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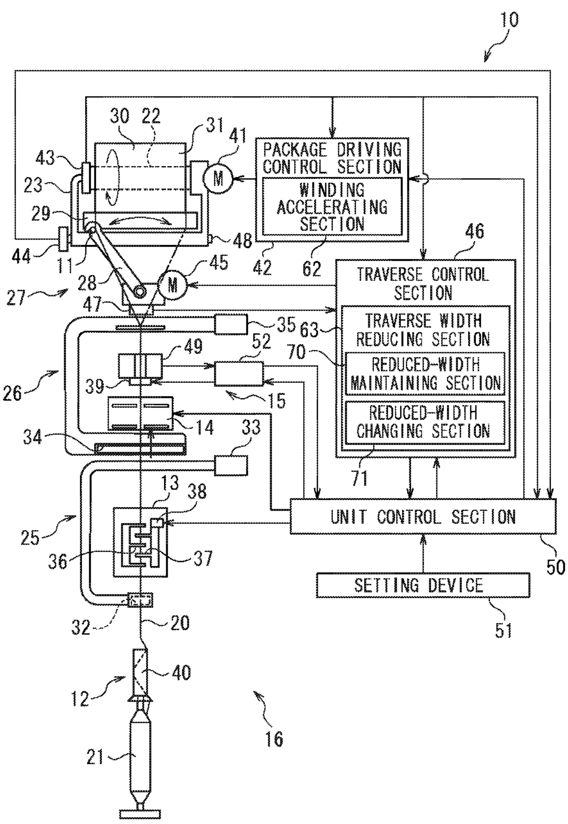
(54) **Yarn Winding Device and Yarn Winding Method**

(57) An automatic winder includes a package driving motor (41) a traverse driving motor (45), and a traverse width reducing section (63). The traverse driving motor reciprocates a traverse guide (11) traversing a yarn (20) being wound around a winding bobbin (22) rotated by the package driving motor. The traverse width reducing section has a reduced-width constant mode and a reduced-width changing mode. In the reduced-width constant mode, the traverse width reducing section controls the traverse driving motor so that during the accelerating winding period, traversing is performed with a constant reduced traverse width that is smaller than a target traverse width based on an initial traverse width set via a setting device. In the reduced-width changing mode, the traverse width reducing section controls the traverse driving motor so that during the accelerating winding period, traversing is performed with a traverse width that increases continuously from the reduced traverse width as a winding speed increases. (Fig. 1)

FIGURE 1



EP 2 105 399 A2

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Description

Field of the Invention

[0001] The present invention relates to a yarn winding device, and specifically, to control of a traverse width during an accelerating winding period.

Background of the Invention

[0002] With a yarn winding device that winds a yarn around a winding bobbin while traversing the yarn to generate a package of a predetermined length, when winding of the winding bobbin is started, rotation of the winding bobbin often does not start smoothly but irregularly and abruptly. Furthermore, the winding speed varies until reaching a predetermined speed. Thus, tension generated in a traveling yarn varies depending on the winding speed. Consequently, during an accelerating winding period lasting from winding start until the winding speed reaches the predetermined speed, the tension of the yarn is likely to vary and is unstable.

[0003] If the tension of the yarn is unstable, the yarn wound into a package is prevented from behaving stably. As a result, yarn stitching is likely to occur.

[0004] To avoid this, the Unexamined Japanese Patent Application Publication (Tokkai) No. 2007-210776 discloses a yarn winding device (yarn winder) configured to perform control such that a traverse width is reduced until the winding speed of the winding bobbin reaches the predetermined speed.

[0005] The yarn winding device described in the Unexamined Japanese Patent Application Publication (Tokkai) No. 2007-210776 includes a rotational driving motor and a traverse device. The rotational driving motor rotationally drives a winding bobbin around which a yarn is wound. When the yarn is wound around the winding bobbin, the traverse device traverses the yarn. The traverse device has a traverse guide that engages with and traverses the yarn, and a traverse guide driving motor. The traverse guide driving motor is driven independently from the winding bobbin rotational driving motor and moves the traverse guide. Moreover, the yarn winding device includes a control device that controls the winding bobbin rotational driving motor and the traverse guide driving motor. The control device includes a winding accelerating means and a traverse stroke reducing means. The winding accelerating means accelerates the winding bobbin rotational driving motor from a speed zero up to a predetermined speed. At least immediately after rotation of the winding bobbin rotational driving motor is started by the winding accelerating means, the traverse stroke reducing means controls the traverse guide driving motor so as to reduce a traverse stroke of the traverse guide. According to the Unexamined Japanese Patent Application Publication (Tokkai) No. 2007-210776, the above-described configuration reduces the traverse width during the accelerating winding period to prevent the yarn stitching even during the accelerating winding period in which the tension of the yarn is unstable.

[0006] However, in the winding of the yarn using the yarn winder, the winding accelerating means may fail to increase the winding speed from zero up to a predetermined speed with a short period of time. For example, to wind a high-quality yarn or a yarn with a fine count, the winding speed needs to be increased more slowly than usual in order to reduce a variation in winding tension. In this case, the accelerating winding period needs to be longer than usual.

[0007] In this regard, with the configuration in the Unexamined Japanese Patent Application Publication (Tokkai) No. 2007-210776, the thickness of a yarn layer formed in an area with a reduced traverse width increases consistently with the length of the accelerating winding period. When the accelerating winding period is over, a yarn layer of a normal traverse width is formed on the already formed yarn layer. Consequently, a step is formed on a surface of the package due to the difference in traverse widths. Furthermore, in a general yarn winder, every time yarn breakage, yarn cutting, or the like occurs during a winding operation, rotation of the winding bobbin is stopped. Then, after a yarn splicing operation, the winding speed is increased again. Thus, every time the winding operation is stopped, the step is formed and stacked on the surface of the package. This causes formation of a pattern winding, which is a defect in the package.

[0008] Furthermore, in a yarn winder that contacts a contact roller with a peripheral surface of the package so as to nip the yarn between the contact roller and the package during winding, the step formed on the package surface as described above may weaken the nipping of the yarn at an axial end side of the package. The thus reduced nipping force may make a winding position at the package end unstable, resulting in the yarn stitching.

[0009] Moreover, in the yarn winding using the yarn winder, a phenomenon may occur in which the surface of the yarn layer near the axially opposite ends of the package rises, in a direction in which the diameter of the package increases (this phenomenon is known as a saddle bag). In this regard, with the configuration in the Unexamined Japanese Patent Application Publication (Tokkai) No. 2007-210776, even when the package is rotating at a relatively high speed immediately before the end of the accelerating winding period, the yarn fails to be traversed to the ends of the package. Thus, as the package rotates, the surface of the yarn layer in the saddle bag portion of the package makes contact with the contact roller repeatedly many times without being covered with a new yarn. Thus, the yarn layer in the saddle bag portion is likely to be damaged by friction against the contact roller, resulting in yarn breakage.

Summary of the Invention

[0010] An object of the present invention is to provide a yarn winder capable of controlling a traverse width during an accelerating winding period to be flexibly changed according to a yarn winding method, thus preventing a formation of a pattern winding or a yarn stitching.

[0011] According to a first aspect of the present invention, a yarn winding device, which winds a yarn around a winding bobbin to form a package, includes a winding section, a winding driving control section, a traverse guide, a traverse guide driving section, a traverse width control section, and a setting section. The winding driving section rotationally drives the winding bobbin. The winding driving control section controls rotation speed of the winding driving section to control a yarn winding speed. The traverse guide traverses the yarn being wound around the winding bobbin. The traverse guide driving section reciprocates the traverse guide. The traverse width control section controls a traverse width of the traverse guide. The setting section sets a traverse width of the traverse guide. The traverse width control section has a first control mode and a second control mode as control modes for controlling the traverse width until a winding speed of the winding bobbin reaches a predetermined speed. In the first control mode, the traverse width control section controls the traverse guide driving section so that traversing is performed with a constant reduced traverse width smaller than a target traverse width according to the set traverse width set via the setting section. In the second control mode, the traverse width control section controls the traverse guide driving section so that traversing is performed with a traverse width increasing continuously as the winding speed increases, starting from a reduced traverse width smaller than the target traverse width according to the set traverse width set via the setting section.

