



(11)

EP 3 569 538 A1

(12)

EUROPEAN PATENT APPLICATION
published in accordance with Art. 153(4) EPC

(43) Date of publication:
20.11.2019 Bulletin 2019/47

(51) Int Cl.:
B65H 63/00 (2006.01) B65H 54/28 (2006.01)

(21) Application number: **17891476.8**

(86) International application number:
PCT/JP2017/047267

(22) Date of filing: **28.12.2017**

(87) International publication number:
WO 2018/131511 (19.07.2018 Gazette 2018/29)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD TN

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

(72) Inventor: **MINAMINO, Katsushi**
Kyoto-shi
Kyoto 612-8686 (JP)

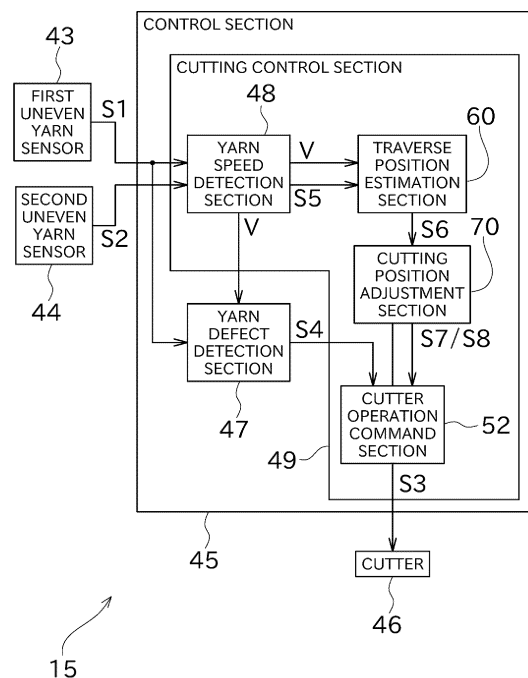
(74) Representative: **Hoffmann Eitle**
Patent- und Rechtsanwälte PartmbB
Arabellastraße 30
81925 München (DE)

(30) Priority: **13.01.2017 JP 2017003938**

(54) **YARN CUTTING CONTROLLING DEVICE, YARN MONITORING DEVICE, AND YARN WINDING DEVICE**

(57) A cutting control section (49) included in a yarn monitoring device (15) controls an operation of a cutter (46) for cutting a yarn that is wound into a package while being traversed, based on a yarn defect detection signal S4. The cutting control section (49) includes a yarn speed detection section (48), a traverse position estimation section (60), and a cutting position adjustment section (70). The yarn speed detection section (48) detects a yarn speed V in which the yarn travels. The traverse position estimation section (60) estimates a traverse position of a yarn based on the yarn speed V that is detected by the yarn speed detection section (48). The cutting position adjustment section (70) adjusts a cutting position where the cutter (46) cuts the yarn, depending on the estimated traverse position of the yarn.

Fig.3



Description

TECHNICAL FIELD

[0001] The present invention mainly relates to a yarn cutting control device capable of adjusting a cutting position for cutting a yarn by using a cutting device.

BACKGROUND ART

[0002] In a yarn winding device adapted to wind a yarn into a package while traversing the yarn, when the yarn is cut depending on detection of a yarn defect, etc., a configuration of a yarn cutting at a timing excluding the timing when the yarn is positioned near a traverse return position has been conventionally known. Patent Document 1 discloses an automatic winder as this kind of yarn winding device.

[0003] The automatic winder of Patent Document 1 is an automatic winder for rewinding a yarn into a package while traversing the yarn and for cutting a yarn depending on detection of a yarn defect. The automatic winder includes a detection mean adapted to detect a traverse movement of the yarn and a control mean for which a cutting timing of the yarn depending on detection of the yarn defect is controlled based on a detection signal of the detection mean. The control mean is adapted to control a yarn cutting depending on detection of the yarn defect at a timing when the yarn is positioned in a traverse area, within a range excluding a position near a traverse return position on at least one end face side of the package, based on the detection signal of the detection mean.

[0004] According to the above-described configuration of Patent Document 1, when a current position of the yarn is located near the traverse return position, delay of a timing of cutting the yarn can prevent the yarn from being dropped off an end face of the package (hereinafter, may be referred to as "an end face drop (end missing)").

PRIOR-ART DOCUMENTS

PATENT DOCUMENTS

[0005] Patent Document 1: Japanese Patent Number 4042271

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0006] The detection mean in the above-described Patent Document 1 includes a plurality of position detection sensors that is an optical sensor constituted by a light emitting element and a light receiving element. Each of the plurality of position detection sensors is arranged in the middle of a travel path of a yarn which travels from a yarn monitoring device to a package (in a traverse re-

gion). Each of the plurality of position detection sensors directly detects a timing when the yarn is positioned near a traverse return position by detecting a moment when the yarn passes as a moment when the light is blocked.

Therefore, in order to appropriately control a timing of cutting the yarn, each of the position detection sensors needs to be mounted to an accurate position.

