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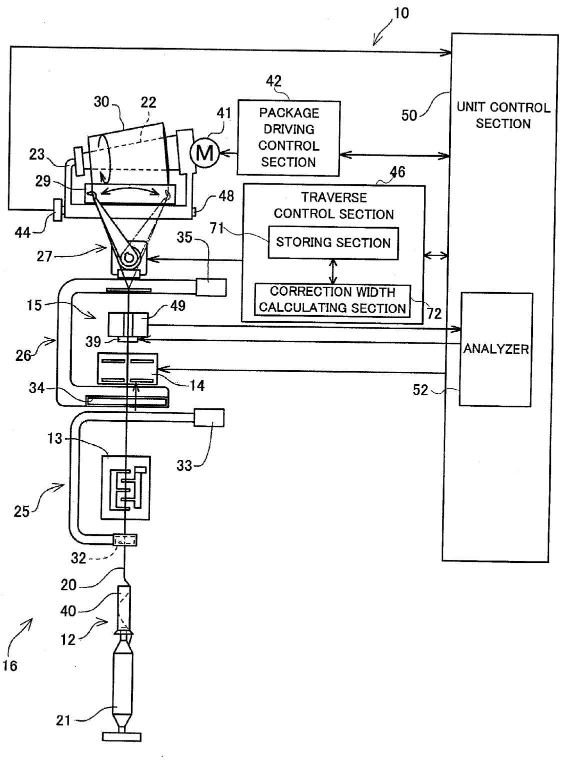
(54) Yarn winding machine and yarn winding method

(57) An automatic winder (10) includes a traverse device (27), a correction width setting section, and a traverse control section (46). The traverse device (27) traverses a yarn to be wound into a package (30). The correction width setting section sets an end correction width for correcting a predetermined target traverse stroke dependent on a predicted package winding diameter. The traverse control section (46) controls the traverse device (27) so as to traverse the yarn under a traverse width determined in accordance with the end correction width that has been set by the correction width setting section.

FIG. 3



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention mainly relates to a yarn winding machine that winds a yarn around a winding bobbin while traversing the yarn.

2. Description of the Related Art

[0002] A yarn winding machine that includes a traverse device for traversing a yarn has been conventionally known. The traverse device includes a yarn guide, a traverse arm, and a driving device. The yarn guide makes contact with a yarn to traverse the yarn. The traverse arm supports the yarn guide. The driving device drives the traverse arm. By reciprocating (i.e., by swinging) the traverse arm by the driving device, a yarn can be wound into a package while being traversed.

[0003] Winding a yarn in the above-described method may cause a phenomenon (i.e., a bulge winding) in which a package is formed with lateral sides of the package being bulged. A yarn in inter-layers of the package is compressed by tightening force of yarn on an outer diameter portion of the package and repulsion force generated from a winding tube. Then, the yarn protrudes from end faces of the package, which causes such a phenomenon.

[0004] Japanese Unexamined Patent Application Publication No. H09-71367 discloses a yarn winding method for preventing occurrence of such a bulge winding. In such a yarn winding method, a winding width can be narrowed by winding a yarn with a winding angle increased to a greater angle, which makes it possible to prevent occurrence of the bulge winding.

[0005] However, when the yarn is wound with the winding angle increased to a greater angle, the traverse device is required to operate rapidly for rapidly traversing the yarn. Accordingly, a major load acts upon the driving device for performing a traversing operation, causing an increase in power consumption. Further, when winding the yarn at a high speed, in case the winding angle is increased, performance limitation of the driving device may be exceeded. Consequently, there were cases in which the above-described method could not be used.

SUMMARY OF THE INVENTION

[0006] It is an object of the present invention to provide a yarn winding machine having a simple structure capable of preventing occurrence of a bulge winding.

[0007] This object is achieved by a yarn winding machine according to claim 1, and by a method according to claim 8.

[0008] According to a first aspect of the present invention, the yarn winding machine includes a yarn traversing device, a correction width setting section, and a control section. The yarn traversing device traverses a yarn to be wound into a package. The correction width setting section sets an end correction width for correcting a predetermined target traverse width dependent on or in accordance with a predicted package winding diameter (e.g. a respective end correction width is associated with a respective package winding diameter). The control section controls the yarn traversing device so as to traverse the yarn under a traverse width determined in accordance with the end correction width that has been set by the correction width setting section.

[0009] That is, the size of a bulge which occurs on a lateral side of the package when the package has been fully wound depends on a distance from a central axis of a winding tube or a distance from the surface of the winding tube. Each of these distances is regarded as the predicted package winding diameter, and the traverse width of the yarn traversing device is narrowed in accordance with an appropriate end correction width associated with the predicted package winding diameter. Since a width to be corrected from an edge of the package can be set, occurrence of a bulge winding can be prevented, for example. Further, occurrence of a bulge winding or the like has been conventionally prevented by increasing a traversing speed to increase a winding angle; however, in the above-described structure, it is not necessary to increase a traversing speed. Accordingly, load acting on the driving source of the yarn traversing device can be reduced, and energy consumption of the yarn winding machine can be reduced.

[0010] The yarn winding machine includes a standard diameter setting section and a package diameter acquiring section. The standard diameter setting section sets the predicted package winding diameter as a standard diameter. The package diameter acquiring section acquires a package diameter, which is a wound diameter of the package. When the package diameter acquired by the package diameter acquiring section is the standard diameter, the control section controls the yarn traversing device so as to traverse the yarn under a traverse width determined in accordance with the end correction width that has been set dependent on or in accordance with the standard diameter (e.g. one end correction width is associated with the standard diameter).

[0011] Accordingly, the package diameter can be acquired with great accuracy in real-time by the package diameter acquiring section. Then, when the package diameter which is kept being acquired becomes equal to the preset standard diameter, the traverse width of the yarn traversing device is narrowed in accordance with the end correction width associated with such a standard diameter. Consequently, occurrence of a bulge winding can be prevented effectively.

[0012] The yarn winding machine further includes a correction width calculating section. The correction width calculating section can calculate an end correction width for a package diameter other than the set standard diameter in accordance with the set standard diameter and the end correction width associated with such a standard diameter. When a package diameter acquired by the package diameter acquiring section is a package diameter other than the set standard diameter, the control section controls the yarn traversing device so as to traverse the yarn under a traverse width determined in accordance with the end correction width calculated by the correction width calculating section. Accordingly, just by setting a certain number of standard diameters and end correction widths associated with such standard diameters, the yarn traversing device can be controlled in accordance with appropriate end correction widths for an entire range of the package diameter that changes from start of a winding operation until an end of the winding operation.

[0013] In the yarn winding machine, the standard diameter setting section includes a smaller-diameter portion standard diameter setting section and a larger-diameter portion standard diameter setting section. The smaller-diameter portion standard diameter setting section sets a standard diameter of a smaller-diameter portion of a cone winding package. The larger-diameter portion standard diameter setting section sets a standard diameter of a larger-diameter portion of the cone winding package. The correction width setting section includes a smaller-diameter portion correction width setting section and a larger-diameter portion correction width setting section. The smaller-diameter portion correction width setting section sets an end correction width of the smaller-diameter portion of the cone winding package dependent on or in accordance with the standard diameter set by the smaller-diameter portion standard diameter setting section (e.g. one end correction width is associated with the standard diameter set by the smaller-diameter portion standard diameter setting section) . The larger-diameter portion correction width setting section sets an end correction width dependent on or in accordance with the standard diameter set by the larger-diameter portion standard diameter setting section (e.g. one end correction width is associated with the standard diameter set by the larger-diameter portion standard diameter setting section).

[0014] That is, in the cone winding package, differences in changes of winding density or the like cause differences between the shape of a bulge winding which occurs on a lateral side of the larger-diameter portion and the shape of a bulge winding which occurs on a lateral side of the smaller-diameter portion. According to the above-described structure, a different end correction width can be set for each of the smaller-diameter portion and the larger-diameter portion; therefore, even in the cone winding package, occurrence of a bulge winding or the like can be prevented effectively.

[0015] In the yarn winding machine, in accordance with the larger-diameter portion standard diameter set by the larger-diameter portion standard diameter setting section and the end correction width of the larger-diameter portion set by the larger-diameter portion correction width setting section, the smaller-diameter portion standard diameter setting section automatically sets the standard diameter of the smaller-diameter portion and the smaller-diameter portion correction width setting section automatically sets the end correction width of the smaller-diameter portion. Accordingly, just by setting the standard diameter and the end correction width for the larger-diameter portion, the standard diameter and the end correction width for the smaller-diameter portion are automatically set. As a result, time and effort for setting a standard diameter and an end correction width can be reduced.

[0016] In the yarn winding machine, in accordance with the smaller-diameter portion standard diameter set by the smaller-diameter portion standard diameter setting section and the end correction width of the smaller-diameter portion set by the smaller-diameter portion correction width setting section, the larger-diameter portion standard diameter setting section automatically sets the standard diameter of the larger-diameter portion and the larger-diameter portion correction width setting section automatically sets the end correction width of the larger-diameter portion. Accordingly, just by setting the standard diameter and the end correction width for the smaller-diameter portion, the standard diameter and the end correction width for the larger-diameter portion are automatically set. As a result, time and effort for setting a standard diameter and an end correction width can be reduced.