[0012] Thus, until the winding speed of the winding bobbin reaches the predetermined speed, the yarn is traversed with a traverse width smaller than the traverse width used after the predetermined winding speed has been reached. This prevents a yarn stitching caused by a variation in yarn tension. Furthermore, one of the two control modes can be selected for controlling the traverse width until the winding speed of the winding bobbin reaches the predetermined speed. This allows the traversing to be flexibly dealt with depending on a package winding method or the like. Moreover, when the second control mode is selected, the traverse width increases continuously from the reduced width accompanying an increase in the winding speed. Accordingly, a step can be prevented forming formed on a surface of the package between a central portion and an end portion thereof. This in turn prevents a pattern winding from being formed, and a yarn stitching from generating as a result of an unstable winding position caused by the step formed on the package. In the second control mode, even if a saddle bag is formed at an axial end portion of the package during winding, the traverse width is increased gradually during accelerating winding period. The yarn is eventually traversed so as to cover the saddle bag portion. This enables avoidance of excessive rubbing of the same portion of a yarn layer surface in the saddle bag portion. As a result, possible yarn breakage caused by damage can be prevented.

[0013] A second aspect of the present invention provides a yarn winding method for winding a yarn around a winding bobbin to form a package. The yarn winding method includes following steps. That is, in a first step, one of a first control mode and a second control mode is selected as a control mode for reducing a traverse width than a traverse width during a steady-state winding period until a winding speed of the winding bobbin reaches a predetermined speed. In a second step, when the first control mode is selected in the first step, the yarn is wound while being traversed with a constant reduced traverse width smaller than the traverse width during the steady-state traverse width (steady-state traverse width). When the second control mode is selected in the first step, the yarn is wound while being traversed with a traverse width increasing continuously as the winding speed increases, starting from the reduced traverse width smaller than the steady-state traverse width.

[0014] Thus, until the winding speed of the winding bobbin reaches the predetermined speed, the yarn is traversed with a traverse width smaller than the traverse width used after the predetermined winding speed has been reached. This prevents the yarn stitching caused by a variation in yarn tension. Furthermore, one of the two control modes can be selected in the first step for controlling the traverse width until the winding speed of the winding bobbin reaches the predetermined speed. This allows the traversing to be flexibly dealt with depending on the package winding method or the like. Moreover, when the second control mode is selected, the traverse width increases continuously from the reduced width accompanying an increase in the winding speed. Accordingly, a step can be prevented from being formed between a central portion and end portions of the package. This in turn prevents a pattern winding from being formed, and a yarn stitching from generating as a result of the unstable winding position caused by the step formed on the package. In the second control mode, even if a saddle bag is formed at an axial end portion of the package during winding, the traverse width is increased gradually during accelerating winding period. The yarn is eventually traversed so as to cover the saddle bag shape portion. This enables avoidance of excessive rubbing of the same portion of the yarn layer in the saddle bag portion. As a result, possible yarn breakage caused by damage can be prevented.

[0015] A third aspect of the present invention provides a package formed by the above-described yarn winding method.

[0016] Thus, a yarn stitching or a formation of a pattern winding is prevented. Furthermore, even if a saddle bag is formed during winding, accumulation of damage to the yarn is small. Consequently, a high-quality package can be provided.

[0017] According to a fourth aspect of the present invention, a yarn winding device, which winds a yarn around a winding bobbin to form a package, includes a winding driving section, a winding driving control section, a traverse guide, a traverse guide driving section, a traverse width control section, and a setting section. The winding driving section rotationally drives the winding bobbin. The winding driving control section controls rotation speed of the winding driving section to control a yarn winding speed. The traverse guide traverses the yarn being wound around the winding bobbin. The traverse guide driving section reciprocates the traverse guide. The traverse width control section controls a traverse width of the traverse guide. The setting section sets a traverse width of the traverse guide. The traverse width control section includes a traverse width changing section. The traverse width changing section controls the traverse guide driving section so that until the winding speed of the winding bobbin reaches a predetermined speed, traversing is performed with a traverse width increasing continuously as the winding speed increases, starting from a reduced traverse width smaller than a target traverse width based on a set traverse width set via the setting section.

[0018] This enables prevention of a yarn stitching at winding start when the tension is unstable. Furthermore, the traverse width increases continuously from the reduced width accompanying an increase in the winding speed. Accordingly, a step is prevented from being formed between the central portion and end portion of the package. This in turn prevents a pattern winding from being formed and a yarn stitching from generating as a result of the unstable winding position caused by the step formed on the package. Even if a saddle bag is formed on the package during winding, at the end of the accelerating winding period, the yarn layer is formed so as to cover the saddle bag portion. This prevents excessive rubbing of the saddle bag portion that may cause a yarn breakage.

[0019] Other features, elements, processes, steps, characteristics and advantages of the present invention will become more apparent from the following detailed description of preferred embodiments of the present invention with reference to the attached drawings.

Brief Description of the Drawings

[0020]

Figure 1 is a schematic front view and a block diagram of an automatic winder according to an embodiment of the present invention.

Figures 2A to 2C are graphs illustrating control of a traverse width in two control modes in association with the winding speed of a winding bobbin.

Figure 3 is a flowchart illustrating traverse control in the automatic winder.

Figure 4 is a schematic front view and a block diagram of an automatic winder according to another embodiment of the present invention.

Detailed Description of the Preferred Embodiments

[0021] Preferred embodiments of the present invention will be described below with reference to the drawings.

[0022] A winder unit 10 shown in Figure 1 winds a yarn 20 unwound from a supplying bobbin 21, around a winding bobbin 22 while traversing the yarn 20. The winder unit 10 thus forms a package 30 of a predetermined length and a predetermined shape. An automatic winder (yarn winding device) according to the present embodiment includes a plurality of winder units 10 arranged in a line and a frame control device (not shown in the drawings) located at one end of the arrangement of the winder units 10 in the direction of the arrangement.

[0023] Each of the winder units 10 includes a winding unit main body 16 and a unit control section 50.

[0024] The winding unit main body 16 includes a balloon controller 12, a tension applying device 13, a splicer device 14, and a clearer (yarn quality measurement instrument) 15 arranged in this order in a yarn traveling path between the supplying bobbin 21 and the winding bobbin 22; the balloon controller 12 is located closest to the supplying bobbin 21.

[0025] The balloon controller 12 lowers a regulation member 40 covering a core tube, in conjunction with unwinding of the yarn 20 from the supplying bobbin 21. The balloon controller 12 thus assists in unwinding the yarn 20 from the supplying bobbin 21. The regulation member 40 makes contact with a balloon formed above the supplying bobbin 21 by the rotation and centrifugal force of the yarn 20 unwound from the supplying bobbin 21. The regulation member 40 thus applies an appropriate tension to the balloon to assist in unwinding the yarn 20. A sensor (not shown in the drawings) is provided in the vicinity of the regulation member 40 to detect a chase portion of the supplying bobbin 21. When the sensor detects that the chase portion is lowering, the regulation member 40 can be lowered in conjunction with the lowering of the chase portion by an air cylinder (not shown in the drawings).

[0026] The tension applying device 13 applies a predetermined tension to the traveling yarn 20. The tension applying device 13 may be of, for example, a gate type in which movable comb teeth 37 are arranged with respect to fixed comb teeth 36. The movable comb teeth 37 may be moved by, for example, a rotary solenoid 38 so as to be engaged or released with respect to the fixed comb teeth 36. The tension applying device 13 applies a given tension to the yarn 20 being wound, to improve the quality of a package 30. Instead of the gate type, the tension applying device 13 may be of, for example, a disc type.

