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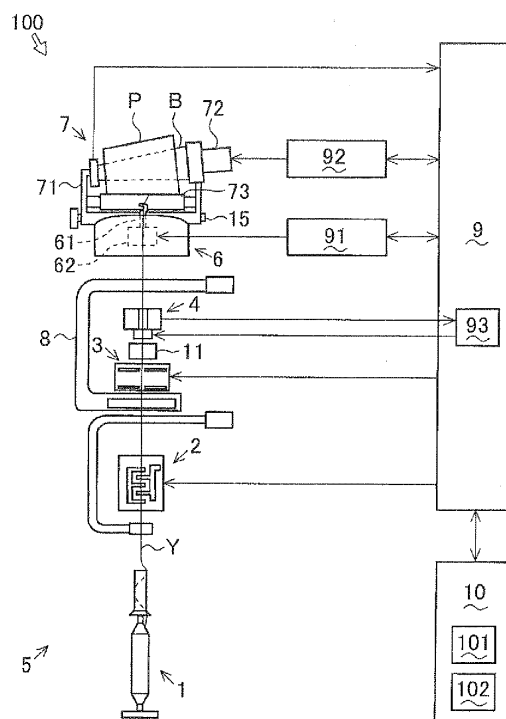
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(54) **Yarn winding machine**

(57) A yarn winding machine (100) adapted to form a conical package (P) by winding a yarn (Y), the yarn winding machine including a touch roller (73) adapted to rotate with the package (P) while making contact with an outer peripheral surface of the package (P); a traverse guide (61) adapted to traverse the yarn (Y) to be wound into the package (P); and a control section (91) adapted to control driving of the traverse guide (61); wherein the control section (91) controls the driving of the traverse guide (61) to prevent a driving point between the package (P) and the touch roller (73) from moving towards a smaller-diameter side of the package (P).

FIG. 1



## Description

### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention

**[0001]** The present invention relates to a technique of a yarn winding machine adapted to form a conical package by winding a yarn.

#### 2. Description of the Related Art

**[0002]** Conventionally, there is known a yarn winding machine adapted to form a package on a bobbin by rotating the bobbin and winding a yarn (see Japanese Unexamined Patent Publication No. 2007-238275). The yarn winding machine includes a touch roller, which rotates with the package, while making contact with an outer peripheral surface of the package, and a traverse guide for traversing the yarn.

**[0003]** The yarn traversed by the traverse guide is guided, to the package along an outer peripheral surface of the touch roller. The touch roller arranges the shape of the package by making contact with the outer peripheral surface of the package.

**[0004]** As illustrated in FIG. 6A, in a package P formed by a conventional yarn winding machine 200, so-called saddle bags SS and SL are formed in which an outer diameter of both end portions of the package P becomes greater than an outer diameter of a central portion in a winding width direction of the package P. This is because a density of the yarn Y becomes high at both end portions of the package P where a traverse guide 161 is reversed, whereas the density of the wound yarn Y becomes low at the central portion in the winding width direction of the package P.

**[0005]** A creeping control for changing driving of the traverse guide 161 in a pulsatile manner is proposed to prevent formation of the saddle bags SS and SL at both end portions of the package P (see Japanese Unexamined Patent Publication No. 2007-230708).

**[0006]** Furthermore, as illustrated in FIG. 6A, in the conical package P, the saddle bag SS on a smaller-diameter side becomes greater than the saddle bag SL on a larger-diameter side. This is because a density difference of the yarn Y between a bag portion and an inward portion thereof tends to become large on the smaller-diameter side of the package P in which a peripheral speed is slow than the larger-diameter side in which the peripheral speed is fast.

**[0007]** A driving point D will be described. The driving point D is a position where the peripheral speed of the package P coincides with the peripheral speed of the touch roller 173. Specifically, the package P is conical and the touch roller 173 is substantially cylindrical, and hence the peripheral speed of the package P coincides with the peripheral speed of the touch roller 173 at one point, the driving point D.

**[0008]** As illustrated in FIG. 6A, as the saddle bag SS on the smaller-diameter side of the package P becomes greater, the driving point D moves towards the smaller-diameter side of the package P (see arrow in FIG. 6A).

5 This is caused by an increase in a frictional force between the package P and the touch roller 173 on the smaller-diameter side of the package P accompanying an increase in the size of the saddle bag SS on the smaller-diameter side of the package P. Accordingly, a rotation speed of the touch roller 173 that rotates accompanying a rotation of the package P is gradually reduced.

**[0009]** When the rotation speed of the touch roller 173 is reduced, the difference between the peripheral speed of the larger-diameter side of the package P and the peripheral speed of the touch roller 173 becomes greater. On the larger-diameter side of the package P, tension of the yarn Y guided along the outer peripheral surface of the touch roller 173 becomes high, and a path of the yarn V when the traverse guide 161 is reversed sometimes shifts inward (the central portion side) (see arrow in FIG. 6B). As illustrated in FIG. 6B, the package P formed on the bobbin B may have an end surface SW on the larger-diameter side tilted with respect to a line Ax perpendicular to an inclination angle of the bobbin B (tapered without being perpendicular).

20 **[0010]** Thereafter, a density distribution further changes accompanying an increase in a wound diameter of the package P, and the driving point D may move towards the larger-diameter side of the package P (see arrow in FIG. 7A). This is caused by an increase in the frictional force between the package P and the touch roller 173 from the end portion on the smaller-diameter side towards the central portion of the package P. Accordingly, the rotation speed of the touch roller 173 that rotates accompanying the rotation of the package P gradually increases.

**[0011]** When the rotation speed of the touch roller 173 increases, the difference between the peripheral speed of the larger-diameter side of the package P and the peripheral speed of the touch roller 173 becomes smaller. On the larger-diameter side of the package P, the tension of the yarn Y guided along the outer peripheral surface of the touch roller 173 becomes low, and the path of the yarn Y when the traverse guide 161 is reversed returns to an initial position (see arrow in FIG. 7B). Accordingly, in the package P formed on the bobbin B, a so-called stitching may occur in which one part of the wound yarn Y slides to the end surface SW on the larger-diameter side.

45 **[0012]** Therefore, in order to prevent the driving point between the package and the touch roller from moving towards the smaller-diameter side of the package, there is proposed a structure in which one part of the touch roller rotates independently (see Japanese Unexamined Futility Model Publication No. 6-61866). However, with such a structure, the yarn may get caught at a gap of the touch roller or irregularities may be formed on the outer peripheral surface of the package.

**[0013]** Therefore, a technique that solves the above problems and improves quality of the package is desired.

#### BRIEF SUMMARY OF THE INVENTION

**[0014]** An object of the present invention is to provide a technique for improving quality of a package of a yarn winding machine that forms a conical package.

**[0015]** A first aspect of the invention relates to a yarn winding machine adapted to form a conical package by winding a yarn. The yarn winding machine includes a touch roller, a traverse guide, and a control section. The touch roller is adapted to rotate with the package while making contact with an outer peripheral surface of the package. The traverse guide is adapted to traverse the yarn to be wound into the package. The control section is adapted to electrically control driving of the traverse guide to prevent a driving point between the package and the touch roller from moving towards a smaller-diameter side of the package.

**[0016]** Accordingly, an end surface on the larger-diameter side of the package can be prevented from tilting with respect to a line perpendicular to an inclination angle of the bobbin and/or occurrence of stitching can be prevented, and the quality of the package can be improved.

**[0017]** A second aspect of the invention relates to the yarn winding machine according to the first aspect. The control section is capable of performing a creeping control to change a traverse width of the traverse guide in a pulsatile manner. At least during a winding start period of the package, the control section is adapted to execute the creeping control in accordance with a first control mode to prevent the driving point between the package and the touch roller from moving towards the smaller-diameter side of the package. The first control mode is a mode in which a pattern for changing the traverse width differs in the smaller-diameter side and the larger-diameter side of the package.

