereinafter referred to as a "driving point") between the winding drum 16 and the package P can be adjusted. The cradle 17 causes a surface of the package P to make contact with a surface of the winding drum 16 at an appropriate contact pressure. With a motor for driving the winding drum 16 and thereby rotating the package P, the yarn winding section 12 winds the yarn Y into the package P while traversing the yarn Y in a predetermined width. At the driving point, an outer peripheral surface of the winding drum 16 and an outer peripheral surface of the package P make contact with each other, and a rotation driving force is transmitted to the package P. The package P rotates responding to the driving force from the winding drum 16. By the traversing, the yarn Y is wound at a predetermined traverse angle θ (see FIG. 4) with respect to a circumferential direction of the package P.

[0046] The yarn winding section 12 is provided with a package rotation sensor 35 (see FIG. 2) capable of measuring a rotation speed of the package P. The package rotation sensor 35 is electrically connected to the unit controller 14 or the like. The package rotation sensor 35 is configured as a rotary encoder, for example, and is adapted to transmit a pulse-like signal to the unit controller 14 every time the package P rotates a predetermined angle. The pulse-like signal output by the package rotation sensor 35 is referred to as a package pulse signal.

[0047] The unit controller 14 controls each component of the winding unit 1. The unit controller 14 includes a Central Processing Unit (CPU) adapted to perform arithmetic processing, a Read Only Memory (ROM) and a Random Access Memory (RAM) functioning as a storage section, or the like. Information required for the control is input from each component of the winding unit 1 into the unit controller 14.

[0048] The unit controller 14 includes, as processing sections, a drum rotation speed detecting section, a package peripheral speed detecting section 21, a package rotation speed detecting section 22, a drive diameter calculating section (driving state calculation value calculating section) 23, a comparing and detecting section 24, or the like. In the unit controller 14, each of the processing sections is configured of software by loading a program stored in the ROM onto the RAM and by executing the program in the CPU. Each of the processing sections may be configured by hardware.

[0049] When the automatic winder (winding machine) is configured by the plurality of the winding units 1, the unit controller 14 transmits/receives various types of information relating to a winding operation to/from a control device

adapted to control the entire automatic winder. The unit controller 14 is electrically connected to the yarn speed sensor 18, the yarn clearer 10, the rotation sensor 31, a display 15, the splicer 8, the lower yarn catching device 7, the upper yarn catching device 11, or the like.

[0050] The package peripheral speed detecting section 21 detects a peripheral speed V_p of the package P. The package peripheral speed detecting section may detect the peripheral speed V_p of the package P by the following equation (3). Peripheral speed V_p of the package P

$$= \text{Yarn travelling speed } V_0 \times \cos (\text{Traverse angle } \theta) \dots (3)$$

[0051] The traverse angle θ is a preset value and is stored in the storage section 28.

[0052] The yarn travelling speed V_0 can be calculated, for example, based on a signal output from the yarn speed sensor 18.

[0053] The package peripheral speed detecting section 21 receives the yarn speed pulse signal and calculates an average yarn speed V_A . Subsequently, the package peripheral speed detecting section 21 calculates the peripheral speed V_p of the package P. The package peripheral speed detecting section 21 can calculate the average yarn speed V_A by use of the number of yarn speed pulse Pu_Y and a yarn speed pulse updating period T_{PY} .

[0054] The number of yarn speed pulse Pu_Y can be acquired based on the yarn speed pulse signal that is output from the yarn speed sensor 18. Every time the yarn Y passes through a predetermined travelling length L_{PY} , for example, the yarn speed pulse signal is transmitted. The package peripheral speed detecting section 21 receives the yarn speed pulse signal and calculates the number of yarn speed pulse Pu_Y .

[0055] The yarn speed pulse updating period T_{PY} is a preset value and is stored in the storage section 28. The yarn speed pulse updating period T_{PY} may be a disturb period to ignore effect of a disturb operation. The disturb period is a period (sec) in which a disturb control for immediately changing rotation of the winding drum 16 is performed to prevent a ribbon winding from occurring. The yarn speed pulse updating period T_{PY} may be set to 2 (sec), for example. The average yarn speed V_A is an average value of the yarn travelling speed V_0 in a period where the yarn speed pulse signal is updated.

[0056] The package rotation speed detecting section 22 detects a rotation speed F_P of the package P. The package rotation speed detecting section 22 calculates the rotation speed F_P of the package P (rpm) based on data output from the rotation sensor 31. The package rotation speed detecting section 22 may calculate the rotation speed F_P of the package P (rpm) by the following equation (4).

Rotation speed F_P of package P

$$= \frac{\text{Number of package pulse } Pu}{\text{Number of package pulse } Pu_1 \text{ per rotation} \times \text{Package pulse updating period } T_p} \dots (4)$$

[0057] The number of package pulse Pu can be acquired based on the package pulse signal output from the package rotation sensor 35. Every time the package P rotates 90 degrees, for example, the package pulse signal is transmitted. The package rotation speed detecting section 22 receives the package pulse signal and calculates the number of package pulse Pu .

[0058] The number of package pulse Pu_1 per rotation is a preset value and is stored in the storage section 28. In a case where every time the package P rotates 90 degrees, the package pulse signal is transmitted, the number of package pulse Pu_1 per rotation is "4".

[0059] A package pulse updating period T_p is a present value and is stored in the storage section 28. The package pulse updating period T_p may be the disturb period. The package pulse updating period T_p may be set to 2 (sec), for example.

[0060] The package rotation speed detecting section 22 may calculate the rotation speed F_P of the package P by use of another data.

[0061] The drive diameter calculating section 23 calculates by the following equation (2), a package drive diameter D_p (see FIG. 3), which is an outer diameter of the package P at a driving point 40 (see FIG. 4). The drive diameter calculating section 23 calculates the package drive diameter D_p in accordance with an outer diameter D_1 of the winding drum and a rotation speed F_1 of the winding drum.

Package drive diameter D_p

$$= \frac{\text{Outer diameter } D_1 \text{ of winding drum} \times \text{Rotation speed } F_1 \text{ of winding drum}}{\text{Rotation speed } F_P \text{ of package P}}$$

... (2)

[0062] A winding number W is the number of winding in the package P , and the number of the rotation of the package P during one reciprocating movement of the yarn Y in a direction of a width of the package P . The drive diameter calculating section 23 can calculate the winding number W of the Package P by the following equation (5).

Winding number W

$$= \frac{\text{Rotation speed } F_P \text{ of package P}}{\text{Rotation speed } F_1 \text{ of winding drum}} \times \text{Winding number } W_1 \text{ of winding drum}$$

$\times 2$... (5)

[0063] A winding number W_1 of the winding drum 16 is a predetermined value and is stored in the storage section 28. The winding number W_1 of the winding drum 16 is the number of the rotation of the winding drum 16 during one reciprocating movement of the yarn Y in the direction of the width of the package P .

[0064] The comparing and detecting section 24 compares the package drive diameter D_p calculated by the drive diameter calculating section 23 with a package reference value (determination reference value). The comparing and detecting section 24 can detect a winding state of the package P by comparing the package drive diameter D_p with the package reference value.

[0065] The comparing and detecting section 24 may enable to be compared, the package drive diameter D_p calculated by the drive diameter calculating section 23 with the package reference value (determination reference value). The comparing and detecting section 24 outputs information relating to the package drive diameter D_p and the package reference value to the display 15 such that an operator can compare the package drive diameter D_p and the package reference value. The operator visually recognizes displayed contents in the display 15 and compares the package drive diameter D_p with the package reference value.

[0066] The unit controller 14 may include the drum rotation speed detecting section and an average diameter calculating section.

[0067] The drum rotation speed detecting section detects a rotation speed F_1 of the winding drum 16. The drum rotation speed detecting section acquires from the motor control section 33, information relating to the rotation speed F_{32} of the drum drive motor 32. The drum rotation speed detecting section calculates the rotation speed F_1 of the winding drum 16. The drum rotation speed detecting section may calculate the rotation speed F_1 of the winding drum 16 by use of another data, or may arrange the rotation sensor 31 adapted to detect the rotation speed F_1 of the winding drum 16 and detect the rotation speed F_1 of the winding drum 16 by use of the rotation sensor 31.