[0027] When the yarn 20 is cut as a result of a detection of a yarn defect by the clearer 15 or the yarn 20 is broken during unwinding of the yarn 20 from the supplying bobbin

21, the splicer device 14 splices a lower yarn on the supplying bobbin 21 side and an upper yarn on the package 30 side. The splicing device that splices the upper yarn and the lower yarn may be of a mechanical type or may use a fluid such as compressed air.

[0028] The clearer 15 includes a clearer head 49 and an analyzer 52. A sensor (not shown in the drawings) is provided in the clearer head 49 of the clearer 15 to detect the thickness of the yarn 20. The analyzer 52 processes a yarn thickness signal from the sensor. The clearer 15 monitors the yarn thickness signal from the sensor to detect a yarn defect such as slub. The clearer 15 can also function as a sensor that detects a traveling speed of the yarn 20 and a sensor that detects a presence or an absence of the yarn 20. A cutter 39 is provided in the vicinity of the clearer head 49 to cut the yarn 20 immediately after the clearer 15 detects the yarn defect.

[0029] A lower-yarn guide pipe 25 is provided below the splicer device 14 to catch a lower yarn on the supplying bobbin 21 side to guide the lower yarn to the splicer device 14. An upper-yarn guide pipe 26 is provided above the splicer device 14 to catch an upper yarn on the package 30 side to guide the upper yarn to the splicer device 14. The lower-yarn guide pipe 25 is pivotally movable around a shaft 33. The upper-yarn guide pipe 26 is pivotally movable around a shaft 35. A suction port 32 is formed at a tip of the lower-yarn guide pipe 25. A suction mouth 34 is formed at a tip of the upper-yarn guide pipe 26. Appropriate negative pressure sources are connected to the lower-yarn guide pipe 25 and the upper-yarn guide pipe 26, respectively. This allows the suction port 32 and the suction mouth 34 to generate suction flows to suck and catch yarn ends of the upper yarn and the lower yarn.

[0030] The winding unit main body 16 includes a cradle 23 and a contact roller 29. The cradle 23 removably supports the winding bobbin (paper tube, core tube, or the like) 22. The contact roller 29 makes contact with a peripheral surface of the package 30 and is rotated by the rotating package 30. The cradle 23 holds opposite ends of the winding bobbin 22 in a manner that the winding bobbin 22 is rotatable. The cradle 23 is pivotally movable around a pivotal shaft 48. An increase in the winding diameter of the package 30 accompanying the winding of the yarn 20 around the winding bobbin 22 can be absorbed by pivotal movement of the cradle 23.

[0031] A package driving motor (winding driving section) 41 is attached to a portion of the cradle 23 that holds the winding bobbin 22. The package driving motor 41 rotationally drives the winding bobbin 22 to wind the yarn 20 into the package 30. When the winding bobbin 22 is supported by the cradle 23, a motor shaft of the package driving motor 41 is coupled to the winding bobbin 22 so as not to be rotatable relative to the winding bobbin 22 (what is called a direct drive scheme).

[0032] Operation of the package driving motor 41 is controlled by a package driving control section (winding driving control section) 42. Upon receiving an operation signal from the unit control section 50, the package driving control section 42 controls operation and stoppage of the package driving motor 41. The package driving control section 42 is configured as a microcomputer and includes a central processing unit (CPU), a read only memory (ROM), and a random access memory (RAM). The package driving control section 42 includes a winding accelerating section 62 that controls the package driving motor 41 to accelerate the rotation of the winding bobbin 22.

[0033] A package rotation sensor 43 is attached to the cradle 23. The package rotation sensor 43 detects rotation of the winding bobbin 22 held by the cradle 23 (rotation of a yarn layer 31 formed on the winding bobbin 22). A rotation detection signal of the winding bobbin 22 is transmitted from the package rotation sensor 43 to the package driving control section 42 or the unit control section 50. Moreover, the rotation detection signal is input to a traverse control section 46 described below.

[0034] A package diameter sensor (diameter sensor) 44 composed of a rotary encoder or the like is attached to the cradle 23. The package diameter sensor 44 transmits a detection signal of the detected pivotal angle of the cradle 23 to the unit control section 50. Based on the received detection signal, the unit control section 50 calculates a package diameter. The unit control section 50 transmits the calculated package diameter to the package driving control section 42 and the traverse control section 46.

[0035] The traverse device 27 is provided in the vicinity of the contact roller 29. The yarn 20 is wound into the package 30 while being traversed by the traverse device 27. The traverse device 27 includes a traverse guide 11 and a traverse driving motor (traverse guide driving section) 45. The traverse guide 11 can be reciprocated in a traverse direction. The traverse driving motor 45 reciprocates the traverse guide 11.

[0036] In the traverse device 27, the hook-shaped traverse guide 11 is provided at a tip of an elongate arm member 28. In the traverse device 27, the traverse driving motor 45 reciprocates the arm member 28 as shown by an arrow in Figure 1. In the present embodiment, the traverse driving motor 45 is a servo motor.

[0037] Operation of the traverse driving motor 45 is controlled by the traverse control section 46. Upon receiving signals from the unit control section 50, the traverse control section 46 controls operation and stoppage of the traverse driving motor 45. The traverse device 27 includes a traverse sensor 47 such as a rotary encoder. The traverse sensor 47 detects a position of the arm member 28 (or the position of the traverse guide 11) and transmits a position signal to the traverse control section 46.

[0038] The traverse control section 46 is configured as a microcomputer and includes a CPU, a ROM, and a RAM. The traverse control section 46 includes a traverse width reducing section (traverse width control section) 63 that controls the traverse driving motor 45 so that the traverse width (traverse stroke) of the traverse guide 11 is reduced under predetermined conditions.

[0039] In the present embodiment, as shown in Figure 1, the package driving motor 41 and the traverse driving motor 45 are separately provided. Therefore, the winding bobbin 22 and the traverse guide 11 are separately and independently driven (controlled). Thus, the yarn 20 can be wound around the winding bobbin 22 in various manners such as precision winding and step precision winding.

[0040] Next, an electric configuration of the winding unit main body 16 will be described. As shown in Figure 1, the unit control section 50 as a control section controls the package driving control section 42 that controls the package driving motor 41, the traverse control section 46 that controls the traverse driving motor 45, the analyzer 52 that drives the cutter 39, the solenoid 38 of the tension applying device 13, the splicer device 14, and the like.

[0041] The unit control section 50 is configured as a microcomputer, and includes a CPU, a ROM, and a RAM (not shown in the drawings). Furthermore, the unit control section 50 includes various control means. The unit control section 50 transmits predetermined signals to control targets, that is, the devices and sections described above, so that the devices and sections control, for example, the operation of winding the yarn 20 and a yarn splicing operation performed when yarn breakage or cutting occurs. Specifically, the unit control section 50 transmits various control parameters to the package driving control section 42 to allow the package driving control section 42 to control the package driving motor 41. Furthermore, the unit control section 50 transmits various control parameters to the traverse control section 46 to allow the traverse control section 46 to control the traverse driving motor 45.

[0042] A setting device (setting section) 51 is electrically connected to the unit control section 50. The setting device 51 includes a display screen and an operation section (not illustrated in the drawings) so that an operator can perform various operations on the winder unit 10. Specifically, the operator can operate the setting device 51 to set, for example, the winding speed during the winding operation (set winding speed), an initial traverse width (set traverse width), and a method of controlling the traverse width during an accelerating winding period described below (control mode).