[0017] The yarn winding machine includes a winding tube supporting section and a winding tube angle setting section. The winding tube supporting section rotatably supports a winding tube around which the yarn is wound to form the package. The winding tube angle setting section sets an angle of the winding tube to be supported by the winding tube supporting section. The standard diameter setting section sets the standard diameter in accordance with the angle of the winding tube set by the winding tube angle setting section. The correction width setting section sets the end correction width in accordance with the angle of the winding tube set by the winding tube angle setting section.

[0018] That is, since change of the angle of the winding tube causes the shape of the package to change, the size of a bulge which occurs on a lateral side of the package also changes. According to the above-described structure, the standard diameter and the end correction width are set in accordance with the angle of the winding tube; therefore, occurrence of a bulge winding or the like can be prevented effectively.

[0019] According to a second aspect of the present invention, a yarn winding method includes a setting step, a package diameter acquiring step, and a controlling step. The setting step is a step of setting a standard diameter and an end correction width, which corrects a predetermined target traverse width, with respect to a package, and storing the set standard diameter and the end correction width. The package diameter acquiring step is a step of acquiring a package diameter, which is a wound diameter of the package. The controlling step is a step of controlling a yarn traversing device, which traverses a yarn, in accordance with an end correction width associated with the acquired package diameter.

[0020] That is, the size of a bulge which occurs on a lateral side of the package when the package is fully wound depends on a distance from a central axis of the winding tube or a distance from the surface of the winding tube. According to the above-described method, a traverse width of the yarn traversing device is narrowed in accordance with an appropriate end correction width associated with the package diameter which gradually increases during a winding operation, which makes it possible to form the package while preventing occurrence of a bulge winding or the like.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021]

Fig. 1 is a schematic view illustrating an automatic winder according to an embodiment of the present invention.
Fig. 2 is a block diagram illustrating a main structure of the automatic winder.
Fig. 3 is a schematic view and a block diagram illustrating a schematic structure of a winder unit.
Fig. 4 is a schematic view illustrating a structure of a traverse device.
Fig. 5 is a schematic view illustrating a cross-sectional shape of a package of when a bulge winding occurs.
Fig. 6 is a flowchart illustrating an example of a process that prevents occurrence of the bulge winding.
Fig. 7 is a graph illustrating an example of setting of a standard diameter and an end correction width.
Fig. 8 is a block diagram illustrating a main structure of an automatic winder according to a first variation.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0022] Next, an embodiment of the present invention will be described. First, by referring to Fig. 1 and Fig. 2, a description will be made on an overall structure of an automatic winder 1 according to the present embodiment. As illustrated in Fig. 1, the automatic winder (a yarn winding machine) 1 includes a plurality of winder units 10 which are arranged next to one another, an automatic doffing device 60, and a machine setting device 90 as main components.

[0023] Each of the winder units 10 winds a yarn 20, which is unwound from a yarn supplying bobbin 21, into a package 30 while traversing the yarn 20 by a traverse device (a yarn traversing device) 27.

[0024] When the package 30 is fully wound in a winder unit 10, the automatic doffing device 60 travels to the position of the such a winder unit 10. Then, the automatic doffing device 60 collects the fully-wound package 30 and supplies an empty bobbin to the winder unit 10. A machine controlling section 94 illustrated in Fig. 1 and Fig. 2 performs a control operation relating to the entire automatic winder 1 including the automatic doffing device 60.

[0025] The machine setting device 90 includes a setting section 91 and a display section 92 as main components. An operator operates the setting section 91 to input a prescribed setting value or to choose an appropriate control method. Accordingly, the setting section 91 can carry out setting for each of the winder units 10. The display section 92 is configured capable of displaying a yarn winding state in the each of the winder units 10, troubles generated in the each of the winder units 10, or the like.

[0026] Next, by referring to Fig. 3, the structure of each of the winder units 10 will be described specifically. Each of the winder units 10 includes a winding unit main body 16 and a unit control section 50 as main components.

[0027] For example, the unit control section 50 includes a Central Processing Unit (CPU), a Random Access Memory (RAM), a Read Only Memory (ROM), an Input-Output (I/O) port, and a communication port. A program for controlling each structure of the winding unit main body 16 is recorded in the ROM. Various components of the winding unit main body 16 (which will be described later) and the machine setting device 90 are connected to the I/O port and the communication port. Accordingly, the unit control section 50 is configured capable of communicating control information.

[0028] The winding unit main body 16 includes a yarn unwinding assisting device 12, a tension applying device 13, a splicer device 14, and a clearer (a yarn quality measuring device) 15, which are arranged along a yarn travelling path between the yarn supplying bobbin 21 and a contact roller 29 and in this order from a yarn supplying bobbin 21 side.

[0029] The yarn unwinding assisting device 12 includes a restricting member 40 covering a core tube of the yarn supplying bobbin 21. The yarn unwinding assisting device 12 lowers the restricting member 40 accompanying unwinding of the yarn from the yarn supplying bobbin 21 in order to assist unwinding of the yarn from the yarn supplying bobbin 21. The restricting member 40 makes contact with a balloon formed in an upper portion of the yarn supplying bobbin 21, which has been formed by rotation and centrifugal forth of the yarn unwound from the yarn supplying bobbin 21, and appropriately adjusts the size of such a balloon in order to assist unwinding of the yarn. In the vicinity of the restricting member 40, a sensor (not illustrated in the drawings) for detecting a chase portion of the yarn supplying bobbin 21 is provided. When the sensor detects lowering of the chase portion, the restricting member 40 is lowered by an air cylinder (not illustrated in the drawings), for example, accompanying the lowering of the chase portion.

[0030] The tension applying device 13 applies predetermined tension to the travelling yarn 20. The tension applying device 13 may be a gate-typed device in which movable comb teeth are arranged with respect to fixed comb teeth. The movable comb teeth can be operated by a rotary solenoid so that the movable comb teeth and the fixed comb teeth can be engaged with or disengaged from one another.

[0031] When a yarn is cut after the clearer 15 detects a yarn defect, or when a yarn breakage occurs while the yarn is being unwound from the yarn supplying bobbin 21, or the like, the splicer device 14 splices a lower yarn from a yarn supplying bobbin 21 side and an upper yarn from a package 30 side. A yarn splicing device that splices the upper yarn and the lower yarn may be a mechanical device, a device using fluid such as compressed air, or the like.

[0032] The clearer 15 includes a clearer head 49 and an analyzer 52. The clearer head 49 includes a sensor (not illustrated in the drawings) which detects the thickness of the yarn 20. The analyzer 52 processes a yarn thickness signal transmitted from such a sensor. The clearer 15 monitors the yarn thickness signal transmitted from the sensor in order to detect a yarn defect such as a slub. A cutter 39 is arranged in the vicinity of the clearer head 49. The cutter 39 cuts the yarn 20 immediately after the clearer 15 detects a yarn defect.

[0033] A lower yarn guiding pipe 25 is provided below the splicer device 14 to catch and guide the lower yarn from the yarn supplying bobbin 21 to the splicer device 14. An upper yarn guiding pipe 25 is provided above the splicer device 14 to catch and guide the upper yarn from the package 30 to splicer device 14. The lower yarn guiding pipe 25 can swing around a shaft 33. The upper yarn guiding pipe 26 can swing around a shaft 35. A suction opening 32 is formed at a tip end of the lower yarn guiding pipe 25. A suction mouth 34 is provided at a tip end of the upper yarn guiding pipe 26. Appropriate negative-pressure sources are connected to the lower yarn guiding pipe 25 and the upper yarn guiding pipe 26, respectively. The winder unit 10 is configured such that suction airflow is generated at the suction opening 32 and the suction mouth 24 in order to suck and catch yarn ends of the upper yarn and the lower yarn.

[0034] The winding unit main body 16 includes a cradle (a winding tube supporting section) 23 and the contact roller 29. The cradle 23 removably supports a winding bobbin (a winding tube) 22. The contact roller 29 can rotate while making contact with the surface of the winding bobbin 22 or the surface of the package 30. The winding unit main body 16 includes the arm-typed traverse device 27 for traversing the yarn 20. The traverse device 27 is located in the vicinity of the cradle 23. In the winding unit main body 16, the yarn 20 can be wound into the package 30 while being traversed by the traverse device 27.

[0035] The cradle 23 can swing around a swing shaft 48. An increase in a diameter of yarn layers accompanying winding of the yarn 20 around the winding bobbin 22 is absorbed by swinging of the cradle 23. As illustrated in Fig. 3, the cradle 23 and the traverse device 27 can form a cone-shaped package 30.