[0068] The average diameter calculating section calculates a package average diameter D_{PA} (see FIG. 3), which is an average outer diameter of the package P . The package average diameter D_{PA} is an outer diameter of when assuming that the package P has a columnar outline (the package P has the same outer diameter in an axial direction of the package P). The package average diameter D_{PA} is an outer diameter at a center point 41 in the axial direction of the package P .

[0069] The average diameter calculating section can calculate the package average diameter D_{PA} as the package reference value by the following equation (1). The average diameter calculating section calculates the package average diameter D_{PA} in accordance with the peripheral speed V_P of the package P and the rotation speed F_P of the package P .

$$\text{Package average diameter } D_{PA} = \frac{\text{Peripheral speed } V_P}{(\text{Rotation speed } F_P \text{ of package P}) \times \pi} \dots (1)$$

[0070] The comparing and detecting section 24 may compare or enable to be compared, the package drive diameter D_p with the package average diameter D_{PA} and output the information relating to the winding state of the package P .

The comparing and detecting section 24 can determine that the driving point 40 exists closer to a small diameter 46 of a winding tube 45 when the package drive diameter D_p is smaller than the package average diameter D_{PA} . The comparing and detecting section 24 can determine that the driving point 40 exists closer to a large diameter 47 of the winding tube 45 when the package drive diameter D_p is greater than the package average diameter D_{PA} . The comparing and detecting section 24 can determine that the driving point 40 exists in proximity to the center point 41 in an axial direction of the winding tube 45 when the package drive diameter D_p is equal to the package average diameter D_{PA} . The comparing and detecting section 24 can determine a position of the driving point 40 and output to the display 15, the information relating to the winding state of the package P.

[0071] When starting the winding in a state where the yarn Y is not wound around the winding tube 45, the comparing and detecting section 24 may determine the position of the driving point 40 by comparing the package drive diameter D_p with a small diameter D_{46} and a large diameter D_{47} of the winding tube 45 (the package reference value) and detect the winding state of the package P. In the case of the automatic winder (winding machine) including the plurality of the winding units 1, positions of the driving points 40 of each of the winding units 1 are compared by a machine base control section adapted to control each winding unit 1. By configuring in such a manner, the automatic winder can perform an adjustment such that deviation in the winding of the yarn Y among the plurality of the winding units 1 becomes small.

[0072] The comparing and detecting section 24 may determine the position of the driving point 40 by comparing the package drive diameter D_p with an outer diameter of the small diameter and/or an outer diameter of the large diameter of the package P (the package reference value) in the winding operation, and detect the winding state of the package P.

[0073] The comparing and detecting section 24 may detect the winding state of the package P by detecting a change in the position of the driving point 40 (a position in the axial direction of the package P) in accordance with a change in the package drive diameter D_p . The comparing and detecting section 24 may detect the winding state of the package P by comparing or enabling to be compared, a change in an assumed position of the driving point 40 with a change in an actual position of the driving point 40.

[0074] The winding unit 1 may include the notifying section adapted to notify a comparison result from the comparing and detecting section, or the calculation value and the reference value that have been enabled by the comparing and detecting section to be compared with each other. The notifying section may be the display section (display 15), a voice output section (speaker), or the like. The unit controller 14 may cause the speaker to output an alarm sound when an abnormality in the winding of the yarn Y is detected.

[0075] The display 15 displays an operation state and the like of the winding unit 1. When the yarn clearer 10 detects the yarn defect, the display 15 may display that the yarn defect has been detected. The display 15 may display the position of the driving point 40 of the package P. The display 15 may, when the abnormality in the winding of the yarn Y is detected, notify the abnormality or perform a display operation to urge the operator to take a countermeasure.

[0076] The unit controller 14 may display by use of the display 15, information for instructing adjustment of an inclination of the package P when detecting the abnormality in the winding of the yarn Y.

[0077] Next, a processing procedure at the time of calculating the package drive diameter D_p will be described with reference to FIG. 5.

[0078] Firstly, the package peripheral speed detecting section 21 of the unit controller 14 detects the peripheral speed V_p of the package P (step S1).

[0079] In step S2, the package rotation speed detecting section 22 detects the rotation speed F_p of the package P. The package rotation speed detecting section 22 detects the rotation speed F_p of the package P based on the data output from the rotation sensor 31.

[0080] In step S3, the drive diameter calculating section 23 calculates the package drive diameter D_p . The drive diameter calculating section 23 calculates the package drive diameter D_p at the driving point 40 by the following equation (2).

Package drive diameter D_p

$$= \frac{\text{Outer diameter } D_1 \text{ of winding drum} \times \text{Rotation speed } F_1 \text{ of winding drum}}{\text{Rotation speed } F_p \text{ of package P}}$$

... (2)

[0081] In step S4, the comparing and detecting section 24 recognizes the position of the driving point 40 in accordance with the package drive diameter D_p calculated by the drive diameter calculating section 23, and determines the presence/absence of the abnormality in the winding of the yarn Y of the package P (detects the winding state of the package P). The comparing and detecting section 24, when determining that there is the abnormality, proceeds to step S5 (step S4 : YES) and, when determining that there is no abnormality, ends the processing here.

[0082] In step S5, the unit controller 14 notifies by use of the display 15, the abnormality in the winding of the yarn Y, and ends the processing here. The display 15 of the present embodiment is arranged in each winding unit 1, but the display 15 may be arranged in the machine base control section that is arranged in the winding machine and that is adapted to control the plurality of the winding units 1.

[0083] By the winding unit 1 of the present embodiment, the package drive diameter D_P at the driving point 40 can be calculated based on the peripheral speed V_P of the package P and the rotation speed F_P of the package P. The winding unit 1 can recognize the package drive diameter D_P and detect the abnormality at the driving point 40 by comparing or enabling to be compared the package drive diameter D_P with the package reference value, thereby detecting the abnormality in the winding of the yarn Y. In the winding unit 1, the abnormality in the winding or the deviation in the winding among the plurality of the winding units 1 can be suppressed by detecting the driving point 40 and adjusting contact pressure of the package P with respect to the winding drum 16.

[0084] Next, a spinning machine according to a second embodiment of the present invention will be described with reference to the drawings. The same description as in the above-described first embodiment (the winding machine provided with the winding unit) will be omitted.

[0085] A spinning machine 51 illustrated in FIG. 6 and FIG. 7 is provided with a plurality of spinning units 52 arranged next to each other. The spinning machine 51 includes a yarn joining cart arranged in a freely travelling manner along a direction in which the spinning units 52 are arranged, a motor box 54, a central control section, which is not illustrated, adapted to perform a control of the spinning machine 51, and the unit controller 14 adapted to control the spinning units 52 (see FIG. 7). The spinning machine 51 may simultaneously drive the plurality of the spinning units 52 or may individually drive the plurality of the spinning units 52. When individually driving the spinning units 52, a yarn joining device may be arranged in each of the spinning units 52 without providing a yarn joining cart (description will be made in detail later).

[0086] The central control section is arranged, for example, inside the motor box 54. The central control section is electrically connected to a plurality of the unit controllers 14 and is adapted to control the plurality of the unit controllers 14 in an integrated manner. The unit controller 14 is arranged in each of the spinning units 52 and individually controls each of the spinning units 52.

[0087] Each spinning unit 52 includes a draft device 56, a spinning section 57, the yarn clearer 10, a yarn slack eliminating device (yarn accumulating device) 58, and a yarn winding section 60 in this order from upstream towards downstream in a yarn travelling direction. In the spinning unit 52, a configuration is made in which the draft device 56 is arranged in proximity to an upper end of a housing 59 of the spinning machine 51, and a fiber bundle 61 fed from the draft device 56 is introduced into and spun in the spinning section 57. The spun yarn Y spun in the spinning section 57 is, after passing through the yarn clearer 10, fed by the yarn slack eliminating device 58 and wound by the yarn winding section 60, thereby forming the package P.

[0088] The draft device 56 is adapted to stretch a sliver 63 into the fiber bundle 61. The draft device 56 includes a plurality of pairs of draft rollers 64 arranged along a feeding direction (transport direction) of the fiber bundle 61 and drafts the fiber bundle 61 using the draft rollers 64. Each draft roller 64 includes a pair of top rollers and a pair of bottom rollers. The top rollers and the bottom rollers are respectively arranged with the sliver 63 therebetween.