[0043] The initial traverse width, set by the setting device 51, means the traverse width obtained when the winding speed reaches the set winding speed (a steady-state winding period described below) during an initial period when the yarn 20 is being wound around the empty winding bobbin 22. The traverse control section 46 determines the traverse width for the winding of the yarn at the set winding speed (target traverse width) as follows based on the initial traverse width.

[0044] That is, by operating the setting device 51, the automatic winder according to the present embodiment can also form a taper winding package in addition to the package 30 with a constant winding width as shown in Figure 1. To form the package 30 with the constant winding width, the traverse control section 46 determines the target traverse width to be always equal to the initial traverse width regardless of the package diameter. On the other hand, to form the taper winding package 30, the traverse control section 46 determines the target traverse width according to parameters such as a taper angle set by the setteing device 51 so that the target traverse width decreases gradually from the initial traverse width as the winding diameter of the package 30 increases.

[0045] The setting device 51 can be used for making a setting for each winder unit 10 or for making a collective setting for a plurality of the winder units 10.

[0046] The unit control section 50 is connected to the tension applying device 13. The tension applied to the yarn 20 is appropriately controlled to inhibit a possible variation in the winding tension of the yarn described below.

[0047] Next, control by the winding accelerating section 62 and the traverse width reducing section 63 during the accelerating winding period will be described with reference to Figures 2A to 2C.

[0048] First, the control by the winding accelerating section 62 will be described. In the winder unit 10, when the empty winding bobbin 22 is appropriately set to the cradle 23, the yarn winding operation is started. The yarn winding operation is also started (resumed) at the time of completion of yarn splicing performed by the splicer device 14.

[0049] At this time, the unit control section 50 transmits a signal to the package driving control section 42. Upon receiving the signal, the package driving control section 42 controls to gradually accelerate the package driving motor 41.

[0050] The accelerating control is performed until the winding speed reaches the set winding speed. Figure 2A is a graph illustrating a variation in winding speed with respect to time elapsed since winding start. As shown in Figure 2A, when the winding speed reaches the set winding speed, the unit control section 50 transmits a signal to the package driving control section 42. Upon receiving the signal, the package driving control section 42 controls the package driving motor 41 to terminate in the increase of the winding speed and to maintain the winding speed to be constant at the set winding speed.

[0051] In the description below, a period of time from the beginning of rotation until the set winding speed is reached is referred to as the accelerating winding period. A period of time after the set winding speed is reached is referred to as a steady-state winding period.

[0052] Next, the control by the traverse width reducing section 63 will be described. That is, during the accelerating winding period, the winding speed varies from zero to the set winding speed. Thus, a variation occurs in yarn traveling tension and the like. Furthermore, even if the yarn 20 is wound with the normal traverse width (that is, the above-described target traverse width), the traverse device 27 may traverse the yarn beyond the normal traverse width due to a delay in control response of the traverse device 27. This may result in the yarn stitching.

[0053] In the present embodiment, to avoid this, the traverse control section 46 includes the traverse width reducing section 63. The traverse width reducing section 63 controls the traverse driving motor 45 such that during the accelerating winding period, the traverse width is reduced so that the yarn 20 is traversed within the reduced traverse width smaller than the traverse width set for the steady-state winding period (target traverse width).

[0054] The traverse width reducing section 63 according to the present embodiment can switch two different control modes to control the traverse width during the accelerating winding period. Thus, the traverse width reducing section 63 includes a reduced-width maintaining section 70 and a reduced-width changing section (traverse width changing section) 71.

[0055] Among the two control modes, in a reduced-width constant mode as a first control mode, the reduced-width maintaining section 70 controls the traverse width to be constant at a traverse width smaller than the target traverse width based on the initial traverse width set via the setting device 51 (reduced traverse width).

[0056] In a reduced-width changing mode as a second control mode, the reduced-width changing section 71 sets, at winding start, the traverse width to be smaller than the target traverse width (reduced traverse width) and then controls the traverse width to gradually approach the target traverse width as the winding speed increases.

[0057] The operator operates the setting device 51 as a control mode switching section to select which of the above-described control modes is used to control the traverse width.

[0058] With reference to Figure 2B, control in the reduced-width constant mode (control by the reduced-width maintaining section 70) will be described. In the reduced-width constant mode, yarn traversing is performed while maintaining the constant reduced traverse width smaller than the traverse width during the steady-state winding period.

[0059] Figure 2B is a graph illustrating a variation in traverse width in the reduced-width constant mode. An axis of abscissa in Figure 2B indicates the time elapsed since winding start. An axis of ordinate indicates the traverse width. The traverse width in the graph is expressed as the ratio thereof to the traverse width during the steady-state winding period (target traverse width) (this ratio is hereinafter referred to as a traverse rate). As shown in Figure 2B, in the reduced-width constant mode, the traverse rate exhibits a predetermined speed smaller than 100% when rotation of the package driving motor 41 is started. The traverse rate is then maintained constant until the accelerating winding period is over. The traverse rate changes to 100% at a moment when the accelerating winding period shifts to the steady-state winding period.

[0060] Next, with reference to Figure 2C, the control in the reduced-width changing mode (control by the reduced-width changing section 71) will be described. In the reduced-width changing mode, yarn traversing is performed while gradually increasing the traverse width from the beginning till the end of the accelerating winding period.

[0061] Figure 2C is also a graph illustrating a variation in traverse width in the reduced-width changing mode. As shown in Figure 2C, in the reduced-width changing mode, the traverse rate exhibits a predetermined speed smaller than 100% when rotation of the package driving motor 41 is started. Accompanying an increase in the winding speed, the traverse rate increases linearly so as to approach 100%. The traverse rate is controlled to reach to 100% when the winding speed reaches the winding speed (when the accelerating winding period is over).

[0062] With the automatic winder according to the present embodiment, the setting device 51 can be used to set the traverse width for the beginning of the accelerating winding period for each of the reduced- width constant mode and the reduced-width changing mode. Various methods are possible for setting the traverse width. In the present embodiment, the traverse rate for the winding start (starting traverse rate) can be set in percents.

[0063] As described above, in the reduced-width changing mode, the traverse width increases linearly with the winding speed. To achieve this, the reduced-width changing section 71 creates a predetermined conversion equation based on the set winding speed and the starting traverse rate set via the setting device 51. The current winding speed is then substituted into the conversion equation to determine the current traverse rate. The traverse control section 46 controls the traverse driving motor 45 so that the yarn 20 is traversed according to the traverse width obtained by multiplying the traverse width for the steady-state winding period (target traverse width) by the above-described traverse rate.

[0064] With this configuration, the operator operates the setting device 51 to set the set winding speed, the initial traverse width, and the like depending on the type of the yarn. At this time, the operator also determines which of the two control modes is to be used for controlling the traversing and also sets the starting traverse rate.

[0065] The starting traverse rate is preferably set to about 80% to 90%. An excessively low traverse rate may cause an end surface of the package 30 to be deformed. In contrast, an excessively high traverse rate hinders the yarn stitching from being prevented.

[0066] Next, with reference to Figure 3, the control of the traverse width in the winder unit 10 will be described. Figure 3 is a flowchart illustrating the control of the traverse width.

[0067] Before starting the operation of the automatic winder, the operator operates the setting device 51 to set various operation conditions (including the set winding speed and the traverse width) depending on the yarn type and the like. At this time, the operator also determines which of the two control modes is to be used to control the traverse width and also sets the starting traverse rate.

[0068] Thereafter, the operator performs an appropriate operation start operation to start the flow in Figure 3. Then, the traverse control section 46 checks which of the reduced-width constant mode and the reduced-width changing mode has been selected (step S101).

[0069] Upon determining in step S101 that the reduced-width constant mode has been selected, the traverse control section 46 traverses the yarn 20 with a constant traverse width. In addition, the winding accelerating section 62 increases the winding speed up to the set winding speed (step S102). The current traverse width (reduced traverse width) is obtained by multiplying the traverse width for the steady-state winding period (target traverse width) by the starting traverse rate set via the setting device 51.

