(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 530 039 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
05.12.2012 Bulletin 2012/49

(21) Application number: **12156893.5**

(22) Date of filing: **24.02.2012**

(51) Int Cl.:
B65H 54/10 *(2006.01)* ***B65H 54/38*** *(2006.01)*
B65H 63/00 *(2006.01)*

(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

(30) Priority: **02.06.2011 JP 2011124660**

(71) Applicant: **Murata Machinery, Ltd.**
Minami-ku
Kyoto-shi
Kyoto 601-8326 (JP)

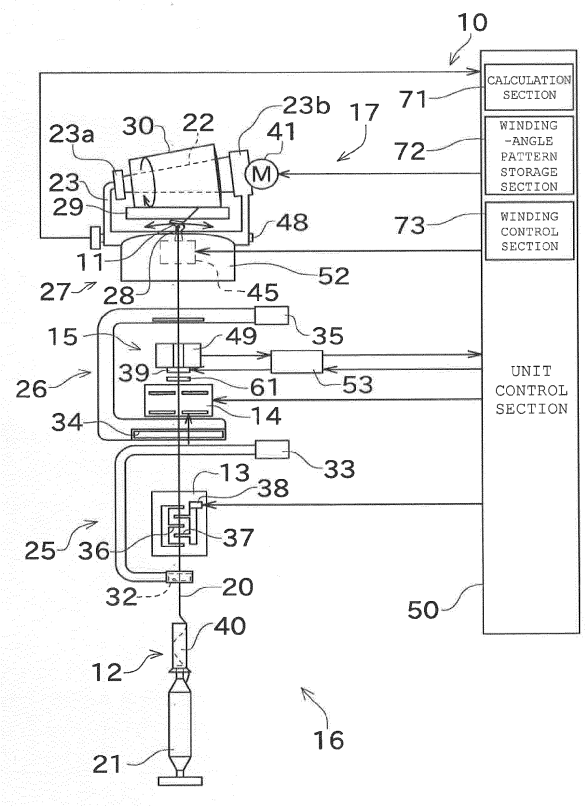
(72) Inventor: **Muta, Katsufumi**
Kyoto-shi, Kyoto 612-8686 (JP)

(74) Representative: **Stöckeler, Ferdinand et al**
Patentanwälte Schoppe, Zimmermann, Stöckeler, Zinkler & Partner
Postfach 246
82043 Pullach (DE)

(54) Yarn winding device

(57) A yarn winding device includes a winding section (17), a winding-angle pattern storage section (72), and a winding control section (73). The winding section is adapted to wind a yarn (20) around a winding bobbin (22) to form a conical package (30). The winding-angle pattern storage section is adapted to store a winding-angle pattern that associates a thickness of a yarn layer of the package with a winding-angle. The winding control section is adapted to control the winding section so as to wind the yarn with the winding-angle determined in accordance with the winding-angle pattern stored in the winding-angle pattern storage section.

FIG. 2



EP 2 530 039 A2

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a yarn winding device adapted to wind a yarn while traversing.

2. Description of the Related Art

[0002] Conventionally, there is known a yarn winding device in which a winding bobbin is rotatably supported by a cradle, and adapted to wind a yarn around an outer peripheral surface of the bobbin to form a package. This type of yarn winding device includes a yarn winding device having a configuration of changing a winding-angle according to an increase in a wound diameter of the package, as illustrated in Japanese Unexamined Patent Publication No. 2007-204191.

[0003] The yarn winding device disclosed in Japanese Unexamined Patent Publication No. 2007-204191 includes a package diameter sensor adapted to detect a package diameter, a traverse device, and a traverse control section adapted to control the traverse device. The traverse control section changes a traverse speed (changes the winding-angle) according to the detected package diameter to prevent a bulge, and the like. In Japanese Unexamined Patent Publication No. 2007-204191, a shape of the package is not particularly mentioned, but a cheese-shaped package is illustrated in the drawing.

[0004] As described above, in the yarn winding device, a control for changing a winding method according to the change in the package diameter (according to advancement in an winding operation) may be carried out. However, in a cone winding package, a package diameter differs depending on a position in a winding width direction. Therefore, in the cone winding package, a control for changing the winding method according to the change in the package diameter of an end region at a larger-diameter side is normally carried out.

[0005] Japanese Unexamined Patent Publication No. 3-288769 discloses a configuration in which a yarn layer is divided into an outermost layer section and an inner layer section based a wound thickness of the package (thickness of the yarn layer) rather than the package diameter, and a control is carried out so that a winding-angle when winding the outermost layer section and a winding-angle when winding the inner layer section become a predetermined ratio. Instead of directly detecting the thickness of the yarn layer, the yarn winding device estimates the thickness of the yarn layer according to an elapsed time and changes the winding-angle according to the estimated value.

[0006] When carrying out a control to suppress the bulge, trial winding of the package may be carried out before the winding operation to determine a set value necessary for the control. In this case, an operator simply winds a yarn around a bobbin without carrying out the control to suppress the bulge to form a trial wound package, actually examines how the bulge appears in the trial wound package, and then determines a winding-angle pattern showing how to change the winding-angle accompanying an increase in the wound thickness of the package. Since how the bulge appears can be predicted from a type of yarn and a winding condition from an empirical value, the operator may set a prediction value to determine the winding-angle pattern. Then, the winding operation is carried out in accordance with the determined winding-angle pattern.

[0007] In the cone winding package, a larger bulge tends to occur on a smaller-diameter side than a larger-diameter side. Therefore, when determining the above winding-angle pattern, the winding-angle is desirably defined with respect to a package diameter on the smaller-diameter side. However, as described above, in the yarn winding device adapted to wind a yarn into the cone winding package, a package diameter on the larger-diameter side and the set value are generally associated. Thus, in the conventional yarn winding device, the winding-angle is required to be defined with respect to the package diameter on the larger-diameter side while looking at the bulge on the smaller-diameter side of the package, which may confuse the operator and lead to a setting mistake.

[0008] The yarn winding device of Japanese Unexamined Patent Publication No. 3-288769 determines the wound thickness of the package based on the elapsed time, and thus cannot respond to a case in which the winding operation is interrupted by yarn joining and the like. Furthermore, Japanese Unexamined Patent Publication No. 3-288769 describes, in the section of Industrial Application, as being a technique related to a cheese-shaped or conical package but contents disclosed in embodiments and the like relate only to the cheese-shaped package and the disclosure is not made on the conical package.

BRIEF SUMMARY OF THE INVENTION

[0009] It is an object of the present invention to provide a yarn winding device capable of effectively suppressing an occurrence of a bulge and the like by changing a winding-angle and forming a cone winding package of a desired shape, the yarn winding device having a configuration in which a setting mistake of the winding-angle is less likely to occur.

[0010] According to an aspect of the present invention, a yarn winding device includes a winding section, a winding-angle pattern storage section, and a winding control section. The winding section is adapted to wind a yarn around a winding tube to form a conical package. The winding-angle pattern storage section is adapted to store a winding-angle pattern that associates a thickness of a yarn layer of the package with a winding-angle. The winding control section is adapted to control the winding sec-

tion so as to wind the yarn with the winding-angle determined in accordance with the winding-angle pattern stored in the winding-angle pattern storage section.