[0089] Although a detailed configuration of the spinning section 57 is not illustrated, in the present embodiment, an air-jet type is employed in which a twist is applied to the fiber bundle 61 by use of whirling airflow to produce spun yarn Y. The spinning section 57 is not limited to the air-jet type.

[0090] The yarn slack eliminating device 58 draws the spun yarn Y from the spinning section 57 by applying a predetermined tension on the spun yarn Y. The yarn slack eliminating device 58 prevents the spun yarn Y from slackening by accumulating the spun yarn Y that is fed from the spinning section 57 at the time of yarn joining by the yarn joining cart 53, or the like. Furthermore, the yarn slack eliminating device 58 adjusts the tension such that a variation in the tension of the spun yarn Y in the yarn winding section 60 is not propagated to the spinning section 57. The yarn slack eliminating device 58 includes a slack eliminating roller (yarn accumulating roller) 65 and accumulates the spun yarn Y by winding a predetermined amount of the spun yarn Y around an outer peripheral surface thereof.

[0091] The yarn clearer 10 is arranged in a position on a front surface of the housing 59 of the spinning machine 51 and between the spinning section 57 and the yarn slack eliminating device 58. The spun yarn Y spun from the spinning section 57 passes through the yarn clearer 10 before being wound by the yarn slack eliminating device 58. The yarn clearer 10 monitors a thickness of the travelling spun yarn Y and, when detecting the yarn defect in the spun yarn Y, transmits a yarn defect detection signal to the unit controller 14.

[0092] When the yarn defect is detected, the unit controller 14 stops the draft device 56, the spinning section 57, or the like at a predetermined timing. At this time, the unit controller 14 cuts the spun yarn Y by stopping injection of compressed air from a nozzle in which the whirling airflow of the spinning section 57 is generated.

[0093] The unit controller 14 transmits a control signal to the yarn joining cart 53 and causes the yarn joining cart 53 to travel to the front of the relevant spinning unit 52. Subsequently, the unit controller 14 drives the spinning section 57 or the like again and controls the yarn joining cart 53 to perform the yarn joining to resume the winding. At this time, the yarn slack eliminating device 58 eliminates a slack of the spun yarn Y that is continuously fed from the spinning section

57, by accumulating the spun yarn Y around a slack eliminating roller 65 between when the spinning section 57 resumes spinning and when the winding is resumed.

[0094] The yarn joining cart 53 includes a splicer (yarn joining device) 66, a suction pipe 67, and a suction mouth 68. When yarn breakage or yarn cut occurs in a spinning unit 52, the yarn joining cart 53 travels on a rail 69 to the relevant spinning unit 52 and stops. The suction pipe 67 sucks and catches a yarn end fed from the spinning section 57, and guides the yarn end to the splicer 66 while vertically swinging with an axis as a center. The suction mouth 68 sucks and catches a yarn end from the package P supported by the yarn winding section 60, and guides the yarn end to the splicer 66 while vertically swinging with an axis as a center. The splicer 66 joins the guided yarn ends.

[0095] The spinning machine 51 may not include the yarn joining cart 53. In this case, the yarn joining device is provided in each spinning unit 52. Specifically, each spinning unit 52 includes a splicer, a suction pipe, and a suction mouth and, when the yarn breakage or the like occurs, each spinning unit 52 guides to the splicer, the spun yarn and the yarn from the package, and performs the yarn joining.

[0096] The yarn winding section 60 includes a cradle (package supporting section) 71 swingably supported around a support shaft 70. The cradle 71 rotatably supports a winding tube (bobbin) 45 to wind the spun yarn Y.

[0097] The yarn winding section 60 includes the winding drum (a rotation drum) 16 and a traverse device 75. The winding drum 16 is configured capable of driving being in contact with the winding tube 45 or an outer peripheral surface of the package, which is formed by winding the spun yarn Y around the winding tube 45. The traverse device 75 includes a traverse guide 76 that is capable of engaging with the spun yarn Y. By driving the winding drum 16 using a drum drive motor 32 while reciprocating the traverse guide 76 by a drive means, which is not illustrated, the yarn winding section 60 rotates the package P being in contact with the winding drum 16, and winds the spun yarn Y while traversing the spun yarn Y.

[0098] Since in the spinning machine 51 configured in such a manner as well, a driving state detecting device (the unit controller 14, see FIG. 2) is provided as in the winding unit 1 or the winding machine of the above-described first embodiment, the package drive diameter D_P at the driving point 40 can be calculated based on the rotation speed F_1 of the winding drum 16 and the rotation speed F_P of the package P. In the spinning machine 51, a yarn Y is spun at a preset constant yarn speed. Since the yarn winding section 60 is controlled such that the slack eliminating roller 65 holds a constant amount of the yarn Y, the yarn speed of the yarn Y spun from the spinning section 57 and a yarn speed of the yarn Y wound by the yarn winding section 60 become equal to each other. Therefore, the driving point 40 can be calculated by employing the preset constant yarn spun speed as the yarn travelling speed V_0 . Alternatively, a yarn speed sensor may be provided as in the winding unit 1. The spinning machine 51 can recognize the package drive diameter D_P and detect the abnormality at the driving point 40 by comparing the package drive diameter D_P and the package reference value, thereby detecting the abnormality in the winding of the yarn Y. In the spinning machine 51, by detecting the driving point 40 and adjusting the contact pressure of the package P with respect to the winding drum 16, the abnormality in the winding and the deviation in the winding among the plurality of the yarn winding sections 60 can be suppressed.

[0099] Next, a contact pressure adjustment mechanism 37 will be described with reference to FIG. 8. FIG. 8 is a plan view illustrating the package P and the cradle 71. The spinning unit 52 may include the contact pressure adjustment mechanism 37 adapted to adjust the contact pressure of the package P with respect to the winding drum 16. The contact pressure adjustment mechanism 37 includes, for example, a pair of cylinders 38. The pair of cylinders 38 is separately arranged in the axial direction of the package P. One end of the cylinder 38 is connected to the cradle 71, and the other end is connected to the housing 59 of the spinning unit 52. In FIG. 8, the other end is connected to a coupling member 39 coupled with the housing 59. By operating the cylinder 38 to change a position of the cradle 71, a position (an inclination in a direction of a rotation axis) of the package P with respect to the winding drum 16 can be adjusted. The position of the package P may be adjusted by changing the position of the cradle 71 using another drive mechanism such as the drive motor 32 instead of the cylinder 38. Similarly, in the yarn winding unit of the above-described first embodiment, the position (the inclination in the direction of the rotation axis) of the package P may be adjusted by changing the position of the cradle 71 by use of the drive mechanism.

[0100] In the spinning unit 52, the position of the driving point 40 of the package P can be adjusted by adjusting the contact pressure between the winding drum 16 and the package P using the contact pressure adjustment mechanism 37. The contact pressure adjustment mechanism 37 may be operated by the operator. The contact pressure adjustment mechanism 37 may be operated in accordance with a command signal from the unit controller 14. The contact pressure adjustment mechanism 37 is not limited to those provided with the cylinder 38, and may be provided with an elastic member such as a spring. The contact pressure adjustment mechanism 37 may be provided with a motor adapted to rotate the cradle 71 in a direction orthogonal to the direction of the rotation axis of the package P. The contact pressure adjustment mechanism 37 may be employed in the yarn winding unit 1 of the above-described first embodiment.

[0101] Next, the spinning machine 51 provided with the plurality of the spinning units 52 according to a third embodiment of the present invention will be described with reference to FIG. 9. The same description as in the above-described first embodiment and the second embodiment will be omitted by denoting the same reference numerals.

[0102] The spinning unit 52 according to the third embodiment includes the driving state detecting device adapted to calculate a slip ratio of the package as a calculation value relating to a driving state of the cone-shaped package, and to compare the calculated slip ratio of the package with the determination reference value. The spinning unit 52 includes a unit controller 80 adapted to perform a control of the spinning unit 52, and the unit controller 80 functions as the driving state detecting device.

[0103] The unit controller 80 includes as processing sections, a drum peripheral speed detecting section 81, a drum rotation speed detecting section 82, a package slip ratio calculating section (driving state calculation value calculating section) 83, a comparing and detecting section 84, or the like.

[0104] The drum rotation speed detecting section 82 detects a rotation speed F_D of the winding drum. The drum rotation speed detecting section 82 calculates the rotation speed F_D (rpm) of the winding drum based on the data output from the rotation sensor 31.