[0007] However, it may have been difficult to mount each position detection sensor at the accurate position in the traverse area, due to an influence of an assembly error that is occurred when each position detection sensor is mounted to a support bracket and a mounting error that is occurred when the support bracket is mounted to an appropriate position of an automatic winder. Once each position detection sensor is mounted to a predetermined position, in general, such position of each position detection sensor is not changed. Therefore, it has been difficult to flexibly change a traverse position (range) in which a yarn cutting is prohibited depending on physical properties of the yarn and the like. Furthermore, in order to control a timing of cutting the yarn with the above-described configuration, a detection signal that is detected by the detection mean needs to be input to a control mean adapted to control operation of the entire automatic winder, and a yarn defect detection signal that is detected by a slab catcher (yarn monitoring device) also needs to be input to the control mean. Therefore, a signal communication between components is complicated, and it is difficult to simplify a configuration for control. In the above-described points, there is room for improvement in the configuration in the above-described Patent Document 1.

[0008] The present invention has been made in view of the circumstances described above, and an object of the present invention is to simplify a configuration of a yarn cutting control device capable of adjusting a cutting position where the yarn is cut by using a cutting device depending on a traverse position of the yarn.

MEANS FOR SOLVING THE PROBLEMS AND EFFECTS THEREOF

[0009] Problems to be solved by the present invention are as described above, and next, means for solving the problems and effects thereof will be described.

[0010] According to the first aspect of the present invention, a yarn cutting control device with the following configuration is provided. That is, the yarn cutting control device controls operation of a cutting device for cutting a yarn that is wound into a package while being traversed. The yarn cutting control device includes a yarn speed detection section, a traverse position estimation section, and a cutting position adjustment section. The yarn speed detection section detects a yarn speed in which a yarn travels. The traverse position estimation section estimates a traverse position of the yarn based on the yarn speed that is detected by the yarn speed detection section. The cutting position adjustment section adjusts a

cutting position where the cutting device cuts the yarn depending on the traverse position of the yarn that is estimated by the traverse position estimation section.

[0011] Accordingly, an end face drop (end missing) of the yarn can be prevented by adjusting the cutting position where the cutting device is operated to cut the yarn depending on the traverse position of the yarn, for example, by not cutting the yarn at a position where the end face drop of the yarn may be occurred. Since the traverse position estimation section estimates the traverse position of the yarn based on the yarn speed that is detected by the yarn speed detection section, a simple configuration can be realized as compared with a case of a configuration having a sensor which directly detects the traverse position of the yarn.

[0012] In the yarn cutting control device, the cutting position adjustment section preferably adjusts a traveling distance of the yarn at a time of operating the cutting device such that the cutting device is operated after a traverse position is moved to a center side in a traverse region in a case that the traverse position of the yarn is located at an end portion of the traverse region of the package. The term "an end portion of the traverse region of the package" as used herein means the traverse region of the package, specifically a region that is closer to an end face of the package.

[0013] Accordingly, the end face drop of the yarn can be prevented by a simple control to increase the traveling distance of the yarn when the cutting device is operated.

[0014] In the yarn cutting control device, the traverse position estimation section estimates the traverse position based on characteristics of the yarn speed that is detected by the yarn speed detection section.

[0015] Accordingly, the cutting position where the yarn is cut can be adjusted to an appropriate position with a simple configuration, as compared with a case of a configuration in which the traverse position is directly detected by a position sensor or the like that is arranged in the traverse region.

[0016] The yarn cutting control device is preferably configured as follows. That is, the package has a cone shape whose diameter increases from one end to the other end in an axial direction. The traverse position estimation section estimates the traverse position based on the traveling distance of the yarn when an extremal value appears in a process of periodically increasing and decreasing the yarn speed that is detected by the yarn speed detection section.

[0017] Accordingly, the traverse position can be appropriately estimated by utilizing periodic increase and decrease in the yarn speed when the yarn is wound to form the package having the cone shape.

[0018] The yarn cutting control device is preferably configured as follows. That is, the traverse position estimation section includes a yarn speed smoothing section adapted to smooth data indicating periodic change in the yarn speed that is detected by the yarn speed detection section. The traverse position estimation section esti-

mates the traverse position based on the traveling distance of the yarn when an extremal value appears in a process of periodically increasing and decreasing the yarn speed after the yarn speed smoothing section smooths the data.

[0019] Accordingly, since errors caused by a fine irregular fluctuation which occurs in the yarn speed can be suppressed, the traverse position can be accurately estimated.

[0020] In the yarn cutting control device, the yarn speed smoothing section preferably smooths the data indicating periodic change in the yarn speed by a moving-average method.

[0021] Accordingly, points of a moving average are appropriately defined, and thereby tendency of increase and decrease in the yarn speed which appears depending on the traverse position can be favorably grasped while suppressing the errors caused by the fine irregular fluctuation occurring in the yarn speed. As a result, the traverse position can be accurately estimated. The yarn speed can be also smoothed with a simple calculation.

[0022] In the yarn cutting control device, the traverse position estimation section preferably estimates the traverse position of the yarn based on a traveling distance between at least two latest yarn travel positions where a local maximal value of the yarn speed appears or a traveling distance between at least two latest yarn travel positions where a local minimal value of the yarn speed appears.

[0023] Accordingly, the traverse position of the yarn can be appropriately estimated based on the traveling distance of the yarn. With reference to the traveling distance of the yarn when the local maximal value or the local minimal value appears in the yarn speed, a cycle of increase and decrease in the yarn speed can be easily and clearly grasped, and thereby the traveling distance of the yarn corresponding to one cycle (one traverse) of increase and decrease in the yarn speed can be accurately obtained. Furthermore, the traveling distance of the yarn corresponding to one traverse may be changed as increasing a diameter of the package. However, in this configuration, since the traverse position of the yarn is estimated based on, for example, the yarn traveling distance in one cycle of the latest increase and decrease in the yarn speed, an estimation accuracy of the traverse position can be stabilized.