[0036] A package driving motor 41 is attached to a portion where the cradle 23 grips and supports the winding bobbin 22. The winder unit 10 winds the yarn 20 into the package 30 by rotating the winding bobbin 22 by the package driving motor 41. When the winding bobbin 22 is supported by the cradle 23, a motor shaft of the package driving motor 41 is connected to the winding bobbin 22 such that the motor shaft cannot relatively rotate with respect to the winding bobbin 22 (i.e., a direct drive system). The operation of the package driving motor 41 is controlled by a package driving control section 42. The package driving control section 42 controls the package driving motor 41 to operate and stop by receiving an operation signal from the unit control section 50.

[0037] An angle sensor (a package diameter acquiring section) 44 for detecting an angle (a swing angle) of the cradle 23 is attached to the swing shaft 48. The angle sensor 44 is formed of a rotary encoder, for example. The angle sensor 44 transmits an angular signal corresponding to the angle of the cradle 23 to the unit control section 50. The angle of the cradle 23 changes accompanying an increase in the winding diameter of the package 30. Accordingly, by detecting the swing angle of the cradle 23 by the angle sensor 44, a package diameter of the package 30 can be detected.

[0038] Next, by referring to Fig. 3 and Fig. 4, the traverse device 27 will be described in details. The traverse device 27 includes a traverse arm 28, a yarn guide 24, and a traverse driving motor 45 as main components. The traverse arm 28 is formed as a tapered arm capable swinging. The yarn guide 24 is connected to a tip end of the traverse arm 28 and is formed in a hook shape. The traverse driving motor 45 drives the traverse arm 28. The traverse driving motor 45 is a servomotor, for example. A base portion of the traverse arm 28 is fixed to a tip end of an output shaft 65 of the traverse driving motor 45.

[0039] As illustrated in Fig. 3, the operation of the traverse driving motor 45 is controlled by a traverse control section 46. The traverse control section 46 includes a hardware device provided with a dedicated microprocessor or the like. The traverse control section 46 controls the traverse driving motor 45 to operate and stop by receiving signals from the unit control section 50. A storing section 71 and a correction width calculating section 72 of the traverse control section 46 will be described later.

[0040] The output shaft 62 of the traverse driving motor 45 is rotated forward and backward. Accordingly, the traverse arm 28 is reciprocated in a direction of the length of the package 30. Thus, the yarn guide 24 supported at a tip end of the traverse arm 28 is reciprocatedin a circular trajectory.

[0041] As a traverse stroke TS indicating a range of the yarn 20 traversed by the yarn guide 24, a target traverse stroke is predetermined according to a shape of a package 30 to be formed and set in the unit control section 50.

[0042] Next, by referring to Fig. 2 through Fig. 7, a description will be made on a process to be performed by the winding unit 10 for preventing occurrence of a bulge winding. As illustrated in Fig. 5, a bulge winding is a phenomenon in which a lateral side of a package bulges. A yarn in inter-layers of the package is compressed by tightening force of yarn on an inner diameter side and an outer diameter side of the package, and then the yarn protrudes from an end face of the package. The amount of protrusion depends on a distance from a central axis of a winding bobbin 22 or a distance from the surface of the winding bobbin 22.

[0043] Accordingly, in the winder unit 10, the distance from the central axis of the winding bobbin 22 is referred to as a predicted bulge occurrence diameter (i.e., a predicted package winding diameter), and the following processes are performed in accordance with a relation between the predicted bulge occurrence diameter and the amount of yarn protrusion in order to prevent the shape of the package 30 from deteriorating.

[0044] Before starting winding of the yarn 20, an operator performs various inputting and setting works to the winder unit 10 by operating the setting section 91 provided in the machine setting device 90.

[0045] The setting section 91 is a section for setting an end correction width which is a value to be used when correcting the traverse width (i. e. , the traverse stroke TS) of the traverse device 27. More specifically, the end correction width is a value indicating how inward the traverse stroke TS is corrected from an edge of a package with respect the predetermined target traverse stroke.

[0046] The end correction width set by the setting section 91 is transmitted to the traverse control section 46 via the unit control section 50. Interpolation processing relating to the end correction width is carried out by the correction width calculating section 72 of the traverse control section 46. Then, the result of such processing is stored in the storing section 71. Further, such processing carried out by the correction width calculating section 72 will be described later.

[0047] As illustrated in Fig. 2, the setting section 91 includes a standard diameter setting section 81 and a correction width setting section 85. The standard diameter setting section 81 includes a larger-diameter portion standard diameter.setting section 82 and a smaller-diameter portion standard diameter setting section 83. The correction width setting section 85 includes a larger-diameter portion correction width setting section 86 and a smaller-diameter portion correction width setting section 87. In a cone winding package, a larger-diameter portion indicates an end portion with a larger diameter (i.e., the right-hand side in Fig. 5). Meanwhile, in the cone winding package, a smaller-diameter portion indicates an end portion with a smaller diameter (i.e., the left side in Fig. 5).

[0048] First, the operator carries out setting for the larger-diameter portion. The operator operates the setting section 91 to input a predicted package winding diameter which is a standard diameter of the larger-diameter portion as a larger-diameter portion standard diameter and further to input an end correction width value associated with such a larger-diameter portion standard diameter. By inputting such values, a larger-diameter portion standard diameter is set by the larger-diameter portion standard diameter setting section 82, and an end correction width associated with such a larger-diameter portion standard diameter is set by the larger-diameter portion correction width setting section 86 (step S101).

[0049] The operator also carries out the above-described operation for the smaller-diameter portion. By carrying out such an operation, a smaller-diameter portion standard diameter is set by the smaller-diameter portion standard diameter setting section 83, and an end correction width associated with such a smaller-diameter portion standard diameter is set by the smaller-diameter portion correction width setting section 87 (step S102).

[0050] As described above, since the end correction width is a value indicating how inward the traverse stroke TS is corrected from an edge of the package, the operator can directly set a width to be corrected from the package edge.

[0051] In the above described embodiment, the setting for the larger-diameter portion is carried out, and then the setting for the smaller-diameter portion is carried out. However, the setting for the smaller-diameter portion may be carried out first, and then the setting for the larger-diameter portion may be carried out.

[0052] Black circles in Fig. 7 indicate examples of the standard diameters and the end correction widths set in the above-described manner. The longitudinal axis in Fig. 7 indicates a package diameter in the center of an axial direction of a package. The horizontal axis in Fig. 7 indicates an end correction width. In the example, four larger-diameter portion standard diameters and four smaller-diameter portion standard diameters are set, and an end correction width for each of all the standard diameters are set. Specifically, as four larger-diameter portion standard diameters, a winding tube diameter, 100 mm, 150 mm, and a fully-wound diameter are set. Meanwhile, as respective end correction widths associated with the four larger-diameter portion standard diameters, 0 mm, 1.0 mm, 0.7 mm, and 0 mm are set. In the same manner, as four smaller-diameter portion standard diameters, the winding tube diameter, 120 mm, 170 mm, and the fully-wound diameter are set. Meanwhile, as respective end correction widths associated with the four smaller-diameter portion standard diameters, 0 mm, 2.0 mm, 1.5 mm, and 0 mm are set. These numerical values just indicate an example; therefore, different values may be appropriately set depending on a package to be wound.

[0053] The line graph illustrated in Fig. 7 is displayed in a display section 92 of the machine setting device 90, for example. Accordingly, the operator can visually confirm settings for a standard diameter and an end correction width. Further, by confirming the line graph, the operator can intuitively imagine the shape of a package to be formed through processing carried out in the present embodiment. Therefore, a package can be easily formed in a shape demanded by the operator. Further, the operator can select whether or not to display a line graph such as the line graph illustrated in Fig. 7.

[0054] The standard diameters set as described above (i.e., the four standard diameters set per each of the larger-diameter portion and the smaller-diameter portion) and the respective end correction widths associated with such standard diameters are transmitted to the correction width calculating section 72. The correction width calculating section 72 is a section for approximating an end correction width for wound diameters other than such standard diameters. That is, although respective end correction widths are set for the above-described set standard diameters, end correction widths are not set for values other than the above-described set standard diameters. Therefore, by carrying out interpolation processing, such an end correction width that has not been set is determined (step S103).

[0055] As an example of the interpolation processing, a method (so-called a linear interpolation) may be adopted in which a line graph such as the line graph illustrated in Fig. 7 is made by connecting dots each indicating a relation between a standard diameter and an end correction width (i.e., four dots for each of the larger-diameter portion and the smaller-diameter portion) with a straight line. An end correction width can be determined for values other than the set standard diameters by such a line graph. End correction widths can be consecutively determined for the package diameter that changes from the winding start until the winding end. Further, instead of using the method for making the line graph, the present embodiment may also adopt a method for calculating an approximation function by an approximation method such as a least-squares method. The relation between standard diameters and end correction widths determined as described above is stored in the storing section 71.

[0056] Next, the operator appropriately operates the setting section 91 of the machine setting device 90 and each of the winder units 10 to start a winding operation of the yarn 20 (step S104). During the winding operation of the yarn 20, a package diameter is acquired by the angle sensor 44 as described above, and the acquired package diameter is transmitted to the unit control section 50 (step S105).