[0070] On the other hand, upon determining in step S101 that the reduced-width changing mode has been selected, the traverse control section 46 performs reduced traverse width changing control. Concurrently, the package driving control section 42 performs winding accelerating control (step S103). Specifically, the reduced-width changing section 71 of the traverse control section 46 controls to carry out traversing with the predetermined traverse width at the beginning of winding, and then to gradually increase the traverse width consistently accompanying an increase in the winding speed. Furthermore, the winding accelerating section 62 of the package driving control section 42 increases the winding speed up to the set winding speed. The traverse width for the beginning of winding (reduced traverse width) is calculated similarly to the reduced traverse width in step S102.

[0071] Then, a determination is made as to whether or not the acceleration of the winding bobbin 22 has been completed (that is, whether or not the winding speed has reached the set winding speed) (step S104). If the acceleration has not been completed, the process returns to step S101 to continue acceleration of the winding speed. A loop from step S101 to step S104 allows the above-described control during the accelerating winding period to be achieved.

[0072] When a determination is made in step S104 that the increase of the winding speed have been completed, the unit control section 50 cancels the reduction of the traverse width (step S105). The unit control section 50 then winds the yarn 20 at the set winding speed while traversing the yarn 20 with the target traverse width (traverse rate: 100%) (step S106).

[0073] Then, the unit control section 50 checks whether or not a yarn breakage or cutting has occurred according to a signal from the clearer 15 (step S107). Upon receiving a signal from the clearer 15 indicating the occurrence of a yarn breakage or cutting, the unit control section 50 immediately stops the winding of the package 30 (step S108). The unit control section 50 further guides the yarn at the package 30 side and the yarn at the supplying bobbin 21 side yarn to the splicer device 14, which then performs the yarn splicing operation (step S109). Once the yarn splicing operation is completed, the process returns to step S101 to traverse the yarn 20 with the traverse width reduced according to the specified control mode. The winding speed is increased to the set winding speed again.

[0074] Upon determining in step S107 that neither a yarn breakage nor yarn cutting has occurred, the unit control section 50 determines whether or not the operation of stopping the operation of the winder unit 10 has been performed (step S110). If the operation of stopping the operation of the winder unit 10 has been detected, the unit control section 50 stops the operation of the winder unit 10 (step S111) to terminate the flow. If the operation stop operation has not been detected, the process returns to step S106 to continue the winding operation at the steady-state speed. A loop of processes of step S106, step S107 and step S110 allows the above-described control during the steady-state winding period to be achieved.

[0075] As described above, the automatic winder according to the present embodiment winds the yarn 20 around the winding bobbin 22 to form the package 30. The winder unit 10 provided in the automatic winder includes the package driving motor 41, the package driving control section 42, the traverse guide 11, the traverse driving motor 45, and the traverse width reducing section 63 provided in the traverse control section 46, and the setting device 51. The package driving motor 41 rotationally drives the winding bobbin 22. The package driving control section 42 controls the rotation speed of the package driving motor 41 to control the yarn winding speed. The traverse guide 11 traverses the yarn 20 being wound around the winding bobbin 22. The traverse driving motor 45 reciprocates the traverse guide 11. The traverse control section 46 controls the traverse width of the traverse guide 11. The setting device 51 can set the setting of the traverse width (the above-described initial traverse width) of the traverse guide 11.

[0076] The traverse width reducing section 63 has the reduced-width constant mode and the reduced-width changing mode as control modes for controlling the traverse width until the winding speed of the winding bobbin 22 reaches the set winding speed (the accelerating winding period). In the reduced-width constant mode, the traverse width reducing section 63 controls the traverse driving motor 45 so that traversing is performed with the constant reduced traverse width that is smaller than the target traverse width based on the set traverse width set via the setting device 51. In the reduced-width changing mode, the traverse width reducing section 63 controls the traverse driving motor 45 so that traversing is performed with a traverse width increasing continuously as the winding speed increases, starting from the reduced traverse width that is smaller than the target traverse width based on the initial traverse width set via the setting device 51.

[0077] With this configuration, during the accelerating winding period, traversing is performed with the traverse width smaller than the traverse width used during the steady-state winding period. Thus, the yarn stitching resulting from a variation in yarn tension or the like can be prevented. Furthermore, the traverse width control mode for the accelerating winding period can be selected from two control modes. This allows the traversing to be flexibly dealt with depending on the method of winding the yarn 20 into the package 30. For example, to generate a package by aligned winding such as precision winding, the reduced-width constant mode is selected to allow the aligned winding to be properly performed.

[0078] Meanwhile, in case of a step precision winding in which the yarn is jumped at a critical winding ratio during winding, the reduced-width changing mode is selected to effectively prevent defects in package such as formation of a pattern winding and yarn stitching. Furthermore, when the reduced-width changing mode is selected, the traverse width increases continuously from the reduced width accompanying an increase in the winding speed. Accordingly, a step can be prevented from being formed on the surface of the package 30 between the central portion and end portions thereof. This in turn prevents a pattern winding from being formed, and a yarn stitching from generating as a result of an unstable winding position caused by the step formed on the package 30. Furthermore, even if a saddle bag is formed at the axial end portion of the package during winding, the traverse width is increased gradually during the accelerating winding period. The yarn 20 is eventually traversed so as to cover the saddle bag portion. This makes it possible to avoid the same portion of the yarn layer surface in the saddle bag portion from making contact with the contact roller 29 repeatedly many times. As a result, possible yarn breakage caused by damage to the yarn layer surface can be prevented.

[0079] Furthermore, the automatic winder according to the present embodiment winds the yarn 20 around the winding bobbin 22 by the following method. A first step selects one of the reduced-width constant mode and the reduced-width changing mode as a control mode in which the traverse width is reduced than the steady-state traverse width (target traverse width) until the winding speed of the winding bobbin 22 reaches the predetermined winding speed. In the second step, when the reduced-width constant mode is selected in the first step, the yarn is wound while being traversed with the constant reduced traverse width smaller than the steady-state traverse width. When the reduced-width changing mode is selected in the first step, the yarn 20 is wound while being traversed with the traverse width that increases continuously as the winding speed increases, starting from the reduced traverse width smaller than the steady-state traverse width.

[0080] This method performs traversing with the reduced traverse width. Thus, the yarn stitching can be prevented even at the beginning of driving of the winding bobbin 22 when the tension is unstable. Furthermore, by selecting an appropriate mode according to the method of forming the package 30 in the first step, the yarn can be wound with the effects of each control mode exerted in the second step. As described above, a high-quality package 30 can be provided in which a yarn stitching or a pattern winding is prevented from occurring and in which accumulated damage to the yarn is reduced even if the saddle bag is formed during winding.

[0081] Furthermore, in the automatic winder according to the present embodiment, the traverse width reducing section 63 includes the reduced-width changing section 71. The reduced-width changing section 71 controls the traverse driving motor 45 so that until the winding speed of the winding bobbin 22 reaches the predetermined winding speed, traversing is performed with the traverse width increasing continuously as the winding speed increases, starting from the reduced traverse width smaller than the target traverse width based on the set traverse width set via the setting device 51.

[0082] Thus, during the accelerating winding period, traversing is performed with the traverse width smaller than the traverse width used during the steady-state winding period. Consequently, the yarn stitching resulting from a variation in yarn tension or the like can be prevented. Furthermore, the traverse width increases continuously from the reduced condition accompanying an increase in the winding speed. Accordingly, a step can be prevented from being formed on the surface of the package 30 between the central portion and end portions thereof. This in turn prevents a pattern winding from being formed, and the yarn stitching from generating as a result of the unstable winding position caused by the step formed on the package 30. Additionally, even if a saddle bag is formed at the axial end portion of the package during winding, the traverse width is increased with progression of the acceleration during the accelerating winding period. The yarn 20 is eventually traversed so as to cover the saddle bag portion. This makes it possible to avoid the same portion of the yarn 20 on the surface of the yarn layer in the saddle bag portion from making contact with the contact roller 29 repeatedly many times. As a result, possible yarn breakage caused by damage to the yarn layer surface can be prevented.

