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(71) Applicant: **TMT Machinery, Inc.**
Osaka-shi, Osaka 541-0041 (JP)

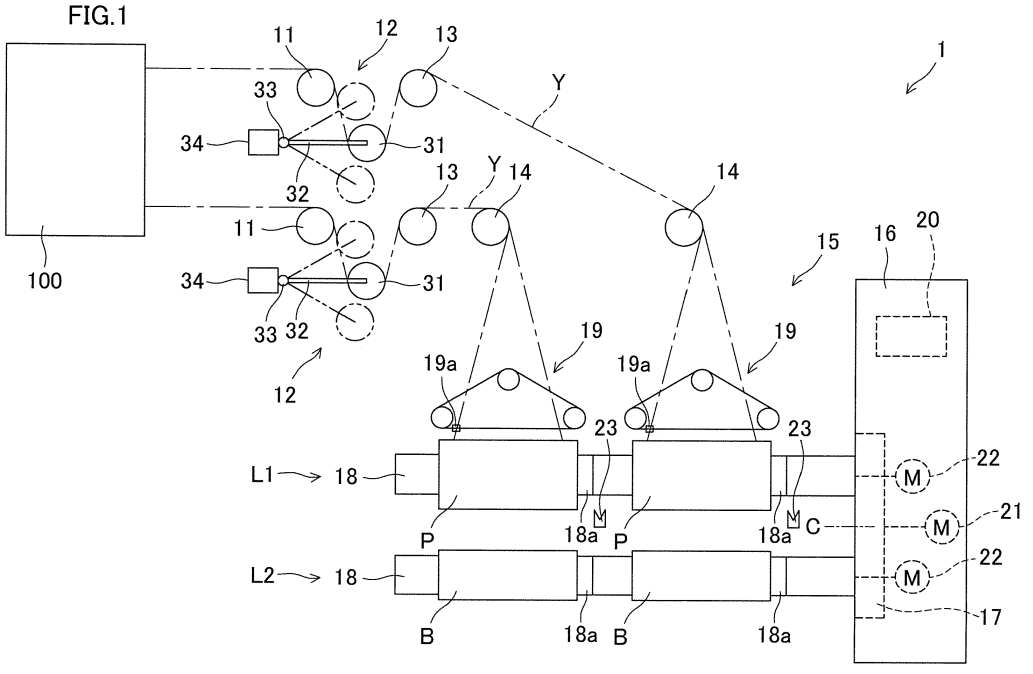
(72) Inventors:
- **SAKAMOTO, Kenichi**
  Kyoto, 612-8686 (JP)
- **HASHIMOTO, Kinzo**
  Kyoto, 612-8686 (JP)

(74) Representative: **Hoffmann Eitle**
Patent- und Rechtsanwälte PartmbB
Arabellastraße 30
81925 München (DE)

(54) YARN WINDER

(57) Positions of dancer rolls are properly controlled in a yarn winder including one or more common spindles each configured to support a plurality of bobbins (packages). The yarn winder includes: traverse units 19 configured to traverse yarns Y respectively; dancer rolls 31 onto which the yarns Y are respectively wound, each of the dancer rolls 31 configured to be movable from a predetermined reference position toward a relaxation side on which a corresponding one of the yarns Y is relaxed and toward a tension side on which yarn slack is removed; position detectors 34 configured to detect positions of the dancer rolls 31, respectively; and a controller 20 configured to control the position of at least one of the dancer rolls 31 based on outputs from the position detectors 34 by adjusting the traversal speed of corresponding at least one of the traverse units 19 traversing the yarn Y wound onto the at least one of the dancer rolls 31.

FIG.1



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Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a yarn winder including dancer rolls configured to reduce the tension fluctuation of yarns.

[0002] When yarns having high stiffness (stiff yarns) are wound in a yarn winder, the tension of the yarns tends to fluctuate. This is because, when the length of the yarns changes due to, for example, a change in the production speed of the yarns or the operation of traversing the yarns, the change of the yarn length is less likely to be absorbed due to the low flexibility of the yarns. To reduce or minimize such tension fluctuation, Patent Literature 1 (Japanese Unexamined Patent Publication No. H11-301930) discloses providing dancer rolls. Onto each dancer roll, a yarn is wound. Each dancer roll is configured so that: when the yarn length is short, the dancer roll moves to a relaxation side on which the yarn is relaxed; and when the yarn length is long, the dancer roll moves to a tension side on which the slack of the yarn is removed. The dancer roll is configured to move to the relaxation side or to the tension side as needed depending on the yarn length, and this makes it possible to reduce or minimize the tension fluctuation.

[0003] If the yarn length greatly changes in the above configuration, there is a possibility that the dancer roll reaches its limit position on the relaxation side or on the tension side. In this case, the tension fluctuation cannot be reduced any more. In such a case, control of returning the dancer roll to a predetermined reference position is performed by adjusting the rotation number of the spindle supporting packages, that is, by adjusting the winding speed of the yarns.

SUMMARY OF THE INVENTION

[0004] In a single-package-per-spindle yarn winder, in which only one package is formed per spindle, it is possible to return a dancer roll to the reference position as needed by adjusting the rotation number of the corresponding spindle as described above, and this allows the tension fluctuation to be reduced or minimized continuously. However, in a multiple-package-per-spindle yarn winder including one or more common spindles each configured to support a plurality of packages, the above control of adjusting the rotation number of the spindle may meet with failure. Now, the following describes this regard in detail.

[0005] In the multiple-package-per-spindle yarn winder, a plurality of dancer rolls are provided respectively for a plurality of yarns. In this yarn winder, the position of each dancer roll changes depending on the length of the corresponding yarn, and there may be large differences among the positions of the dancer rolls. If, under this situation, the rotation number of the spindle is adjusted so as to return the position of one of the dancer rolls to the reference position, all the dancer rolls corresponding to this spindle uniformly move to the relaxation side or to the tension side. As a result, even though the one of the dancer rolls is returned back to the reference position, there is a possibility that one or more other dancer rolls reach the limit position. Although Patent Literature 1 describes such a multiple-package-per-spindle yarn winder, the above problem is not mentioned at all.

[0006] The present invention has been made in view of the above-described problem. An object of the present invention is to properly control the positions of dancer rolls in a yarn winder including one or more common spindles each configured to support a plurality of bobbins (packages).

[0007] According to an aspect of the present invention, a yarn winder including at least one common spindle each configured to support a plurality of bobbins, the yarn winder configured to rotate the spindle to wind yarns onto the bobbins respectively to form packages, includes: traverse units configured to traverse the yarns respectively; dancer rolls onto which the yarns are respectively wound, each of the dancer rolls configured to be movable from a predetermined reference position toward a relaxation side on which a corresponding one of the yarns is relaxed and toward a tension side on which yarn slack is removed; position detectors configured to detect positions of the dancer rolls, respectively; and a controller configured to control a position of at least one of the dancer rolls based on outputs from the position detectors by adjusting traversal speed of corresponding at least one of the traverse units traversing the yarn wound onto the at least one of the dancer rolls .

[0008] In the above aspect of the present invention, the traverse units are respectively provided for the yarns. The position of a desired one of the dancer rolls is controllable by adjusting the traversal speed of the traverse unit traversing the yarn wound onto the desired one of the dancer rolls. Thus, the position of each dancer roll is controllable by adjusting the traversal speed of the corresponding traverse unit. This makes it possible to control the positions of the dancer rolls individually, and therefore to properly control the position of each dancer roll.

[0009] Furthermore, in the above aspect of the present invention, it is preferable that when a difference between positions of freely-selected two of the dancer rolls exceeds a predetermined threshold, the controller performs positional difference eliminating control of reducing the difference between the positions of the two dancer rolls to a level equal to or smaller than the threshold by adjusting the traversal speed of at least one of two traverse units traversing the yarns wound onto the two dancer rolls.

[0010] When there is a large difference between the positions of the dancer rolls, the difference is reduced by performing the positional difference eliminating control.

[0011] Furthermore, in the above aspect of the present invention, it is preferable that in the positional difference eliminating control, the controller is configured to de-

crease the traversal speed of a corresponding one of the two traverse units which traverses the yarn wound onto a relaxation-side dancer roll of the two dancer rolls, the relaxation-side dancer roll being on the relaxation side relatively to the other dancer roll.

[0012] This moves the relaxation-side dancer roll to the tension side, and decreases the difference between the positions of the dancer rolls. A yarn slip may occur as a result of increasing the traversal speed. However, the position of the dancer roll is controlled by decreasing the traversal speed as above, and therefore the yarn slip is avoidable.

[0013] Furthermore, in the above aspect of the present invention, it is preferable that the controller is configured to perform processing of the positional difference eliminating control within a time period of a single reciprocation cycle in which the traverse unit reciprocates the yarn once in a traverse direction.

[0014] Long-term execution of the positional difference eliminating control, in which the traversal speed is changed, may misshape the package. Performing the processing of the positional difference eliminating control only for the short period of time as described above ensures good quality of the packages.

[0015] Furthermore, in the above aspect of the present invention, the at least one spindle includes two spindles, and it is preferable that the yarn winder further includes: a switching device configured to support the two spindles so that positions of the two spindles are interchangeable with each other between a winding position at which the yarns are respectively wound onto the bobbins and a collection position at which the packages are collected; and a plurality of cutting means configured to respectively cut the yarns leading to the packages supported by the spindle having been moved from the winding position to the collection position by the switching device, wherein the controller is configured to perform the positional difference eliminating control immediately before interchanging the positions of the two spindles by the switching device, irrespective of whether or not the difference between the positions of the two dancer rolls exceeds the threshold.

[0016] When there is a large difference between the positions of the dancer rolls at the time of cutting the yarns, there is a possibility that variations in the timings of cutting the yarns occur and/or one or some of the yarns cannot be cut. Forcedly performing the positional difference eliminating control immediately before the interchanging the positions of the spindles as above enables cutting the yarns simultaneously.