[0011] Since the thickness of the yarn layer of the package does not differ according to the position in the winding width direction of the package, after trial winding when determining the winding-angle pattern, the winding-angle pattern can be determined by simply referencing, for example, the thickness of the yarn layer on the smaller-diameter side and the package shape on the smaller-diameter side (the larger-diameter side does not need to be referenced). Therefore, the setting mistake of the winding-angle pattern can be reduced. Furthermore, the thickness of the yarn layer can be acquired by simply measuring a distance from an outer peripheral surface of the winding tube. Thus, as compared to the package diameter, the thickness of the yarn layer can be easily acquired as a highly accurate value. Therefore, by creating the winding-angle pattern using the thickness of the yarn layer and winding the yarn in accordance with the relevant winding-angle pattern, the winding-angle can be controlled at satisfactory accuracy.

[0012] In the above yarn winding device, the winding-angle pattern storage section is preferably adapted to associate and store the thickness of the yarn layer at any position in a winding width direction of the package with the winding-angle.

[0013] Accordingly, the winding-angle can be set in association with the thickness of the yarn layer at any position in the winding width direction of the package (e.g., end region at the larger-diameter side, end region at the smaller-diameter side, central part, or the like), and the winding-angle can be accurately controlled according to various conditions and demands.

[0014] In the above yarn winding device, the winding-angle pattern storage section is preferably adapted to associate and store the thickness of the yarn layer at a position located within an end region at a smaller-diameter side in the winding width direction of the package with the winding-angle.

[0015] Accordingly, the winding-angle pattern can be set using the thickness of the yarn layer on the smaller-diameter side of the package where the bulge is likely to occur, and the occurrence of the bulge can be accurately suppressed.

[0016] The above yarn winding device preferably includes an operation section adapted to be operated for an input of the winding-angle pattern. The winding-angle pattern storage section is adapted to store the winding-angle pattern that is input via the operation section.

[0017] Accordingly, the winding section can carry out the winding operation of the package in accordance with the winding-angle pattern determined through an experience of the operator, for example.

[0018] The above yarn winding device preferably includes an operation section and a calculation section. The operation section is adapted to be operated for an input of a thickness of a yarn layer of a fully-wound package, a default value of the winding-angle, and an adjusting value for determining a changing amount of the winding-angle. The calculation section is adapted to calculate the winding-angle pattern in accordance with values input via the operation section. The winding-angle pattern storage section is adapted to store the winding-angle pattern calculated by the calculation section.

[0019] Accordingly, while saving work load of the operator to determine and input the winding-angle pattern, the winding section can carry out the winding operation of the package in accordance with the appropriate winding-angle pattern calculated by the minimal input content.

[0020] The above yarn winding device preferably includes a display section adapted to display the winding-angle pattern stored in the winding-angle pattern storage section. Accordingly, the operator can appropriately check the set winding-angle pattern.

[0021] In the above yarn winding device, the winding section preferably includes a package driving section, a traverse section, and a driving section. The package driving section is adapted to rotationally drive the package. The traverse section is adapted to traverse the yarn to be wound into the package. The traverse driving section is provided independently from the package driving section and adapted to drive the traverse section.

[0022] Accordingly, the yarn winding device can drive the traverse section independently from a rotation of the package, and the control for changing the winding-angle can be easily carry out.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023]

FIG. 1 is a front view of an automatic winder according to one embodiment of the present invention;
FIG. 2 is a front view and a block diagram of a winder unit;
FIG. 3 is a schematic side view of a traverse device;
FIG. 4 is a schematic front view of the traverse device;
FIG. 5 is a schematic view illustrating a cross-sectional shape of a package obtained by trial winding;
FIG. 6A is a diagram illustrating a winding-angle pattern, and FIG. 6B is a diagram illustrating an input content for causing a calculation section to calculate the winding-angle pattern; and
FIG. 7 is a graph illustrating a setting example of the winding-angle with respect to a yarn layer thickness.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0024] Embodiments of the invention will be hereinafter described. First, an overall configuration of an automatic winder (yarn winding device) 1 according to an embodiment will be described with reference to FIG. 1. FIG. 1 is a front view of the automatic winder 1 according to

one embodiment of the present invention. Herein, "upstream" and "downstream" respectively refer to upstream and downstream in a travelling direction of a yarn at the time of yarn winding.

[0025] As illustrated in FIG. 1, the automatic winder (yarn winding device) 1 includes a plurality of winder units 10 arranged in line, an automatic doffing device 80, and a main control device 90.

[0026] Each winder unit 10 is configured to wind a yarn 20 unwound from a yarn supplying bobbin 21 while traversing the yarn 20 to form a package 30.

[0027] When the package 30 is fully wound in one of the winder units 10, the automatic doffing device 80 travels to a position of the relevant winder unit 10 to collect the fully-wound package 30 and supply an empty winding bobbin.

[0028] The main control device 90 includes an operation section 91 and a display section 92. The operation section 91 enables an operator to input a predetermined set value or select an appropriate control method to carry out setting with respect to each winder unit 10. The display section 92 may display winding status of the yarn 20 in each winder unit 10, content of trouble that occurred, and the like.

[0029] Next, a description will be made on a detailed configuration of the winder unit 10 with reference to FIG. 2. FIG. 2 is a front view and a block diagram of the winder unit 10.

[0030] As illustrated in FIG. 2, each winder unit 10 includes a winding unit main body 16, and a unit control section 50.

[0031] The unit control section 50 includes, for example, a Central Processing Unit (CPU), and a Read Only Memory (ROM). The ROM stores a program for controlling each component of the winding unit main body 16. The CPU executes the program stored in the ROM. The unit control section 50 includes a calculation section 71, a winding-angle pattern storage section 72, and a winding control section 73. The detailed configuration thereof will be described later.

[0032] The winding unit main body 16 is configured with a yarn-unwinding assisting device 12, a tension applying device 13, a splicer device 14, a yarn length detecting sensor 61, a clearer (yarn quality measuring equipment) 15, and a winding section 17 arranged in this order from the yarn supplying bobbin 21 along a yarn travelling path between the yarn supplying bobbin 21 and the winding bobbin (winding tube) 22.

[0033] The yarn-unwinding assisting device 12 causes a regulation member 40 to make contact with a balloon formed at an upper part of the yarn supplying bobbin 21 when the yarn 20 unwound from the yarn supplying bobbin 21 is swung around, and controls the balloon to an appropriate size to assist the unwinding of the yarn 20. A sensor (not illustrated) for detecting a chase portion of the yarn supplying bobbin 21 is arranged in proximity to the regulation member 40. When this sensor detects lowering of the chase portion, the yarn-unwinding assisting device 12 can lower the regulation member 40 by an air cylinder (not illustrated), for example, following thereto.

[0034] The tension applying device 13 applies a predetermined tension on the travelling yarn 20. The tension applying device 13 may be a gate-type in which movable comb teeth 37 are arranged with respect to fixed comb teeth 36. The movable comb teeth 37 are swung by a rotary solenoid 38 or the like, so as to be in a meshed state or a released state with respect to the fixed comb teeth 36. The tension applying device 13 applies a predetermined tension on the yarn 20 to be wound, thus improving quality of the package 30. A disc-type tension applying device 13, for example, may be adopted instead of the gate-type tension applying device described above.

[0035] The splicer device 14 joins a lower yarn from the yarn supplying bobbin 21 and an upper yarn from the package 30 after a yarn cut when the clearer 15 detects a yarn defect and cuts the yarn 20 with a cutter 39, or after a yarn breakage while unwinding the yarn 20 from the yarn supplying bobbin 21. Such a yarn joining device adapted to join the upper yarn and the lower yarn may be a mechanical type or a type that uses fluid such as compressed air.