[0083] Next, another embodiment of the automatic winder will be described with reference to Figure 4. Arrangements in the other embodiment which are the same as or similar to those in the above-described embodiments are denoted by the same reference numerals in the drawings and will not be described below.

[0084] As shown in Figure 4, in the automatic winder according to the other embodiment, the unit control section 90 includes the winding accelerating section 62 and the traverse width reducing section 63. In this embodiment, the unit control section 90 transmits a winding acceleration command and a traverse width reduction command to the package driving control section 42 and the traverse control section 46 to control the package driving motor 41 and the traverse driving motor 45. In the automatic winder according to this embodiment, the unit control section 90 functions as a winding driving control section and a traverse width control section.

[0085] The preferred embodiments of the present invention have been described. However, the above-described configurations can be changed as described below.

[0086] In the reduced-width change mode according to the above-described embodiments, the traverse width (traverse rate) is increased linearly accompanying an increase in the winding speed. However, the present invention is not limited to this arrangement. The traverse width has only to be continuously increased according to the winding speed so as to gradually approach the target traverse width. For example, the control may be changed such that the traverse width (traverse rate) is increased so that a corresponding graph is curved according to an appropriate function.

[0087] In the above-described embodiments, the arm member 28 is used for traversing. Alternatively, for example, a belt type traverse device may be used for traversing.

[0088] In the above-described embodiments, the direct drive scheme is adopted to rotationally drive the winding bobbin 22. Alternatively, a driving section may be connected to the contact roller 29 so that the package 30 (winding bobbin 22) rotates in conjunction with rotation of the contact roller 29.

[0089] In the above-described embodiments, the traverse driving motor 45 is a servo motor. Alternatively, the traverse driving motor 45 may be a voice coil motor or a step motor.

[0090] The above-described configurations may be changed such that the setting device 51 is operated to set a control mode other than the above-described two control modes in which the traverse width reducing control by the traverse width reducing section 63 is not performed during the accelerating winding period (no reduction mode, third control mode).

[0091] In the above-described embodiments, the control mode is manually selected by the operator. However, for example, when the winder unit 10 is operated, the reduced-width changing mode may be automatically selected unless a special operation is performed. The reduced-width maintaining section 70 in Figure 1 may be omitted so that the traverse width is always controlled in the reduced-width changing mode.

[0092] In the above-described embodiments, the operator operates the setting device 51 to input the starting traverse rate. Alternatively, the starting traverse rate may be pre-stored in the setting device 51 so that traversing can be performed with the stored starting traverse rate. Alternatively, a plurality of starting traverse rates may be stored in the setting device 51 so that the control is performed at the starting traverse rate selected by the operator.

[0093] In the above-described embodiments, the control for reducing the traverse width below the normal speed (this mode is hereinafter referred to as the reduced width mode) is terminated at the same time when the accelerating winding period is over. However, the timing for terminating the reduced width mode may be changed to be slightly before or after the timing when the accelerating winding period is over. However, to reliably prevent the yarn stitching, the reduced width mode is preferably terminated at the same time when the accelerating winding period is over.

[0094] While the present invention has been described with respect to preferred embodiments thereof, it will be apparent to those skilled in the art that the disclosed invention may be modified in numerous ways and may assume many embodiments other than those specifically set out and described above. Accordingly, it is intended by the appended claims to cover all modifications of the present invention that fall within the true spirit and scope of the invention.

Claims

1. A yarn winding device, which winds a yarn around a winding bobbin to form a package, the yarn winding device comprising:

   a winding driving section (41) that rotationally drives the winding bobbin;
   a winding driving control section (42) that controls rotation speed of the winding driving section (41) to control a yarn winding speed;
   a traverse guide (11) that traverses the yarn wound around the winding bobbin;
   a traverse guide driving section (45) that reciprocates the traverse guide (11);
   a traverse width control section (63) that controls a traverse width of the traverse guide (11) ; and
   a setting section (51) that sets the traverse width of the traverse guide (11),
   characterized in that the traverse width control section (63) has, as a control mode for controlling the traverse width until a winding speed of the winding bobbin reaches a predetermined winding speed,
   a first control mode in which the traverse width control section (63) controls the traverse guide driving section (45) so that traversing is performed with a constant reduced traverse width that is smaller than a target traverse width based on the set traverse width set via the setting section (51); and
   a second control mode in which the traverse width control section (63) controls the traverse guide driving section (45) so that traversing is performed with a traverse width that increases

continuously as the winding speed increases, starting from a reduced traverse width that is smaller than the target traverse width based on the set traverse width set via the setting section (51).

2. A yarn winding method of winding a yarn around a winding bobbin to form a package, the yarn winding method comprising:

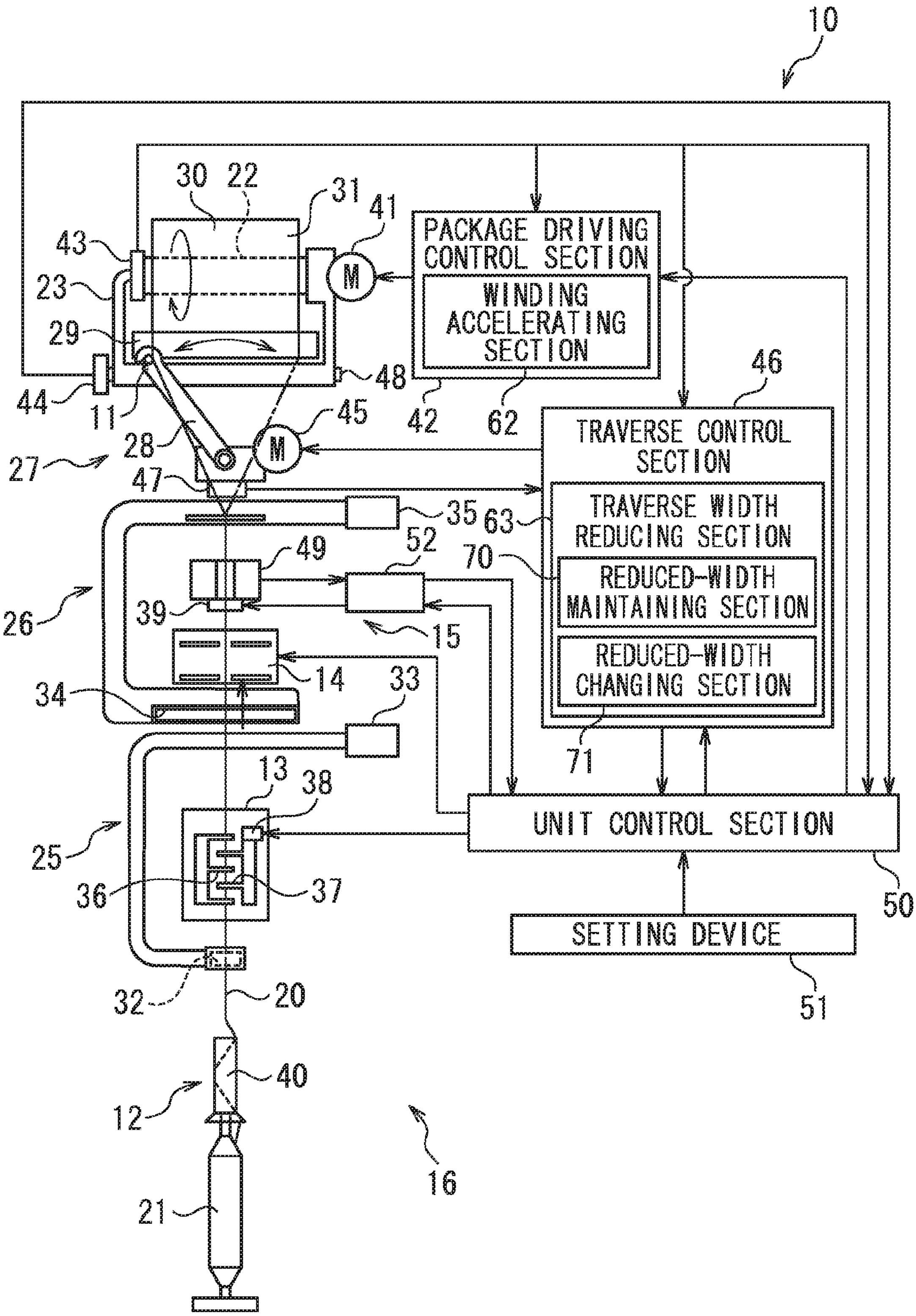
a first step of selecting one of a first control mode and a second control mode as a control mode for reducing a traverse width smaller than a steady state traverse width until a winding speed of the winding bobbin reaches a predetermined winding speed;
a second step of, when the first control mode is selected in the first step, winding the yarn while traversing the yarn with a constant reduced traverse width that is smaller than the steady state traverse width, and when the second control mode is selected in the first step, winding the yarn while traversing the yarn with a traverse width that increases continuously as the winding speed increases, starting from the reduced traverse width that is smaller than the steady state traverse width.