[0024] The yarn cutting control device is preferably configured as follows. That is, the yarn cutting control device includes a prohibition determination section adapted to determine whether or not the cutting device can be operated and to output a command signal for instructing a cutting device operation command section to operate or not to operate the cutting device, based on the traverse position of the yarn that is estimated by the traverse position estimation section. The prohibition determination section determines whether or not the cutting device can be operated based on a traverse traveling distance that is a traveling distance of the yarn that is

detected during a latest one cycle of increase and decrease in the yarn speed, a prohibited range representing a range where a yarn cutting is prohibited in one cycle of traverse with reference to a traveling distance of the yarn when the local maximal value or the local minimal value of the yarn speed appears, and a traveling distance of the yarn that is detected from a latest yarn travel position where the local maximal value or the local minimal value of the yarn speed appears to the current position.

[0025] Accordingly, whether or not the cutting device can be operated is appropriately and easily determined by detecting the traveling distance where the yarn has traveled from the latest yarn travel position at which the local maximal value/local minimal value of the yarn speed appeared to the current position, and checking whether or not this traveling distance is within a range of the traveling distance where the yarn cutting is prohibited in the prohibited range. This can prevent the end face drop of the yarn. Furthermore, the traveling distance of the yarn corresponding to one cycle of traverse is changed as increasing the diameter of the package, however, in this configuration, whether or not the cutting device can be operated is determined based on the traveling distance of the yarn in the latest one cycle in which the yarn speed increases and decreases. Therefore, the end face drop of the yarn can be stably prevented without being affected by an increase in the package diameter. The cutting device operation command section is preferably configured to output an operation command signal to the cutting device and to cause the cutting device to be operated.

[0026] The yarn cutting control device is preferably configured as follows. That is, the yarn cutting control device is configured to change a length of a cutting prohibition traverse range that is a range where the yarn cutting is prohibited at an end portion of the traverse region of the package. The cutting position adjustment section adjusts the traveling distance of the yarn when the cutting device is operated such that the cutting device is operated after the traverse position of the yarn is moved and deviated from the cutting prohibition traverse range in a case that the traverse position that is estimated in the traverse position estimation section is within the cutting prohibition traverse range when a yarn cutting signal requiring the yarn cutting is input to the yarn cutting control device.

[0027] Accordingly, since the cutting device is operated to cut the yarn after delaying until the yarn reaches a position deviated from the cutting prohibition traverse range, the end face drop of the yarn can be surely prevented. Since the length of the cutting prohibition traverse range can be changed by software, an operator can flexibly change the length of the cutting prohibition traverse range in consideration of physical properties of the yarn, etc. This can improve convenience.

[0028] According to a second aspect of the present invention, a yarn monitoring device with the following configuration is provided. That is, the yarn monitoring

device includes the yarn cutting control device, and further includes a yarn defect detection section adapted to detect a defect of the yarn. When the yarn defect is detected, the yarn defect detection section outputs a yarn defect detection signal as the yarn cutting signal requiring the yarn cutting, to the yarn cutting control device, upon detection of the defect of the yarn.

[0029] Accordingly, when the yarn defect detection section detects the yarn defect, the yarn can be cut by a cutter at the traveling distance of the yarn that is adjusted such that the end face drop of the yarn does not occur.

[0030] The yarn monitoring device preferably includes the cutting device.

[0031] Accordingly, communication of control signals from detection of the yarn defect to operation of the cutting device is easily completed in the yarn monitoring device, which can simplify a configuration.

[0032] In the yarn monitoring device, the cutting device is preferably a cutter.

[0033] Accordingly, the yarn can be cut with a simple configuration.

[0034] The yarn winding device is preferably configured as follows. That is, the yarn winding device includes a yarn feed part and a package forming part. A yarn feed bobbin is supported in the yarn feed part. The package forming part winds a yarn of the yarn feed bobbin in the yarn feed part to form the package. The yarn monitoring device is arranged between the yarn feed part and the package forming part.

[0035] Accordingly, the yarn winding device with a simple configuration that is less likely to occur the end face drop of the yarn.

[0036] The yarn winding device is preferably configured as follows. That is, the yarn winding device includes a winding drum, a yarn joining device, and a control section. The winding drum comes in contact with the package and drives the package to rotate in order to wind the yarn from the yarn feed part into the package. The yarn joining device performs a yarn joining between the yarn from the yarn feed part and the yarn from the package forming part when the cutting device has operated to cut the yarn. The control section controls the yarn winding device. The control section controls the winding drum such that the package is reversed until the yarn is pulled out of the package over a length longer than or equal to the traveling distance of the yarn from a yarn position when the defect of the yarn has detected in the yarn defect detection section to a position where the cutting device is operated to cut the yarn, and then causes the yarn joining device to perform yarn joining operation.

[0037] That is, in the yarn winding device having the above-described yarn monitoring device, even if the yarn monitoring device detects the yarn defect, a timing of the operation of the cutting device may be delayed in order to prevent the end face drop. In this respect, according to the present configuration, even if the yarn is additionally wound into the package for the delayed length in the operation of the cutting device, the yarn joining device

performs the yarn joining operation after a sufficient length of the yarn including the additional length is pulled out of the package. Therefore, the yarn defect that is detected by the yarn monitoring device can be surely removed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0038]

[Fig. 1] A side view of a winder unit according to one embodiment of the present invention.