[0105] The drum peripheral speed detecting section 81 detects a peripheral speed V_D of the winding drum. The drum peripheral speed detecting section 81 calculates the peripheral speed V_D of the winding drum based on the outer diameter D_1 of the winding drum and the rotation speed F_D of the winding drum. The drum peripheral speed detecting section 81 may detect the peripheral speed V_D of the winding drum by the following equation (6).

$$\text{Peripheral speed } F_D \text{ of winding drum} = \text{Outer diameter } D_1 \text{ of winding drum} \times \pi \times \text{Rotation speed } F_D \text{ of winding drum} \dots (6)$$

[0106] The package slip ratio calculating section 83 calculates the slip ratio of the package P with respect to the winding drum by the following equation (7). The package slip ratio calculating section 83 calculates the slip ratio of the package P based on the peripheral speed V_D of the winding drum and the peripheral speed V_P of the package P.

$$\begin{aligned} &\text{Slip ratio } S \text{ of package } P \\ &= \frac{\text{Peripheral speed } V_D \text{ of winding drum} - \text{Peripheral speed } V_P \text{ of package } P}{\text{Peripheral speed } V_D \text{ of winding drum}} \dots \\ &(7) \end{aligned}$$

[0107] The comparing and detecting section 84 compares the slip ratio S of the package P calculated by the package slip ratio calculating section 83 with the determination reference value. The comparing and detecting section 84 can detect the winding state of the package P by comparing the slip ratio S of the package P with the determination reference value.

[0108] The comparing and detecting section 84 can employ an average slip ratio S_A as the determination reference value. The average slip ratio S_A may be calculated from previous data. Alternatively, an average value may be calculated from data of slip ratios of the plurality of units. As the average slip ratio S_A , 10% may be employed, for example. The determination reference value may be arbitrarily set by the operator.

[0109] The comparing and detecting section 84 may determine that there is an abnormality in the driving state of the cone-shaped package in a case where the slip rate S becomes the double of the average slip rate S_A when the slip rate S is compared with the average slip rate S_A .

[0110] Since the driving state detecting device (unit controller 80) is provided in the spinning unit 52 configured in such a manner, the slip ratio S of the package P can be recognized by calculating the slip ratio S of the package P and comparing the slip ratio S with the determination reference value, and the abnormality in the driving of the package P can be detected. By detecting and correcting an abnormality in the slip ratio S, the abnormality in the winding or the deviation in the winding among the plurality of the devices can be suppressed.

[0111] The spinning unit 52 may include the notifying section adapted to notify information relating to the slip ratio S of the package P. Since the notifying section displays the information relating to the slip ratio, the operator can promptly execute a subsequent adjustment operation by recognizing the abnormality in the slip ratio S. In FIG. 9, the display 15 is arranged in each spinning unit 52, but the display 15 may be arranged in the motor box 54 that is arranged in the spinning machine and is adapted to control the plurality of the spinning units 52.

[0112] Next, one example of the displayed contents displayed in the display (display section) 15 will be described with reference to FIG. 10. The display 15 displays the calculation value and the reference value that have been enabled by the comparing and detecting section 24 to be compared with each other. The display 15 can display data relating to a comparison result together with an image illustrating the package P. The display 15 may display data relating to equipment

specifications together with the image of the package P.

[0113] The display 15 displays a traverse width W_t and a taper angle δ of the winding tube 45 (a yarn tube) as the data relating to the equipment specifications. The traverse width W_t is a width in a horizontal direction of the yarn Y wound around the winding tube 45, and a length in a direction along an outline of an outer peripheral surface of the winding tube 45 when viewed from a side (viewed from a direction intersecting the axial direction of the winding tube 45). The traverse width W_t of the package P of the present embodiment is, for example, 0.1524 m.

[0114] Taper angle δ of the winding tube 45 is an angle between the axial line of the winding tube 45 and a line parallel to the outline of the outer peripheral surface of the winding tube 45 when viewed from a side. The taper angle δ of the winding tube 45 of the present embodiment is, for example, 5° .

[0115] The display 15 displays as the data relating to the comparison result, the package drive diameter D_P , the package average diameter D_{PA} , a traverse center width W_{tc} , a small diameter end portion package diameter D_{PS} , a large diameter end portion package diameter D_{PL} , and a drive package position P_d , for example.

[0116] The package drive diameter D_P can be calculated by the above-described equation (2). The package average diameter D_{PA} can be calculated by the above-described equation (1). The traverse center width W_{tc} can be calculated by the following equation (8). The traverse center width W_{tc} is a traverse width (width of the package) in the axial direction of the package P.

Traverse center width W_{tc}

$$= \text{Traverse width } W_t \times \cos (\text{Taper angle } \delta \text{ of winding tube}) \dots (8)$$

[0117] The small diameter end portion package diameter D_{PS} can be calculated by the following equation (9). The small diameter end portion package diameter D_{PS} is an outer diameter of a small diameter end portion of the package P.

Small diameter end portion package diameter D_{PS}

$$= \text{Package average diameter } D_{PA} - \text{Traverse center width } W_{tc} \times \tan (\text{Taper}$$

$$\text{angle } \delta \text{ of winding tube}) \dots (9)$$

[0118] The large diameter end portion package diameter D_{PL} can be calculated by the following equation (10). The large diameter end portion package diameter D_{PL} is an outer diameter of a large diameter end portion of the package P.

Large diameter end portion package diameter D_{PL}

$$= \text{Package average diameter } D_{PA} + \text{Traverse center width } W_{tc} \times \tan (\text{Taper}$$

$$\text{angle } \delta \text{ of winding tube}) \dots (10)$$

[0119] The drive package position P_d can be calculated by the following equation (11). The drive package position P_d is a position of the driving point 40 of the package P and indicates a position from a center of the package P in a direction along the traverse width of the package P. For example, when the drive package position P_d exists closer to the large diameter than the center, the drive package position P_d is indicated by a positive numerical value and, when the drive package position P_d exists closer to the small diameter than the center, the drive package position P_d is indicated by a negative numerical value.

Drive package position P_d

$$= \frac{\text{Package drive diameter } D_P - \text{Package average diameter } D_{PA}}{2 \times \tan (\text{Winding tube taper angle } \delta)} \dots (11)$$

[0120] The data relating to the equipment specifications, which is displayed in the display 15, is stored in the storage section 28 of the unit controller 14, for example. The calculations of the package drive diameter D_P , the package average diameter D_{PA} , the traverse center width W_{tc} , the small diameter end portion package diameter D_{PS} , the large diameter end portion package diameter D_{PL} , and the drive package position P_d can be performed by the unit controller 14.

[0121] The display 15 can illustrate the positions of the driving point 40 and the center point 41 on a package image. The display 15 can change the displayed position of the driving point 40 in accordance with a change in the position of the driving point 40.

[0122] Embodiments of the present invention have been described, but the present invention is not limited to the above-described embodiments. For example, a configuration may be made in which while the package is rotated by the rotating winding drum 16, the yarn Y is traversed on the surface of the relevant package, or a configuration may be made in which driving the package and traversing are independent from each other. Such a winding unit may be, for example, an arm-type traverse device adapted to traverse the yarn Y by a traversing arm, a winding unit provided with a belt-type traverse device adapted to traverse the yarn Y by a yarn hooking member which reciprocates from side to side by a belt, or the like. Furthermore, each of component members provided in the spinning unit 52 or the winding unit 1 is not limited to an arrangement in the above-described embodiment, and the arrangement may be changed in an appropriate manner.

[0123] The driving state detecting device of the present invention may be applied to another yarn processing device without limited to the winding machine and the spinning machine.

[0124] In the above-described embodiment, the driving state of the cone-shaped package is detected by calculating the package drive diameter D_P or the slip ratio S as the calculation value relating to the driving state of the cone-shaped package, but the driving state of the cone-shaped package may be detected by calculating the package drive diameter D_P and the slip ratio S. Alternatively, another calculation value may be calculated and be compared with the determination reference value.

Claims

1. A driving state detecting device (14, 80) comprising:

a driving state calculation value calculating section (23, 83) adapted to calculate a calculation value relating to a driving state of a cone-shaped package that rotates by abutting against an outer peripheral surface of a winding drum (16) rotating around an axial line and into which a traversed yarn is wound; and

a comparing and detecting section (24, 84) adapted to compare or enable to be compared the calculation value calculated by the driving state calculation value calculating section (23, 83) with a determination reference value.