[0057] The correction width calculating section 72 determines an end correction width for the acquired package diameter in accordance with contents stored in the storing section 71. The traverse control section 46 calculates a value by subtracting such an end correction width from the preset target traverse stroke. The traverse control section 46 controls the traverse device 27 (especially the traverse driving motor 45) such that the calculated value becomes equal to the actual traverse stroke TS (step S106).

[0058] For example, during the winding operation, suppose that a result detected by the angle sensor 44 indicates that the package diameter is 150 mm. In such case, it can be determined from the line graph in Fig. 7 that the end correction width of the larger-diameter portion and the end correction width of the smaller-diameter portion are respectively 0.7 mm and 1.7 mm. The traverse device 27 is controlled such that the preset traverse stroke TS is shortened by 0.7 mm from the larger-diameter edge and shortened 1.7 mm from the smaller-diameter edge.

[0059] When the traverse stroke TS is narrowed, the narrowed traverse stroke TS balances with a bulge of the package 30 that would occur due to the tightening force of the yarn 20. Therefore, the package 30 can be formed in an appropriate shape as illustrated by the alternate long and double-short dashed line in Fig. 5.

[0060] The unit control section 50 detects whether or not the package 30 is fully wound (step S107) . The unit control section 50 performs the above-described control operations (steps S105 and S106) until the package 30 is fully wound. When the package 30 is fully wound, a winding operation ends (step S108).

[0061] Occurrence of a bulge winding has been conventionally prevented by increasing a traversing speed and increasing a winding angle. Accordingly, there were cases where a winding angle of a package which has been formed results being different from a winding angle intended by an operator. That is, there were cases where winding density of the package which has been formed results being different from winding density intended by the operator.

[0062] Meanwhile, in the present embodiment, the traverse stroke TS of the traverse device 27 is narrowed in accordance with an appropriate end correction width. The winder unit 10 according to the present embodiment does not increase a traversing speed in order to prevent occurrence of a bulge winding. Accordingly, a winding angle of a package which has been formed does not change contrary to the intention of the operator. That is, in the present embodiment, it is possible to prevent occurrence of a bulge winding and also form a package with winding density intended by the operator.

[0063] As described above, the automatic winder 1 according to the present embodiment includes the traverse device 27, the correction width setting section 85, and the traverse control section 46. The traverse device 27 traverses a yarn to be wound into the package 30. The correction width setting section 85 sets the end correction width for correcting the predetermined target traverse stroke by associating with the predicted bulge occurrence diameter. The traverse control section 46 controls the traverse device 27 so as to traverse the yarn under the traverse stroke TS determined in accordance with the end correction width that has been set by the correction width setting section 85.

[0064] That is, the size of a bulge which occurs on a lateral side of the package 30 when the package 30 has been formed depends on a distance from a central axis of the winding bobbin 22 or a distance from the surface of the winding bobbin 22 (i.e., depends on the predicted bulge occurrence diameter). Accordingly, since the traverse stroke TS of the traverse device 27 is narrowed in accordance with an appropriate end correction width associated with the predicted bulge occurrence diameter, occurrence of a bulge winding can be prevented.

[0065] The automatic winder 1 according to the present embodiment includes the standard diameter setting section 81, the correction width setting section 85, and the angle sensor 44. The standard diameter setting section 81 sets the predicted bulge occurrence diameter as the standard diameter. The angle sensor 44 acquires the package diameter, which is a wound diameter of the package 30. When the package diameter acquired by the angle sensor 44 is the standard diameter, the traverse control section 46 controls the traverse device 27 so as to traverse the yarn under the traverse stroke TS determined in accordance with an end correction width that has been set by being associated with such a standard diameter.

[0066] Accordingly, the package diameter can be acquired with great accuracy in real-time by the angle sensor 44. When the package diameter which is kept being acquired becomes equal to the preset standard diameter, the traverse stroke TS of the traverse device 27 is narrowed in accordance with the end correction width associated with such a standard diameter. Consequently, occurrence of a bulge winding can be prevented effectively.

[0067] The automatic winder 1 according to the present embodiment includes the correction width calculating section 72. The correction width calculating section 72 can calculate an end correction width for a package diameter other than the set standard diameter in accordance with the set standard diameter and an end correction width associated with such a standard diameter. When the package diameter acquired by the angle sensor 44 is a package diameter other than the set standard diameter, the traverse control section 46 controls the traverse device 27 so as to traverse the yarn under the traverse stroke TS determined in accordance with the end correction width calculated by the correction width calculating section 72.

[0068] Accordingly, just by setting a certain number of standard diameters and end correction widths associated with such standard diameters, the correction width calculating section 72 can form a line graph capable of obtaining end correction widths for package diameters other than the standard diameter. By controlling the traverse device 27 in accordance with the line graph, an appropriate end correction width can be applied to an entire range of the package diameter that changes during from start of a winding operation until and end of the winding operation. Consequently, occurrence of a bulge winding can be prevented effectively. Further, since an operator is not required to set an end correction width for every single package diameter, the operator can easily perform a setting operation.

[0069] In the automatic winder 1 according to the present embodiment, the standard diameter setting section 81 includes the smaller-diameter portion standard diameter setting section 83 and the larger-diameter portion standard diameter setting section 82. The smaller-diameter portion standard diameter setting section 83 sets the standard diameter of the smaller-diameter portion of the cone winding package. The larger-diameter portion standard diameter setting section 82 sets the standard diameter of the larger-diameter portion of the cone winding package. The correction width setting section 85 includes the smaller-diameter portion correction width setting section 87 and the larger-diameter portion correction width setting section 86. The smaller-diameter portion correction width setting section 87 sets the end correction width of the smaller-diameter portion of the cone winding package by associating with the standard diameter of the smaller-diameter portion. The larger-diameter portion correction width setting section 86 sets the end correction width of the larger-diameter portion of the cone winding package by associating with the standard diameter of the larger-diameter portion.

[0070] That is, in the cone winding package, differences in changes of winding density or the like cause differences between a shape of a bulge winding which occurs on a lateral side of the larger-diameter portion of the cone winding package and a shape of a bulge winding which occurs on a lateral side of the smaller-diameter portion. According to the above-described structure, a different end correction width can be set for each of the smaller-diameter portion and the larger-diameter portion; therefore, even in the cone winding package, occurrence of a bulge winding can be prevented effectively.

[0071] Next, by referring to Fig. 8, a first variation of the above-described embodiment will be described. In the following description on the variations of the above-described embodiment, like reference numerals are used in the drawings for elements that are the same or similar to those of the above-described embodiment, and description thereof is omitted.

[0072] In the first variation, a setting section 91 of a machine setting device 90 includes a winding tube angle setting section 89 capable of setting an angle of a winding bobbin 22. By setting the angle of the winding bobbin 22 in the winding tube angle setting section 89, a standard diameter and an end correction width associated with such an angle are set with respect to each of winding units 10. Further, the angle of the winding bobbin 22 indicates an angle formed by a central axis of the winding bobbin 22 and an outline of the winding bobbin 22 when the winding bobbin 22 is seen from a lateral side. General automatic winders normally use winding bobbins 22 with an angle of 3.30 degrees or an angle of 5.57 degrees.

[0073] In the first variation, the correction width calculating section 72 is not provided. This is because when the winding tube angle setting section 89 sets the standard diameter and the end correction width, a relation is not discretely set but is consecutively set.

[0074] As described above, the automatic winder 1 according to the first variation includes the cradle 23 and the winding tube angle setting section 89. The cradle 23 rotatably supports the winding bobbin 22 around which a yarn is wound to form a package 30. The winding tube angle setting section 89 can set the angle of the winding bobbin 22. A standard diameter setting section 81 sets the standard diameter in accordance with the angle of the winding bobbin 22 set by the winding tube angle setting section 89. A correction width setting section 85 sets the end correction width in accordance with the angle of the winding bobbin 22 set by the winding tube angle setting section 89.

[0075] That is, change of the angle of the winding bobbin 22 causes the shape of the package 30 to change. Consequently, the size of a bulge which is occurs on a lateral side of the package 30 also changes. According to the above-described structure, the standard diameter and the end correction width are set in accordance with the angle of the winding bobbin 22; therefore, occurrence of a bulge winding can be prevented effectively.

[0076] Next, a second variation will be described. An automatic winder according to the second variation includes a correction width calculating section 72 that automatically calculates a standard diameter and an end correction width for a smaller-diameter portion when a standard diameter and an end correction width with respect to a larger-diameter portion are set. Various methods can be used as such a calculating method. For example, a method can be used in which a predicted bulge of a package is calculated in accordance with the ratio between a larger diameter and a smaller diameter and the size of such a bulge is set as an end correction width.