[Fig. 2] A front elevational view of the winder unit.

[Fig. 3] A block diagram showing a configuration of a yarn monitoring device included in the winder unit.

[Fig. 4] A block diagram showing a configuration of a traverse position estimation section and a cutting position adjustment section.

[Fig. 5]

(a) A graph showing data of periodic change in a yarn speed before smoothing.

(b) A graph showing data of periodic change after smoothing by a moving-average method.

[Fig. 6] A graph explaining a process to calculate a reference position to be estimated that the yarn is located at an end portion of a traverse region of a package and a distance interval for calculating a latest traverse traveling distance, by using data indicating periodic change in the yarn speed.

[Fig. 7] A drawing explaining a cutting prohibition traverse range that is set in the end portion of the traverse region of the package.

[Fig. 8] A drawing explaining a prohibition traverse ratio that is calculated based on the cutting prohibition traverse range.

[Fig. 9] A flowchart showing a process performed by a traverse position estimation section and a cutting position adjustment section in order to adjust a position of a yarn cutting.

[Fig. 10] A flowchart showing a process performed by a unit control section.

EMBODIMENT FOR CARRYING OUT THE INVENTION

[0039] Next, a configuration of a yarn monitoring device having a yarn cutting control device and an automatic winder having the yarn monitoring device according to one embodiment of the present invention will be described with reference to drawings. Fig. 1 is a side view of a winder unit 10 according to one embodiment of the present invention. Fig. 2 is a front elevational view of the winder unit 10.

[0040] The winder unit 10 as a yarn winding device shown in Fig. 1 and Fig. 2 winds a spun yarn 20 (hereinafter, may be referred to as a "yarn".) that is unwound from a yarn feed bobbin 21 onto a wound bobbin 22 while

traversing the spun yarn 20, and then forms a package 30 with a predetermined length and a predetermined shape (in this embodiment, with a cone shape whose diameter increases as approaching from one end to the other end). The automatic winder of this embodiment includes the plurality of winder units 10 arranged side by side, and a machine control device (not shown) arranged at one end in a direction where the plurality of winder units 10 is arranged side by side.

[0041] Each of the winder units 10 includes an unit frame 11 provided on one side in left or right in a front view as shown in Fig. 1, and a winding unit body 16 provided on a side of the unit frame 11. The winding unit body 16 mainly includes a package forming part 31 and a yarn feed part 28. The package forming part 31 is also referred to as a winding part.

[0042] The yarn feed part 28 supports the yarn feed bobbin 21 in which the yarn 20 is wound, in a substantially upright position. The yarn feed bobbin 21 of this embodiment is supplied to a supporting part of the yarn feed part 28 by a magazine type feed device 9 shown in Fig. 1, for example. A feed type of the yarn feed bobbin 21 is not limited to the magazine type. For example, the yarn feed bobbin 21 is supplied by a tray type feed device.

[0043] The package forming part 31 is adapted to wind the yarn of the yarn feed bobbin 21 in the yarn feed part 28 and form the package 30. Specifically, the package forming part 31 includes a cradle 23 for rotatably supporting a wound bobbin 22, and a winding drum 24 for traversing the yarn 20 and causing the wound bobbin 22 to be driven. The cradle 23 is configured to be swung in a direction close to or away from the winding drum 24. Accordingly, even if the diameter of the package 30 increases as being wound the yarn 20 onto the package 30, the package 30 can be stably driven in rotation by the winding drum 24. As shown in Fig. 2, a traverse 27 with a spiral shape (helix shape) is formed on an outer circumferential surface of the winding drum 24. The winding drum 24 is rotated in a state that the yarn 20 is positioned inside the traverse groove 27, and thereby the yarn 20 is traversed.

[0044] The winding drum 24 that is arranged opposite to the wound bobbin 22 is driven in rotation and thereby the wound bobbin 22 is accordingly rotated. The yarn 20 is traversed by the traverse groove 27 and also wound into a circumference of the wound bobbin 22 being rotated. The winding drum 24 is connected to an output shaft of a drum drive motor 53. The operation of the drum drive motor 53 is controlled by a motor control section 54. The motor control section 54 performs controls to drive and stop the drum drive motor 53 in response to a control signal from the unit control section 50.

[0045] A rotation sensor 42 for detecting a rotation angle of the winding drum 24 is mounted to the winding drum 24. The rotation sensor 42 is electrically connected to the unit control section 50.

[0046] In the winding unit body 16, an unwinding assist device 12, a tension applying device 13, a yarn joining

device 14, and a yarn monitoring device 15 are arranged in this order from the yarn feed part 28 side, in a yarn travel path between the yarn feed part 28 and the package forming part 31.

[0047] The unwinding assist device 12 assists an unwinding of the yarn 20 from the yarn feed bobbin 21 by lowering a restricting member 40 which overlies a core tube in conjunction with the unwinding of the yarn 20 from the yarn feed bobbin 21. The restricting member 40 comes in contact with a balloon that is formed above the yarn feed bobbin 21 by swinging the yarn 20 that is unwound from the yarn feed bobbin 21. The restricting member 40 accordingly applies an appropriate tension to the balloon, and thereby assists the unwinding of the yarn.

[0048] The tension applying device 13 applies a predetermined tension to the traveling yarn 20. For example, a gate type in which a movable comb is arranged relative to a fixed comb is used as the tension applying device 13. The movable comb can be driven in rotation by a rotary type solenoid such that the combs are brought into an engaged state with each other or a released state. The tension applying device 13 applies a predetermined tension to the yarn 20 to be wound, and thereby the quality of the package 30 can be improved.