[0017] Furthermore, in the above aspect of the present invention, it is preferable that the controller is configured to perform the positional difference eliminating control immediately after the yarns are cut by the plurality of cutting means, irrespective of whether or not the difference between the positions of the two dancer rolls exceeds the threshold.

[0018] Although in the present invention, the position of each dancer roll is controllable by adjusting the traversal speed of the corresponding traverse unit, it is preferable that the traversal speed is as constant as possible in order to improve the quality of the packages. Thus, forcedly performing the positional difference eliminating control immediately after cutting the yarns as described above, i.e., at the time of starting the winding of the yarns onto empty bobbins, minimizes the necessity to change the traversal speed during the winding process.

[0019] Furthermore, in the above aspect of the present invention, it is preferable that the controller is capable of changing traverse widths of the traverse units.

[0020] When the traversal speed of a yarn is changed, the actual winding width of the yarn may change, which will be described later. Thus, the above arrangement in which the traverse width of each traverse unit is changeable makes it possible to keep its winding width constant by adjusting the traverse width depending on the change of the traversal speed.

[0021] Furthermore, in the above aspect of the present invention, it is preferable that when decreasing the traversal speeds of one or more of the traverse units, the controller is configured to decrease the traverse widths of the one or more traverse units.

[0022] As described above, the slip of a yarn is avoidable by decreasing the traversal speed to control the position of the corresponding dancer roll. However, the decrease of the traversal speed makes the winding width longer, which may lead to cob-webbing. To deal with this, the traverse width is decreased at the same time when the traversal speed is decreased. This makes it possible to maintain the winding width constant while avoiding the slip of the yarn.

[0023] Furthermore, in the above aspect of the present invention, it is preferable that the controller is configured to perform winding speed control of moving the positions of the dancer rolls by adjusting a rotation number of the spindle.

[0024] Performing the winding speed control makes it possible to control the positions of the dancer rolls not only by adjusting the traversal speed, but also by adjusting the rotation number of the spindle.

[0025] Furthermore, in the above aspect of the present invention, it is preferable that in the winding speed control, the controller is configured to adjust the rotation number of the spindle so that one of the dancer rolls is moved to the reference position.

[0026] With this winding speed control, one of the dancer rolls is moved to the reference position. Due to this, merely by performing the positional difference eliminating control for the other dancer roll(s) so as to reduce the difference from the one of the dancer rolls, it is possible to keep all the dancer rolls at the reference position.

[0027] Furthermore, in the above aspect of the present invention, it is preferable that in the winding speed control, the controller is configured to adjust the rotation number of the spindle so that out of the dancer rolls, the dancer roll positioned farthest on the tension side from

the reference position is moved to the reference position.

[0028] As a result of performing the winding speed control as above so as to move the farthest dancer roll on the tension side to the reference position, the other dancer roll(s) is/are positioned on the relaxation side relatively to the reference position. When performing the positional difference eliminating control to the each of the other dancer rolls so as to reduce the difference in position from the one of the dancer rolls, the traversal speed shall be decreased. Accordingly, the slip of the yarn is avoidable, as described above.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029]

FIG. 1 is a schematic diagram of a yarn winder of a present embodiment.

FIG. 2 is a series of schematic diagrams illustrating the operation of interchanging the positions of spindles.

FIG. 3 is a flowchart illustrating processing of positional control of dancer rolls.

FIG. 4 is a flowchart illustrating processing of winding speed control.

FIG. 5 is a flowchart illustrating processing of positional difference eliminating control.

FIG. 6 is a schematic diagram illustrating a change in winding width with a change in traversal speed.

FIG. 7 is a flowchart illustrating processing of winding speed control in another embodiment.

FIG. 8 is a flowchart illustrating processing of positional difference eliminating control in the other embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

(Structure of Yarn Winder)

[0030] The following will describe an example of embodiments of a yarn winder of the present invention. FIG. 1 is a schematic diagram of a yarn winder of the present embodiment. A yarn winder 1 is configured to wind yarns Y produced in a yarn production apparatus 100 onto bobbins B, to form packages P. In the present embodiment, the yarn winder 1 is configured to wind two yarns Y onto two bobbins B to form two packages P.

[0031] As shown in FIG. 1, the yarn winder 1 includes: first rollers 11, dancer roll mechanisms 12, second rollers 13, fulcrum rollers 14, and a winding device 15, in this order from an upstream side in a yarn running direction. Of these, the first roller 11, the dancer roll mechanism 12, the second roller 13, and the fulcrum roller 14 are provided for each of the yarn paths of the two yarns Y. The winding device 15 is provided to be shared by the two yarns Y.

[0032] The first rollers 11 and the second rollers 13 are fixed. Each dancer roll mechanism 12 includes a dancer roll 31, which is provided between the corresponding first and second rollers 11 and 13. Each yarn Y is wound around upper portions of the corresponding first and second rollers 11 and 13, and is wound around a lower portion of the corresponding dancer roll 31. Due to this, the yarn path extending from the first roller 11 to the second roller 13 via the dancer roll 31 has a V-shape. The dancer roll mechanisms 12 will be detailed later. The fulcrum rollers 14 are fixed, and function as fulcrums when the yarns Y are traversed in the winding device 15. The fulcrum rollers 14 may be omitted when the second rollers 13 are used to function as the fulcrum rollers 14.

[0033] The winding device 15 includes a base 16, a turret 17, spindles 18, traverse units 19, a controller 20, and the like. The turret 17 has a disc-like shape and is attached to the base 16. The turret 17 is rotated and driven by a turret motor 21. The two long cylindrical spindles 18 cantilever from the turret 17. The spindles 18 are rotated and driven by their respective spindle motors 22. Two bobbins B are attached to each spindle 18 so as to be aligned in the axial direction of the spindle 18. The operations of the turret motor 21 and the spindle motors 22 are controlled by the controller 20.

[0034] The positions of the two spindles 18 are interchangeable with each other between a winding position L1 and a collection position L2, by rotating the turret 17 by the turret motor 21 about a central axis C which is parallel to the axial direction of the spindles 18. In a winding process of the yarns Y, the yarns Y are wound onto the bobbins B attached to the spindle 18 at the winding position L1, so that packages P are formed. When the packages P become full, the positions of the two spindles 18 are interchanged with each other. After the spindle 18 supporting the full packages P moves to the collection position L2, the packages P are collected.

[0035] Ring-shaped yarn holding portions 18a are fitted around each spindle 18 so as to be movable in the axial direction. Each yarn holding portion 18a is provided near a position where the corresponding bobbin B is attached. The yarn holding portion 18a is configured to hold the corresponding yarn Y between the yarn holding portion 18a and the bobbin B in the following manner: a gap is first created between the yarn holding portion 18a and the bobbin B by moving the yarn holding portion 18a away from the bobbin B, and then, as soon as the yarn Y enters the gap, the yarn holding portion 18a is moved toward the bobbin B so that the yarn Y is held between them. Cutters 23 are provided in the vicinity of the respective yarn holding portions 18a. Each cutter 23 is configured to cut the corresponding yarn Y leading to the full package P. The operations of the yarn holding portions 18a and the cutters 23 are controlled by the controller 20.

[0036] Now, a description is given to the operation of starting the winding process of the yarns Y onto the bobbins B attached to the spindle 18 having just moved to the winding position L1 as a result of interchanging the positions of the two spindles 18. FIG. 2 is a series of schematic diagrams illustrating the operation of inter-

changing the positions of the spindles 18. In FIG. 2, the two spindles 18 are viewed from the left side in FIG. 1.

[0037] When each package P supported by the spindle 18 at the winding position L1 becomes full as shown in FIG. 2(a), the turret 17 is rotated 180 degrees in a counterclockwise direction in FIG. 2, so that the positions of the two spindles 18 are interchanged with each other as shown in FIG. 2(b). In the state of FIG. 2(b), each yarn Y still leads to the corresponding package P, and the yarn Y is in contact with the outer circumferential surface of the corresponding bobbin B attached to the spindle 18 which has just come to the winding position L1. Then, substantially at the same time when each yarn holding portion 18a provided to the spindle 18 at the winding position L1 is actuated to hold the corresponding yarn Y, the yarn Y is cut by the corresponding cutter 23, at a point between a portion held by the yarn holding portion 18a and the package P. Consequently, as shown in FIG. 2(c), the yarn Y is handed over from the package P at the collection position L2 to the empty bobbin B at the winding position L1, and then winding of the yarn Y onto the empty bobbin B is started.

[0038] Returning back to FIG. 1, each traverse unit 19 is attached to the base 16 via an unillustrated supporting member. The traverse units 19 are provided respectively for the two yarns Y. The traverse units 19 are controlled independently from each other by the controller 20. A traverse guide 19a provided to each traverse unit 19 is configured to reciprocate in the axial direction of the spindles 18, i.e., in a "traverse direction". As each traverse guide 19a to which the corresponding yarn Y is threaded reciprocates in the traverse direction, the yarn Y is traversed about the corresponding fulcrum roller 14. While being traversed, the yarn Y is wound onto the corresponding bobbin B. In the example of FIG. 1, each traverse unit 19 is formed by the combination of pulleys and a belt, however, the structure of the traverse unit 19 is not limited to this. For example, the traverse unit may be formed by a ball screw and the like.

[0039] The yarns Y intended herein to be wound by the yarn winder 1 are stiff yarns having an elastic modulus of 3 GPa or higher, such as carbon fiber yarns or aramid fiber yarns, for example. Nylon yarns, which are typical synthetic fiber yarns, have a relatively low stiffness, and therefore even when the tension fluctuation of the yarns occurs, the tension fluctuation can be absorbed due to the flexibility of the yarns. To the contrary, the above-mentioned stiff yarns have little flexibility, and therefore the tension of the yarns may greatly fluctuate. To deal with this, the yarn winder 1 is provided with the dancer roll mechanisms 12, which make it possible to reduce or minimize the tension fluctuation of the yarns Y even when the yarns Y have high stiffness. In the yarn winder 1, the traversal speed is 35 m/min or lower, and the winding speed is 100 m/min or lower. That is, the yarn winder 1 is structured so that the yarns Y are wound at a relatively low speed.