[0036] The yarn length detecting sensor 61 detects a yarn length of the yarn 20 wound into the package 30 in a non-contacting manner. The yarn length detecting sensor 61 detects an amount of hairiness of the yarn 20 to calculate a movement amount of the yarn 20, and detects the yarn length. Specifically, although not illustrated, the yarn length detecting sensor 61 includes a plurality of optical hairiness detecting sections having a light receiving element and a light source along a yarn travelling direction. The yarn length detecting sensor 61 detects a travelling length of the yarn 20 in accordance with a change in an output signal of the hairiness detecting sections located at different positions in the yarn travelling direction.

[0037] The clearer 15 includes a clearer head 49 provided with a sensor (not illustrated) for detecting a thickness of the yarn 20, and an analyzer 53 for processing a yarn thickness signal from the sensor. The clearer 15 detects a yarn defect such as slub by monitoring the yarn thickness signal from the sensor. The cutter 39 is provided in proximity to the clearer head 49, and immediately cuts the yarn 20 when the clearer 15 detects the yarn defect. The analyzer 53 may be arranged in the unit control section 50.

[0038] A lower yarn guiding pipe 25 for catching the lower yarn from the yarn supplying bobbin 21 and guiding the lower yarn to the splicer device 14, and an upper yarn guiding pipe 26 for catching the upper yarn from the package 30 and guiding the upper yarn to the splicer device 14 are respectively arranged below and above the splicer device 14. The lower yarn guiding pipe 25 and the upper yarn guiding pipe 26 can respectively swing with shafts 33 and 35 as a center. A suction port 32 is formed at a distal end of the lower yarn guiding-pipe 25. A suction

mouth 34 is arranged at a distal end of the upper yarn guiding pipe 26. An appropriate negative pressure source (not illustrated) is connected to the lower yarn guiding pipe 25 and the upper yarn guiding pipe 26. Accordingly, a suction flow is generated at the suction port 32 and the suction mouth 34 to suck and catch yarn ends of the upper yarn and the lower yarn with the upper yarn guiding pipe 26 and the lower yarn guiding pipe 25.

[0039] The winding unit main body 16 includes a cradle 23 adapted to removably support the winding bobbin (paper tube or core tube) 22, and a contact roller 29 adapted to be driven and rotated when brought into contact with a peripheral surface of the winding bobbin 22 or a peripheral surface of the package 30. The winding unit main body 16 also includes an arm-type traverse device 27 in proximity to the cradle 23 to traverse the yarn 20 with respect to the surface of the package 30, so that the yarn 20 can be wound into the package 30 while being traversed with the traverse device 27.

[0040] The winding section 17 includes a cradle 23, a package driving motor (package driving section) 41, and the traverse device 27.

[0041] The cradle 23 includes a smaller-diameter-side supporting arm 23a for supporting a smaller-diameter side of the conical (tapered) winding bobbin 22, and a larger-diameter-side supporting arm 23b for supporting a larger-diameter side of the winding bobbin 22. The cradle 23 grips the conical winding bobbin 22 with the smaller-diameter-side supporting arm 23a and the larger-diameter-side supporting arm 23b to rotatably support the conical winding bobbin 22.

[0042] The cradle 23 can swing with a swing shaft 48 as the center. An increase in a yarn layer diameter of the package 30 accompanying the winding of the yarn 20 around the winding bobbin 22 can be absorbed by the swinging of the cradle 23. In other words, even if the yarn layer diameter of the package 30 changes due to the winding of the yarn 20, the surface of the package 30 can be appropriately made in contact with the surface of the contact roller 29. By winding the yarn 20 around the conical winding bobbin 22, the cradle 23 and the traverse device 27 can form the conical package 30 as illustrated in FIG. 2.

[0043] A package driving motor 41 such as a servo motor is attached to the cradle 23. When the winding bobbin 22 is rotationally driven by the package driving motor 41, the yarn 20 is wound around the surface of the winding bobbin 22 (or the surface of the package 30). A motor shaft of the package driving motor 41 is coupled with the winding bobbin 22 so as to be relatively non-rotatable when the winding bobbin 22 is supported by the cradle 23 (so-called direct drive type). An operation of the package driving motor 41 is controlled by the unit control section 50. A package-driving-motor control section which is independent from the unit control section 50 may be provided, and the operation of the package driving motor 41 may be controlled by the package-driving-motor control section.

[0044] Next, the traverse device 27 will be described. The traverse device 27 includes a traverse arm (traverse section) 28, a traverse-arm driving motor (traverse driving section) 45, and a yarn guiding member 52. FIG. 3 and FIG. 4 are respectively a schematic side view and a front view of the traverse device 27.

[0045] The traverse arm 28 is configured as an elongate arm adapted to swing about a supporting axis. A traverse guide 11 is connected to a distal end of the traverse arm 28. The traverse guide 11 is a hook-shape adapted to engage the yarn 20. A basal end of the traverse arm 28 is fixed to a drive shaft 45a of the traverse-arm driving motor 45. The traverse-arm driving motor 45 is provided to drive the traverse arm 28 and is configured by a servo motor. Instead of the servo motor, the traverse-arm driving motor 45 may be an appropriate motor such as a brushless DC motor, a stepping motor, or a voice coil motor.

[0046] The traverse device 27 drives the traverse-arm driving motor 45 with the yarn 20 engaged to the traverse guide 11 to reciprocate the traverse arm 28 as illustrated with an arrow in FIG. 4. As a result, the traverse guide 11 is reciprocated to the left and the right (winding width direction of the package 30) and the yarn 20 is traversed with respect to the surface of the package 30 in the left and right direction. Accordingly, the yarn 20 can be wound around the winding bobbin 22 while being traversed at a predetermined speed and to a predetermined winding width to form the yarn layer on the outer peripheral surface of the winding bobbin 22 at a desired density.

[0047] An operation of the traverse-arm driving motor 45 is controlled by the winding control section 73. However, the operation of the traverse-arm driving motor 45 may be controlled by the unit control section 50, or a dedicated traverse control section may be provided for control. The yarn guiding member 52 is arranged upstream of the traverse guide 11 in the yarn travelling direction. The yarn guiding member 52 bends the yarn path of the yarn 20 located upstream of the yarn guiding member 52 in the yarn travelling direction towards the contact roller 29 to guide the yarn 20 so as to be caught by the traverse guide 11.

[0048] As illustrated in FIG. 3, the drive shaft 45a of the traverse-arm driving motor 45 is arranged to form an angle close to parallel with respect to the yarn path of the yarn 20 located upstream of the yarn guiding member 52 (extended line of the drive shaft 45a and the yarn path of the yarn 20 form an acute angle) when seen in a direction of a line connecting one end side and the other end side of a traverse stroke. When seen in the direction of the line connecting one end side and the other end side of the traverse stroke, a virtual line connecting a basal end of the traverse arm 28 and the traverse guide 11 is arranged to be substantially orthogonal to the extended line of the yarn path of the yarn 20 located upstream of the yarn guiding member 52. The yarn path of the yarn 20 is substantially perpendicular to an installation surface of the winder unit 10 (horizontal surface in

the present embodiment). Therefore, in the automatic winder 1 of the present embodiment, the traverse guide 11 reciprocates within a plane substantially parallel to the installation surface of the winder unit 10 (horizontal surface in the present embodiment).