2. The driving state detecting device (14) according to claim 1, comprising:

a package peripheral speed detecting section (21) adapted to detect a peripheral speed V_P of the cone-shaped package;

a package rotation speed detecting section (22) adapted to detect a rotation speed F_P of the package; and an average diameter calculating section adapted to calculate a package average diameter D_{PA} , which is an average outer diameter of the package, as the determination reference value;

wherein the driving state calculation value calculating section (23) is a drive diameter calculating section (23) adapted to calculate as the calculation value, a package drive diameter D_P , which is an outer diameter of the package at a driving point in which a rotation drive force of the winding drum (16) is transmitted; and the comparing and detecting section (24) is adapted to compare or to enable to be compared the package drive diameter D_P with the package average diameter D_{PA} .

3. The driving state detecting device (14) according to claim 2, comprising a drum rotation speed detecting section (82) adapted to detect a rotation speed F_1 of the winding drum (16);

wherein the drive diameter calculating section (23) is adapted to calculate the package drive diameter D_P based on the rotation speed F_1 of the winding drum (16); and

the comparing and detecting section (24) is adapted to compare or to enable to be compared the package drive diameter D_P with the package average diameter D_{PA} , and outputs information relating to a winding state of the package.

4. The driving state detecting device (14) according to claim 3, wherein a package reference value is given as one determination reference value and the package reference value is a small diameter and/or a large diameter of a winding tube around which the yarn is wound.

5. The driving state detecting device (14) according to claim 3 or claim 4, wherein the package reference value is given as one determination reference value and the package reference value is an outer diameter of the small diameter

and/or an outer diameter of the large diameter of the package that is in a winding operation.

6. The driving state detecting device (14) according to any one of claim 3 through claim 5, wherein the comparing and detecting section (24) is adapted to detect a change in the package drive diameter D_P and to enable the package drive diameter D_P to be compared with the determination reference value.
7. The driving state detecting device (14) according to any one of claim 3 through claim 6, wherein the average diameter calculating section is adapted to calculate the package average diameter D_{PA} , which is an average outer diameter of the package, by the following equation (1).

$$\text{Package average diameter } D_{PA} = \frac{\text{Peripheral speed } V_P \text{ of package } P}{(\text{Rotation speed } F_P \text{ of package } P) \times \pi} \dots (1)$$

8. The driving state detecting device (14) according to any one of claim 3 through claim 7, wherein the drive diameter calculating section (23) calculates the package drive diameter D_P by the following equation (2).

$$\begin{aligned} &\text{Package drive diameter } D_P \\ &= \frac{\text{Outer diameter } D_1 \text{ of winding drum} \times \text{Rotation speed } F_1 \text{ of winding drum}}{\text{Rotation speed } F_P \text{ of package } P} \\ &\dots (2) \end{aligned}$$

9. The driving state detecting device (14) according to any one of claim 2 through claim 8, comprising:

a notifying section (15) adapted to notify information for instructing adjustment of an inclination of a package supporting section (17, 71) adapted to support the package;
wherein the comparing and detecting section (24) is adapted to compare the package drive diameter D_P with the package average diameter D_{PA} and, when the winding state of the package that has been detected in the comparison by the comparing and detecting section (24) deviates from a predefined state, the notifying section (15) is adapted to notify the information for instructing the adjustment of the inclination of the package supporting section (17, 71).

10. The driving state detecting device (80) according to claim 1, wherein the calculation value is a slip ratio of the package with respect to the winding drum (16).

11. The driving state detecting device (80) according to claim 10, comprising:

a drum peripheral speed detecting section (81) adapted to detect a peripheral speed V_D of the winding drum (16); and
a package peripheral speed detecting section (21) adapted to detect a peripheral speed V_P of the package;
wherein the driving state calculation value calculating section (83) is a package slip ratio calculating section (83) adapted to calculate the slip ratio of the package based on the peripheral speed V_D of the winding drum (16) and the peripheral speed V_P of the package.

12. The driving state detecting device (80) according to claim 10 or claim 11, comprising the notifying section (15) adapted to notify information relating to the slip ratio of the package.

13. The driving state detecting device (14) according to any one of claim 1 through claim 8, comprising the notifying section (15) adapted to notify the calculation value and the determination reference value, that have been enabled by the comparing and detecting section (24) to be compared with each other, or a comparison result from the comparing and detecting section (24).

14. The driving state detecting device (14) according to claim 13, wherein the notifying section (15) is a display section adapted to display the comparison result on a package image.

15. A winding unit (1) comprising:

the winding drum (16) adapted to rotate around the axial line;
 the package supporting section (17, 71) adapted to support the cone-shaped package that rotates in response to drive force from the winding drum (16) by abutting against the outer peripheral surface of the winding drum (16) and into which the traversed yarn is wound;
 a yarn speed detecting section (18) adapted to detect a yarn travelling speed of the yarn travelling between a yarn supplying section adapted to supply the yarn and the package; and
 the driving state detecting device (14, 80) according to any one of claim 1 through claim 14.

16. The winding unit (1) according to claim 15, comprising the package peripheral speed detecting section (21) adapted to detect the peripheral speed V_P of the package by the following equation (3).

Peripheral speed V_P of package P

= Yarn travelling speed $V_0 \times \cos$ (Traverse angle θ) ... (3)

17. The winding unit (1) according to claim 15 or claim 16, comprising a contact pressure adjustment mechanism (37) adapted to adjust a contact state of the package with respect to the winding drum (16).

18. The winding unit (1) according to claim 17, wherein the contact pressure adjustment mechanism (37) includes a cylinder (38) or a motor that is connected to the package supporting section (17, 71).

19. A winding machine comprising a plurality of the winding units (1) according to any one of claim 15 through claim 18.

20. A spinning unit (52) comprising:

a draft roller (64) adapted to draft a fiber bundle;
 a spinning section (57) adapted to spin the fiber bundle, which has been drafted by the draft roller (64), by whirling airflow and generate the yarn;
 the winding drum (16) adapted to rotate around the axial line;
 the package supporting section (17, 71) adapted to support the cone-shaped package that rotates in response to the drive force from the winding drum (16) by abutting against the outer peripheral surface of the winding drum (16) and into which the traversed yarn is wound; and
 the driving state detecting device (14, 80) according to any one of claim 1 through claim 14.

21. The spinning unit (52) according to claim 20, wherein the spinning section (57) is adapted to spin the yarn at a preset constant yarn travelling speed; and
 the driving state detecting device (14) is adapted to calculate the package average diameter D_{PA} , which is the average outer diameter of the package, by employing the preset constant yarn travelling speed.

22. The spinning unit (52) according to claim 20 or claim 21, comprising the contact pressure adjustment mechanism (37) adapted to adjust a contact pressure of the package with respect to the winding drum (16).

23. The spinning unit (52) according to claim 22, wherein the contact pressure adjustment mechanism (37) includes the cylinder (38) or a drive motor that is connected to the package supporting section (17, 71).

24. A spinning machine (51) comprising a plurality of the spinning units (52) according to any one of claim 20 through claim 23.