[0040] Each dancer roll mechanism 12 includes a dancer roll 31, a dancer arm 32, a shaft 33 and a position sensor 34. As described above, the dancer roll 31 is provided between the corresponding first roller 11 and second roller 13 with respect to the yarn running direction. The yarn path extending from the first roller 11 to the second roller 13 via the dancer roll 31 has a V-shape. The dancer roll 31 is rotatably supported at a leading end portion of the dancer arm 32. A base end portion of the dancer arm 32 is attached to the shaft 33 in a swingable manner, and this allows the dancer roll 31 to move in an up-down direction.

[0041] Each dancer roll mechanism 12 is adjusted so that the dancer roll 31 is basically at a predetermined reference position. The reference position is indicated with solid lines in FIG. 1. When the tension of the yarn Y fluctuates due to a change in the length of the yarn Y, for example, the dancer roll 31 moves in the up-down direction from the reference position, thereby to reduce or minimize the tension fluctuation. Specifically, when the length of the portion of the yarn Y between the yarn production apparatus 100 and the winding device 15 becomes shorter, the dancer roll 31 moves toward an upper side (equivalent to a "relaxation side" in the present invention) to relax the yarn Y, with the result that the tension fluctuation of the yarn Y is reduced or minimized. Meanwhile, when the length of the portion of the yarn Y between the yarn production apparatus 100 and the winding device 15 becomes longer, the dancer roll 31 moves toward a lower side (equivalent to a "tension side" in the present invention) to eliminate the slack of the yarn Y, with the result that the tension fluctuation of the yarn Y is reduced or minimized. However, there is a limitation to the range of the movement of the dancer roll 31 in the up-down direction. The dancer roll 31 is movable only between an upper limit position (position indicated with dashed lines in FIG. 1) and a lower limit position (position indicated with two-dot chain lines in FIG. 1).

[0042] Each position sensor 34 is configured to detect the swing angle of the corresponding dancer arm 32. The swing angle indicates the position of the dancer roll 31. The controller 20 is configured to control the rotation number of the spindle 18 and the traversal speed and traverse width of each traverse unit 19, based on the output from each position sensor 34.

(Positional Control of Dancer Roll)

[0043] Conventionally, when the length of a part of a yarn Y between the yarn production apparatus 100 and the winding device 15 greatly changes and therefore the corresponding dancer roll 31 reaches its upper limit position or lower limit position, the rotation number of the corresponding spindle 18 is adjusted to adjust the winding speed, so as to return the dancer roll 31 to the reference position. Now, in the present embodiment, the plurality of bobbins B are supported by the common spindle 18. In such an arrangement, the above-described positional control of the dancer rolls 31 through adjusting the

rotation number of the spindle 18 may meet with failure if there is a large difference between the positions of the dancer rolls 31.

[0044] Specifically, in cases where the two bobbins B are supported by the common spindle 18 as in the present embodiment, adjustment of the rotation number of the spindle 18 to return back one of the dancer rolls 31 to the reference position necessitates the other of the dancer rolls 31 to move simultaneously. As a result, even though the one of the dancer rolls 31 is returned back to the reference position, the other of the dancer rolls 31 may reach the upper limit position or the lower limit position. That is, because the adjustment of the rotation number of the spindle 18 disadvantageously moves all the dancer rolls 31 uniformly, there has been a limitation in the positional control of each individual dancer roll 31. Taking the above into consideration, in the present embodiment, in addition to the "winding speed control" of adjusting the rotation number of the spindle 18, there is performed "positional difference eliminating control" of adjusting the traversal speed of each traverse unit 19 individually. This enables versatile control.

[0045] One of factors for causing a large difference between the positions of the two dancer rolls 31 is a difference between the production speeds of the two yarns Y. For example, reference is made to a case where carbon fiber yarns Y are produced in the yarn production apparatus 100. In this case, the yarns Y are produced by baking material precursors. A large difference between the production speeds of the two yarns Y may be caused by a difference between the degrees of shrinkage at the time of baking, a difference between the gripping forces of rollers feeding the yarns Y, and/or the like. The positional difference eliminating control of the present embodiment is particularly effective in such a case.

[0046] FIG. 3 is a flowchart illustrating processing of the positional control of the dancer rolls 31. FIG. 4 is a flowchart illustrating processing of the winding speed control. FIG. 5 is a flowchart illustrating processing of the positional difference eliminating control. While the yarns Y are wound, the processing of the winding speed control (Step S10) and the processing of the positional difference eliminating control (Step S11) are performed at appropriate timings (for example, at predetermined time intervals). While in the present embodiment, the processing of the positional difference eliminating control is performed subsequently to the processing of the winding speed control, both the control processes may be performed simultaneously. In the following description, directions with respect to the position of the dancer roll 31 are defined as follows: the direction toward the upper side (relaxation side) is a positive direction of a coordinate, and the direction toward the lower side (tension side) is a negative direction of the coordinate.

[0047] Now, the winding speed control is described with reference to FIG. 4. In the winding speed control of the present embodiment, the rotation number of the spindle 18 is adjusted so that the lower dancer roll 31, positioned lower than the other, is returned to a reference position PO. Hereinafter, for the sake of differentiation, "A" is affixed to reference sings for elements related to one of the yarns Y, and "B" is affixed to reference signs for elements related to the other of the yarns Y, as needed.

[0048] First of all, the controller 20 obtains positions PA and PB of the dancer rolls 31A and 31B, which are respectively detected by the position sensors 34A and 34B (Step S20). Then, the controller 20 determines whether the position PA of the dancer roll 31A is lower than the position PB of the dancer roll 31B (Step S21). When the position PA of the dancer roll 31A is lower than the position PB of the dancer roll 31B (Step S21: YES), the controller 20 determines whether the position PA of the dancer roll 31A is higher than the reference position PO (Step S22). When the position PA of the dancer roll 31A is higher than the reference position PO (Step S22: YES), the controller 20 reduces the rotation number of the spindle 18 (Step S23), so as to lower the position PA of the dancer roll 31A to the reference position PO, and then the processing of the winding speed control ends.

[0049] Meanwhile, when the position PA of the dancer roll 31A is not higher than the reference position PO (Step S22: NO), the controller 20 determines whether the position PA of the dancer roll 31A is lower than the reference position PO (Step S24). When the result of the above determination shows that the position PA of the dancer roll 31A is lower than the reference position PO (Step S24: YES), the controller 20 increases the rotation number of the spindle 18 (Step S25) so as to raise the position PA of the dancer roll 31A to the reference position PO, and then the processing of the winding speed control ends. When the position PA of the dancer roll 31A is not lower than the reference position PO (Step S24: NO), it is indicated that the position PA of the dancer roll 31A is level with the reference position PO, and therefore the processing of the winding speed control ends without changing the rotation number of the spindle 18.

[0050] When the result of the determination in Step S21 is NO, the controller 20 determines whether the position PB of the dancer roll 31B is higher than the reference position PO (Step S26). When the result of the above determination shows that the position PB of the dancer roll 31B is higher than the reference position PO (Step S26: YES), the controller 20 decreased the rotation number of the spindle 18 (Step S27) so as to lower the position PB of the dancer roll 31B to the reference position PO, and then the processing of the winding speed control ends.

[0051] Meanwhile, when the position PB of the dancer roll 31B is not higher than the reference position PO (Step S26: NO), the controller 20 determines whether the position PB of the dancer roll 31B is lower than the reference position PO (Step S28). When the result of the above determination shows that the position PB of the dancer roll 31B is lower than the reference position PO (Step S28: YES), the controller 20 increases the rotation

number of the spindle 18 (Step S29) so as to raise the position PB of the dancer roll 31B to the reference position PO, and then the processing of the winding speed control ends. When the position PB of the dancer roll 31B is not lower than the reference position PO (Step S28: NO), it is indicated that the position PB of the dancer roll 31B is level with the reference position PO, and therefore the processing of the winding speed control ends without changing the rotation number of the spindle 18.

[0052] Next, the processing of the positional difference eliminating control is described with reference to FIG. 5. In the positional difference eliminating control of the present embodiment, when there is a large difference between the position PA of the dancer roll 31A and the position PB of the dancer roll 31B, the traversal speed of the traverse unit 19 traversing the yarn Y wound onto the dancer roll 31 higher than the other is adjusted so as to move only the higher dancer roll 31 to the reference position PO.

[0053] First of all, the controller 20 obtains the positions PA and PB of the dancer rolls 31A and 31B, which are respectively detected by the position sensors 34A and 34B (Step S30). Then, the controller 20 determines whether the difference between the position PA of the dancer roll 31A and the position PB of the dancer roll 31B is within (equal to or smaller than) a predetermined threshold PX (Step S31). When the difference between the position PA of the dancer roll 31A and the position PB of the dancer roll 31B is equal to or smaller than the threshold PX (Step S31: YES), the processing of the positional difference eliminating control ends without changing the traversal speed of any of the traverse units 19A and 19B.

[0054] Meanwhile, when the difference between the position PA of the dancer roll 31A and the position PB of the dancer roll 31B exceeds the threshold PX (Step S31: NO), the controller 20 determines whether the position PA of the dancer roll 31A is lower than the position PB of the dancer roll 31B (Step S32). When the result of the above determination shows that the position PA of the dancer roll 31A is lower than the position PB of the dancer roll 31B (Step S32: YES), the controller 20 decreases the traversal speed of the traverse unit 19B for a predetermined period of time so as to lower the position PB of the dancer roll 31B, which is positioned higher, to the reference position PO (Step S33). Then, the controller 20 returns the traversal speed of the traverse unit 19B back to its original speed (Step S34), and the processing of the positional difference eliminating control ends.