[0049] The yarn monitoring device 15 detects a defect of the yarn 20 (hereinafter, may be referred to as "yarn defect") by monitoring the traveling yarn 20. If the yarn defect has found, the yarn monitoring device 15 cuts the yarn 20 at an appropriate timing when the end face drop does not occur. As shown in Fig. 1 to Fig. 3, the yarn monitoring device 15 mainly includes two uneven yarn sensors 43, 44, a cutter 46, and a control section 45. Each of the two uneven yarn sensors 43, 44 constituted by, for example, a light emitting element and a light receiving element detects the thickness of the yarn 20 by the amount of light (light receiving amount) that is received in the light receiving element. Both signals from the uneven yarn sensors 43, 44 are processed in the control section 45, which can detect the yarn defect and also detect the speed of the yarn 20 (hereinafter, may be referred to as "yarn speed".) which travels in the yarn monitoring device 15. Furthermore, the control section 45 controls a traveling distance of the yarn 20 at a time of cutting the yarn 20 by estimating a traverse position of the yarn 20 based on the yarn speed that is detected as described above, and outputting a cutter operation command signal (cutting device operation command signal) S3 for operating the cutter (cutting device) 46 depending on the traverse position of the yarn 20. A detailed configuration of the yarn monitoring device 15 will be described later.

[0050] The yarn joining device 14 performs yarn joining between a lower yarn in the yarn feed part 28 (yarn feed bobbin 21) side and an upper yarn in the package forming part 31 (package 30) side at a time of cutting the yarn due to detection of the yarn defect by the yarn monitoring device 15, or in a case of yarn breakage during unwinding

from the yarn feed bobbin 21. A mechanical device, a device using fluid such as compressed air or the like can be used as the yarn joining device 14.

[0051] A lower yarn guide pipe (first yarn capture guide member) 25 for capturing and guiding a lower yarn on the yarn feed part 28 side, and an upper yarn guide pipe (second yarn capture guide member) 26 for capturing and guiding the upper yarn on the package forming part 31 side are provided in a lower side and an upper side of the yarn joining device 14. A suction port 23 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. In this embodiment, a width in a left-right direction (a width in a longitudinal direction) of the suction mouth 34 is set to the length similar to the width in the left-right direction (the width on the outer circumferential surface) of the package 30. An appropriate negative pressure source is connected to the lower yarn guide pipe 25 and the upper yarn guide pipe 26 respectively. This makes a suction flow act on the suction port 32 and the suction mouth 34.

[0052] In this configuration, at a time of yarn cutting or yarn breakage, the suction port 32 of the lower yarn guide pipe 25 captures the lower yarn at a position shown in Fig. 1 and Fig. 2, and then the lower yarn guide pipe 25 is driven in rotation upward around a shaft 33. Thereby, the lower yarn is guided to the yarn joining device 14. At substantially the same time, the upper yarn guide pipe 26 is driven in rotation upward from a position shown in the drawings around the shaft 35, and the suction mouth 34 captures the upper yarn unwound from the package 30 that is reversed by the drum drive motor 53. Subsequently, the upper yarn guide pipe 26 is rotated downward around the shaft 35, and thereby the upper yarn is guided to the yarn joining device 14. Thus, joining between the lower yarn and the upper yarn (yarn joining) is performed by the yarn joining device 14.

[0053] Next, a configuration of the yarn monitoring device 15 will be detailedly described with reference to Fig. 2 and Fig. 3.

[0054] As shown in Fig. 3 and the like, the yarn monitoring device 15 includes two uneven yarn sensors 43, 44, a cutter 46, and a control section 45. The control section 45 is configured as a small computer with hardware such as CPU, RAM, ROM etc. The ROM stores various kinds of software including a control program and the like. Collaboration of the hardware and the software allows the control section 45 to function as a yarn defect detection section 47 and a cutting control section (yarn cutting control device) 49, etc.

[0055] As shown in Fig. 2, the first uneven yarn sensor 43 and the second uneven yarn sensor 44 are arranged side by side at an appropriate interval in a yarn traveling direction. In this embodiment, the uneven yarn sensors 43, 44 are constituted as a light emitting element and a light receiving element. The light receiving element receives the light emitted from the light emitting element and detects the light receiving amount. In this configuration, when the thickness of the traveling yarn 20 is

changed, the light receiving amount of the uneven yarn sensors 43, 44 is changed. Therefore, unevenness of the thickness of the yarn 20 (yarn unevenness) can be detected. As shown in Fig. 3, output signals (uneven yarn signals S1, S2) of the uneven yarn sensors 43, 44 are input to the control section 45 after A/D conversion. More specifically, the uneven yarn signals S1 and S2 are input to a yarn speed detection section 48 of the cutting control section 49 included in the control section 45. The uneven yarn signal S1 from the first uneven yarn sensor 43 that is arranged downstream of the second uneven yarn sensor 44 is input to the yarn defect detection section 47 included in the control section 45. However, instead of this input, the uneven yarn signal S2 from the second uneven yarn sensor 44 that is arranged upstream of the first uneven yarn sensor 43 may be input to the yarn defect detection section 47 included in the control section 45. Alternatively, instead of these inputs, both the uneven yarn signal S1 from the first uneven yarn sensor 43 and the uneven yarn signal S2 from the second uneven yarn sensor 44 may be input to the yarn defect detection section 47 included in the control section 45.