[0049] The processes carried out by the automatic winder 1 to suppress the occurrence of bulge will now be described with reference to FIG. 4 to FIG. 7. FIG. 5 is a schematic diagram illustrating a cross-sectional shape of the package 30 obtained by trial winding. FIG. 6A is a diagram illustrating a winding-angle pattern and FIG. 6B is a diagram illustrating an input content for causing the calculation section 71 to calculate the winding-angle pattern. FIG. 7 is a graph illustrating a set example of a winding-angle with respect to a yarn layer thickness.

[0050] When winding the yarn 20 with a new winding condition, firstly, trial winding is carried out to check an occurrence degree of the bulge. In such trial winding, a process for suppressing the occurrence of the bulge, to be described later, is not performed.

[0051] As illustrated with a solid line in FIG. 5, the package 30 having a shape in which the side surface is bulged out is formed by the trial winding. Such bulging of the side surface is hereinafter referred to as the bulge. The bulge occurs when the yarn 20 of an intermediate layer of the package 30 is compressed by a tightening force of the yarn 20 on an outer diameter side and a repulsion force from the winding bobbin 22, thus running out from an end face of the package 30. The running-out amount depends on the distance (thickness of the yarn layer) from the surface of the winding bobbin 22. In the case of the conical package 30, the bulge is known to significantly appear (influence of the bulge is large) on the smaller-diameter side than the larger-diameter side.

[0052] Next, the operator measures the shape of the package 30 obtained by the trial winding, and determines the winding-angle pattern in accordance with the measurement result. The winding-angle pattern indicates how to change the winding-angle (see a winding-angle θ illustrated in FIG. 4) in accordance with the advancement of the winding of the package 30. In the present embodiment, the winding-angle is an inclination angle of the yarn 20 on the package 30 with respect to a perpendicular line with respect to an axis of the winding bobbin 22. However, an intersecting angle of the yarn 20 and the yarn 20 may be adopted for the winding-angle. In this case, however, a numerical value of the winding-angle is different from the numerical value of the angle illustrated in the present embodiment.

[0053] Conventionally, when forming the conical package 30, the winding-angle pattern that associates the package diameter on the larger-diameter side with the winding-angle is used. In such a conventional winding-angle pattern, in order to effectively suppress the occurrence of the bulge on the smaller-diameter side in which the influence of the bulge is large, the winding-angle needs to be defined with respect to the package diameter on the larger-diameter side while looking at the degree of bulge appearing on the smaller-diameter side in the trial wound package. Therefore, a work load of conversion is cumbersome, and a setting mistake also increases. Furthermore, when measuring the package diameter on the larger-diameter side, a projecting end or the like of the winding bobbin 22 may become an obstacle in an accurate measurement. If the package end on the larger-diameter side changes according to the yarn layer such as in taper winding, the package diameter differs depending on a measurement position (the same applies to the smaller-diameter side of the package 30).

[0054] In the present embodiment, the winding-angle pattern that associates the thickness of the yarn layer with the winding-angle is used. Since the thickness of the yarn layer does not differ according to the position in the winding width direction, the winding-angle pattern can be determined by simply referencing the thickness of the yarn layer on the smaller-diameter side and the package shape on the smaller-diameter side (thickness of the yarn layer on the larger-diameter side of the package 30 and the package shape on the larger-diameter side do not need to be referenced). The thickness of the yarn layer of the package 30 can be easily obtained by measuring the distance from the outer peripheral surface, of the winding bobbin 22. Therefore, the operator places a ruler on a side surface of the yarn layer of the trially wound package 30 (in particular, side surface on the smaller-diameter side of the package 30) with the ruler directed perpendicular to the outer peripheral surface of the winding bobbin 22 to examine where or how many mm from the surface of the winding bobbin 22, the running-out (bulge) of the yarn layer of about how many mm is appearing. The operator can directly designate the winding-angle pattern in accordance with the examined result. Therefore, the direct designation can be made at the time of the setting of the winding-angle pattern, and the occurrence of the setting mistake as described above can be prevented.

[0055] In the present embodiment, the winding-angle pattern can be set through roughly two methods. A first setting method is a method in which the operator determines the winding-angle pattern in accordance with a comparison result of the thickness of the yarn layer and the bulge shape, and manually inputs the determined winding-angle pattern (e.g., content illustrated in FIG. 6A) using the operation section 91. The input winding-angle pattern is stored in the winding-angle pattern storage section 72 of each winder unit 10.

[0056] In the second setting method, firstly, in accordance with the comparison result of the thickness of the yarn layer and the bulge shape, the operator determines a final yarn layer thickness, which is a thickness of the yarn layer of the fully-wound package 30, a default value of the winding-angle to be set, and a winding-angle adjusting value, which is a value for determining a changing amount of the winding-angle (see FIG. 6B). The operator inputs the determined value by operating the operation section 91. The input content is output to the calculation

section 71 of each winder unit 10. From the above three input values, the calculation section 71 can automatically generate the winding-angle pattern (content as illustrated in FIG. 6A) for suppressing the bulge through calculation. The parameters corresponding to the yarn layer thicknesses of 20 mm and 70 mm in FIG. 6A are calculated by appropriately using a relational expression or the like obtained theoretically or empirically and stored in the calculation section 71 in advance. The created winding-angle pattern is stored in the winding-angle pattern storage section 72 of each winder unit 10.

[0057] The winding-angle pattern is set in the above manner. The operator operates the operation section 91 to display the set winding-angle pattern on the display section 92 in a form of a table as illustrated in FIG. 6A or display the set winding-angle pattern in a form of a graph as illustrated in FIG. 7. Accordingly, the operator can appropriately check the set winding-angle pattern.

[0058] The winding control section 73 controls the winding section 17 to wind the yarn 20 in accordance with the winding-angle pattern stored in the winding-angle pattern storage section 72. A description will be made on the control carried out by the winding control section 73 in accordance with the winding-angle pattern illustrated in FIG. 7. The winding control section 73 first controls the traverse device 27 (specifically, the traverse-arm driving motor 45) such that the winding-angle is 12.5 degrees (a default value of the winding-angle) to wind the yarn 20 by the winding section 17.

[0059] In accordance with the yarn length detected by the yarn length detecting sensor 61 and the type (yarn count or the like) of the yarn 20 set in the main control device 90 or the like in advance, the winding control section 73 obtains the thickness of the yarn layer of the package 30 at a predetermined interval during the winding of the yarn 20. The winding control section 73 controls the traverse device 27 so that the winding-angle becomes greater as the thickness of the yarn layer increases. After the obtained thickness of the yarn layer becomes 20 mm, the winding control section 73 stops the control for increasing the winding-angle, and controls the traverse device 27 so that the winding-angle is maintained at 14.5 degrees.

[0060] After the obtained thickness of the yarn layer becomes 70 mm, the winding control section 73 controls the traverse device 27 such that the winding-angle becomes smaller as the thickness of the yarn layer increases. According to such a control, the winder unit 10 can form the package 30 in which the occurrence of the bulge is effectively suppressed.

[0061] Generally, if the traverse section and the package are independently drivable, from the viewpoint of winding control, various settings and controls are sometimes desirably carried out using the package diameter at the central part in the winding width direction of the package. If the package is conical as described above, various settings and controls are generally carried out using the package diameter on the larger-diameter side. Therefore, as in the present embodiment, if the traverse arm 28 and the package 30 are independently drivable and the package 30 is conical, it is difficult to determine the package diameter of which position in the winding width direction of the package 30 is to be used to carry out the control, and the operator may get confused. In the present embodiment, since the control is carried out using the thickness of the yarn layer of which value does not change according to the position in the winding width direction of the package 30, the confusion of the operator can be prevented.