[0055] Meanwhile, when the result of the determination in Step S32 is NO, the controller 20 decreases the traversal speed of the traverse unit 19A for the predetermined period of time so as to lower the position PA of the dancer roll 31A, which is positioned higher, to the reference position PO (Step S35). Then, the controller 20 returns the traversal speed of the traverse unit 19A back to its original speed (Step S36), and the processing of the positional difference eliminating control ends. The above-mentioned "predetermined period of time" during which the traversal speed is adjusted in each Step S33, S35 may be freely set as needed. In the present embodiment, the predetermined period of time is equal to a time period of a single reciprocation cycle in which the traverse guide 19a reciprocates once in the traverse direction.

[0056] As described above, in the positional control of the dancer rolls 31 of the present embodiment, the processing of the winding speed control is performed first. With this, both of the dancer rolls 31A and 31B move uniformly toward the upper or lower side so that the lower one of the dancer rolls 31A and 31B, which is positioned lower than the other, returns back to the reference position PO. In the processing of the positional difference eliminating control performed subsequently, only the upper dancer roll 31, which is positioned higher than the other, is moved to the reference position PO when there is a large difference between the position PA of the dancer roll 31A and the position PB of the dancer roll 31B. In this case, the difference in position between this dancer roll 31 and the other dancer roll 31, which has already moved to the reference position PO in the winding speed control, is reduced. That is, by performing the processing of the winding speed control in Step S10 and subsequently performing the processing of the positional difference eliminating control in Step S11, both the dancer rolls 31A and 31B are kept at or close to the reference position PO.

[0057] Returning back to FIG. 3, after Steps S10 and S11 are performed, the controller 20 determines whether the formation of the packages P has been completed, that is, whether the packages P have become full, based on outputs from unillustrated sensors or the like (Step S12). When the formation of the packages P has not been completed (Step S12: NO), the processing of the winding speed control and the processing of the positional difference eliminating control are repeated.

[0058] Meanwhile, when the formation of the packages P has been completed (Step S12: YES), processing of forced positional difference eliminating control is performed (Step S13). The forced positional difference eliminating control is the same as the positional difference eliminating control except that it is forcedly performed regardless of whether the difference between the position PA of the dancer roll 31A and the position PB of the dancer roll 31B exceeds the threshold PX. Specifically, in this processing, Step S31 is skipped in the flowchart of FIG. 5, and Step S32 is performed after Step S30. Immediately after the processing of the forced positional difference eliminating control is performed, the turret 17 is rotated to interchange the positions of the two spindles 18 with each other, and then the yarn holding portions 18a are controlled so that the yarns Y are held by the respective bobbins B, and simultaneously with this, the yarns Y leading to the respective packages P are cut by the respective cutters 23 (Step S14). With this, winding of the yarns Y onto the respective empty bobbins B is started. Immediately after the start of the winding, the processing of the forced positional difference eliminating control is per-

formed again (Step S15), and the series of steps are repeatedly performed from Step S10.

(Advantageous Effects)

[0059] In the present embodiment, the position of a desired one of the dancer rolls 31 is controllable by adjusting the traversal speed of the traverse unit (19A or 19B) traversing the yarn Y wound onto the desired one of the dancer rolls 31. Thus, the position PA, PB of each dancer roll 31A, 31B is individually controllable by adjusting the traversal speed of the corresponding traverse unit. This makes it possible to properly control the position PA, PB of the dancer roll 31A, 31B.

[0060] Furthermore, in the present embodiment, when the difference between the positions PA and PB of the two dancer rolls 31A and 31B exceeds the predetermined threshold PX, the controller 20 performs the positional difference eliminating control of reducing the difference between the positions PA and PB of the two dancer rolls 31A and 31B to a level equal to or smaller than the threshold PX by adjusting the traversal speed of at least one of the two traverse units 19A and 19B traversing the yarns Y wound onto the two dancer rolls 31A and 31B. When there is a large difference between the positions PA and PB of the dancer rolls 31A and 31B, the difference is reduced by performing the positional difference eliminating control.

[0061] Furthermore, in the positional difference eliminating control in the present embodiment, the controller 20 is configured to decrease the traversal speed of the traverse unit 19 which traverses the yarn Y wound onto the upper dancer roll 31, which is positioned on the upper side (relaxation side) relatively to the other, out of the two dancer rolls 31A and 31B. This moves the upper dancer roll 31 to the lower side (tension side), and decreases the difference between the positions PA and PB the dancer rolls 31A and 31B. A slip of the yarn Y may occur as a result of increasing the traversal speed. However, the position of the dancer roll 31 is controlled by decreasing the traversal speed as above, and therefore the slip of the yarn Y is avoidable.

[0062] Furthermore, in the present embodiment, the controller 20 is configured to perform processing of the positional difference eliminating control within the time period of a single reciprocation cycle in which the traverse unit 19 reciprocates the yarn Y once in the traverse direction. Long-term execution of the positional difference eliminating control, in which the traversal speed is changed, may misshape the package P. Performing the processing of the positional difference eliminating control only for the short period of time as described above ensures good quality of the packages P.

[0063] Furthermore, in the present embodiment, the controller 20 is configured to perform the positional difference eliminating control irrespective of whether or not the difference of the positions PA and PB of the two dancer rolls 31A and 31B exceeds the threshold PX (the controller 20 is configured to perform the forced positional difference eliminating control) immediately before interchanging the positions of the two spindles 18 by the turret 17 (switching device). When there is a large difference between the positions PA and PB of the dancer rolls 31A and 31B at the time of cutting the yarns Y, there is a possibility that variations in the timings of cutting the yarns Y occur, and/or one or some of the yarns Y cannot be cut. Forcedly performing the positional difference eliminating control immediately before the interchanging the positions of the spindles 18 as above enables cutting the yarns Y simultaneously.

[0064] Furthermore, in the present embodiment, the controller 20 is configured to perform the positional difference eliminating control irrespective of whether or not the difference between the positions PA and PB of the two dancer rolls 31A and 31B exceeds the threshold PX (the controller 20 is configured to perform the forced positional difference eliminating control) immediately after the yarns Y are cut by the cutters 23 (cutting means). Although in the present embodiment, the position PA, PB of the dancer roll 31A, 31B is controllable by adjusting the traversal speed of the corresponding traverse unit, it is preferable that the traversal speed is as constant as possible in order to improve the quality of the packages P. Thus, forcedly performing the positional difference eliminating control immediately after cutting the yarns Y as described above, i.e., at the time of starting the winding of the yarns Y onto empty bobbins B, minimizes the necessity to change the traversal speed during the winding process.

[0065] Furthermore, in the present embodiment, the controller 20 is capable of changing the traverse widths of the traverse units 19. This advantageous feature is described with reference to FIG. 6. FIG. 6 is a schematic diagram illustrating the change in the winding width with a change in the traversal speed. FIG. 6 shows a development view of a package P on a sheet. At normal winding times during which no positional difference eliminating control is performed, the traverse guide 19a reciprocates at a traversal speed V1 and a traverse width W1, and draws a trajectory S1, which is indicated with a dashed line. Between the traverse guide 19a and the outer circumferential surface of the package P, the yarn Y has a part which does not follow the traverse guide 19a at the time of turnaround of the traverse guide 19a, the part being so called "free length". Due to this, when the traverse guide 19a turns around, the wound yarn Y turns back at a point inward of the trajectory of the traverse guide 19a, as indicated with bold solid lines in FIG. 6. That is to say, the actual winding width X1 is shorter than the traverse width W1. Taking the above phenomenon into consideration, the traversal speed V1 and the traverse width W1 are determined beforehand so that the winding width X1 is equal to a desired value.

[0066] Now, when the traversal speed is decreased to V2 while keeping the traverse width at W1 in the positional difference eliminating control, the trajectory of the

traverse guide 19a changes to S2, as indicated with two-dot chain line. The decrease of the traversal speed makes it easier for the yarn Y to follow the traverse guide 19a at the time of turnaround of the traverse guide 19a, and therefore the winding width X2 in this situation is longer than the winding width X1 of the normal winding times. To the contrary, when the traversal speed is increased, the winding width becomes shorter than the winding width X1 of the normal winding times, though it is not illustrated. Thus, the actual winding width changes with the change of the traversal speed. Accordingly, in the above-described arrangement in which the traverse width of each traverse unit 19 is changeable, it is possible to keep the winding width constant by adjusting the traverse width depending on the change of the traversal speed.

[0067] For example, in the present embodiment, it is preferable that when decreasing the traversal speed of one or more of the traverse units 19, the controller 20 decreases the traverse widths of the one or more traverse units 19. As described above, the slip of the yarn Y is avoidable by decreasing the traversal speed to control the position of the dancer roll 31. However, the decrease of the traversal speed makes the actual winding width longer, which may lead to cob-webbing. To deal with this, the traverse width is decreased to be shorter than W1 at the same time when the traversal speed is decreased. This makes it possible to maintain the winding width constant at X1, while avoiding the slip of the yarn Y.

[0068] Furthermore, in the present embodiment, the controller 20 is configured to perform the winding speed control of moving the positions of the dancer rolls 31A and 31B by adjusting the rotation number of the spindle 18. Performing the winding speed control makes it possible to control the position of the dancer roll 31A, 31B not only by adjusting the traversal speed, but also by adjusting the rotation number of the spindle 18.