[0056] The cutter 46 is arranged in a position where the cutter 46 can enter into and retract from a yarn path. The cutter 46 is driven by a drive mechanism (not shown). A cutter operation command signal (cutting device operation command signal) S3 for operating the cutter 46 is input to the drive mechanism from the control section 45 (cutting control section 49) shown in Fig. 3. Thereby, the drive mechanism is immediately driven and the cutter 46 that is located at a retracted position can enter into the yarn path and cut the yarn 20. The above-described drive mechanism can be constituted by a solenoid, for example. In this case, the above-described cutter operation command signal S3 can be a solenoid drive signal.

[0057] The yarn defect detection section 47 detects the defect of the yarn 20 which requires cutting and removing the yarn 20 (for example, a defect in which the thickness of the yarn 20 is less than a threshold) based on the uneven yarn signal S1 from the first uneven yarn sensor 43 that is arranged in a downstream side, and outputs a yarn defect detection signal S4 indicating that the yarn defect has detected, to the cutting control section 49. When the yarn defect detection section 47 determines the presence or absence of the yarn defect, a yarn speed V that is input from the yarn speed detection section 48, which will be described later, is also considered.

[0058] Here, when the yarn monitoring device 15 detects the yarn defect, the yarn monitoring device 15 cuts the yarn 20 by the cutter 46 in order to remove a portion having the yarn defect. Therefore, the yarn defect detection signal S4 that is output by the yarn defect detection section 47 is a signal substantially requiring cutting the yarn 20 (yarn cutting signal).

[0059] The cutting control section 49 controls operations of the cutter 46 based on the yarn defect detection signal S4 that is input from the yarn defect detection section 47. The cutting control section 49 includes the yarn

speed detection section 48, a traverse position estimation section 60, a cutting position adjustment section 70, and a cutter operation command section (cutting device operation command section) 52.

[0060] The yarn speed detection section 48 calculates the amount of temporal deviation by comparing the uneven yarn signal S1 from the first uneven yarn sensor 43 that is arranged in a downstream side with the uneven yarn signal S2 from the second uneven yarn sensor 44 that is arranged in an upstream side, and thereby can calculate (detect) the yarn speed V based on the calculated amount of temporal deviation and an interval of the first and second uneven yarn sensors 43, 44. The yarn speed V that is detected by the yarn speed detection section 48 is output to the traverse position estimation section 60. Simultaneously, the yarn speed detection section 48 generates a pulse signal S5 which changes in a time corresponding to a time at which the yarn 20 travels for a fixed length (for example, 1mm) based on the detected yarn speed V, and outputs the pulse signal S5 to the traverse position estimation section 60.

[0061] The traverse position estimation section 60 estimates the current traverse position of the yarn 20 based on the yarn speed V and the pulse signal S5 which are input from the yarn speed detection section 48. A signal indicating the estimated traverse position (a traverse position signal S6) is output to the cutting position adjustment section 70.

[0062] The cutting position adjustment section 70 determines whether or not there is a high possibility that the end face drop occurs if the yarn cutting by the cutter 46 is performed at the current yarn position, based on the traverse position signal S6 that is input from the traverse position estimation section 60. Based on such determination result, the cutting position adjustment section 70 outputs a cutting prohibition signal S7 indicating that cutting of the yarn 20 is prohibited, or a cutting permission signal S8 indicating that cutting of the yarn 20 is permitted, to the cutter operation command section 52. The cutting prohibition signal S7 and the cutting permission signal S8 are command signals for commanding operation or non-operation of the cutter 46, the command signals in which the prohibition determination section 72 of the cutting position adjustment section 70 outputs to the cutter operation command section 52.

[0063] When the yarn defect detection signal S4 is input from the yarn defect detection section 47, the cutter operation command section 52 checks the contents of the signal that is input from the cutting position adjustment section 70 at that time. If the cutting permission signal S8 is input to the cutter operation command section 52, the cutter operation command section 52 immediately outputs the cutter operation command signal S3 to the cutter 46. On the other hand, when the cutting prohibition signal S7 is input to the cutter operation command section 52 at a time when the yarn defect detection signal S4 is input, the cutter operation command section 52 waits (delays) until the signal to be input is switched from the cut-

ting prohibition signal S7 to the cutting permission signal S8, and outputs the cutter operation command signal S3 to the cutter 46. In such configuration, the control section 45 (cutting control section 49) of the yarn monitoring device 15 can cut the yarn 20 at a cutting position that is appropriately adjusted so that the end face drop does not occur if the yarn defect has found.

[0064] Next, configurations of the traverse position estimation section 60 and the cutting position adjustment section 70 will be detailedly described with reference to Fig. 4 to Fig. 8. Fig. 4 is a block diagram showing a configuration of the traverse position estimation section 60 and the cutting position adjustment section 70. Fig. 5 is a graph showing data of periodic change in the yarn speed V, and data of periodic change after smoothing. Fig. 6 is a graph explaining a process to calculate a reference position Ps to be estimated that the yarn is located at an end portion of a traverse region of the package 30 and a distance interval for calculating a latest traverse traveling distance L, by using data indicating the periodic change in the yarn speed V. Fig. 7 is a drawing explaining a cutting prohibition traverse range that is set in the end portion of the traverse region of the package 30. Fig. 8 is a drawing explaining a prohibition traverse ratio that is calculated based on the cutting prohibition traverse range.