[0062] As described above, the automatic winder 1 of the present embodiment includes the winding section 17, the winding-angle pattern storage section 72, and the winding control section 73. The winding section 17 winds the yarn 20 around the winding bobbin 22 to form the conical package 30. The winding-angle pattern storage section 72 stores the winding-angle pattern that associates the thickness of the yarn layer of the package 30 with the winding-angle. The winding control section 73 controls the winding section 17 so that the yarn 20 is wound at the winding-angle determined in accordance with the winding-angle pattern stored in the winding-angle pattern storage section 72.

[0063] Accordingly, since the thickness of the yarn layer does not differ according to the position in the winding width direction, after the trial winding in determining the winding-angle pattern, the winding-angle pattern can be determined by simply referencing, for example, the thickness of the yarn layer on the smaller-diameter side and the package shape on the smaller-diameter side (the larger-diameter side does not need to be referenced). Therefore, the setting mistake of the winding-angle pattern can be reduced. Furthermore, the thickness of the yarn layer can be acquired by simply measuring the distance from the outer peripheral surface of the winding bobbin 22. Thus, the thickness of the yarn layer can be easily acquired as a highly accurate value compared to the package diameter. Therefore, by creating the winding-angle pattern using the thickness of the yarn layer and winding the yarn 20 in accordance with the winding-angle pattern, the winding-angle can be controlled at satisfactory accuracy.

[0064] In the automatic winder 1 of the present embodiment, the winding-angle pattern storage section 72 associates and stores the thickness of the yarn layer at a position located within an end region at a smaller-diameter side in the winding width direction of the package 30 with the winding-angle. Accordingly, the winding-angle pattern can be set using the thickness of the yarn layer on the smaller-diameter side where the bulge easily occurs, and the occurrence of the bulge can be accurately suppressed.

[0065] The automatic winder 1 of the present embodiment includes an operation section 91 adapted to be operated for an input of the winding-angle pattern. The winding-angle pattern storage section 72 stores the winding-angle pattern that is input via the operation section

91. Accordingly, the automatic winder 1 can carry out the winding operation of the package 30 in accordance with the winding-angle pattern determined through the experience of the operator, for example.

[0066] The automatic winder 1 of the present embodiment includes the operation section 91 and the calculation section 71. The operation section 91 is adapted to be operated for an input of a thickness of a yarn layer of a fully-wound package, a default value of the winding-angle, and an adjusting value for determining a changing amount of the winding-angle. The calculation section 71 is adapted to calculate the winding-angle pattern in accordance with values input via the operation section 91. The winding-angle pattern storage section 72 is adapted to store the winding-angle pattern calculated by the calculation section 71.

[0067] Accordingly, while saving the work load of the operator to determine and input the winding-angle pattern, the winding section 17 can carry out the winding operation of the package 30 in accordance with the appropriate winding-angle pattern calculated by the minimal input content.

[0068] The automatic winder 1 of the present embodiment includes a display section 92 adapted to display the winding-angle pattern stored in the winding-angle pattern storage section 72. Accordingly, the operator can appropriately check the set winding-angle pattern.

[0069] In the automatic winder 1 of the present embodiment, the winding section 17 includes the package driving motor 41, the traverse arm 28, and the traverse arm driving motor 45. The package driving motor 41 is adapted to rotationally drive the package 30. The traverse arm 28 is adapted traverse the yarn 20 to be wound into the package 30. The traverse arm driving motor 45 is provided independently from the package driving motor 41 and is adapted to drive the traverse arm 28. Accordingly, the automatic winder 1 can drive the traverse arm 28 independently from the rotation of the package 30, and the control of changing the winding-angle can be easily carried out.

[0070] The preferred embodiments of the present invention have been described above, but the above configurations may be modified as below.

[0071] The operation section 91 and the display section 92 are not limited to the configuration of being arranged in the main control device 90, and may be arranged for every winder unit 10. The calculation section 71 and the winding-angle pattern storage section 72 are not limited to the configuration of being arranged for every winder unit 10, and may be arranged in the main control device 90.

[0072] In the embodiment described above, the thickness of the yarn layer of the package 30 is calculated in accordance with the yarn length detected by the yarn length detecting sensor 61, and the winding condition set in the main control device 90. Alternatively, for example, by storing in advance the relationship (obtained empirically) of the length of the yarn 20 to be wound into the package 30 and the thickness of the yarn layer of the package 30, such calculation may be omitted.

[0073] As the configuration of obtaining the thickness of the yarn layer of the package 30, an angle sensor for detecting an angle of the cradle 23 (swing angle about the swing shaft 48) may be used. The angle sensor includes a rotary encoder, for example, and transmits an angle signal corresponding to the angle of the cradle 23 to the unit control section 50. Since the angle of the cradle 23 changes accompanying the increase in the wound diameter of the package 30, the package diameter can be detected by detecting the angle with the angle sensor. The thickness of the yarn layer of the package 30 can be calculated by subtracting the diameter of the winding bobbin 22 from the detected package diameter. As the method of detecting the package diameter, an appropriate configuration such as a method using an analog sensor or an absolute type sensor may be used other than the angle sensor.

[0074] As the configuration for obtaining the thickness of the yarn layer of the package 30, a timer capable of measuring the elapsed time can be used. In this case, a temporal change in the thickness of the yarn layer is defined in advance through calculation or empirical value in accordance with the winding condition. Then, the thickness of the yarn layer is obtained in accordance with the defined value and the measured elapsed time. The timer can measure the elapsed time, while taking into consideration the time the winding was interrupted by yarn cut or yarn breakage.

[0075] In addition, the thickness of the yarn layer of the package 30 can be obtained using the travelling length of the yarn 20 detected by the yarn length detecting sensor 61. Specifically, the winding-angle can be calculated in accordance with the yarn travelling speed calculated from the yarn travelling length detected by the yarn length detecting sensor 61, and the traverse speed. Then, the package diameter is calculated in accordance with the winding-angle, the peripheral speed of the package 30, and the number of rotations of the package 30. By subtracting the diameter of the winding bobbin 22 from the calculated package diameter, the thickness of the yarn layer can be obtained.

[0076] An example of a general cone winding package has been described in the above embodiments by way of example, but the present invention can also be applied to a cone winding package of which an end surface is tapered.

[0077] In place of the arm-type traverse device as described above, the traverse device 27 may be a belt-type traverse device adapted to reciprocate the traverse guide to left and right by belt drive, a rotary-type traverse device using a rotary blade, or a rod-type traverse device adapted to reciprocate a rod to which a traverse guide is attached.

[0078] As described above, the traverse device 27 is not limited to a configuration of reciprocating the traverse arm 28 within a substantially horizontal plane with respect

to the installation surface of the winder unit 10. For example, as in Japanese Unexamined Patent Publication No. 2007-204191, a configuration (conventional configuration) may be adopted in which the longitudinal direction of the traverse arm is substantially perpendicular to the installation surface of the winder unit.

[0079] The package driving motor 41 is not limited to a servo motor, and may be various types of motors such as a step motor or an induction motor, The contact roller 29 may be driven with an appropriate driving device and the package 30 may be rotated accompanying the rotation of the contact roller 29.