[0069] Furthermore, in the present embodiment, the controller 20 is configured to adjust the rotation number of the spindle 18 so that one of the dancer rolls 31A and 31B moves to the reference position PO in the winding speed control. With this winding speed control, one of the dancer rolls (dancer roll 31A or 31B) is moved to the reference position PO. Due to this, merely by performing the positional difference eliminating control for the other of the dancer rolls (dancer roll 31B or 31A) so as to reduce the difference between the positions PA and PB of the dancer rolls 31A and 31B, it is possible to keep all the dancer rolls 31A and 31B at the reference position PO.

[0070] Furthermore, in the present embodiment, the controller 20 adjusts, in the winding speed control, the rotation number of the spindle 18 so that the lowest one of the dancer rolls 31A and 31B moves to the reference position PO. When the winding speed control is performed so that the lowest one of the dancer rolls (dancer roll 31A or 31B) moves to the reference position PO, the other one of the dancer rolls (dancer roll 31B or 31A) shall be positioned higher than the reference position PO. When performing the positional difference eliminating control to the other one of the dancer rolls (dancer roll 31B or 31A) so as to reduce the difference from the position (PA or PB) of the one of the dancer rolls (dancer roll 31A or 31B), the traversal speed shall be decreased. Accordingly, the slip of the yarn Y is avoidable, as described above.

(Other Embodiments)

[0071] While the above-described embodiment deals with an example of the positional control of the dancer rolls 31, the specific contents of the control are not limited to those described in the above embodiment. For example, in the winding speed control, one of the dancer rolls 31 which has been selected beforehand may be moved to the reference position PO, or the rotation number of the spindle 18 may be adjusted so that the average position of the plurality of dancer rolls 31 is level with the reference position PO. Furthermore, in the positional difference eliminating control, the dancer roll(s) 31 to be moved is changeable as needed, and two or more dancer rolls 31 may be moved at the same time, that is, the traversal speeds of two or more traverse units 19 may be changed at the same time.

[0072] The winding speed control and the positional difference eliminating control in another embodiment are described with reference to FIG. 7 and FIG. 8. In the winding speed control of the other embodiment, the rotation number of the spindle 18 is adjusted so that the dancer roll 31A is returned to the reference position PO. First of all, the controller 20 obtains the position PA of the dancer roll 31A, which is detected by the position sensor 34A (Step S40). Then, the controller 20 determines whether the position PA of the dancer roll 31A is higher than the reference position PO (Step S41). When the position PA of the dancer roll 31A is higher than the position PO (Step S41: YES), the controller 20 reduces the rotation number of the spindle 18 so as to lower the position PA of the dancer roll 31A to the reference position PO (Step S42), and the processing of the winding speed control ends. When the result of the determination in Step S41 is NO, the controller 20 determines whether the position PA of the dancer roll 31A is lower than the reference position PO (Step S43). When the result of the above determination shows that the position PA of the dancer roll 31A is lower than the reference position PO (Step S43: YES), the controller 20 increases the rotation number of the spindle 18 so as to raise the position PA of the dancer roll 31A to the reference position PO (Step S44), and the processing of the winding speed control ends. When the result of the above determination in Step S43 is NO, the result shows that the position PA of the dancer roll 31A is level with the reference position PO, and therefore the processing of the winding speed control ends without changing the rotation number of the spindle 18.

[0073] In the positional difference eliminating control

of the other embodiment, when there is a large difference between the position PA of the dancer roll 31A and the position PB of the dancer roll 31B, the traversal speed of the traverse unit 19B is adjusted so as to move the dancer roll 31B to the reference position PO. First of all, the controller 20 obtains the positions PA and PB of the dancer rolls 31A and 31B, which are respectively detected by the position sensors 34A and 34B (Step S50). Then, the controller 20 determines whether the difference between the position PA of the dancer roll 31A and the position PB of the dancer roll 31B is within (equal to or smaller than) a predetermined threshold PX (Step S51). When the difference between the position PA of the dancer roll 31A and the position PB of the dancer roll 31B is equal to or smaller than the threshold PX (Step S51: YES), the processing of the positional difference eliminating control ends without changing the traversal speed of any of the traverse units 19A and 19B.

[0074] Meanwhile, when the difference between the position PA of the dancer roll 31A and the position PB of the dancer roll 31B exceeds the threshold PX (Step S51: NO), the controller 20 determines whether the position PB of the dancer roll 31B is higher than the reference position PO (Step S52). When the result of the above determination shows that the position PB of the dancer roll 31B is higher than the reference position PO (Step S52: YES), the controller 20 decreases the traversal speed of the traverse unit 19B for a predetermined period of time so as to lower the position PB of the dancer roll 31B to the reference position PO (Step S53). Then, the controller 20 returns the traversal speed of the traverse unit 19B back to its original speed (Step S54), and the processing of the positional difference eliminating control ends. Meanwhile, when the result of the determination in Step S52 is NO, the controller 20 increases the traversal speed of the traverse unit 19B for a predetermined period of time so as to raise the position PB of the dancer roll 31B to the reference position PO (Step S55). Then, the controller 20 returns the traversal speed of the traverse unit 19B back to its original speed (Step S56), and the processing of the positional difference eliminating control ends.

[0075] Thus, the positional control of the dancer rolls 31 of the other embodiment is arranged such that: the winding speed control is made so as to move the dancer roll 31A to the reference position PO; and the positional difference eliminating control is made so as to move the dancer roll 31B to the reference position PO. That is, the dancer roll to be controlled is fixed in each control processing, and this simplifies the positional control.

[0076] In the above-described embodiment, the yarn winder 1 is configured so that each common spindle 18 supports two bobbins (packages P). In this regard, however, three or more bobbins B (packages P) may be supported by one spindle 18.

[0077] Furthermore, while in the above-described embodiments, the reference position PO of the dancer rolls 31 is defined as a predetermined position, the reference position PO may be defined as a predetermined range.

Claims

1. A yarn winder including at least one common spindle each configured to support a plurality of bobbins, the yarn winder configured to rotate the spindle to wind yarns onto the bobbins respectively to form packages, the yarn winder comprising:

   traverse units configured to traverse the yarns respectively;
   dancer rolls onto which the yarns are respectively wound, each of the dancer rolls configured to be movable from a predetermined reference position toward a relaxation side on which a corresponding one of the yarns is relaxed and toward a tension side on which yarn slack is removed;
   position detectors configured to detect positions of the dancer rolls, respectively; and
   a controller configured to control a position of at least one of the dancer rolls based on outputs from the position detectors by adjusting traversal speed of corresponding at least one of the traverse units traversing the yarn wound onto the at least one of the dancer rolls.

2. The yarn winder according to claim 1, wherein when a difference between positions of freely-selected two of the dancer rolls exceeds a predetermined threshold, the controller performs positional difference eliminating control of reducing the difference between the positions of the two dancer rolls to a level equal to or smaller than the threshold by adjusting the traversal speed of at least one of two traverse units traversing the yarns wound onto the two dancer rolls.

3. The yarn winder according to claim 2, wherein in the positional difference eliminating control, the controller is configured to decrease the traversal speed of a corresponding one of the two traverse units which traverses the yarn wound onto a relaxation-side dancer roll of the two dancer rolls, the relaxation-side dancer roll being on the relaxation side relatively to the other dancer roll.

4. The yarn winder according to claim 2 or 3, wherein the controller is configured to perform processing of the positional difference eliminating control within a time period of a single reciprocation cycle in which the traverse unit reciprocates the yarn once in a traverse direction.

5. The yarn winder according to any one of claims 2 to 4, in which the at least one spindle includes two spin-

dles, the yarn winder further comprising:

a switching device configured to support the two spindles so that positions of the two spindles are interchangeable with each other between a winding position at which the yarns are respectively wound onto the bobbins and a collection position at which the packages are collected; and

a plurality of cutting means configured to respectively cut the yarns leading to the packages supported by the spindle having been moved from the winding position to the collection position by the switching device, wherein

the controller is configured to perform the positional difference eliminating control immediately before interchanging the positions of the two spindles by the switching device, irrespective of whether or not the difference between the positions of the two dancer rolls exceeds the threshold.

6. The yarn winder according to claim 5, wherein the controller is configured to perform the positional difference eliminating control immediately after the yarns are cut by the plurality of cutting means, irrespective of whether or not the difference between the positions of the two dancer rolls exceeds the threshold.

7. The yarn winder according to any one of claims 1 to 6, wherein the controller is capable of changing traverse widths of the traverse units.

8. The yarn winder according to claim 7, wherein when decreasing the traversal speeds of one or more of the traverse units, the controller is configured to decrease the traverse widths of the one or more traverse units.

9. The yarn winder according to any one of claims 1 to 8, wherein the controller is configured to perform winding speed control of moving the positions of the dancer rolls by adjusting a rotation number of the spindle.

10. The yarn winder according to claim 9, wherein in the winding speed control, the controller is configured to adjust the rotation number of the spindle so that one of the dancer rolls is moved to the reference position.

11. The yarn winder according to claim 10, wherein in the winding speed control, the controller is configured to adjust the rotation number of the spindle so that out of the dancer rolls, the dancer roll positioned farthest on the tension side from the reference position is moved to the reference position.