3. A package **characterized by** being formed by the yarn winding method according to Claim 2.

4. A yarn winding device, which winds a yarn around a winding bobbin to form a package, the yarn winder comprising:

a winding driving section (41) that rotationally drives the winding bobbin;
a winding driving control section (42) that controls rotation speed of the winding driving section (41) to control a yarn winding speed;
a traverse guide (11) that traverses the yarn wound around the winding bobbin;
a traverse guide driving section (45) that reciprocates the traverse guide (11);
a traverse width control section (63) that controls a traverse width of the traverse guide (11); and
a setting section (51) that sets the traverse width of the traverse guide (11),
characterized in that the traverse width control section (63) includes a traverse width changing section (71), and
the traverse width changing section (71) controls the traverse guide driving section (45) so that traversing is performed with a traverse width that increases continuously as the winding speed increases, starting from a reduced traverse width that is smaller than a target traverse width based on a set traverse width set via the setting section (51).

FIGURE 1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PACKAGE DRIVING CONTROL SECTION
WINDING ACCELERATING SECTION
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27
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TRAVERSE CONTROL SECTION
TRAVERSE WIDTH REDUCING SECTION
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52
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REDUCED-WIDTH MAINTAINING SECTION
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39
15
REDUCED-WIDTH CHANGING SECTION
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UNIT CONTROL SECTION
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SETTING DEVICE
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FIGURE 2A