[0080] In the embodiments described above, the winding-angle pattern that associates the thickness of the yarn layer of the end region at the smaller-diameter side with the winding-angle is used. However, instead of the thickness of the yarn layer on the smaller-diameter side, for example, the winding-angle pattern may be used that associates the winding-angle with the thickness of the yarn layer at an arbitrary position in the winding width direction of the package 30 such as the thickness of the yarn layer on the larger-diameter side or the thickness of the yarn layer at the central part in the winding width direction. Instead of being set to a broken-line shape as in FIG. 7, the winding-angle pattern may be set with an appropriate curve such as a polynomial curve.

[0081] The present invention is not limited to the automatic winder, and may be applied to other yarn winding devices such as a re-winding machine, a fine spinning machine (e.g., an air-jet spinning machine, an open-end spinning machine, or the like).

Claims

1. A yarn winding device comprising:

a winding section (17) adapted to wind a yarn (20) around a winding tube (22) to form a conical package (30);
a winding-angle pattern storage section (72) adapted to store a winding-angle pattern that associates a thickness of a yarn layer of the package (30) with a winding-angle; and
a winding control section (73) adapted to control the winding section (17) so as to wind the yarn (20) with the winding-angle determined in accordance with the winding-angle pattern stored in the winding-angle pattern storage section (72).

2. The yarn winding device according to claim 1, wherein the winding-angle pattern storage section (72) is adapted to associate and store the thickness of the yarn layer at any position in a winding width direction of the package (30) with the winding-angle.

3. The yarn winding device according to claim 2, wherein the winding-angle pattern storage section (72) is adapted to associate and store the thickness of the yarn layer at a position located within an end region at a smaller-diameter side in the winding width direction of the package (30) with the winding-angle.

4. The yarn winding device according to any one of claim 1 through claim 3, further comprising an operation section (91) adapted to be operated for an input of the winding-angle pattern,
wherein the winding-angle pattern storage section (72) is adapted to store the winding-angle pattern that is input via the operation section (91).

5. The yarn winding device according to any one of claim 1 through claim 3, further comprising:

an operation section (91) adapted to be operated for an input of a thickness of a yarn layer of a fully-wound package (30), a default value of the winding-angle, and an adjusting value for determining a changing amount of the winding-angle; and
a calculation section (71) adapted to calculate the winding-angle pattern in accordance with values input via the operation section (91),
wherein the winding-angle pattern storage section (72) is adapted to store the winding-angle pattern calculated by the calculation section (71).

6. The yarn winding device according to any one of claim 1 through claim 5, further comprising a display section (92) adapted to display the winding-angle pattern stored in the winding-angle pattern storage section (72).

7. The yarn winding device according to any one of claim 1 through claim 6, wherein the winding section (17) includes:

a package driving section (41) adapted to rotationally drive the package (30);
a traverse section (28) adapted to traverse the yarn (20) to be wound into the package (30); and
a traverse driving section (45) provided independently from the package driving section (41) and adapted to drive the traverse section (28).