FIG.1

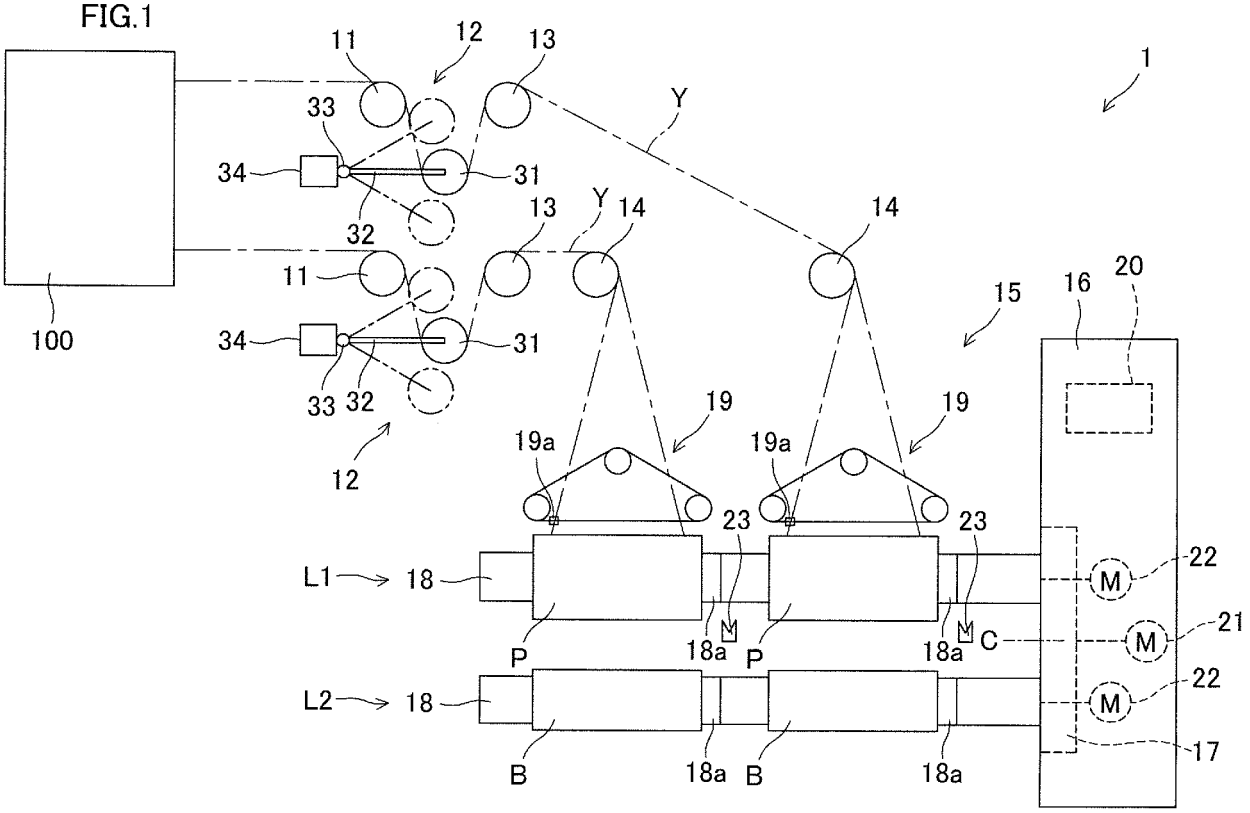

1
11
12
13
Y
33
34
31
32
14
100
15
16
20
19
19a
23
18
L1
L2
P
B
18a
C
M
21
22
17

FIG.2

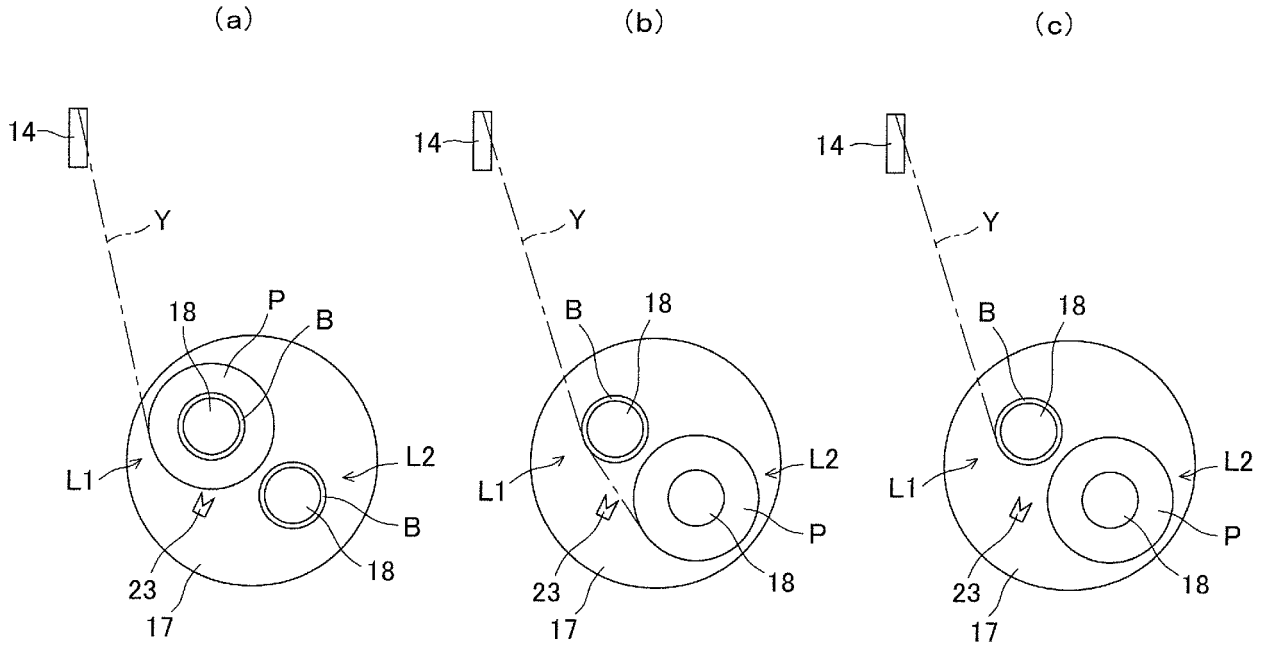


FIG.3

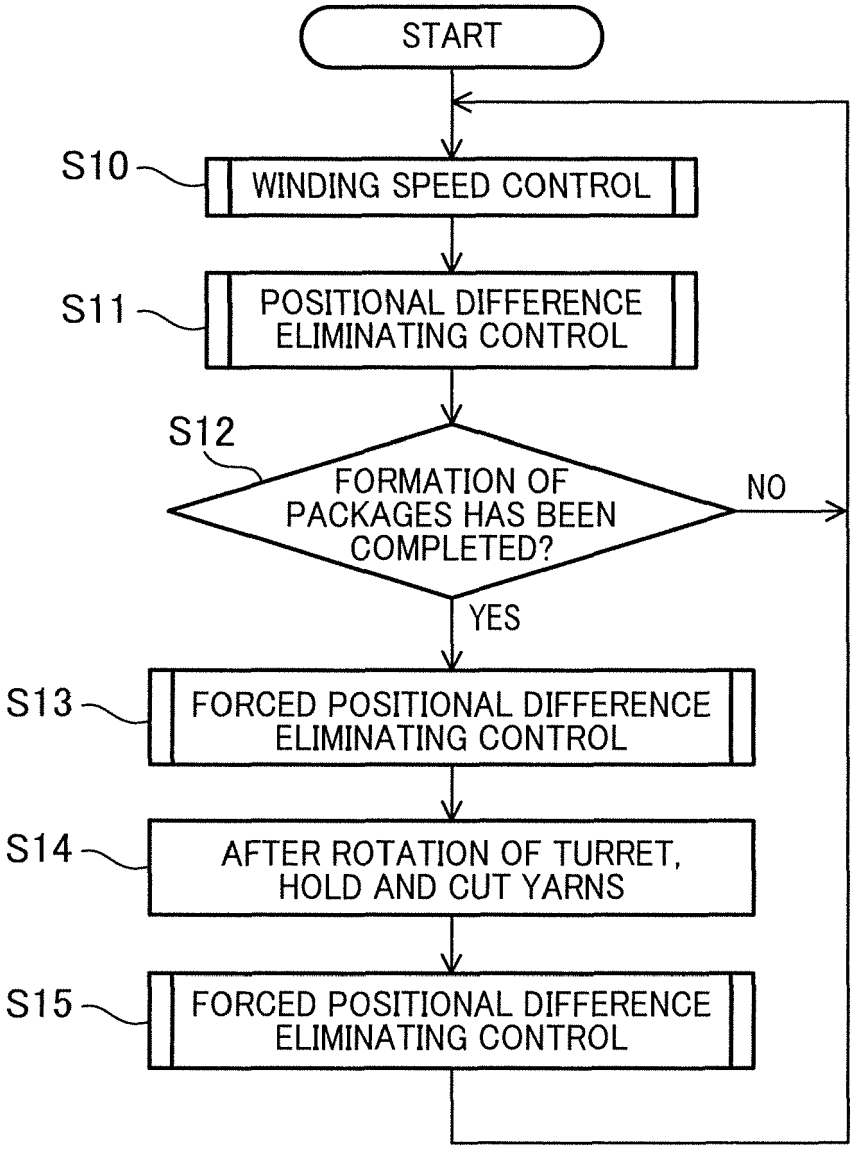

START
S10
WINDING SPEED CONTROL
S11
POSITIONAL DIFFERENCE ELIMINATING CONTROL
S12
FORMATION OF PACKAGES HAS BEEN COMPLETED?
NO
YES
S13
FORCED POSITIONAL DIFFERENCE ELIMINATING CONTROL
S14
AFTER ROTATION OF TURRET, HOLD AND CUT YARNS
S15
FORCED POSITIONAL DIFFERENCE ELIMINATING CONTROL