**[0018]** As described above, during the winding start period of the package, the driving point tends to easily move towards the smaller-diameter side of the package. Therefore, by executing the creeping control in accordance with the first control mode at least during the winding start period of the package, a saddle bag on the smaller-diameter side of the package which tends to easily occur during the winding start period of the package can be suppressed. As a result, the end surface on the larger-diameter side of the package can be prevented from tilting with respect to a line perpendicular to an inclination angle of the bobbin and/or the occurrence of the stitching can be prevented, and the quality of the package can be improved.

**[0019]** A third aspect of the invention relates to the yarn winding machine according to the second aspect. The pattern is at least one of a changing length of the traverse width, a change in an imaginary area formed by an end surface of the package and a path of a reversal position of a traverse operation of the traverse guide, and a chang-

ing frequency of the traverse width.

**[0020]** Accordingly, the reversal position of the traverse operation of the traverse guide is changed, and in particular, the saddle bag on the smaller-diameter side of the package can be suppressed. As a result, the end surface on the large-diameter side of the package can be prevented from tilting with respect to a line perpendicular to an inclination angle of the bobbin and/or the occurrence of the stitching can be prevented, and the quality of the package can be improved.

**[0021]** A fourth aspect of the invention relates to the yarn winding machine according to the first aspect. The control section is capable of performing a creeping control to change a traverse width of the traverse guide in a pulsatile manner. At least during a winding start period of the package, the control section is adapted to execute the creeping control in accordance with a second control mode to prevent the driving point between the package and the touch roller from moving towards the smaller-diameter side of the package. The second control mode is a mode in which a pattern for changing the traverse width differs only in the smaller-diameter side of the package.

**[0022]** Accordingly, the formation of the saddle bag on the smaller-diameter side which tends to be easily formed during the winding start period of the package can be preferentially suppressed. As a result, the end surface on the larger-diameter side of the package can be prevented from tilting with respect to a line perpendicular to an inclination angle of the bobbin and/or the occurrence of the stitching can be prevented, and the quality of the package can be improved.

**[0023]** A fifth aspect of the invention relates to the yarn winding machine according to the fourth aspect. The pattern is at least one of a changing length of the traverse width, a change in an imaginary area formed by an end surface of the package and a path of a reversal position of the traverse operation of the traverse guide, and a changing frequency of the traverse width.

**[0024]** Accordingly, the reversal position of the traverse operation of the traverse guide is changed, and the saddle bag on the smaller-diameter side of the package can be suppressed. As a result, the end surface on the larger-diameter side of the package can be prevented from tilting with respect to a line perpendicular to an inclination angle of the bobbin and/or the occurrence of the stitching can be prevented, and the quality of the package can be improved.

**[0025]** A sixth aspect of the invention relates to the yarn winding machine according to any one of the second to fifth aspects. Only during the winding start period of the package, the control section is adapted to execute one of the first control mode and the second control mode.

**[0026]** Accordingly, the formation of the saddle bag on the smaller-diameter side of the package which tends to be easily formed during the winding start period of the package can be suppressed, and no special control is

performed thereafter. As a result, the yarn winding machine can form a desired package.

**[0027]** A seventh aspect of the invention relates to the yarn winding machine according to any one of the second to fifth aspects. The control section is capable of executing a third control mode in which the creeping control is constant under a preset control manner. During the winding start period of the package, the control section is adapted to execute one of the first control mode and the second control mode, and after an elapse of the winding start period of the package, the control section is adapted to execute the third control mode.

**[0028]** Accordingly, the formation of the saddle bag on the smaller-diameter side of the package which tends to be easily formed during the winding start period of the package can be suppressed by the first control mode or the second control mode, and thereafter, the creeping control for softening the end surface of the package can be executed by the third control mode. As a result, the yarn winding machine can form the desired package.

**[0029]** An eighth aspect of the invention relates to the yarn winding machine according to any one of the second to seventh aspects. The yarn winding machine further includes a detecting section adapted to detect the winding start period of the package. The control section is adapted to control the driving of the traverse guide in accordance with a detection result of the detecting section. Accordingly, the driving of the traverse guide can be accurately controlled.

**[0030]** A ninth aspect of the invention relates to the yarn winding machine according to the eighth aspect. The detecting section is adapted to detect a thickness of a yarn layer of the package. Accordingly, a movement of the driving point towards the smaller-diameter side of the package can be appropriately prevented. That is, in a conical package, the outer diameter of the package differs depending on a position in a winding width direction. Meanwhile, the thickness of the yarn layer of the package, which is a distance from the surface of the bobbin B, is substantially constant irrespective of the position in the winding width direction. Therefore, by detecting the winding start period based on the thickness of the yarn layer of the package, the creeping control in accordance with the first control mode or the second control mode can be accurately performed.

**[0031]** A tenth aspect of the invention relates to the yarn winding machine according to the eighth aspect. The detecting section is adapted to detect a length of the yarn to be wound into the package. Accordingly, a determination can be accurately made as to whether or not it is during the winding start period of the package.

**[0032]** An eleventh aspect of the invention relates to the yarn winding machine according to the eighth aspect. The detecting section is adapted to detect an elapse of time from start of winding of the yarn. Accordingly, the yarn winding machine can accurately determine whether or not it is during the winding start period of the package with a simple structure.

**[0033]** A twelfth aspect of the invention relates to the yarn winding machine according to the eighth aspect. The detecting section is adapted to detect an outer diameter of the package. Accordingly, a determination can be accurately made as to whether or not it is during the winding start period of the package.

**[0034]** A thirteenth aspect of the invention relates to the yarn winding machine according to any one of the second to twelfth aspects. The yarn winding machine further includes a traverse width setting section adapted to set a traverse width of the traverse guide, and a control pattern setting section adapted to set at least one of the first control mode and the second control mode. Accordingly, the setting of the creeping control can be accurately carried out.

**[0035]** A fourteenth aspect of the invention relates to the yarn winding machine according to any one of the first to thirteenth aspects. The yarn winding machine further includes a yarn supplying section adapted to supply the yarn to be wound into the package; a yarn joining device adapted to join cut yarns; and a yarn guiding section adapted to catch a yarn end of the yarn wound into the package and to guide the yarn end to the yarn joining device.

**[0036]** Accordingly, a general yarn winding machine including the yarn supplying section, the yarn joining device, and the yarn guiding section can be provided. In the yarn winding machine adapted to wind a yarn into a package while performing the yarn joining operation, a print length of the yarn on the touch roller inevitably becomes long due to an arrangement of the yarn guiding section adapted to catch the yarn end from the package. If the print length becomes long, the yarn path with respect to the package becomes unstable at both ends, and thus the end surface on the larger-diameter side of the package tends to tilt with respect to the line perpendicular to the inclination angle of the bobbin, and the stitching tends to easily occur. In the yarn winding machine including the yarn supplying section), the yarn joining device, and the yarn guiding section as well, the driving point can be prevented from moving towards the smaller-diameter side of the package, and a high quality package can be formed.

**[0037]** According to the present invention, a technique can be provided for improving the quality of the package of the yarn winding machine adapted to form a conical package.

#### BRIEF DESCRIPTION OF THE DRAWINGS

**[0038]**

FIG. 1 is a view illustrating an overall structure of a yarn winding machine according to one embodiment of the present invention;

FIG. 2 is a view illustrating a state of forming a conical package;

FIG. 3 is a view illustrating a control manner of a first

control mode;

FIG. 4 is a view illustrating a control manner of a second control mode;

FIG. 5 is a view illustrating a control manner in which the first control mode is executed during a winding start period of a package, and a third control mode is executed after elapse of the winding start period of the package;

FIG. 6A is a view illustrating a state in which a driving point is moved towards a smaller-diameter side of a package according to a prior art;

FIG. 6B is a view illustrating a state in which an end surface on a larger-diameter side of the package is tilted with respect to a line perpendicular to an inclination angle of a bobbin according to the prior art;

FIG. 7A is a view illustrating a state in which the driving point is moved towards the larger-diameter side of a package according to the prior art; and

FIG. 7B is a view illustrating a state in which stitching occurs according to the prior art.

#### DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

**[0039]** First, a yarn Winding machine 100 according to one embodiment of the present invention will be described with reference to FIG. 1. As illustrated in FIG. 1, the yarn winding machine 100 includes a winding section 7, a traverse device 6, and a yarn supplying section 5. The yarn winding machine 100 also includes a suction arm 8, which is a yarn guiding section.

**[0040]** The winding section 7 winds a yarn Y into a package P. The winding section 7 includes a cradle 71, a package driving section 72, and a touch roller 73. The cradle 71 includes a bearing (not illustrated), a package driving section 72, and the like. The bearing, which can be removably attached with a bobbin B, grips both ends of the bobbin B in a freely rotating manner. The cradle 71 can swing with a swing shaft 15 at the center. Therefore, even when the outer diameter of the package P becomes large accompanying progress in winding of the yarn Y, the cradle 71 enables the touch roller 73 to push the outer peripheral surface of the package P at a prescribed load.

**[0041]** The package driving section 72 rotates the bobbin B and the package P formed on the bobbin B. A servo motor of the package driving section 72 is coupled with the bobbin B in a relatively non-rotatable manner when the bobbin B is gripped by the bearing of the cradle 71 (so-called direct drive method). The bobbin B is actively rotated and driven by the package driving section 72 to wind the yarn Y into the package P. The touch roller 73 makes contact with the peripheral surface of the bobbin B and rotates accompanying the rotation of the bobbin B. The package driving section 72 is driven in accordance with a control signal from a package-drive control section 92. Although the package driving section 72 uses a servo motor for a power source to rotate the package P, a step motor, an induction motor, or the like may also be used,

i.e., any type of motor can be used.

**[0042]** The traverse device 6 is arranged near the bobbin B (package P). The yarn Y is wound around the bobbin B while being traversed by the traverse device 6. The traverse device 6 includes a traverse guide 61, and a traverse guide driving section 62. The traverse guide 61 is a hook-shaped member adapted to traverse the yarn Y with the yarn Y hooked thereto. The shape of the traverse guide 61 is not limited to a hook shape, and may be a fork shape in which a distal end is opened. The traverse guide driving section 62 reciprocates the traverse guide 61 by driving the traverse guide 61 so as to reciprocate in a direction of the winding width of the bobbin B, that is, both ends of a first end (end on a left side in the drawing) and a second end (end on a right side in the drawing) of the bobbin B. The traverse guide driving section 62 is driven in accordance with a control signal from a traverse control section 91

**[0043]** The yarn supplying section 5 supplies the yarn Y to be wound around the bobbin B. A yarn supplying bobbin 1 is set in the yarn supplying section 5. A tension applying device 2, a yarn joining device 3, and a yarn clearer 4 serving as a cutting device are arranged in this order from the yarn supplying section 5 side and along a yarn travelling path between the yarn supplying section 5 and the touch roller 73. The tension applying device 2 applies appropriate tension on the yarn Y. The yarn clearer 4 detects a thickness of the yarn Y passing through a portion of a detecting section (not illustrated) by a sensor (not illustrated), and analyzes a signal from the sensor by an analyzer 93 to detect a yarn defect such as slub. The yarn clearer 4 is provided with a cutter for cutting the yarn Y when the yarn defect is detected (clearer cut), or for cutting the yarn Y to interrupt the winding due to a traverse defect although the yarn defect is not detected (additional cut). The yarn joining device 3 carries out a yarn joining operation of joining a lower yarn from the yarn supplying bobbin 1 and an upper yarn from the package P after the yarn cut by the yarn clearer 4, or after yarn breakage of the yarn Y from the yarn supplying bobbin 1.

**[0044]** The suction arm 8 catches the yarn Y (upper yarn) wound into the package P and guides the yarn Y to the yarn joining device 3. Specifically, the yarn Y (upper yarn) wound into the package P is caught when the suction arm 8 is swung to an upper side, and the caught yarn Y is guided to the yarn joining device 3 when the suction arm 8 is swung to a lower side.

**[0045]** Next, the structure of the traverse device 6 and the winding section 7 will be described in further detail with reference to FIG. 2.

**[0046]** As described above, the traverse device 6 includes the traverse guide 61 adapted to traverse the yarn Y, and the traverse guide driving section 62 adapted to drive the traverse guide 61.

**[0047]** The traverse guide 61 is an arm member having a hooking section 61a for hooking the yarn Y. The traverse guide 61 reciprocates in the direction of the wind-

ing width of the bobbin B (see arrow in the drawing) with the yarn Y hooked to the hooking section 61a to traverse the yarn Y.

**[0048]** The traverse guide driving section 62 is mainly configured by a servo motor. The traverse guide driving section 62 reciprocates the traverse guide 61 by forwardly rotating or reversely rotating a motor shaft of the servo motor. In the present embodiment, the traverse guide driving section 62 uses a servo motor for the power source to drive the traverse guide 61, but for example, a step motor, an induction motor, a linear motor or the like may also be used, i.e., any type of motor can be used. The direction of the motor shaft of the servo motor, that is, the attaching direction of the traverse guide 61, is also not limited.

**[0049]** As described above, the yarn winding machine 100 adopts a so-called arm-type traverse device adapted to traverse the yarn Y by hooking the yarn Y to the arm member for the traverse device 6. However, the traverse device 6 may be a so-called belt-type traverse device adapted to traverse the yarn Y by hooking the yarn Y to a yarn guide arranged on a belt member. The traverse guide 6 may also be a so-called rotary traverse device.

**[0050]** As described above, the winding section 7 includes the cradle 71 for supporting the bobbin B in a removably attachable manner, the package driving section 72 for rotating the bobbin B and the package P formed on the bobbin B, and the touch roller 73.

**[0051]** The touch roller 73 rotates with the package P while making contact with the outer peripheral surface of the package P. The touch roller 73 arranges the shape of the package P by pushing the outer peripheral surface of the package P. The touch roller 73 is a substantially cylindrical rotating body but may also be a conical rotating body.

**[0052]** As described above, the yarn winding machine 100 is structured such that the package P is rotated by the package driving section 72, and the touch roller 73 is driven with the rotation of the package P. However, the yarn winding machine 100 may be structured such that the touch roller 73 is rotated by the package driving section 72, and the package P is driven with the rotation of the touch roller 73, for example.

**[0053]** Next, the control manner of the traverse guide 61 will be described in detail.

**[0054]** FIG. 3 is a view illustrating a control manner of a first control mode. A vertical axis of FIG. 3 indicates an elapsed time. A horizontal axis of FIG. 3 indicates a traversed width on a smaller-diameter side and a larger-diameter side of the package P. The traverse width is a movement distance of the traverse guide 61 from an origin O.

**[0055]** In the first control mode, the control manner of a creeping control differs for the smaller-diameter side and the larger-diameter side of the package P. Specifically, in the first control mode, the frequency of the creeping control on the smaller-diameter side of the package P is greater than the frequency of the creeping control

on the larger-diameter side of the package P. That is, as indicated in the following equation, a creeping cycle  $t_2$  on the smaller-diameter side of the package P is the same as or shorter than a creeping cycle  $t_1$  on the larger-diameter side of the package P.

$$\text{Creeping cycle: } t_1 \geq t_2$$

**[0056]** In the present description, "creeping pattern" is at least one of (1) a changing length of the traverse width (e.g., reducing length from the end surface of the package P, i.e., size of TA in FIG. 3), (2) a change in an imaginary area formed, by an end surface of the package P and a path of a reversal position of the traversing operation of the traverse guide 61 (imaginary area  $\alpha$  on the smaller-diameter side of the package P and imaginary area  $\beta$  on the larger-diameter side of the package P), and (3) a changing frequency of the traverse width (frequency of changing the length and/or frequency of changing the imaginary area).