FIG. 1

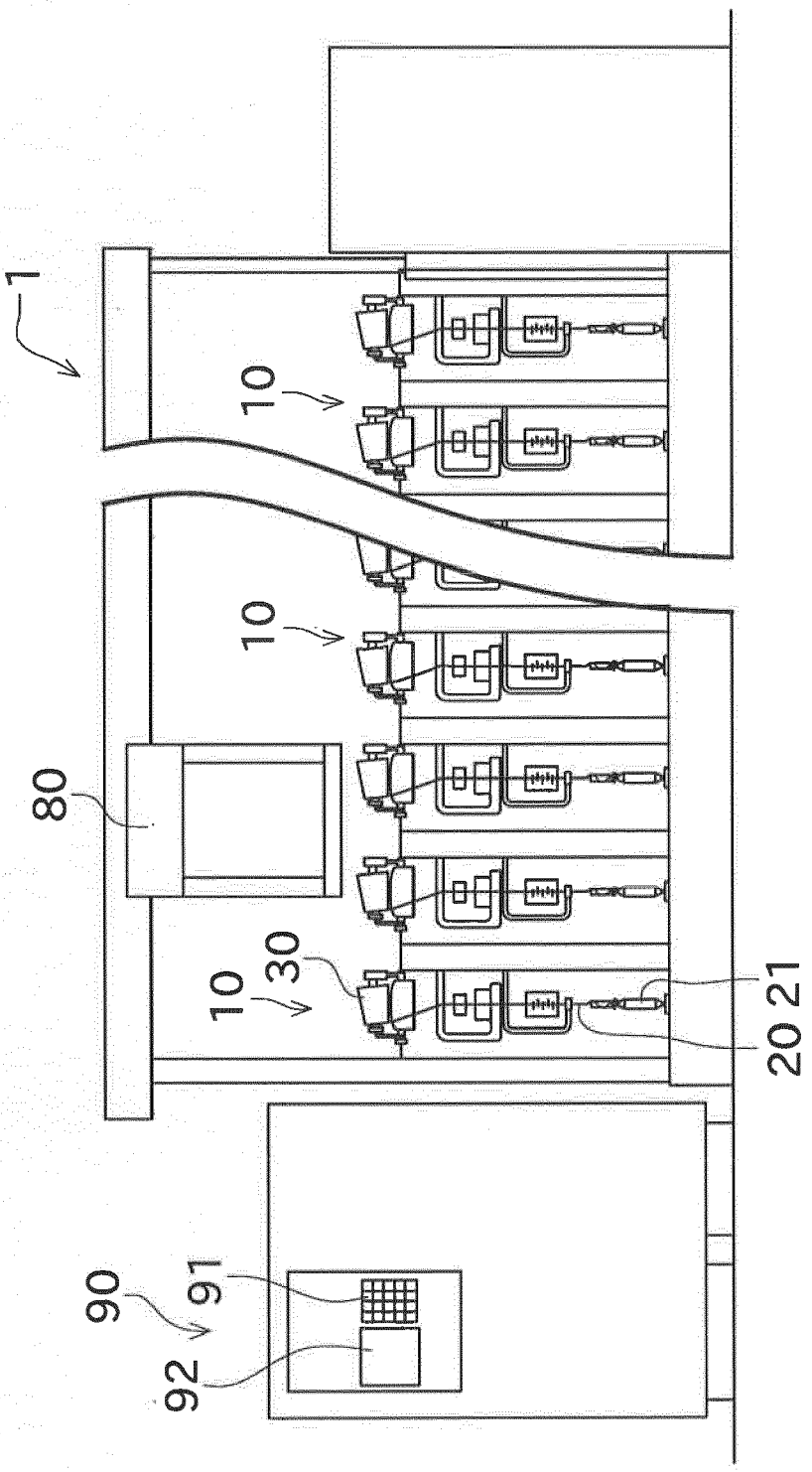


FIG. 2

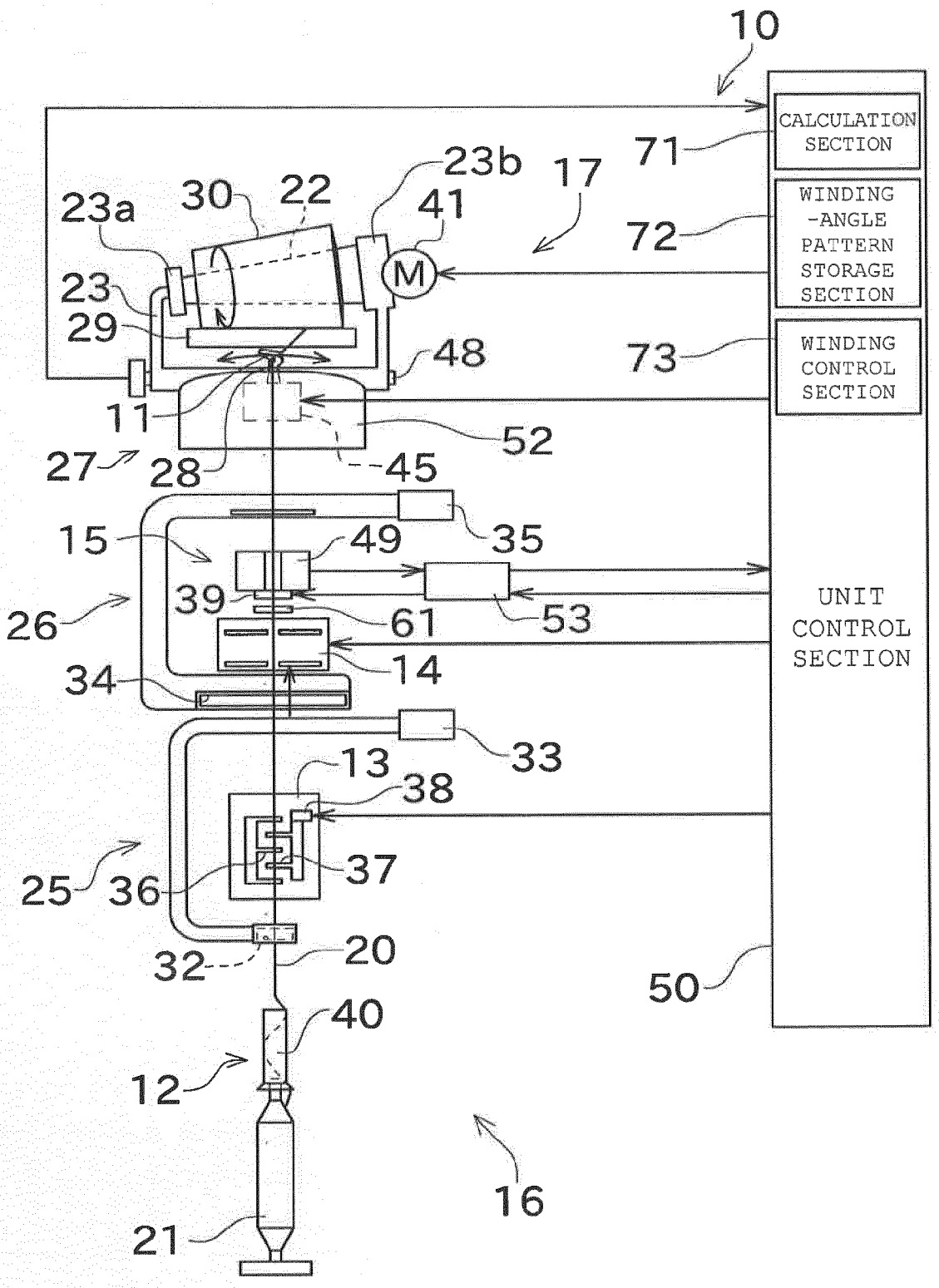

10
CALCULATION SECTION
71
WINDING -ANGLE PATTERN STORAGE SECTION
72
WINDING CONTROL SECTION
73
UNIT CONTROL SECTION
50
23a
30
22
23b
41
17
M
23
29
48
11
52
27
28
45
15
49
35
39
61
53
26
14
34
33
13
38
25
36
37
32
20
40
12
16
21