[0065] As shown in Fig. 4, the traverse position estimation section 60 includes a data smoothing section (yarn speed smoothing section) 61, a return position estimation section 62, a reference position detection section 63, a latest traverse traveling distance calculation section 64, and a current traverse ratio calculation section 65, etc.

[0066] The data smoothing section 61 is adapted to smooth the data indicating the periodic change in the yarn speed V by calculating a moving average of the yarn speed V that is received from the yarn speed detection section 48. That is, the data (raw data) indicating the periodic change in the yarn speed V that is received from the yarn speed detection section 48 drastically, finely and irregularly changed as shown in Fig. 5 (a), and therefore it is difficult to grasp overall features of the change in the yarn speed V. There are various reasons in such situation, but one of the reasons is that the yarn 20 that is entered and traversed in the traverse groove 27 of the winding drum 24 behaves in a complicated way depending on a shape and the like of the traverse groove 27. Therefore, in the data smoothing section 61 of the traverse position estimation section 60, the data indicating the periodic change in the yarn speed V is smoothed by the moving-average method. This makes it easy to grasp periodic increase and decrease tendency of the yarn speed V, as shown in Fig. 5 (b). The moving average points are suitably defined so that the periodic increase and decrease tendency of the yarn speed V can be appropriately grasped while suppressing the above-described irregular change in the yarn speed V.

[0067] The return position estimation section 62 shown

in Fig. 4 is adapted to estimate a return position that is a position at which the traverse position of the yarn 20 is returned at the end portion in the traverse region of the package 30, based on the data indicating the periodic change in the yarn speed V. Specifically, in the package 30 having a cone shape as in this embodiment, it has known that the yarn speed V indicates a local maximal value when the traverse position of the yarn 20 is located in a large diameter end of the package 30. In this embodiment, by utilizing such indication, as shown in Fig. 6, a travel position at which the yarn speed V reaches the maximum in the data of the yarn speed V is estimated as a position at which the traverse position of the yarn 20 has located in the large diameter end of the package 30 (the other end), that is, a return position.

[0068] A reference position detection section 63 shown in Fig. 4 is adapted to detect the travel position of the yarn 20 at which the yarn speed V most recently reaches the maximum (in other words, the latest return position in the large diameter side of the package), as a reference position Ps, based on the data indicating the periodic change in the yarn speed V. The reference position Ps is used as a reference position, when estimating a distance where the yarn 20 has traveled to the traverse position which appears next.

[0069] The latest traverse traveling distance calculation section 64 detects the position of the yarn 20 at which the yarn speed V most recently reaches the maximum at a position before the reference position Ps, based on the data indicating the periodic change in the yarn speed V, and calculates a distance where the yarn 20 has traveled between such detected position and the reference position Ps, as the traveling distance of the yarn 20 per one latest traverse. In the following description, the traveling distance of the yarn 20 per one traverse may be referred to as a "traverse traveling distance". In other words, the traverse traveling distance can be also referred to as a traveling distance equivalent to one cycle of increase and decrease in the yarn speed V. The latest traverse traveling distance L can be accurately calculated by counting the pulse signal S5 input from the yarn speed detection section 48 between the latest at least two travel positions of the yarn 20 at which the local maximum value appears in the data indicating the periodic change in the yarn speed V shown in Fig. 6.

[0070] The current traverse ratio calculation section 65 calculates a current traverse ratio in which the current traverse position of the yarn 20 is indicated by a traverse ratio. The traverse ratio means a ratio of the distance where the yarn 20 has traveled from a certain position (in this embodiment, the reference position Ps that is a position estimated that the yarn 20 is positioned in the traverse end portion on the large diameter side) to the current position.

[0071] The current traverse ratio calculation section 65 is adapted to calculate the distance where the yarn 20 has traveled from the reference position Ps to the current position by counting the pulse signal S5 that is input from

the yarn speed detection section 48. Next, the current traverse ratio calculation section 65 calculates the current traverse ratio by dividing the calculated traveling distance by the latest traverse traveling distance L that is calculated by the latest traverse traveling distance calculation section 64.

[0072] The current traverse ratio takes values generally from 0 to 1 (from 0% to 100% in percentage) as shown in Fig. 8, and increases from 0 to 1 as the yarn 20 is traversed. When the current traverse ratio reaches 1 (i.e., when one traverse is completed), the current traverse ratio returns to 0 and again increases to reach 1. The current traverse ratio is a ratio indicating that the current position of the yarn 20 corresponds to which position in a process in which the yarn 20 reciprocates once by being traversed, based on the position of the yarn 20 when the yarn 20 is positioned in the traverse end portion on the large diameter side (in other words, the traveling distance of the yarn 20 when the yarn speed V indicates the local maximal value) as a reference (0). Therefore, it can be said that the current traverse ratio substantially indicates the current traverse position of the yarn 20. The obtained value of the current traverse ratio is output as the traverse position signal S6, from the current traverse ratio calculation section 65 to the cutting position adjustment section 70.

[0073] The cutting position adjustment section 70 includes a prohibition traverse ratio calculation section 71 and a prohibition determination section 72.

[0074] The prohibition traverse ratio calculation section 71 is adapted to calculate a prohibition traverse ratio representing a range of the traveling distance where the yarn cutting is prohibited among the above-described traverse traveling distances, as a traverse ratio. The above-described prohibition traverse ratio is determined based on a range of the traverse position (cutting prohibition traverse range) where the yarn cutting with the cutter 46 is prohibited, the range in which the operator pre-sets by using a cutting prohibition traverse range setting section (not shown). The cutting prohibition traverse range setting section can be configured as an input key (not shown) included in the above-described machine control device.