[0077] As described above, in an automatic winder 1 according to the second variation, in accordance with the standard diameter of the larger-diameter portion set by the larger-diameter portion standard diameter setting section 82 and the end correction width of the larger-diameter portion set by the larger-diameter portion correction width setting section 86, the smaller-diameter portion standard diameter setting section 83 automatically sets the standard diameter of the smaller-diameter portion, and the smaller-diameter portion correction width setting section 87 automatically sets the end correction width of the smaller-diameter portion. Accordingly, just by setting the standard diameter and the end correction width with respect to the larger-diameter portion, the standard diameter and the end correction width with respect to the smaller-diameter portion can be automatically set. As a result, time and effort for setting a standard diameter and an end correction width can be reduced.

[0078] Next, a third variation will be described. In an automatic winder 1 according to the third variation, in accordance with a standard diameter of a smaller-diameter portion set by the smaller-diameter portion standard diameter setting section 83 and an end correction width of the smaller-diameter portion set by the smaller-diameter portion correction width setting section 87, the larger-diameter portion standard diameter setting section 82 automatically sets a standard diameter of a larger-diameter portion, and the larger-diameter portion correction width setting section 86 automatically sets an end correction width of the larger-diameter portion. Accordingly, just by setting the standard diameter and the end correction width with respect to the smaller-diameter portion, the standard diameter and the end correction width with respect to the larger-diameter portion can be automatically set. As a result, time and effort for setting a standard diameter and an end correction width can be reduced.

[0079] While a preferred embodiment and variations of the present invention have been described, the above-described structures can be further modified as follows.

[0080] In the above-described embodiment, the end correction width is set so as to be associated with the predicted bulge occurrence diameter. However, the end correction width may be set to be associated with a predicted package winding diameter other than the predicted bulge occurrence diameter. Accordingly, also for purposes than prevention of bulge winding, when the operator sets a width to be corrected from an edge of a package, the operator can intuitively carry out the setting.

[0081] In the above-described embodiment, the operator manually sets a standard diameter and an end correction width. However, such a structure may be replaced with a structure in which the standard diameter and the end correction width are automatically set according to package information that has been set by the machine setting device 90 or the like.

[0082] In the above-described embodiment, an end correction width is changed according to the package diameter acquired by the angle sensor 44. However, for example, such a structure may be replaced with a structure in which the end correction width is changed according to a period of time that has elapsed from the start of a winding operation. In such a case, by setting a relation between the period of time that has elapsed and the end correction width in accordance with a relation between the predicted bulge occurrence diameter and the end correction width, it possible to eliminate the necessity for setting a standard diameter.

[0083] The winder unit 10 can form packages of various shapes (such as a cheese-shaped package and a tapered package) other than a cone-shaped package.

[0084] In the winder unit 10 according to the above-described embodiment and variations, a yarn is traversed by the arm-type traverse device 27. However, such a structure can be replaced with a traverse device that is driven and reciprocated by a belt.

[0085] In the above-described embodiment and variations, the package driving control section 42 and the traverse control section 46 are described as components that are provided separately from the unit control section 50. However, such a structure can be replaced with a structure in which the unit control section 50 includes at least one of the package driving control section 42 and the traverse control section 46.

[0086] In the above-described embodiment and variations, the package driving motor 41 drives the package 30. However, such a structure can be replaced with a structure in which an appropriate driving device drives the contact roller 29 so as to drive and rotate the package 30.

[0087] In the above-described embodiment and variations, the angle sensor 44 acquires a package diameter. However, such a structure can be replaced with a structure in which the package diameter is calculated by detecting a rotational speed of the contact roller 29.

[0088] In the above-described embodiment and variations, the angle sensor 44 is formed as a rotary encoder. However, the angle sensor 44 can be replaced with an analog-type sensor such as a potentiometer.

[0089] In the above-described embodiment and variations, the traverse driving motor 45 is formed as a servomotor. However, the servomotor can be replaced with an appropriate driving device such as a step motor and a voice coil motor.

[0090] In the above-described embodiment and variations, the machine setting device 90 includes the setting section 91 for setting a standard diameter, an end correction width, an angle of the winding tube, or the like. Alternatively, each of the winder units 10 may include the setting section 91. However, it is advantageous for the machine setting device 90 to include the setting section 91 since the setting for a plurality of winder units can be carried out at once.

[0091] In the above-described embodiment and variations, a distance that is twice as long as a distance from a center portion of the winding bobbin 22 in an axial direction to the surface of a package is set as a standard diameter. However, in place of such a distance, a distance (a yarn layer length) from the surface of the winding bobbin 22 to the surface of the package can be set as the standard diameter.

[0092] The above-described embodiment and variations are not limited to an automatic winder, and can also be applied widely to a yarn winding machine in which a yarn is wound while being traversed by the traverse device.

Claims

1. A yarn winding machine, comprising:

> a yarn traversing device (27) adapted to traverse a yarn to be wound into a package,
> a correction width setting section (85) adapted to set an end correction width for correcting a predetermined target traverse width dependent on a predicted package winding diameter, and
> a control section (46) adapted to control the yarn traversing device (27) so as to traverse the yarn under a traverse width determined in accordance with the end correction width that has been set by the correction width setting section (85).

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

> a standard diameter setting section (81) adapted to set the predicted package winding diameter as a standard diameter, and
> a package diameter acquiring section (44) adapted to acquire a package diameter, which is a wound diameter of the package,
> wherein, when the package diameter acquired by the package diameter acquiring section (44) is the standard diameter, the control section (46) is adapted to control the yarn traversing device (27) so as to traverse the yarn under a traverse width determined in accordance with the end correction width that has been set dependent on the standard diameter.

3. The yarn winding machine according to claim 2, further comprising:

> a correction width calculating section (72) adapted to calculate an end correction width for a package diameter other than the set standard diameter in accordance with the set standard diameter and the end correction width associated with such standard diameter,
> wherein, when a package diameter acquired by the package diameter acquiring section (44) is a package diameter other than the set standard diameter, the control section (46) is adapted to control the yarn traversing device (27) so as to traverse the yarn under a traverse width determined in accordance with the end correction width calculated by the correction width calculating section (72).

4. The yarn winding machine according to claim 2 or claim 3, wherein
the standard diameter setting section (81) includes:

> a smaller-diameter portion standard diameter setting section (83) adapted to set a standard diameter of a smaller-diameter portion of a cone winding package, and
> a larger-diameter portion standard diameter setting section (82) adapted to set a standard diameter of a larger-diameter portion of the cone winding package, and the correction width setting section (85) includes:
>
> > a smaller-diameter portion correction width setting section (87) adapted to set an end correction width of the smaller-diameter portion of the cone winding package de-

pendent on the standard diameter set by the smaller-diameter portion standard diameter setting section (83), and
a larger-diameter portion correction width setting section (86) adapted to set an end correction width of the larger-diameter portion of the cone winding package dependent on the standard diameter set by the larger-diameter portion standard diameter setting section (82).

5. The yarn winding machine according to claim 4, wherein, in accordance with the larger-diameter portion standard diameter set by the larger-diameter portion standard diameter setting section (82) and the end correction width of the larger-diameter portion set by the larger-diameter portion correction width setting section (86), the smaller-diameter portion standard diameter setting section (83) is adapted to automatically set the standard diameter of the smaller-diameter portion and the smaller-diameter portion correction width setting section (87) is adapted to automatically set the end correction width of the smaller-diameter portion.

6. The yarn winding machine according to claim 4, wherein, in accordance with the smaller-diameter portion standard diameter set by the smaller-diameter portion standard diameter setting section (83) and the end correction width of the smaller-diameter portion set by the smaller-diameter portion correction width setting section (87), the larger-diameter portion standard diameter setting section (82) is adapted to automatically set the standard diameter of the larger-diameter portion and the larger-diameter portion correction width setting section (86) is adapted to automatically set the end correction width of the larger-diameter portion.

7. The yarn winding machine according to claim 2, further comprising:

a winding tube supporting section (23) adapted to rotatably support a winding tube around which the yarn is wound to form the package, and
a winding tube angle setting section (89) adapted to set an angle of the winding tube to be supported by the winding tube supporting section (23),
wherein the standard diameter setting section (81) is adapted to set the standard diameter in accordance with the angle of the winding tube set by the winding tube angle setting section (89), and
the correction width setting section (85) is adapted to set the end correction width in accordance with the angle of the winding tube set by the winding tube angle setting section (89).

8. A yarn winding method comprising:

a setting step (S101, S102) of setting a standard diameter and an end correction width, which corrects a predetermined target traverse width, with respect to a package, and storing the set standard diameter and the end correction width,
a package diameter acquiring step (S105) of acquiring a package diameter, which is a wound diameter of the package, and
a controlling step (S106) of controlling a yarn traversing device (27), which traverses a yarn, in accordance with an end correction width associated with the acquired package diameter.