**[0057]** In the present example, the change in the imaginary area will be described for the creeping pattern.

**[0058]** Assuming that the creeping pattern is the imaginary area  $\alpha$  and the imaginary area  $\beta$ , the imaginary area  $\alpha$  has a size greater than or equal to the imaginary area  $\beta$  ( $\alpha \geq \beta$ ). In other words, a creeping amount on the smaller-diameter side of the package P is greater than a creeping amount on the larger-diameter side of the package P. The imaginary area  $\alpha$  becomes larger with advancement in the winding of the package P (in FIG. 3,  $\alpha_1 < \alpha_2 < \alpha_3$ ). Accordingly, during a winding start period of the package P, the driving point D between the package P and the touch roller 73 can be prevented from moving towards the smaller-diameter side of the package P.

**[0059]** As described above, by executing the creeping control in accordance with the first control mode at least during the winding start period of the package P, the yarn winding machine 100 can suppress the saddle bag SS on the smaller-diameter side of the package P which tends to be formed during the winding start period of the package P. That is, the reversal position of the traversing operation of the traverse guide 61 is changed, and the saddle bag SS on the smaller-diameter side of the package P can be suppressed. As a result, the end surface SW on the larger-diameter side of the package P can be prevented from tilting with respect to a line Ax perpendicular to an inclination angle of the bobbin B and/or the occurrence of the stitching can be prevented. Accordingly, the quality of the package P can be improved.

**[0060]** As illustrated in FIG. 4, in a second control mode, the creeping control is not carried out on the larger-diameter side of the package P, and the creeping control is carried out only on the smaller-diameter side of the package P.

**[0061]** Accordingly, the yarn winding machine 100 can preferentially suppress the formation of the saddle bag SS on the smaller-diameter side which tends to be easily

formed during the winding start period of the package P. That is, the reversal position of the traversing operation of the traverse guide 61 is changed, and the saddle bag SS on the smaller-diameter side of the package P can be suppressed. As a result, the end surface SW on the larger-diameter side of the package P can be prevented from tilting with respect to the line Ax perpendicular to the inclination angle of the bobbin B and/or the occurrence of the stitching can be prevented. Accordingly, the quality of the package P can be improved.

**[0062]** In the yarn winding machine 100, the first control mode or the second control mode is executed only during the winding start period of the package P. The winding start period of the package P in the present description refers to a predetermined period from when the yarn Y starts to be wound around an empty bobbin B around which the yarn Y is not wound.

**[0063]** The yarn winding machine 100 suppresses the formation of the saddle bag SS on the smaller-diameter side which tends to be formed during the winding start period of the package P, and does not perform any special control thereafter. Accordingly, the yarn winding machine 100 can form a desired package P.

**[0064]** Furthermore, the yarn winding machine 100 can execute a third control mode in which the creeping control is constant with the control manner set in advance. Therefore, the yarn winding machine 100 can execute the first control mode or the second control mode during the winding start period of the package P, and execute the third control mode after the elapse of the winding start period of the package P. The third control mode can soften the end surface of the package P.

**[0065]** FIG. 5 is a view illustrating a control manner in which the first control mode is executed during the winding start period of the package P, and the third control mode is executed after the elapse of the winding start period of the package P. In FIG. 5, the winding start period of the package P is denoted by T1, and a period after the elapse of the winding start period of the package P is denoted by T2.

**[0066]** The yarn winding machine 100 suppresses the formation of the saddle bag SS on the smaller-diameter side which tends to be formed during the winding start period of the package P by the first control mode, and thereafter generally executes the creeping control that softens the end surface of the package P by the third control mode. Accordingly, the yarn winding machine 100 can form the desired package.

**[0067]** The yarn winding machine 100 includes a main control section 10 electrically connected to a unit control section 9 (see FIG. 1). The machine control section 10 includes a traverse width setting section 101 and a control pattern setting section 102, thus enabling an operator to arbitrarily set the traverse width and the control pattern.

**[0068]** Since the yarn winding machine 100 includes the traverse width setting section 101 and the control pattern setting section 102, the yarn winding machine 100 can accurately carry out the setting of the creeping

control.

**[0069]** Next, a description will be made on the structure for the yarn winding machine 100 to determine whether or not it is during the winding start period of the package P.

5 **[0070]** The yarn winding machine 100 determines whether or not it is during the winding start period of the package P in accordance with a detection result of a wound-length detecting section (detecting section) 11.

10 **[0071]** As described above, by determining whether or not it is during the winding start period, of the package P in accordance with the detection result of the wound-length detecting section 11, the yarn winding machine 100 can accurately control the driving of the traverse guide 61.

15 **[0072]** The yarn winding machine 100 includes the wound-length detecting section 11 between the yarn joining device 3 and the yarn clearer 4 (see FIG. 1). The unit control section 9 of the yarn winding machine 100 determines whether or not it is during the winding start period of the package P in accordance with the length of the yarn Y wound into the package P, which is the detection result of the wound-length detecting section 11.

20 **[0073]** Specifically, the wound-length detecting section 11 detects a pulse signal of a prescribed cycle from the yarn Y, and transmits the relevant pulse signal to the unit control section 9. The unit control section 9 accumulates the pulse signals received from the start of the winding of the yarn Y to recognize the length of the yarn Y wound into the package P and to obtain a thickness of a yarn layer (see FIG. 2) of the package P. For example, the unit control section 9 obtains the thickness of the yarn layer L (see FIG. 2) in accordance with the number of pulse signals accumulated, from the start of the winding of the yarn Y, the winding speed of the yarn Y, and/or the type of the yarn Y (yarn count), and the like.

30 **[0074]** In the yarn winding machine 100, a period when the thickness of the yarn layer L is smaller than or equal to 60 mm is defined as the winding start period of the package P. That is, the yarn winding machine 100 stops the first control mode or the second control mode when the thickness of the yarn layer L exceeds 60 mm. However, for example, a period when the thickness of the yarn layer L is smaller than or equal to 25 mm may be defined as the winding start period of the package P, and the winding start period is not limited a specific numerical value.

40 **[0075]** As described above, by detecting the length of the yarn Y wound into the package P, the yarn winding machine 100 can accurately determine whether or not it is during the winding start period of the package P.

50 **[0076]** In the embodiment described above, the unit control section 9 determines whether or not it is during the winding start period of the package P in accordance with the detection result of the wound-length detecting section 11. The present invention is not limited to such an embodiment, and for example, a timer (detecting section) (not illustrated) for measuring the elapsed time from the start of the winding of the yarn Y may be arranged in

the unit control section 9. In accordance with the elapsed time from the start of the winding of the yarn Y, the unit control section 9 of the yarn winding machine 100 recognizes the length of the yarn Y wound into the package P, and obtains the thickness of the yarn layer L (see FIG. 2) of the relevant package P. For example, the unit control section 9 obtains the thickness of the yarn layer L (see FIG. 2) in accordance with the elapsed time from the start of the winding of the yarn Y, the winding speed of the yarn Y, and/or the type of the yarn Y (yarn count), and the like.

**[0077]** In such a structure, a timer function is stopped when the winding of the yarn Y is interrupted such as when joining the yarn ends with the yarn joining device 3. Accordingly, the yarn winding machine 100 can accurately detect the elapsed time from the start of the winding of the yarn Y.

**[0078]** As described above, by detecting the elapsed time from the start of the winding of the yarn Y, the yarn winding machine 100 can accurately determine whether or not it is during the winding start period of the package P with a simple structure.

**[0079]** In another further embodiment, an angle sensor (detecting section) (not illustrated) for detecting the tilt of the cradle 71 may be arranged in the winding section 7. The unit control section 9 of the yarn winding machine 100 obtains the thickness of the yarn layer L of the package P (see FIG. 2) in accordance with the tilt angle of the cradle 71 detected by the angle sensor.

**[0080]** The tilt angle of the cradle 71 has a correlation with the outer diameter of the package P. Thus, the angle sensor for detecting the tilt angle of the cradle 71 indirectly detects the outer diameter of the package P. Therefore, a structure for directly detecting the outer diameter of the package P rather than detecting the tilt angle of the cradle 71 may be adopted.

**[0081]** Accordingly, by detecting the outer diameter of the package P, the yarn winding machine 100 can accurately determine whether or not it is during the winding start period of the package P.