FIG. 1

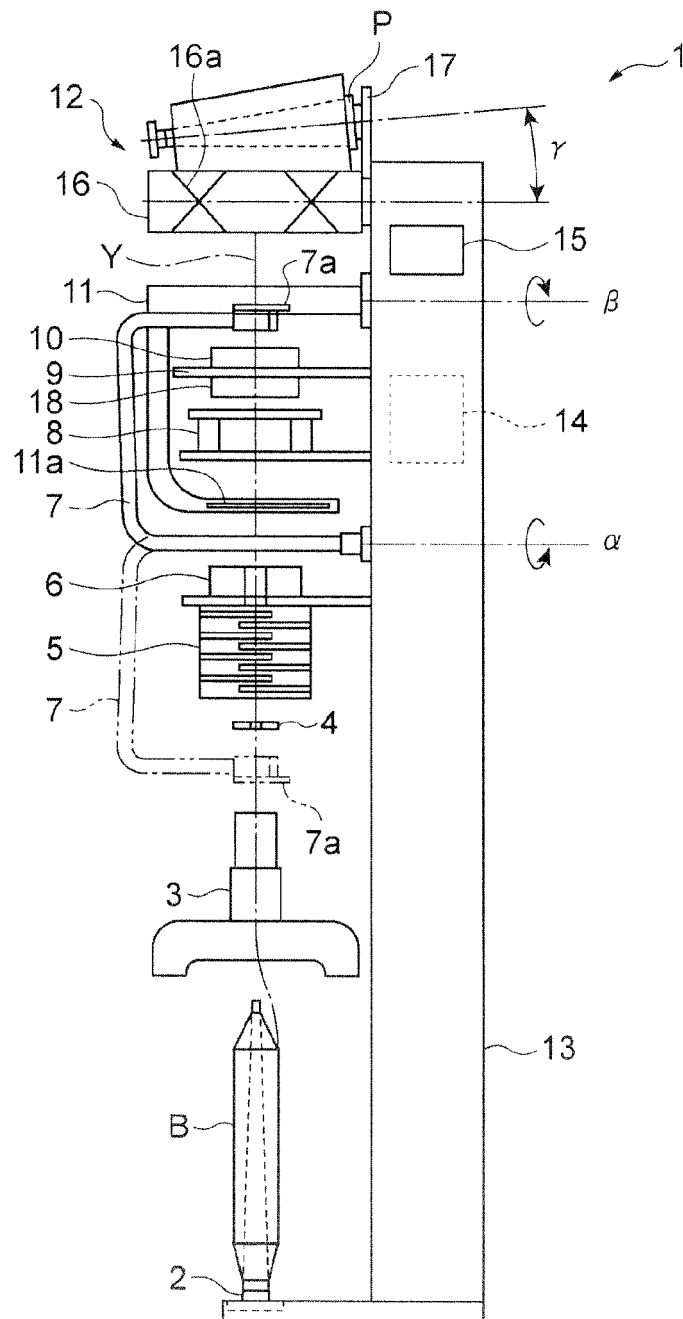


FIG. 2

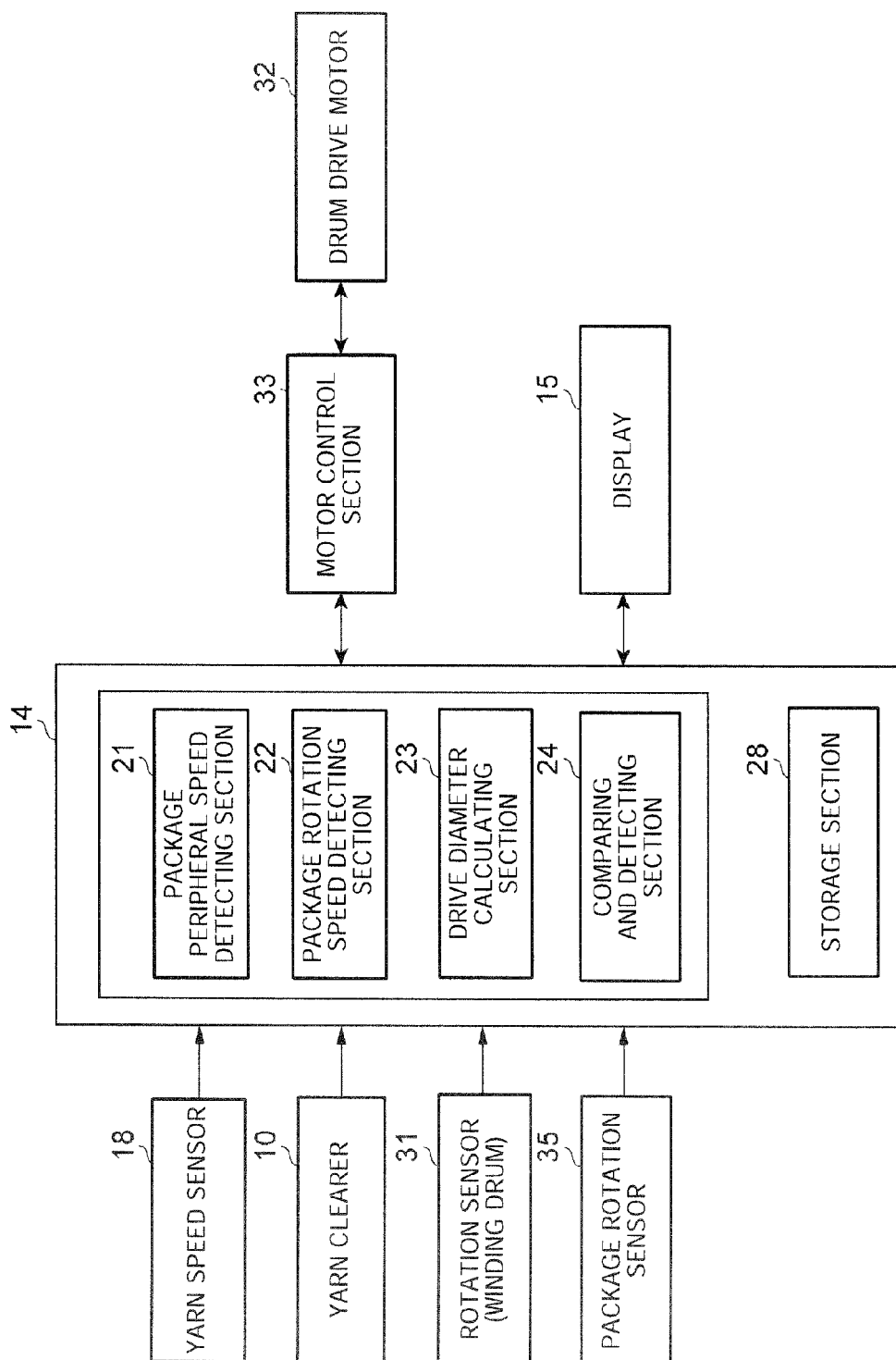


FIG. 4

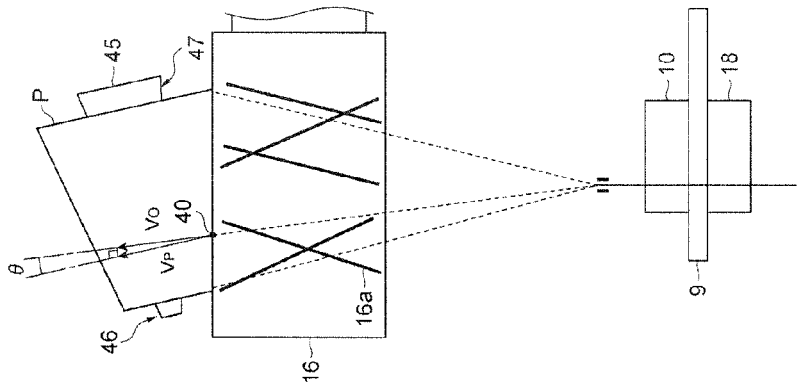


FIG. 3

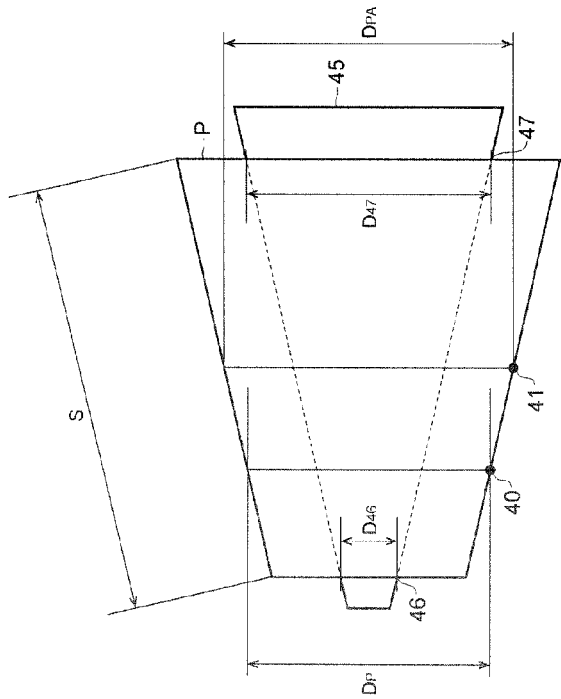