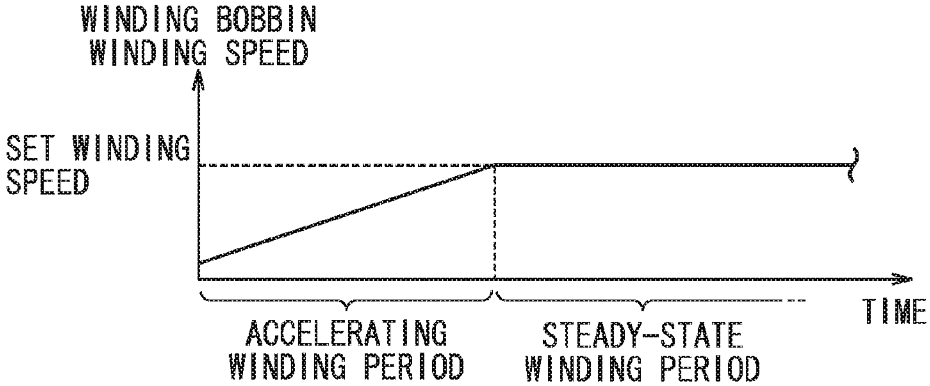


FIGURE 2B

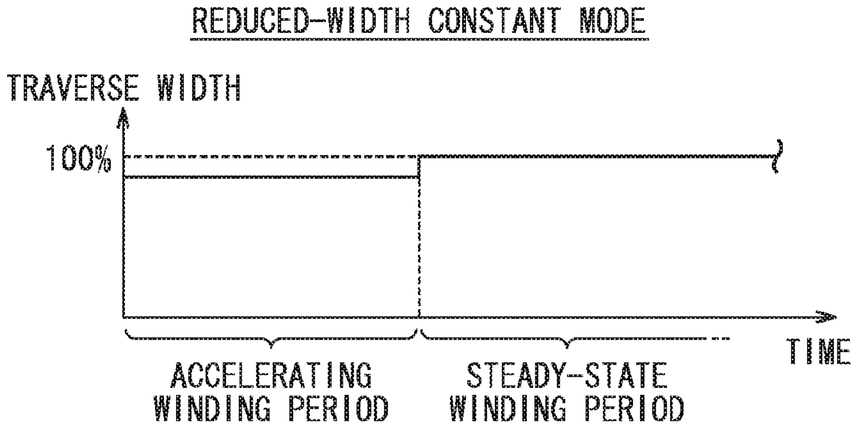


FIGURE 2C

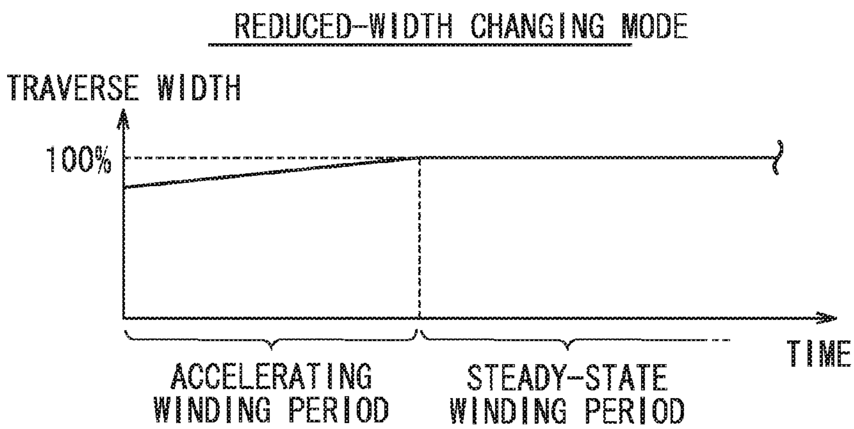


FIGURE 3

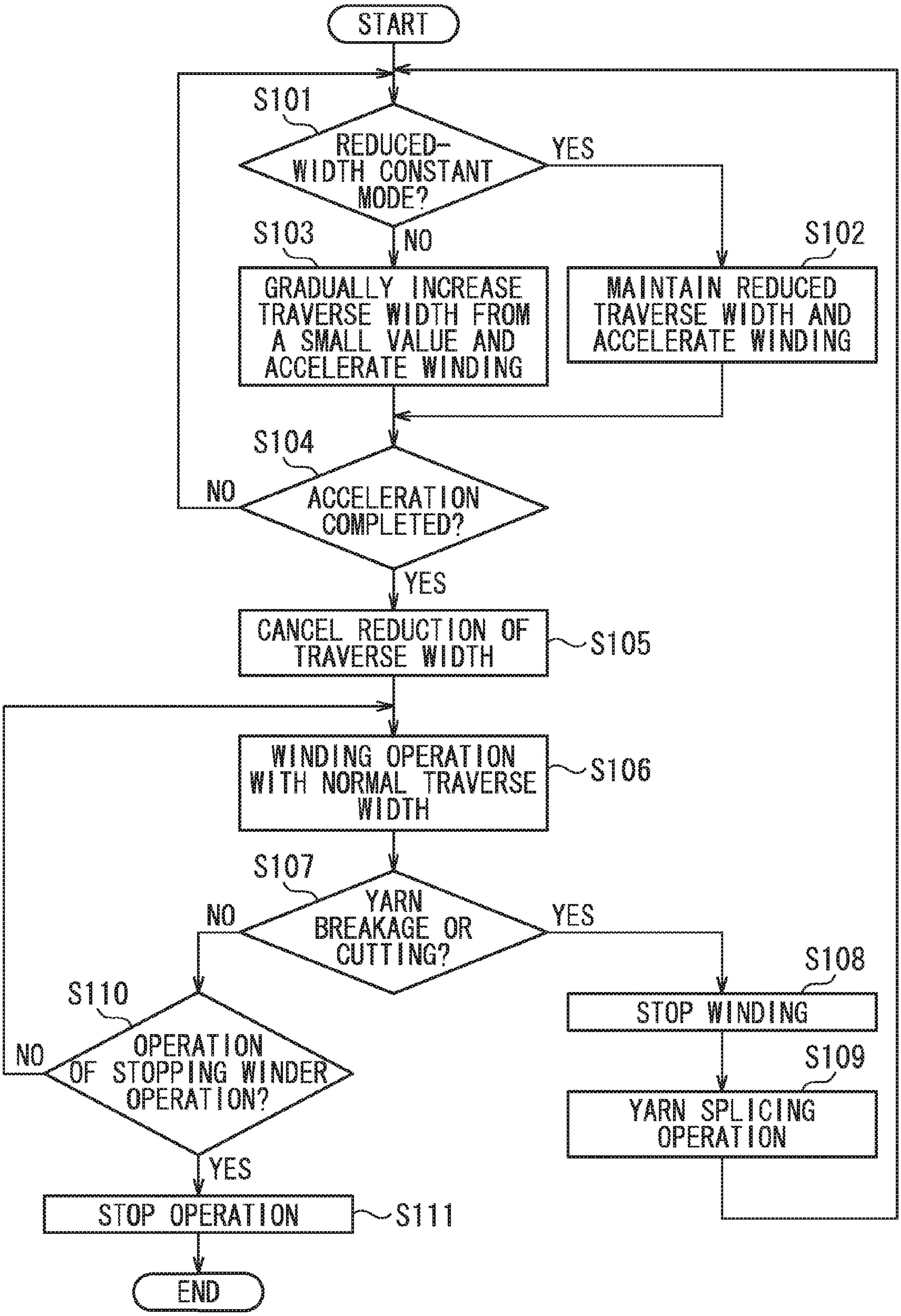
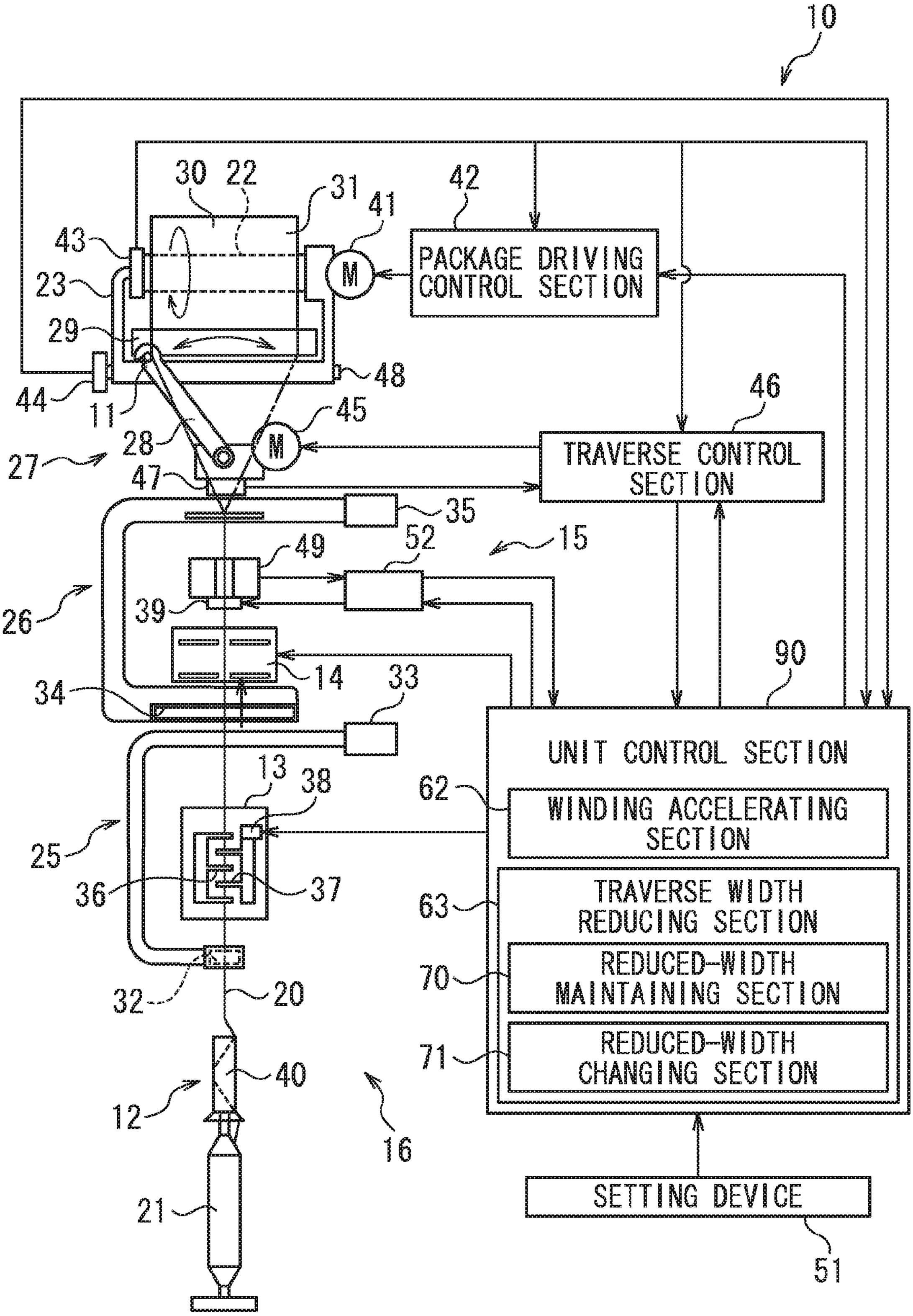

START
S101
REDUCED-WIDTH CONSTANT MODE?
YES
NO
S102
MAINTAIN REDUCED TRAVERSE WIDTH AND ACCELERATE WINDING
S103
GRADUALLY INCREASE TRAVERSE WIDTH FROM A SMALL VALUE AND ACCELERATE WINDING
S104
ACCELERATION COMPLETED?
NO
YES
CANCEL REDUCTION OF TRAVERSE WIDTH
S105
WINDING OPERATION WITH NORMAL TRAVERSE WIDTH
S106
S107
YARN BREAKAGE OR CUTTING?
NO
YES
S108
STOP WINDING
S109
YARN SPLICING OPERATION
S110
OPERATION OF STOPPING WINDER OPERATION?
NO
YES
STOP OPERATION
S111
END

FIGURE 4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12
16
21
51
PACKAGE DRIVING CONTROL SECTION
M
M
TRAVERSE CONTROL SECTION
UNIT CONTROL SECTION
WINDING ACCELERATING SECTION
TRAVERSE WIDTH REDUCING SECTION
REDUCED-WIDTH MAINTAINING SECTION
REDUCED-WIDTH CHANGING SECTION
SETTING DEVICE

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2007210776 A **[0004] [0005] [0005] [0007] [0009]**