**[0082]** In another embodiment, the following structure may be adopted. First, the yarn winding machine 100 may include a speed detection sensor that is adapted to detect a travelling speed of the yarn Y to be guided to the package P and arranged along a travelling path of the yarn Y. In this case, the yarn winding machine 100 calculates a winding angle R (see FIG. 2) from the travelling speed of the yarn Y detected by the speed detection sensor and the driving speed of the traverse guide 61. Then, the outer diameter of the package P is calculated from the winding angle R, the peripheral speed of the package P, and the number of rotation of the package P. The yarn winding machine 100 obtains the thickness of the yarn layer L (see FIG. 2) in accordance with the calculated outer diameter of the package P.

**[0083]** In the above described embodiment and alternative embodiments, the yarn winding machine 100 obtains the thickness of the yarn layer L of the package P.

This is because it is advantageous in terms of setting the first control mode or the second control mode, and the third control mode. In other words, in the conical package P, an absolute value of the outer diameter of the package P differs between the larger-diameter side end and the smaller-diameter side end. Generally, the outer diameter of the larger-diameter side end of the package P is obtained for a next step in the yarn winding machine 100. However, in a setting based on the outer diameter of the larger-diameter side end of the package P, a setting of the first control mode and the like for suppressing the movement of the driving point D towards the smaller-diameter side of the package P cannot be intuitively carried out. By enabling the setting based on the thickness of the yarn layer L, the operator can accurately set the first control mode and the like.

**[0084]** As described above, by obtaining the thickness of the yarn layer L of the package P, the yarn winding machine 100 can appropriately prevent the movement of the driving point D towards the smaller-diameter side of the package P. In other words, in the conical package P, the outer diameter of the package P differs depending on the position in the winding width direction. Meanwhile, the thickness of the yarn layer L of the package P, which is the distance from the surface of the bobbin B, is substantially constant irrespective of the position in the winding width direction. Therefore, by detecting whether or not it is during the winding start period based on the thickness of the yarn layer L of the package P, the yarn winding machine 100 can accurately carry out the creeping control in accordance with the first control mode or the second control mode.

**[0085]** In the description made above, the timing to start the first control mode or the second control mode is not indicated. However, the first control mode or the second control mode is at least not required to be immediately executed from the start of the winding of the yarn Y, and can be executed after the yarn layer L becomes a predetermined thickness.

**[0086]** Another method of preventing the driving point D from moving towards the smaller-diameter side of the package P includes appropriately setting a lead ratio of the traverse guide 61. The lead ratio is a ratio of the driving speed of the traverse guide 61 on the smaller-diameter side of the package P and the driving speed of the traverse guide 61 on the larger-diameter side of the package P (also a ratio of the driving time of the traverse guide 61 on the smaller-diameter side of the package P and the driving time of the traverse guide 61 on the larger-diameter side of the package P).

**[0087]** However, if such a method is used, the driving speed of the traverse guide 61 becomes faster on the smaller-diameter side than the larger-diameter side of the package P, and hence the lead ratio is required to be set so that the driving speed at the relevant time does not exceed the acceptable range. Therefore, the yarn Y cannot be wound at high speed that is demanded in recent years. Furthermore, if the lead ratio is made ex-

tremely large, the density of the yarn Y on the larger-diameter side of the package P becomes too high and the quality of the package P tends to be lowered.

[0088] In the yarn winding machine 100 according to one embodiment of the present invention, since the driving speed of the traverse guide 61 does not exceed the acceptable range, the yarn Y can be wound at high speed.

[0089] The automatic winder has been described for the yarn winding machine according to one embodiment of the present invention, but the yarn winding machine may be other yarn winding machines such as an air-jet spinning machine, a yarn twisting machine, or a re-winding machine. The features of all dependent claims and all embodiments can be combined with each other as long as they do not

## Claims

1. A yarn winding machine adapted to form a conical package by winding a yarn, the yarn winding machine comprising:

a touch roller (73) adapted to rotate with the package (P) while making contact with an outer peripheral surface of the package (P);  
a traverse guide (61) adapted to traverse the yarn (Y) to be wound into the package (P); and  
a control section (91) adapted to electrically control driving of the traverse guide (61) to prevent a driving point between the package (P) and the touch roller (73) from moving towards a smaller-diameter side of the package (P).

2. The yarn winding machine according to claim 1, wherein the control section (91) is capable of performing a creeping control to change a traverse width of the traverse guide (61) in a pulsatile manner, and at least during a winding start period of the package (P), the control section (91) is adapted to execute the creeping control in accordance with a first control mode to prevent the driving point between the package (P) and the touch roller (73) from moving towards the smaller-diameter side of the package (P), the first control mode being a mode in which a pattern for changing the traverse width differs in the smaller-diameter side and a larger-diameter side of the package (P).

3. The yarn winding machine according to claim 2, wherein the pattern is at least one of a changing length of the traverse width, a change in an imaginary area formed by an end surface of the package (P) and a path of a reversal position of the traverse guide (61), and a changing frequency of the traverse width.

4. The yarn winding machine according to claim 1,

wherein the control section (91) is capable of performing a creeping control to change a traverse width of the traverse guide (61) in a pulsatile manner, and at least during a winding start period of the package (P), the control section (91) is adapted to execute the creeping control in accordance with a second control mode to prevent the driving point between the package (P) and the touch roller (73) from moving towards the smaller-diameter side of the package (P), the second control mode being a mode in which a pattern for changing the traverse width differs only in the smaller-diameter side of the package (P).

5. The yarn winding machine according to claim 4, wherein the pattern is at least one of a changing length of the traverse width, a change in an imaginary area formed by an end surface of the package (P) and a path of a reversal position of the traverse guide (61), and a changing frequency of the traverse width.

6. The yarn winding machine according to any one of claim 2 through claim 5, wherein only during the winding start period of the package (P), the control section (91) is adapted to execute one of the first control mode and the second control mode.

7. The yarn winding machine according to any one of claim 2 through claim 5, wherein the control section (91) is capable of executing a third control mode in which the creeping control is constant under a preset control manner; and  
during the winding start period of the package (P), the control section (91) is adapted to execute one of the first control mode and the second control mode, and after an elapse of the winding start period of the package (P), the control section (91) is adapted to execute the third control mode.

8. The yarn winding machine according to any one of claim 2 through claim 7, further comprising a detecting section (11.) adapted to detect the winding start period of the package (P),  
wherein the control section (91) is adapted to control the driving of the traverse guide (61) in accordance with a detection result of the detecting section (11).

9. The yarn winding machine according to claim 8, wherein the detecting section is adapted to detect a thickness of a yarn layer of the package (P).

10. The yarn winding machine according to claim 8, wherein the detecting section is adapted to detect a length of the yarn (Y) to be wound into the package (P).

11. The yarn winding machine according to claim 8, wherein the detecting section is adapted to detect an elapse of time from start of winding of the yarn (Y).