FIG. 5

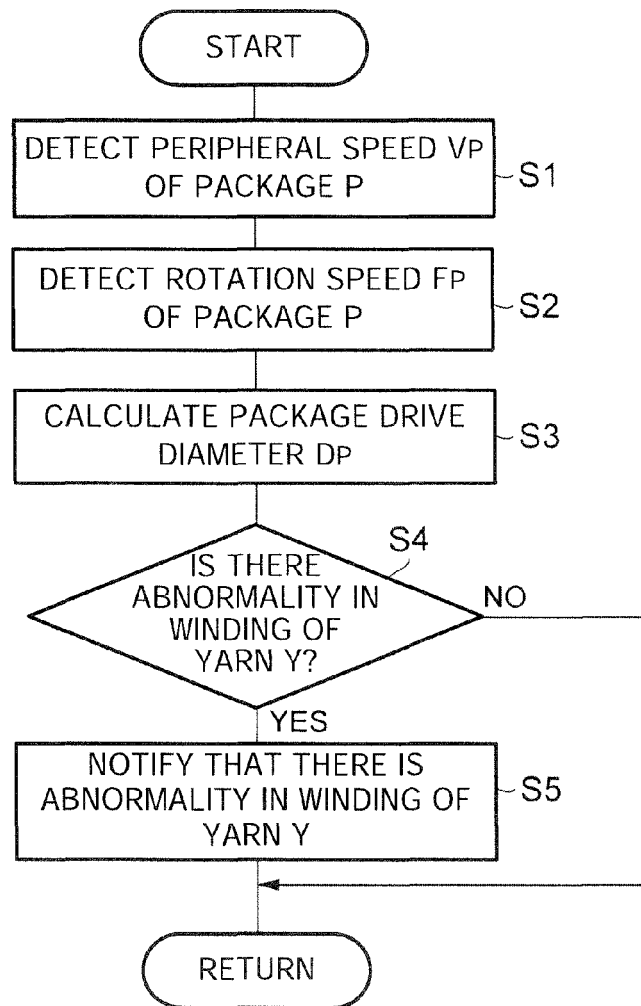


FIG. 6

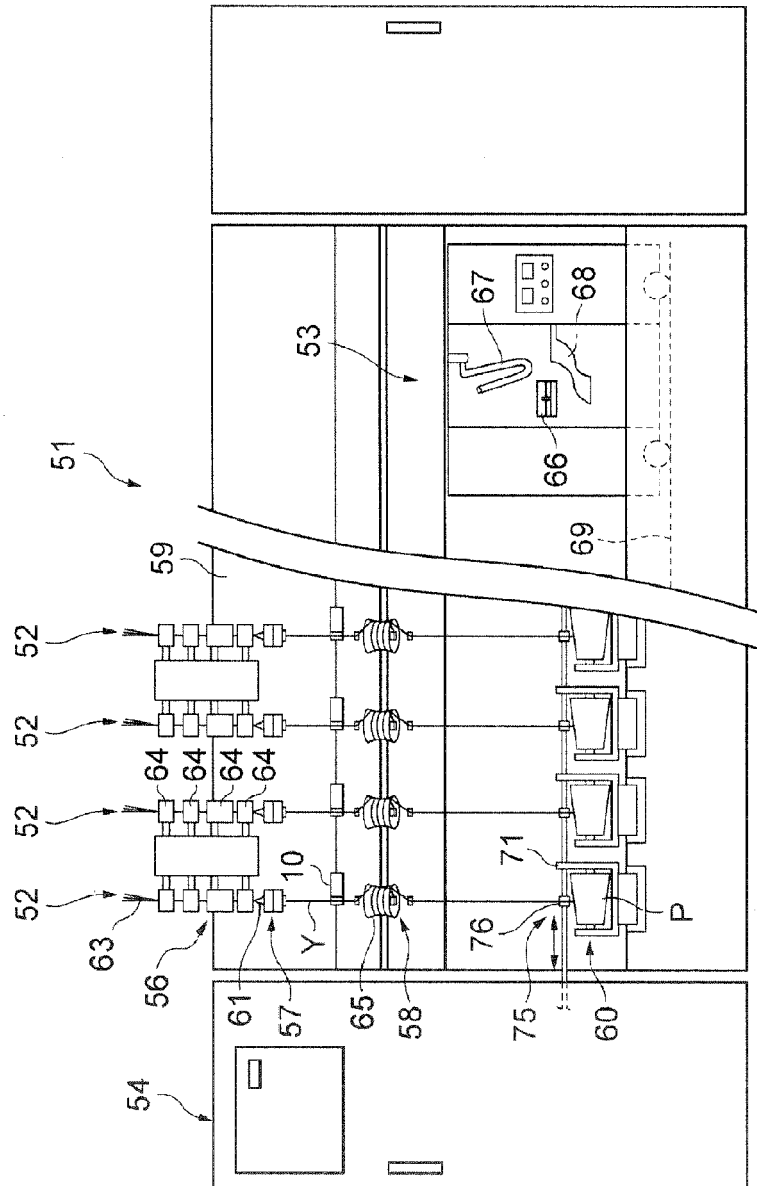


FIG. 7

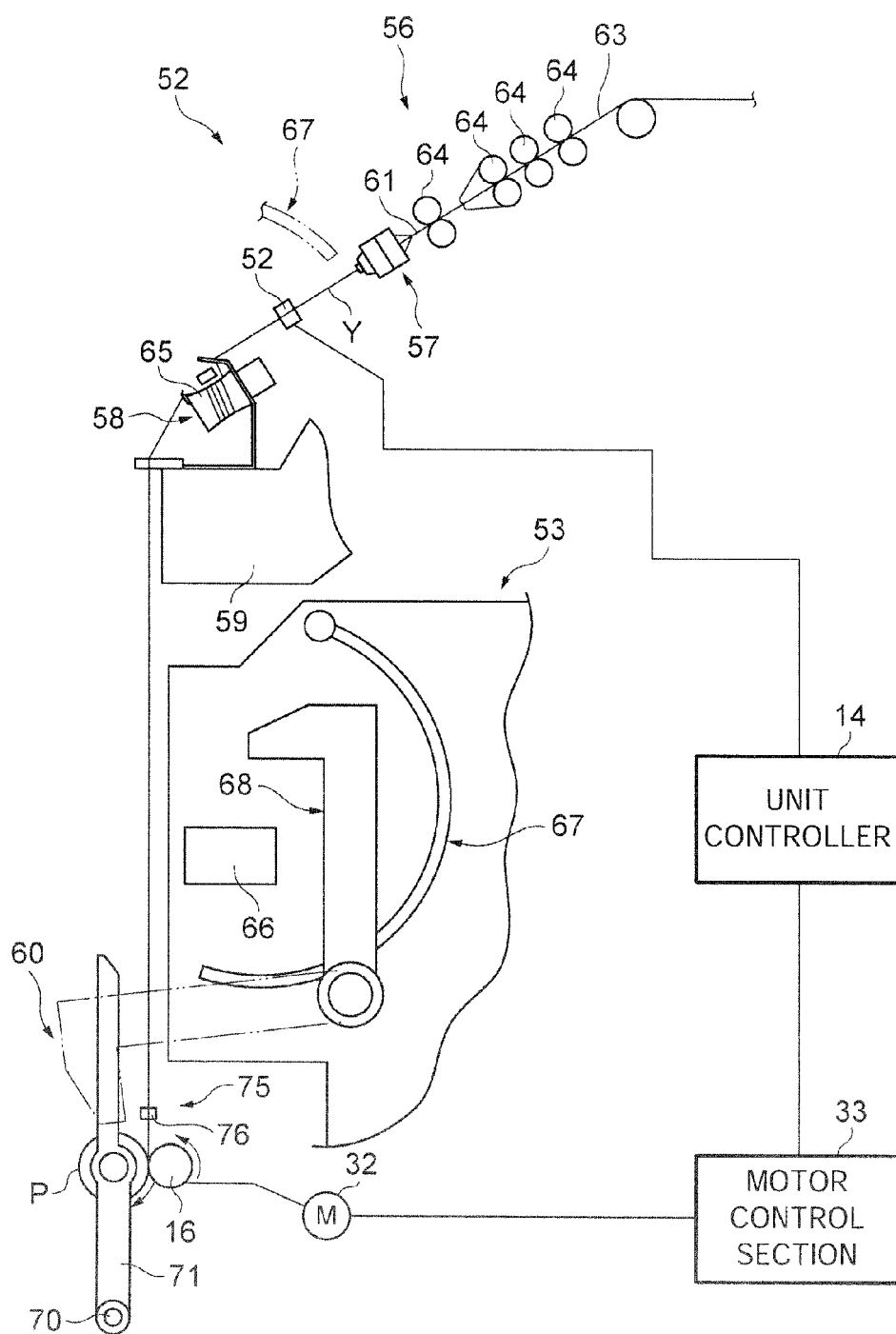


FIG. 8

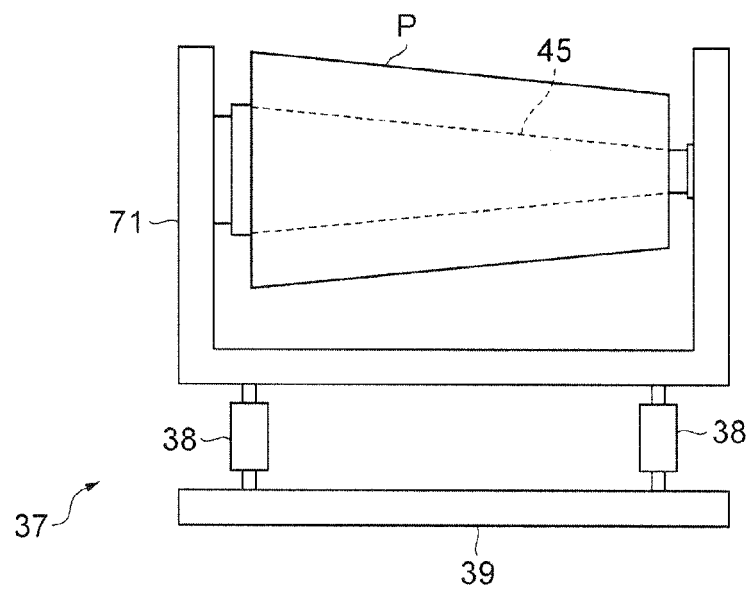