FIG.4

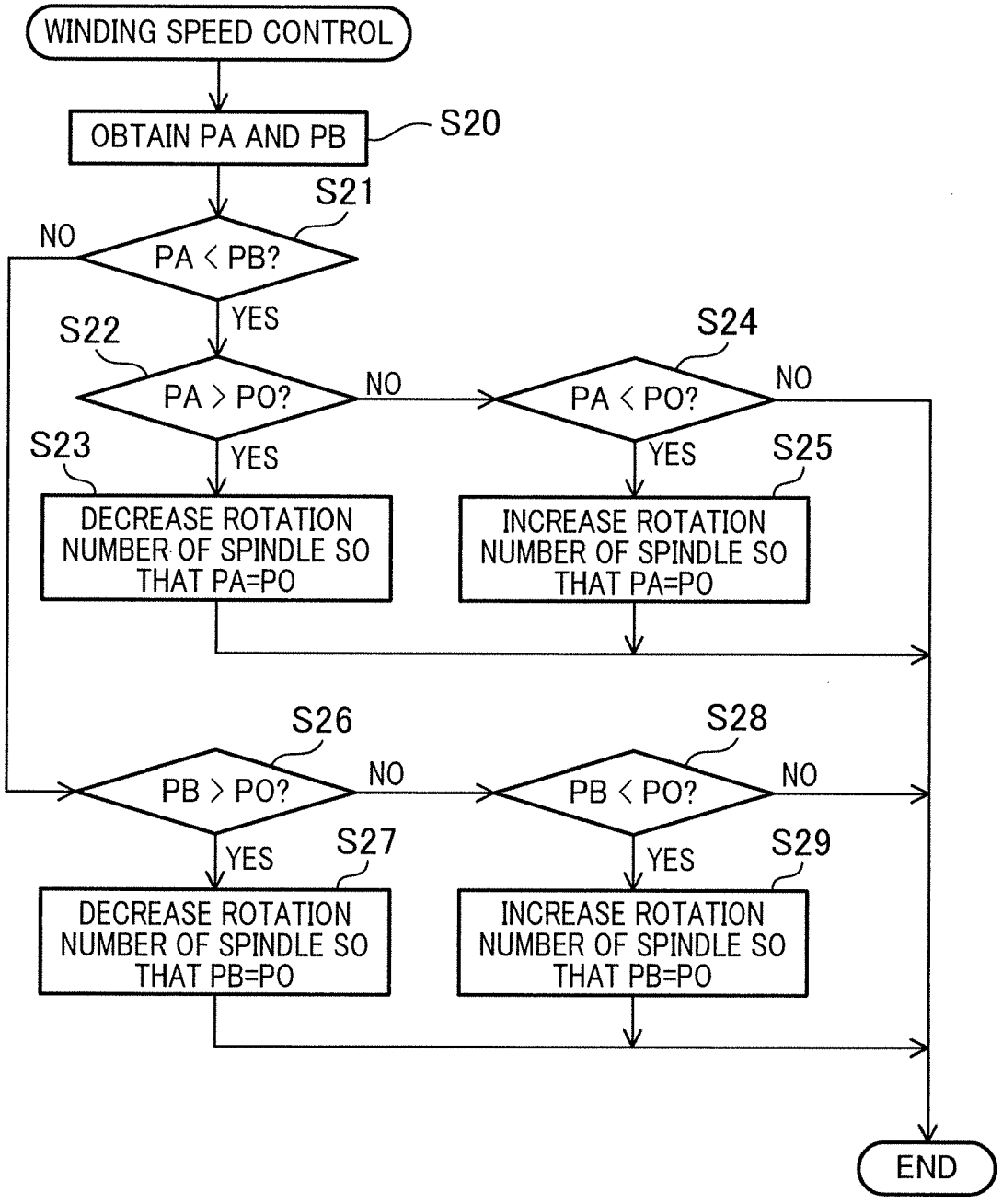

WINDING SPEED CONTROL
OBTAIN PA AND PB
S20
S21
PA < PB?
NO
YES
S22
PA > PO?
NO
YES
S23
DECREASE ROTATION NUMBER OF SPINDLE SO THAT PA=PO
S24
PA < PO?
NO
YES
S25
INCREASE ROTATION NUMBER OF SPINDLE SO THAT PA=PO
S26
PB > PO?
NO
YES
S27
DECREASE ROTATION NUMBER OF SPINDLE SO THAT PB=PO
S28
PB < PO?
NO
YES
S29
INCREASE ROTATION NUMBER OF SPINDLE SO THAT PB=PO
END

FIG.5

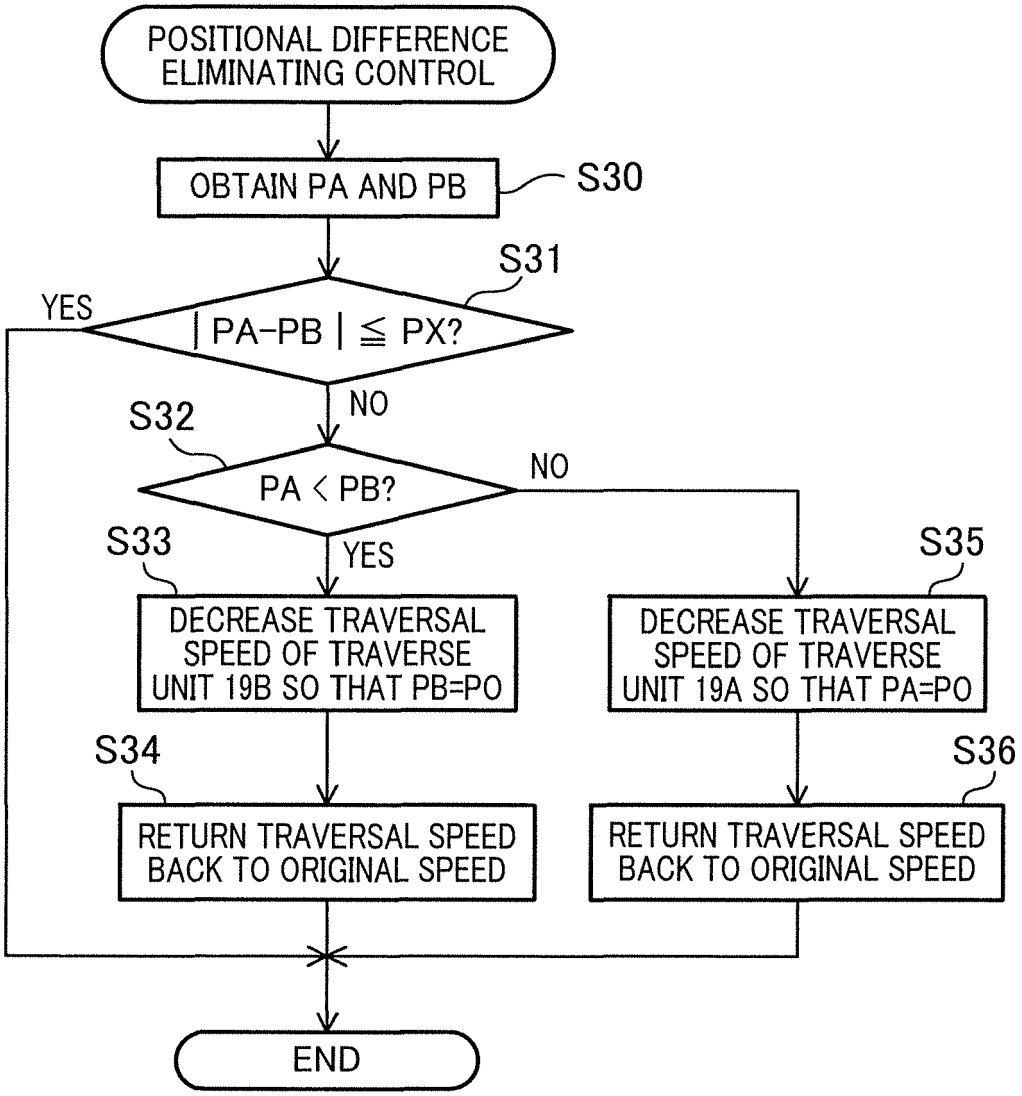

POSITIONAL DIFFERENCE ELIMINATING CONTROL
OBTAIN PA AND PB
S30
S31
YES
| PA-PB | ≦ PX?
NO
S32
PA < PB?
NO
S33
YES
S35
DECREASE TRAVERSAL SPEED OF TRAVERSE UNIT 19B SO THAT PB=PO
DECREASE TRAVERSAL SPEED OF TRAVERSE UNIT 19A SO THAT PA=PO
S34
S36
RETURN TRAVERSAL SPEED BACK TO ORIGINAL SPEED
RETURN TRAVERSAL SPEED BACK TO ORIGINAL SPEED
END