FIG. 1

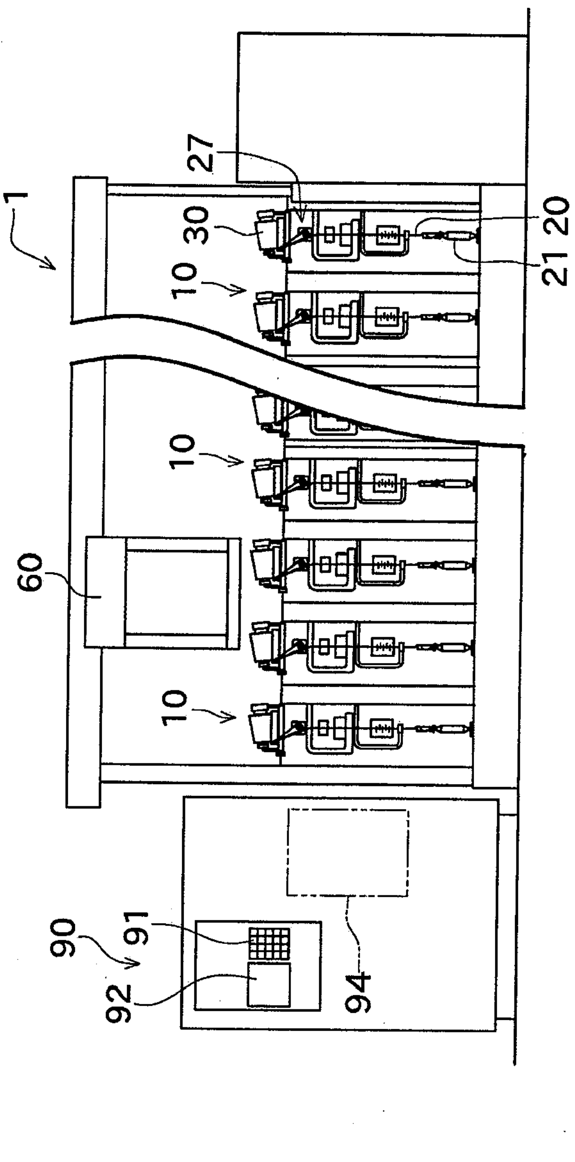


FIG. 2

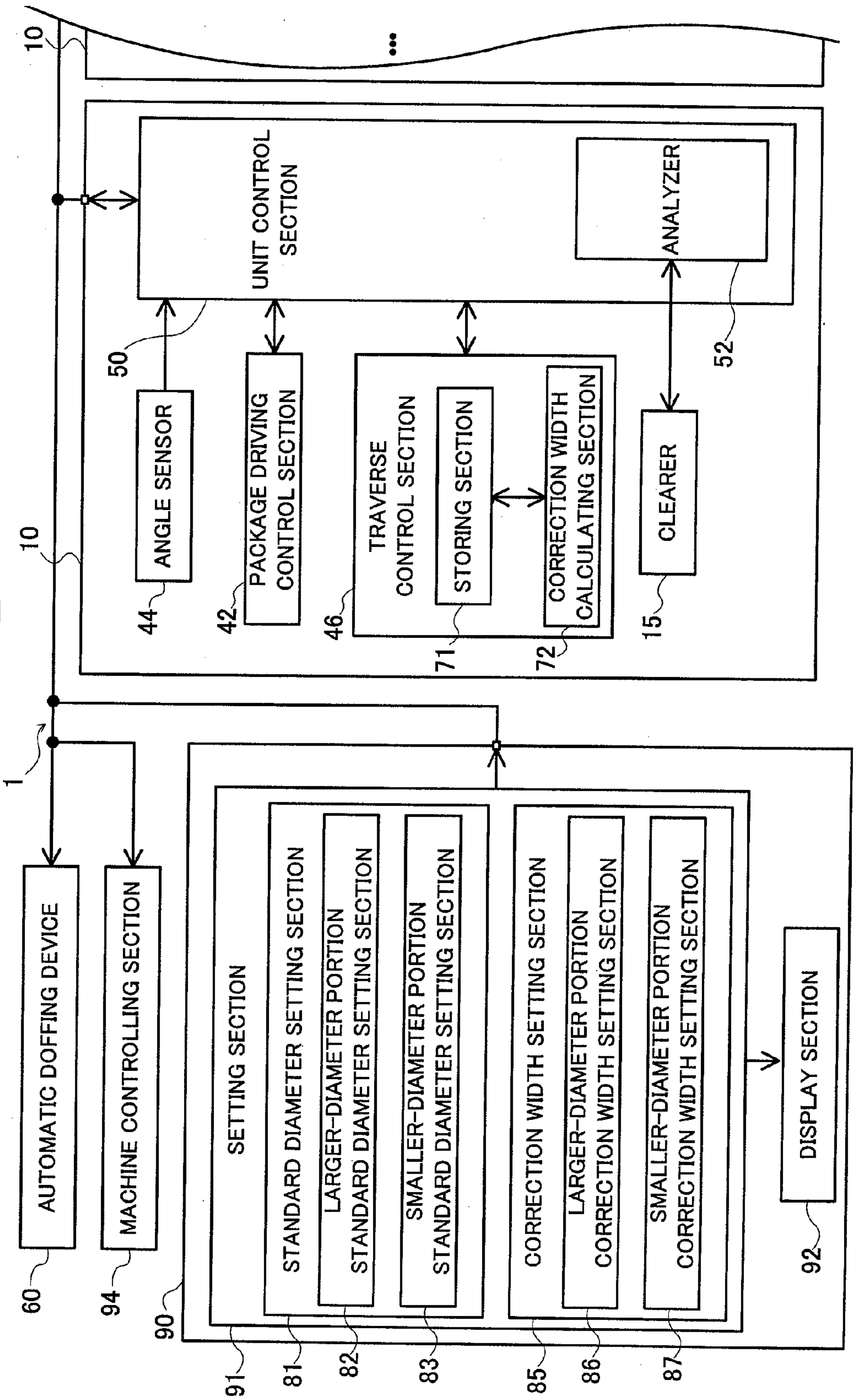

UNIT CONTROL SECTION
ANALYZER
ANGLE SENSOR
PACKAGE DRIVING CONTROL SECTION
TRAVERSE CONTROL SECTION
STORING SECTION
CORRECTION WIDTH CALCULATING SECTION
CLEARER
AUTOMATIC DOFFING DEVICE
MACHINE CONTROLLING SECTION
SETTING SECTION
STANDARD DIAMETER SETTING SECTION
LARGER-DIAMETER PORTION STANDARD DIAMETER SETTING SECTION
SMALLER-DIAMETER PORTION STANDARD DIAMETER SETTING SECTION
CORRECTION WIDTH SETTING SECTION
LARGER-DIAMETER PORTION CORRECTION WIDTH SETTING SECTION
SMALLER-DIAMETER PORTION CORRECTION WIDTH SETTING SECTION
DISPLAY SECTION
1
10
15
42
44
46
50
52
60
71
72
81
82
83
85
86
87
90
91
92
94