FIG. 9

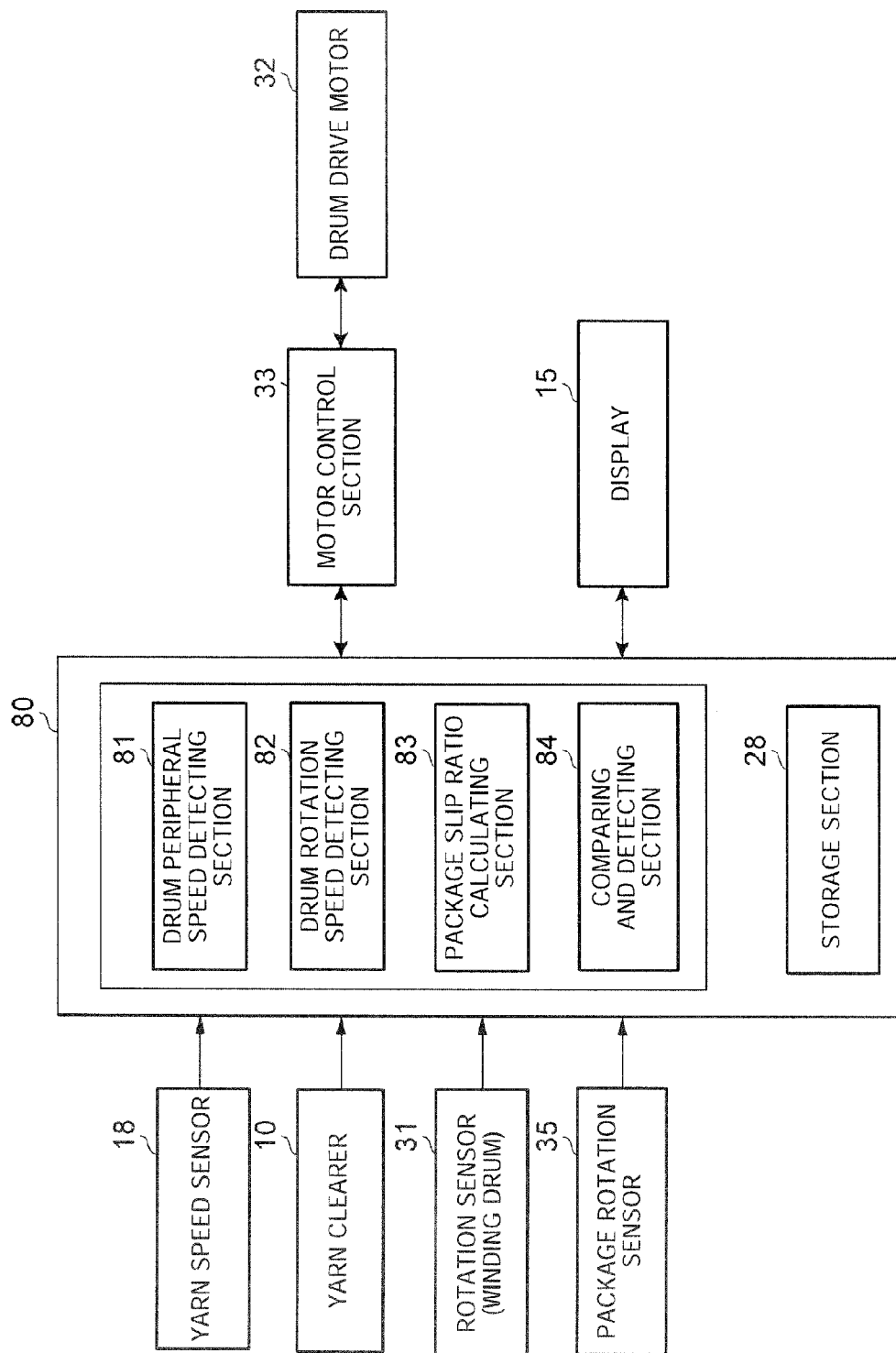
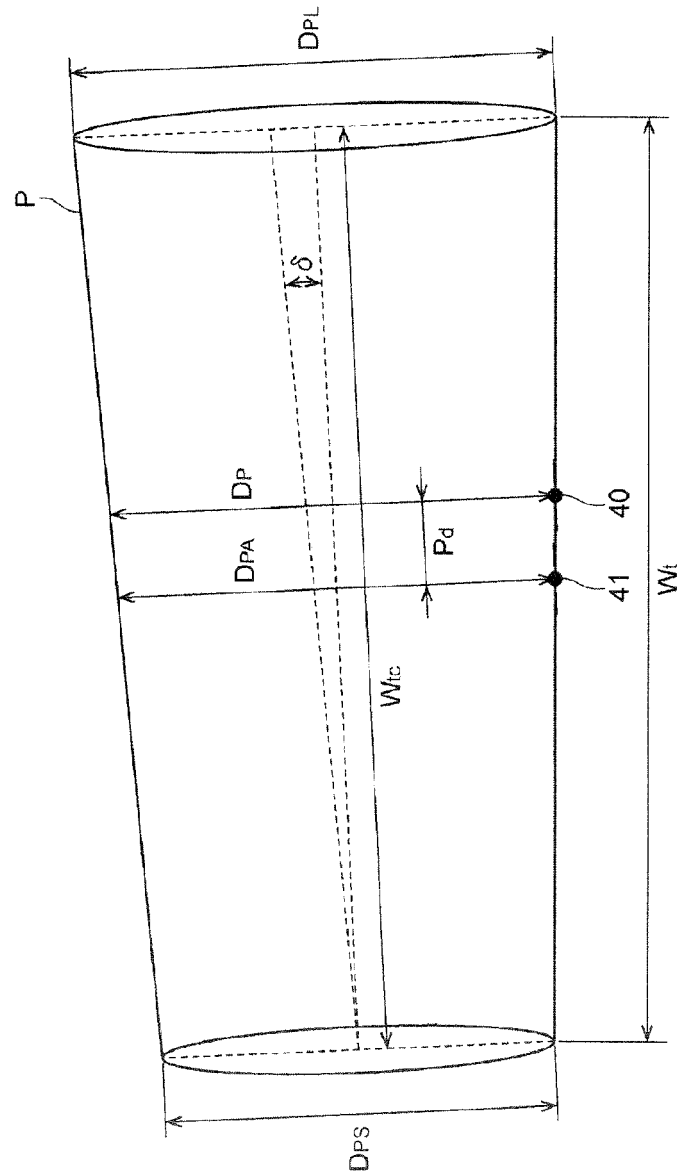


FIG. 10



REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP H4217557 B [0002]