FIG.6

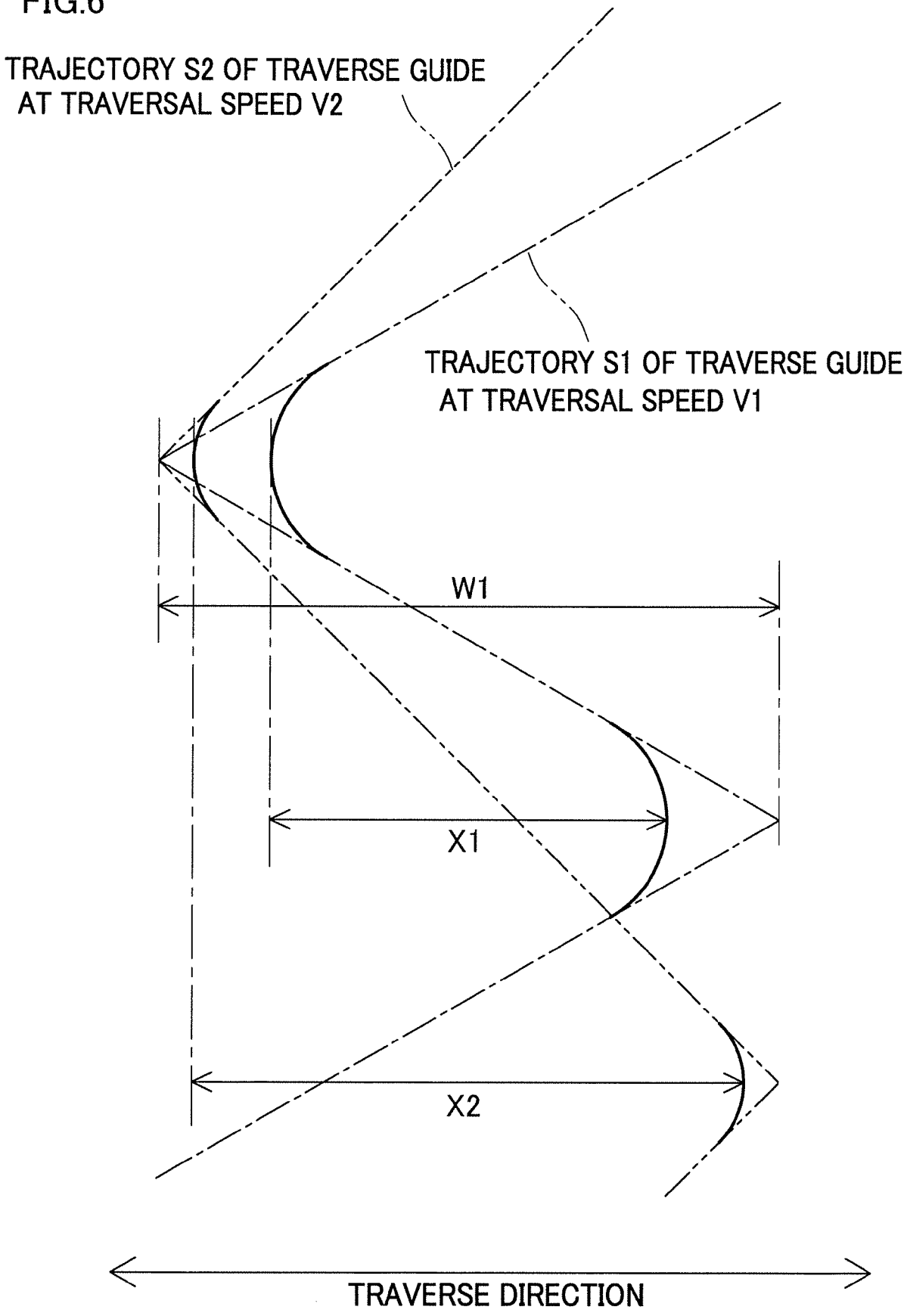

TRAJECTORY S2 OF TRAVERSE GUIDE AT TRAVERSAL SPEED V2
TRAJECTORY S1 OF TRAVERSE GUIDE AT TRAVERSAL SPEED V1
W1
X1
X2
TRAVERSE DIRECTION

FIG.7

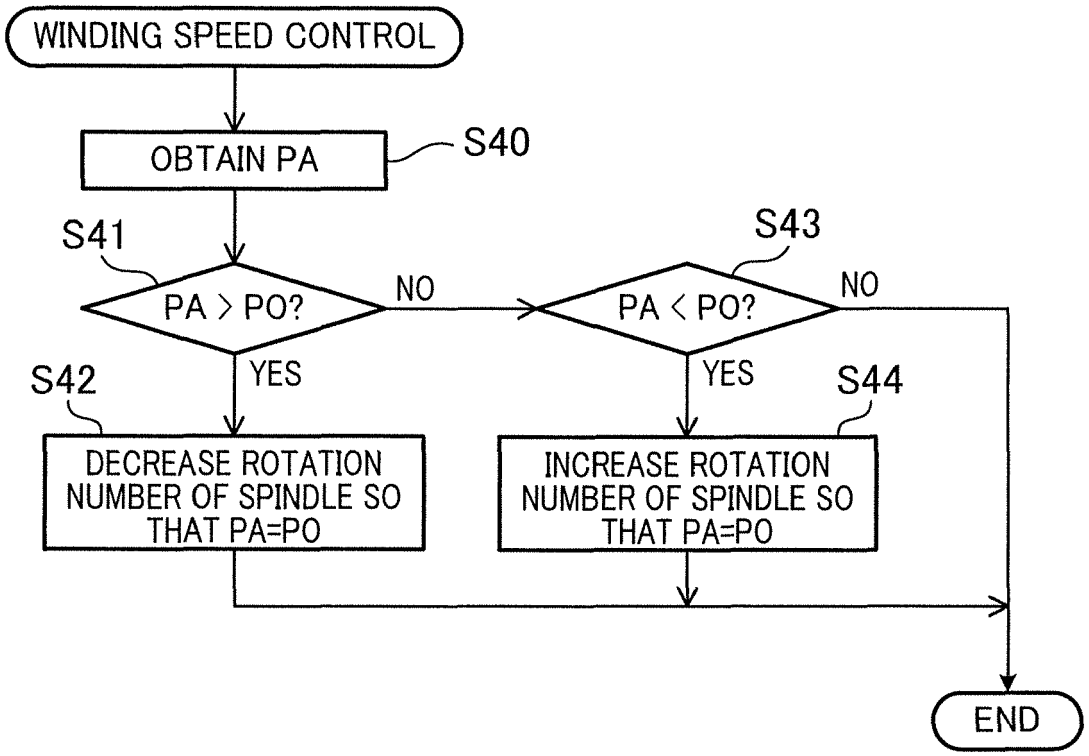
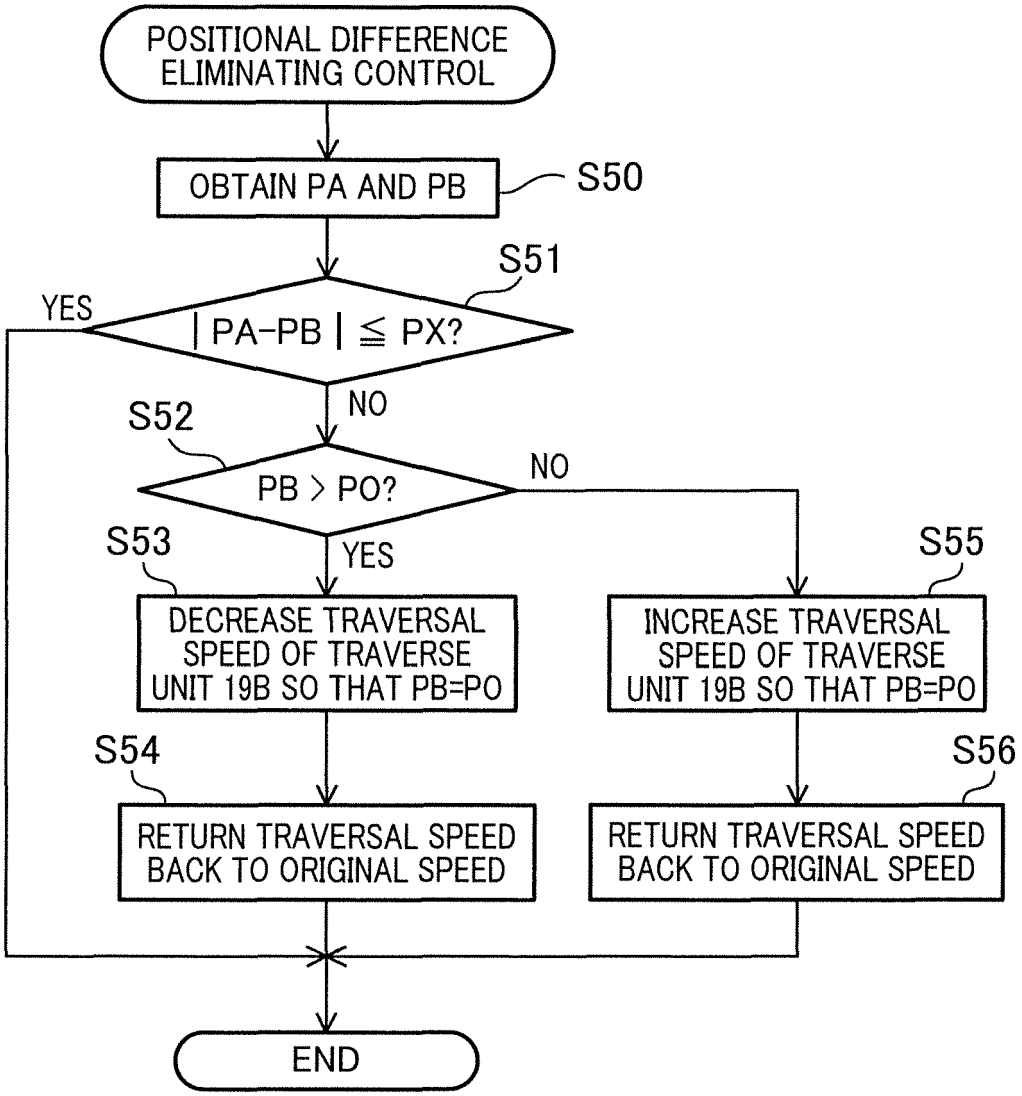

WINDING SPEED CONTROL
OBTAIN PA
S40
S41
PA > PO?
NO
S43
PA < PO?
NO
YES
YES
S42
S44
DECREASE ROTATION NUMBER OF SPINDLE SO THAT PA=PO
INCREASE ROTATION NUMBER OF SPINDLE SO THAT PA=PO
END

FIG.8


POSITIONAL DIFFERENCE ELIMINATING CONTROL
OBTAIN PA AND PB
S50
S51
YES
| PA-PB | ≦ PX?
NO
S52
PB > PO?
NO
S53
YES
S55
DECREASE TRAVERSAL SPEED OF TRAVERSE UNIT 19B SO THAT PB=PO
INCREASE TRAVERSAL SPEED OF TRAVERSE UNIT 19B SO THAT PB=PO
S54
S56
RETURN TRAVERSAL SPEED BACK TO ORIGINAL SPEED
RETURN TRAVERSAL SPEED BACK TO ORIGINAL SPEED
END

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EUROPEAN SEARCH REPORT

Application Number
EP 18 15 5075

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	6 July 2018	Lemmen, René

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X : particularly relevant if taken alone
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D : document cited in the application
L : document cited for other reasons

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