FIG. 3

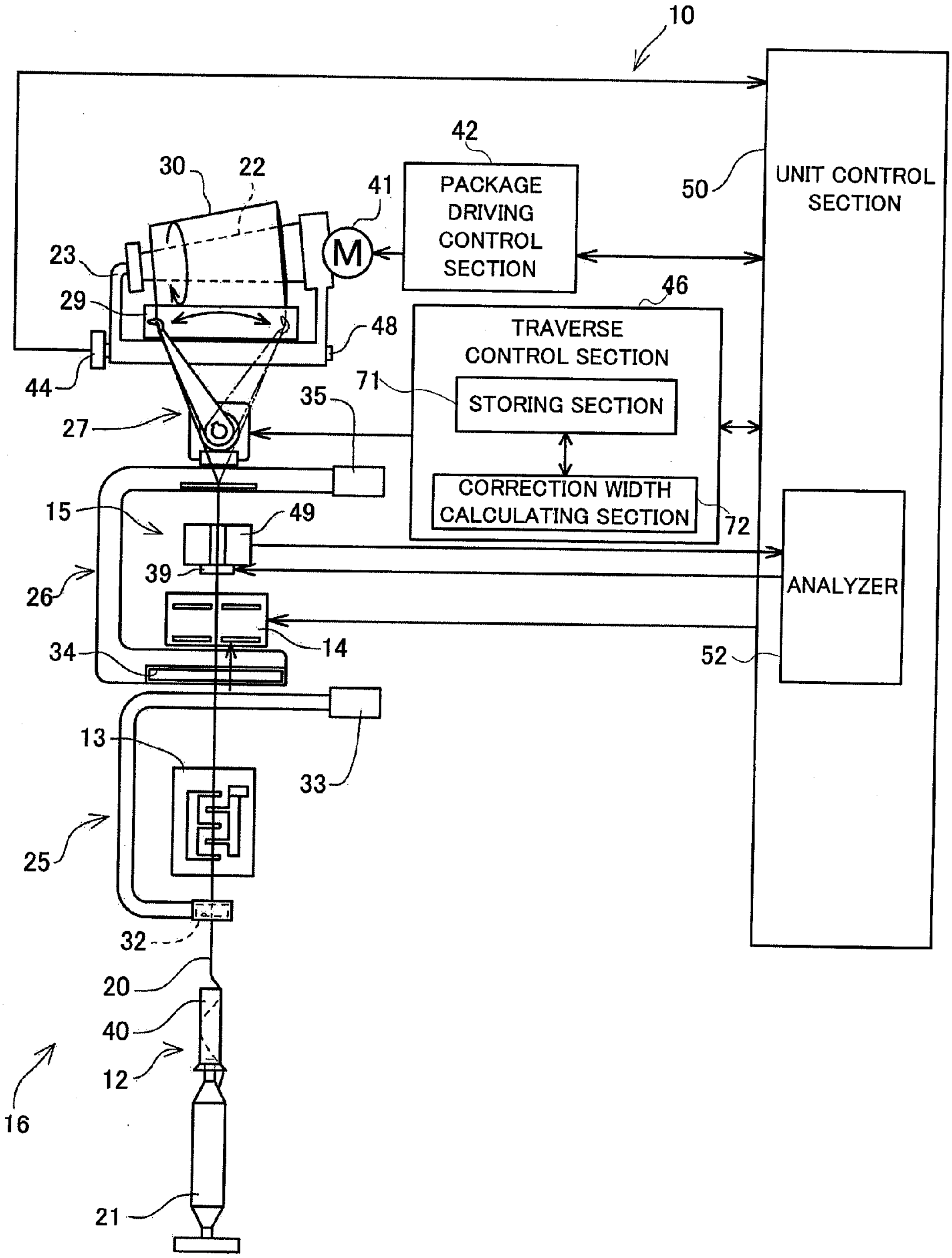

10
42
PACKAGE DRIVING CONTROL SECTION
30
22
41
M
50
UNIT CONTROL SECTION
23
29
46
TRAVERSE CONTROL SECTION
48
44
71
STORING SECTION
35
27
CORRECTION WIDTH CALCULATING SECTION
72
15
49
39
26
ANALYZER
14
34
52
13
33
25
32
20
40
12
16
21

FIG. 4

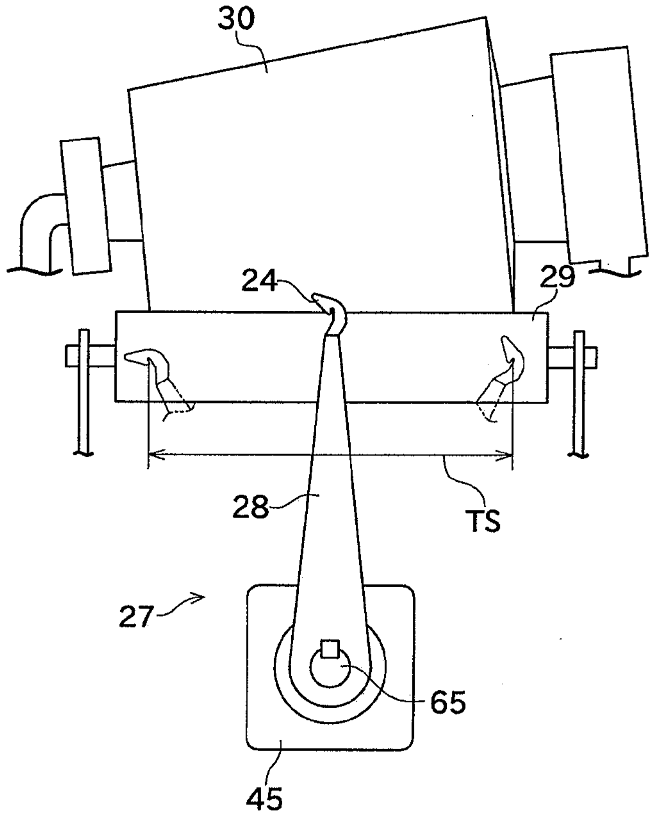
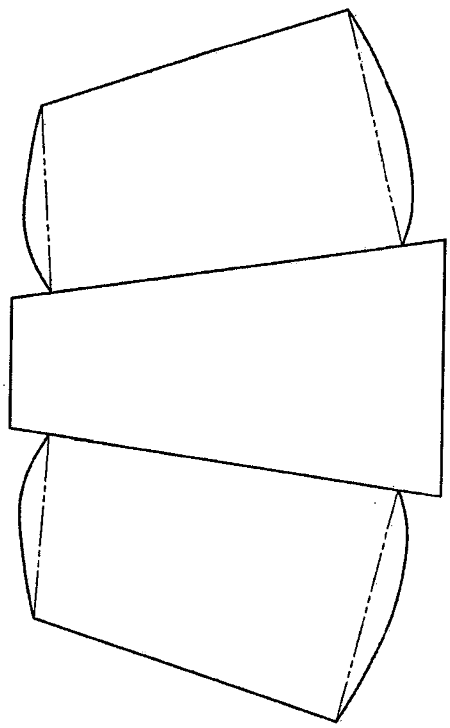


FIG. 5



SHAPE OF PACKAGE
OF WHEN BULGE WINDING OCCURS

IDEAL SHAPE OF PACKAGE

FIG. 6

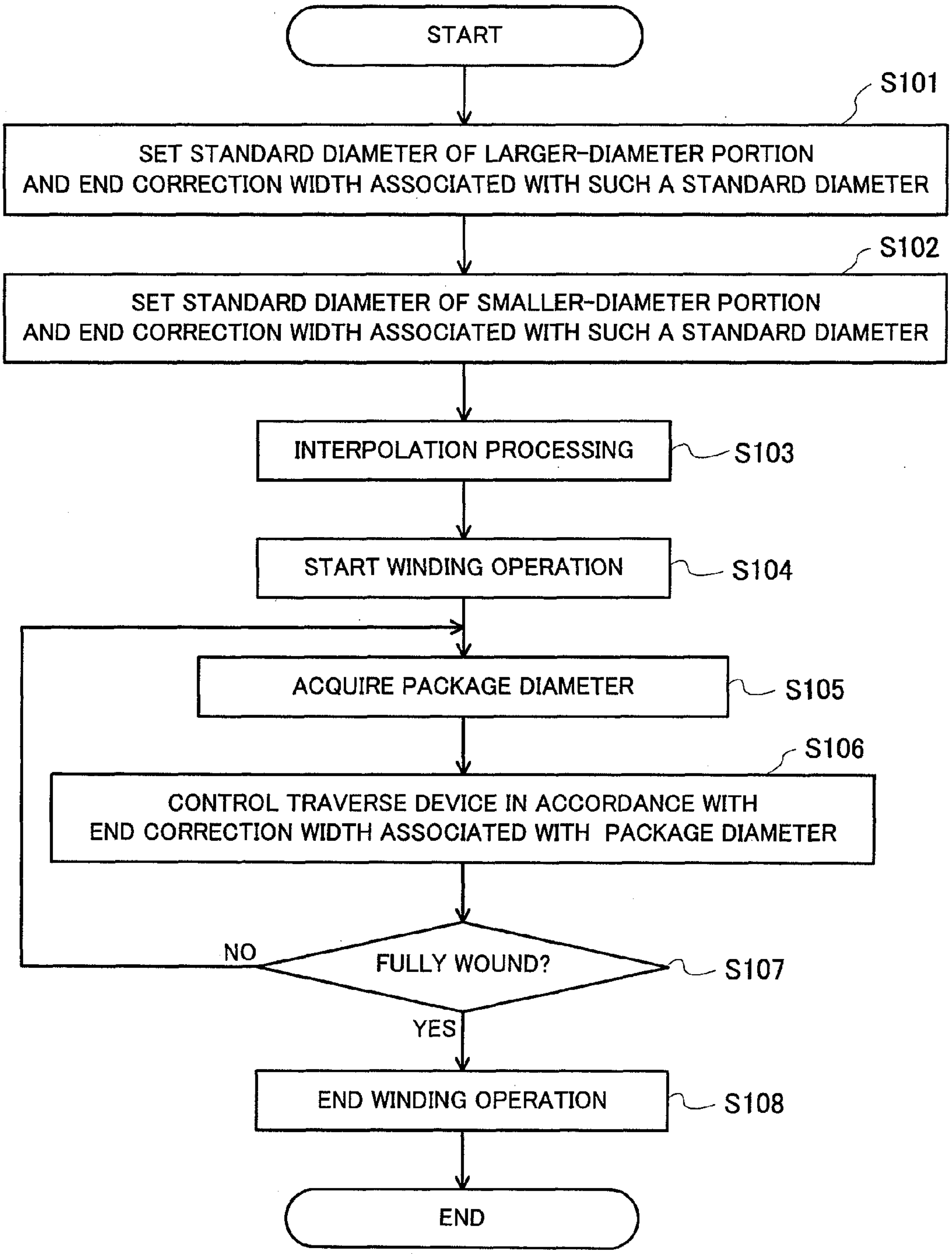

START
S101
SET STANDARD DIAMETER OF LARGER-DIAMETER PORTION
AND END CORRECTION WIDTH ASSOCIATED WITH SUCH A STANDARD DIAMETER
S102
SET STANDARD DIAMETER OF SMALLER-DIAMETER PORTION
AND END CORRECTION WIDTH ASSOCIATED WITH SUCH A STANDARD DIAMETER
INTERPOLATION PROCESSING
S103
START WINDING OPERATION
S104
ACQUIRE PACKAGE DIAMETER
S105
S106
CONTROL TRAVERSE DEVICE IN ACCORDANCE WITH
END CORRECTION WIDTH ASSOCIATED WITH PACKAGE DIAMETER
NO
FULLY WOUND?
S107
YES
END WINDING OPERATION
S108
END