12. The yarn winding machine according to claim 8,  
wherein the detecting section is adapted to detect  
an outer diameter of the package (P).
13. The yarn winding machine according to any one of 5  
claim 2 through claim 12, further comprising:
- a traverse width setting section (101) adapted  
to set a traverse width of the traverse guide (61),  
and 10  
a control pattern setting section (102) adapted  
to set at least one of the first control mode and  
the second control mode.
14. The yarn winding machine according to any one of 15  
claim 1 through claim 13, further comprising:
- a yarn supplying section (5) adapted to supply  
the yarn (Y) to be wound into the package (P) ;  
a yarn joining device (3) adapted to join cut 20  
yarns;  
a yarn guiding section (8) adapted to catch a  
yarn end of the yarn (Y) wound into the package  
(P) and to guide the yarn end to the yarn joining  
device (3). 25

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FIG. 1

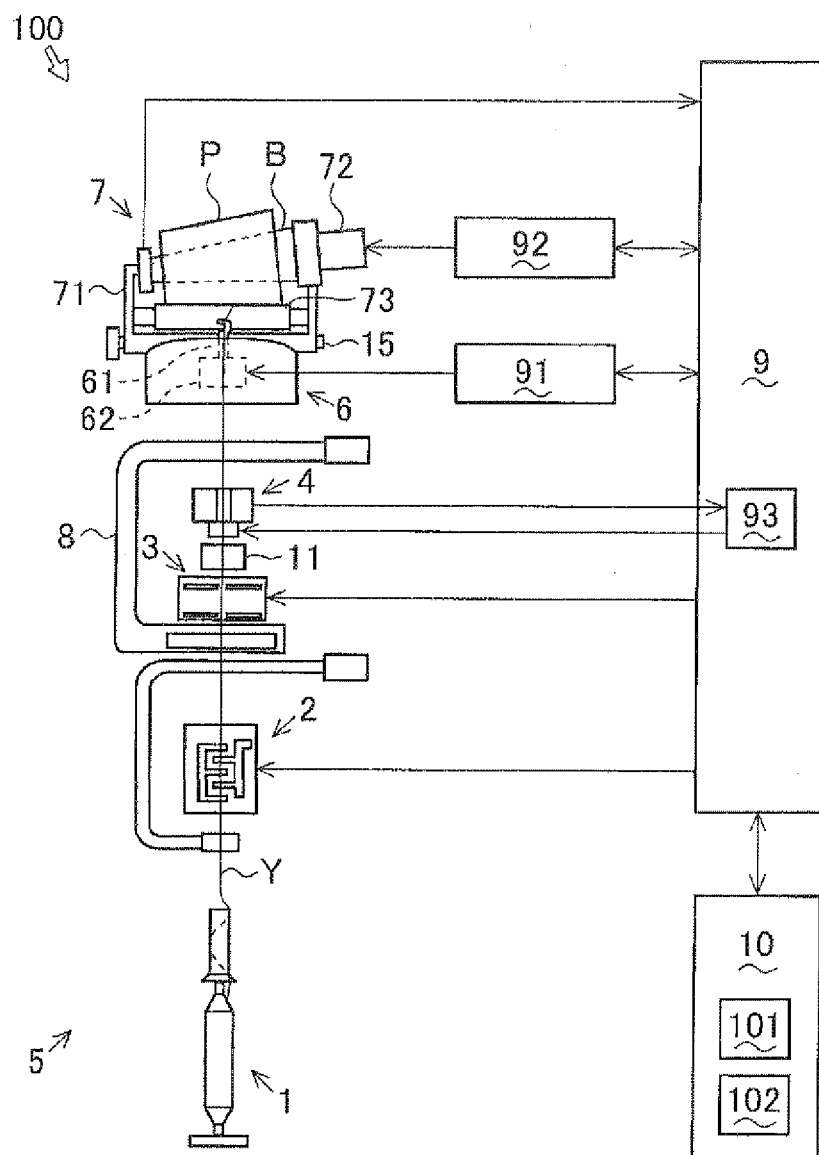