FIG. 3

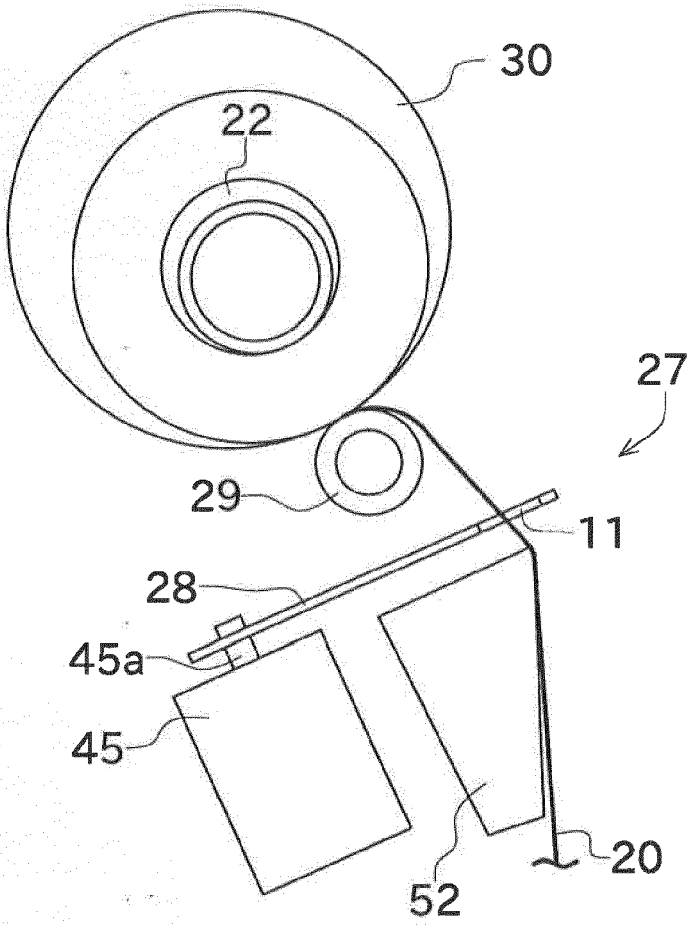


FIG. 4

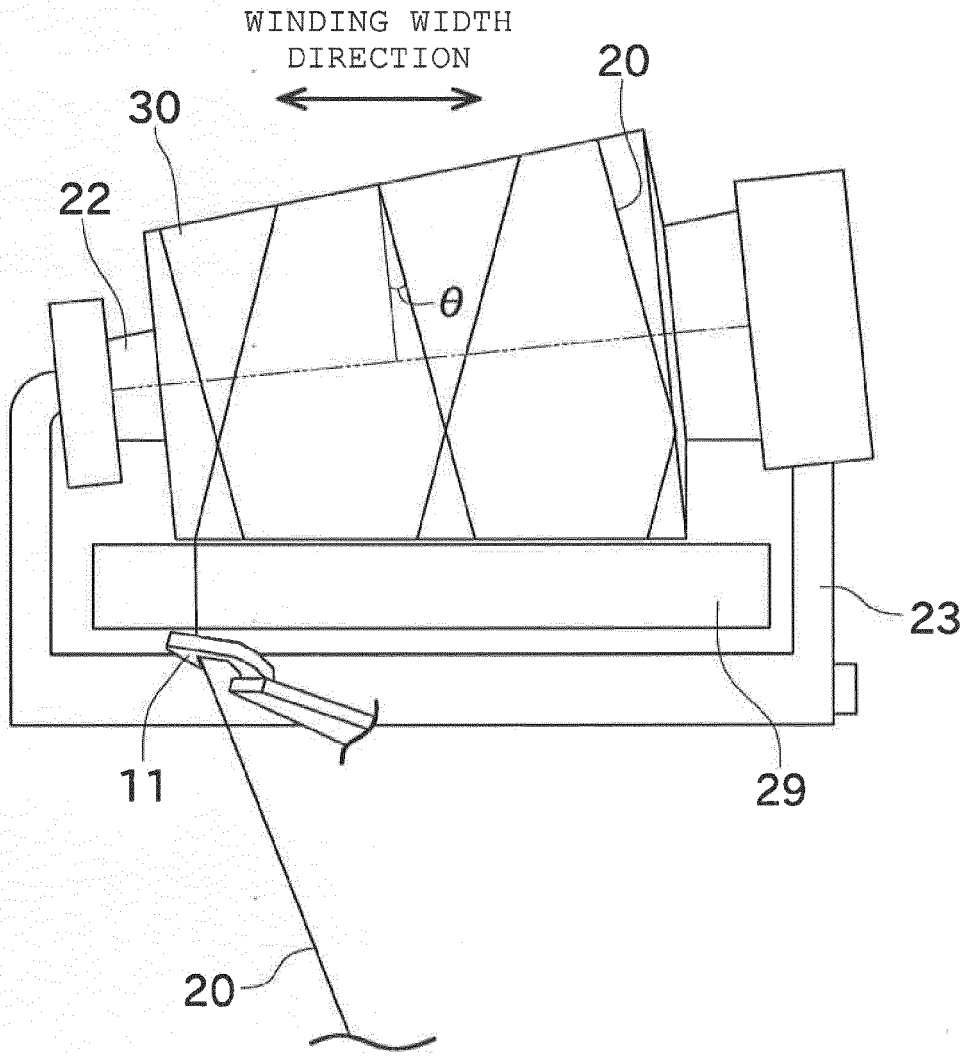


FIG. 5

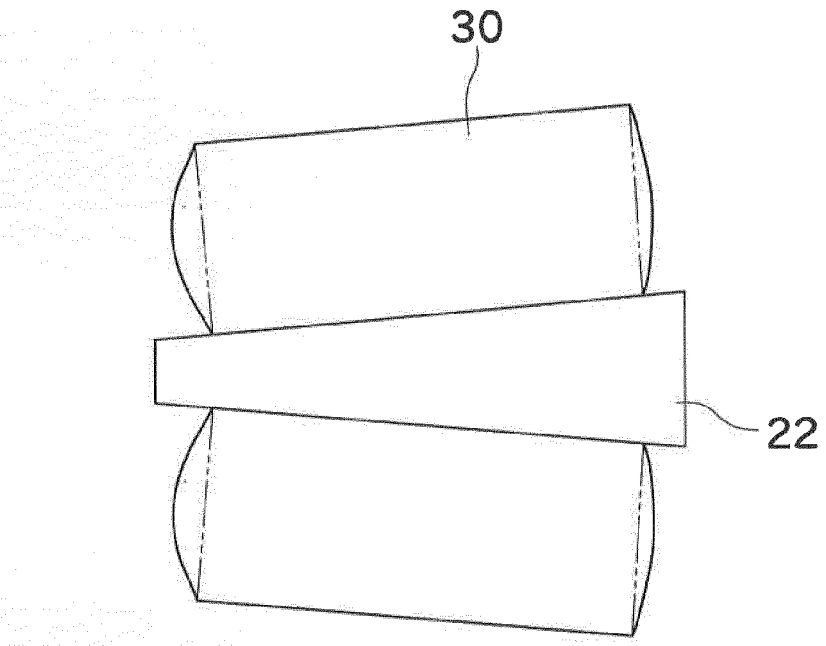

30
22
SHAPE OF PACKAGE AT THE TIME OF OCCURRENCE OF BULGE
IDEAL SHAPE OF PACKAGE

FIG. 6A

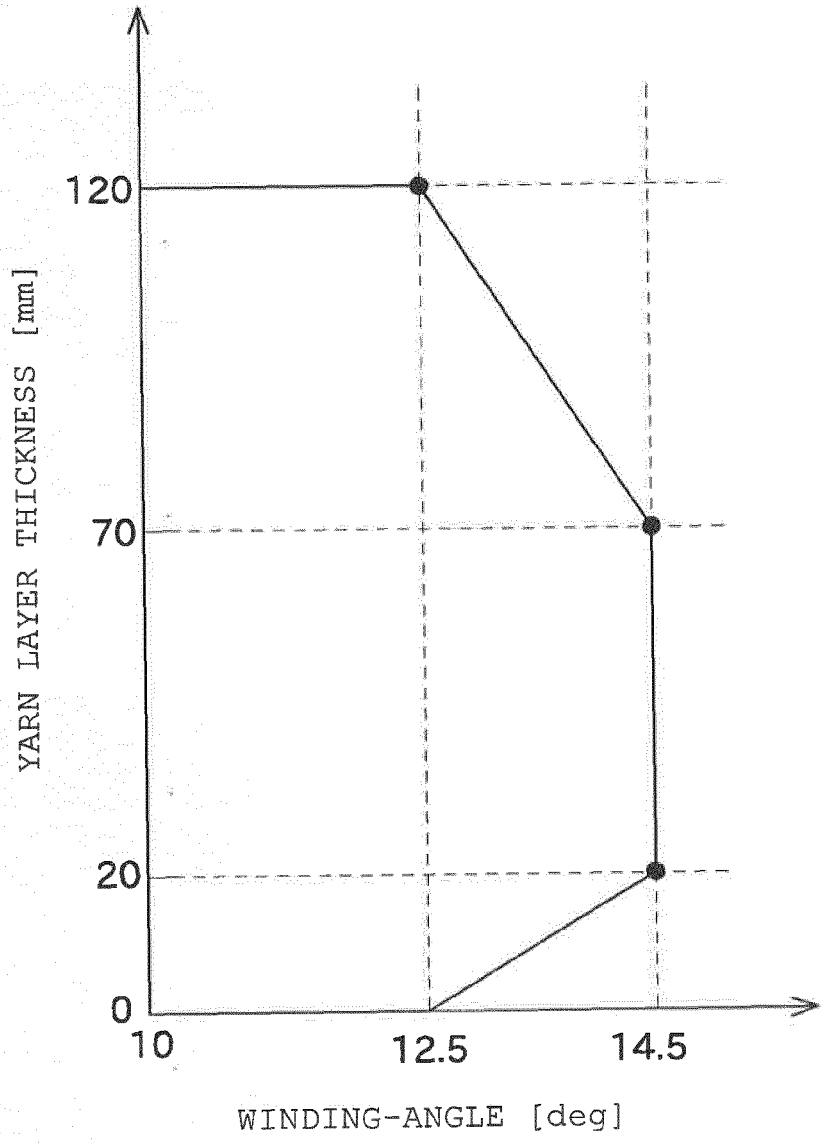
WINDING-ANGLE PATTERN	
YARN LAYER THICKNESS	WINDING-ANGLE
0 mm	12.5 degree
20 mm	14.5 degree
70 mm	14.5 degree
120 mm	12.5 degree

FIG. 6B

INPUT CONTENT

FINAL YARN LAYER THICKNESS	WINDING-ANGLE ADJUSTING VALUE	DEFAULT VALUE OF WINDING-ANGLE
120 mm	2 degree	12.5 degree

FIG. 7


120
70
20
0
10
12.5
14.5
YARN LAYER THICKNESS [mm]
WINDING-ANGLE [deg]

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 2007204191 A **[0002] [0003] [0078]**
- JP 3288769 A **[0005] [0008]**