FIG. 7

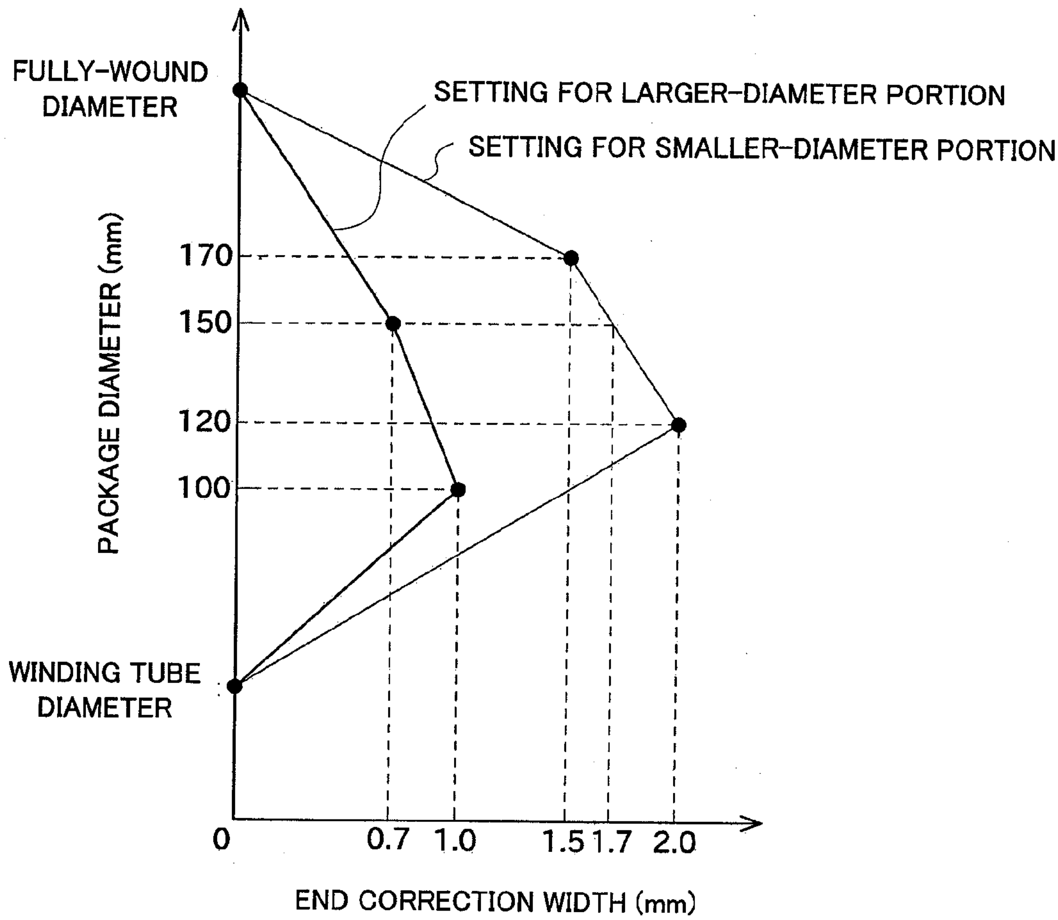
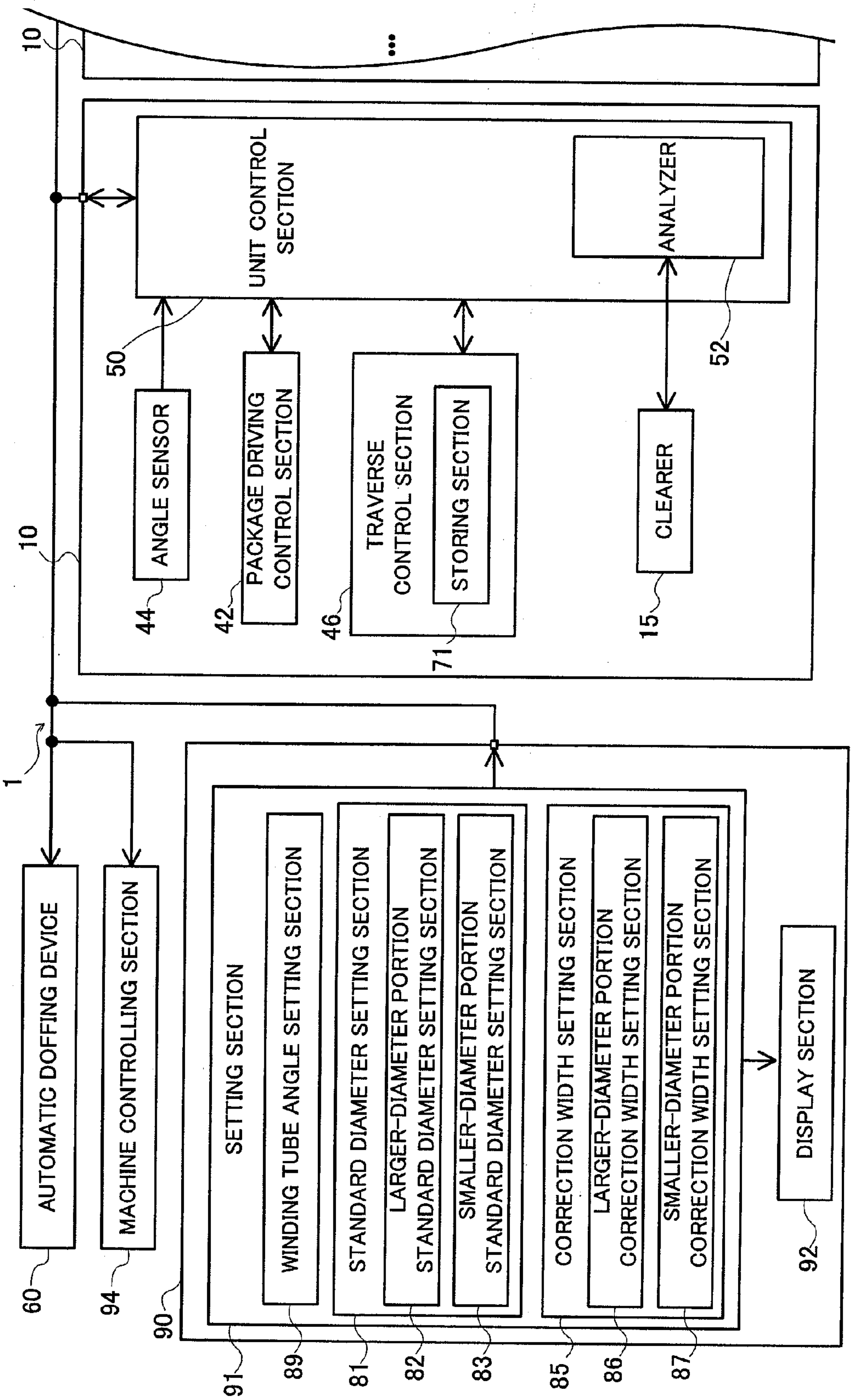

FULLY-WOUND DIAMETER
SETTING FOR LARGER-DIAMETER PORTION
SETTING FOR SMALLER-DIAMETER PORTION
PACKAGE DIAMETER (mm)
170
150
120
100
WINDING TUBE DIAMETER
0
0.7
1.0
1.5
1.7
2.0
END CORRECTION WIDTH (mm)

FIG. 8


10
UNIT CONTROL SECTION
ANALYZER
50
52
ANGLE SENSOR
PACKAGE DRIVING CONTROL SECTION
TRAVERSE CONTROL SECTION
STORING SECTION
CLEARER
10
44
42
46
71
15
1
AUTOMATIC DOFFING DEVICE
MACHINE CONTROLLING SECTION
SETTING SECTION
WINDING TUBE ANGLE SETTING SECTION
STANDARD DIAMETER SETTING SECTION
LARGER-DIAMETER PORTION STANDARD DIAMETER SETTING SECTION
SMALLER-DIAMETER PORTION STANDARD DIAMETER SETTING SECTION
CORRECTION WIDTH SETTING SECTION
LARGER-DIAMETER PORTION CORRECTION WIDTH SETTING SECTION
SMALLER-DIAMETER PORTION CORRECTION WIDTH SETTING SECTION
DISPLAY SECTION
60
94
90
92
91
89
81
82
83
85
86
87

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP H0971367 B **[0004]**