FIG. 2

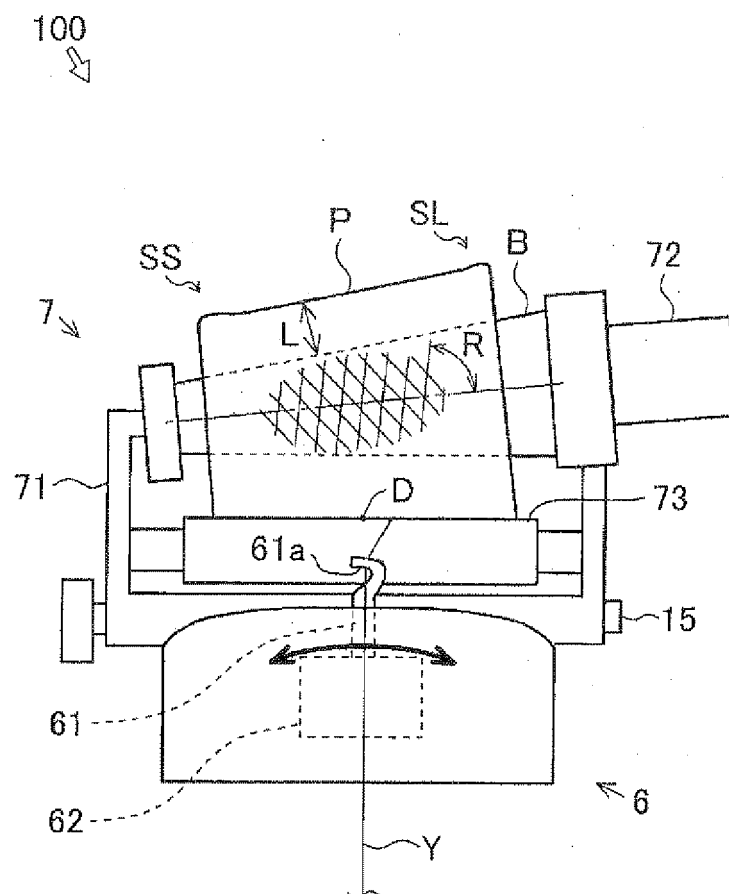


FIG. 3

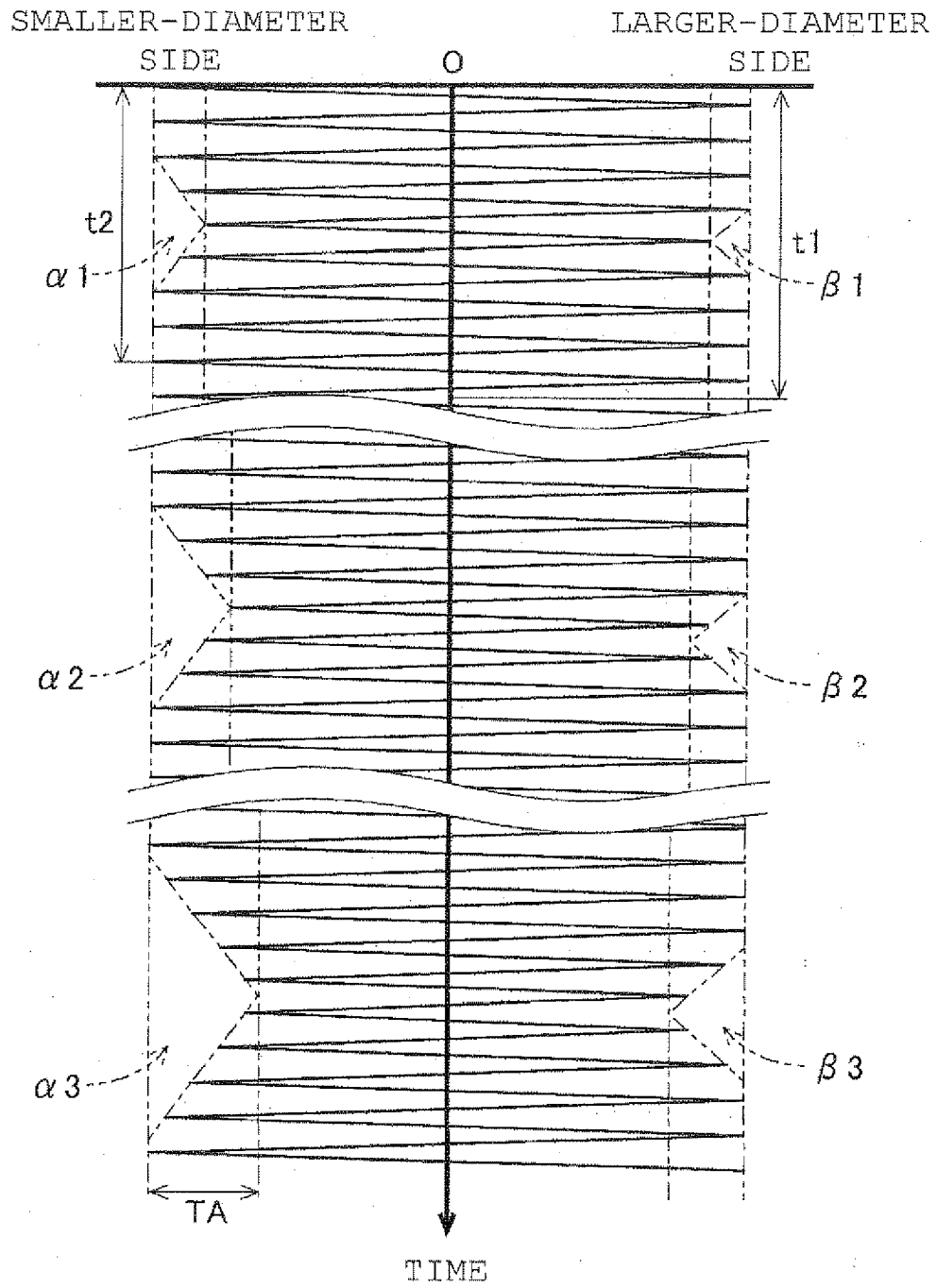


FIG. 4

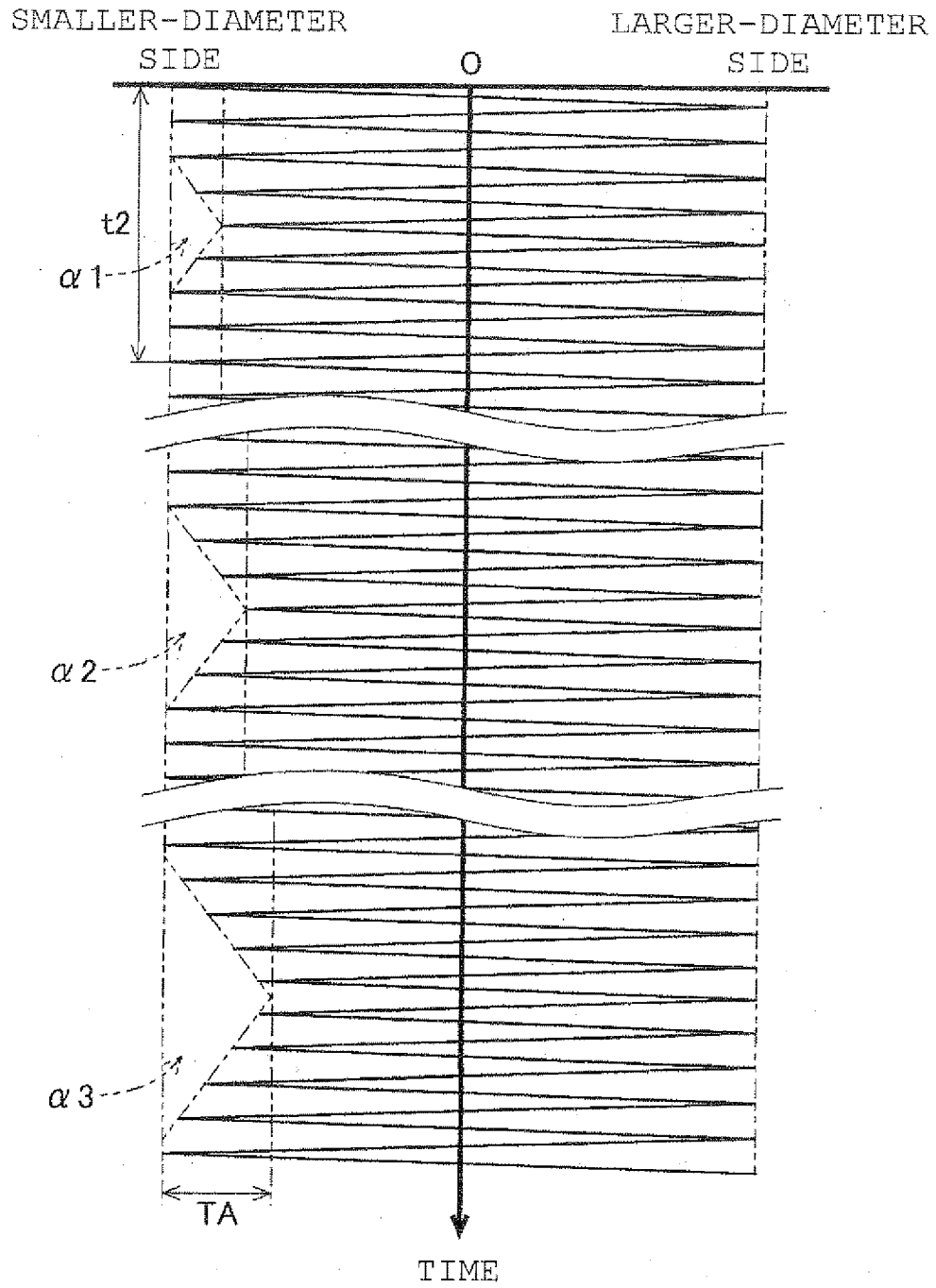


FIG. 5

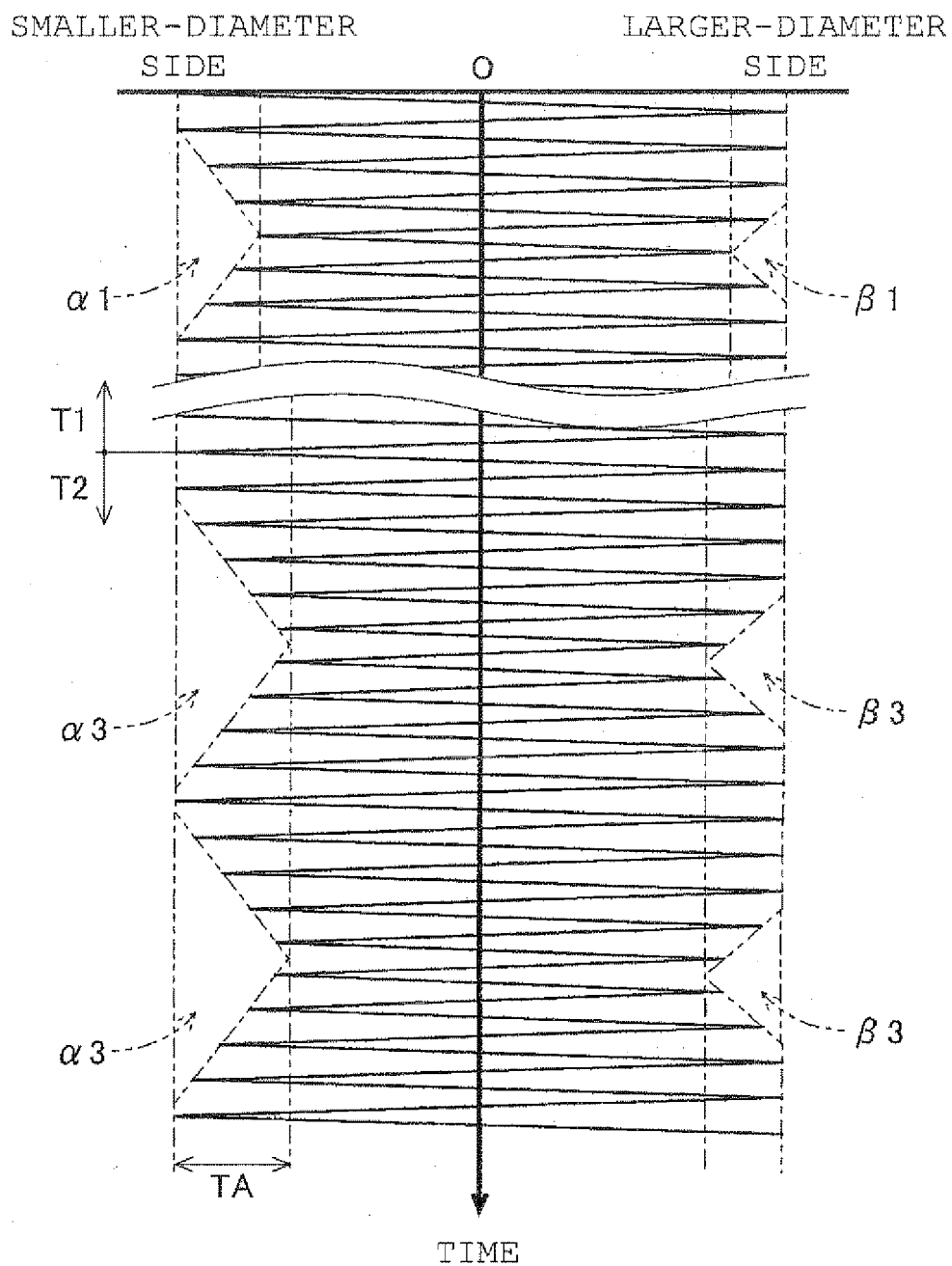


FIG. 6A

FIG. 6B

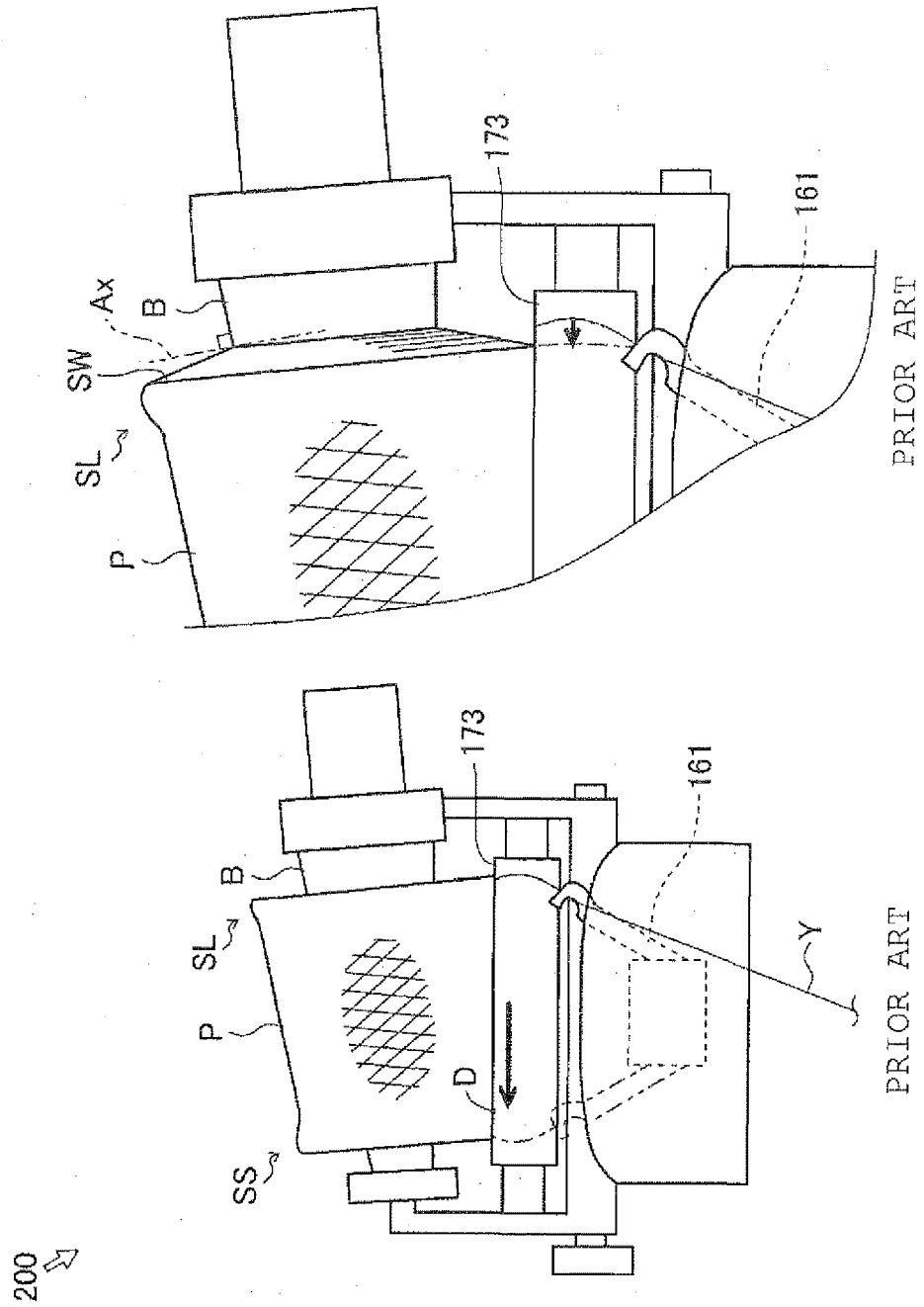
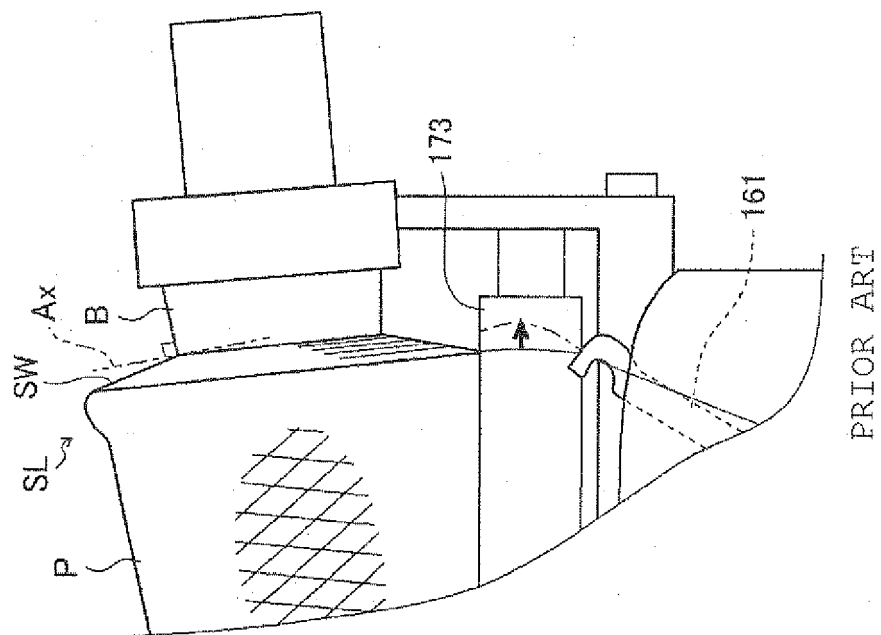
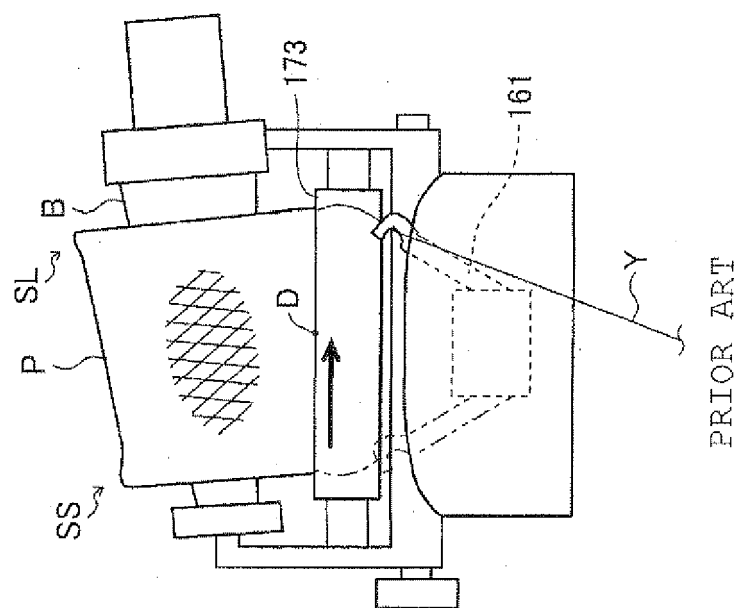


FIG. 7A

FIG. 7B

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**REFERENCES CITED IN THE DESCRIPTION**

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