[0075] Fig. 7 shows a setting example of the above-described cutting prohibition traverse range. In this example, in order to prevent a cause of the end face drop by performing the yarn cutting on both ends of the package 30 and its vicinity (the end portion in the traverse region of the package 30), the traverse position from the end face on the small diameter side to 5mm and the traverse position from the end face on the large diameter side to 5mm in a traverse width direction are set as the cutting prohibition traverse range. However, the length of the cutting prohibition traverse range (5mm from the small diameter side, 5mm from the large diameter side) is an example. For example, the operator operates the above-described cutting prohibition traverse range setting section (input key), and thereby the length may be

appropriately changed to 10mm, 15mm, 20mm, 25mm, or 30mm, etc.

[0076] The above-described length of the cutting prohibition traverse range is preferably set in consideration of physical properties and the like of the yarn 20. For example, it is conceivable that the length in the cutting prohibition traverse range is set short if the yarn 20 has a physical property in which the end face drop is less likely to be occurred, and the length in the cutting prohibition traverse range is set long if the yarn 20 has a physical property in which the end face drop is likely to be occurred. When the length in the cutting prohibition traverse range is long, operation of the cutter 46 is greatly delayed. Thereby, the amount of waste yarn is increased. Then, it is preferable to set the length of the cutting prohibition traverse range, in consideration of reduction of the waste yarn.

[0077] The prohibition traverse ratio calculation section 71 calculates the prohibition traverse ratio based on the winding number of the traverse groove 27 in the winding drum 24, etc., in response to the length in the cutting prohibition traverse range that is set as described above. The prohibition traverse ratio represents a range of the traveling distance where the cutting of the yarn 20 is prohibited (a range indicated by hatching in Fig. 8), as a ratio with respect to the traveling distance of the yarn 10 for one traverse. The prohibition traverse ratio is determined in consideration of an error of estimate in which the traverse position estimation section 60 estimates the traverse position, in anticipation of an appropriate margin. Furthermore, considering that a certain time lag occurs from a time when the cutter operation command signal S3 is output to the cutter 46 to a time when the cutter 46 actually cuts the yarn 20, the range of the traveling distance in which the yarn cutting is prohibited in the prohibition traverse ratio is offset so that start and end of cutting prohibition are slightly advanced.

[0078] Hereafter, as shown in Fig. 8, the traverse ratio will be represented as a percentage, and will be described that the prohibition traverse ratio corresponding to "5mm from the end face on the small diameter side" that is the length in the cutting prohibition traverse range has calculated to be 45% to 60%, and the prohibition traverse ratio corresponding to "5mm from the end face on the large diameter side" that is the length in the cutting prohibition traverse range has calculated to be 85% to 100% and 0% to 3%.

[0079] The prohibition determination section 72 shown in Fig. 4 determines whether or not the current traverse ratio is within the range from the start of prohibition to the end of the prohibition in the above-described prohibition traverse ratio (0% to 3%, 45% to 60%, or 85% to 100%), based on the traverse position signal S6 that is input from the traverse position estimation section 60. The prohibition determination section 72 outputs the cutting prohibition signal S7 to the cutter operation command section 52 when the current traverse ratio is in the range of the prohibition traverse ratio, and otherwise outputs the cut-

ting permission signal S8 to the cutter operation command section 52.

[0080] Next, process performed by the traverse position estimation section 60 and the cutting position adjustment section 70 of the yarn monitoring device 15 in order to perform the yarn cutting at an appropriate traveling distance will be described with reference to Fig. 9. Fig. 9 is a flowchart showing a process performed by the traverse position estimation section 60 and the cutting position adjustment section 70 in order to adjust a position of the yarn cutting.

[0081] Firstly, based on the length of the preset cutting prohibition traverse range shown in Fig. 7, on the basis of the distance (traverse traveling distance) where the yarn 20 has traveled during one traverse, the prohibition traverse ratio calculation section 71 included in the cutting position adjustment section 70 calculates the prohibition traverse ratio representing a range of the traveling distance where the yarn cutting is prohibited, as the traverse ratio (step S101 in Fig. 9). This can obtain the prohibition traverse ratio (0% to 3%, 45% to 60%, or 85% to 100%) shown in Fig. 8.

[0082] Next, the data smoothing section 61 included in the traverse position estimation section 60 calculates the moving average in the yarn speed V that is obtained from the yarn speed detection section 48, and creates data indicating the periodic change in the yarn speed V after smoothing as shown in Fig. 5 (b) (step S102 in Fig. 9).

[0083] Next, the return position estimation section 62 estimates the traveling distance of the yarn 20 where the yarn speed V indicates the local maximal value as shown in Fig. 6 in the data indicating the periodic change in the yarn speed V, as the traveling distance (return position) of the yarn 20 when the traverse position of the yarn 20 is located in the end (other end) on the large diameter side of the package 30. As shown in Fig. 5 (b), although it is conceivable that the yarn speed V indicates the local maximum value even in a position other than the return position, the traveling distance when the traverse position of the yarn 20 is located on the large diameter side can be estimated to some extent in advance based on the last obtained return position and the traverse traveling distance. Therefore, the local maximal value which appears in its vicinity can be used. Even when the plurality of local maximal values appears during one stroke, the return position estimation section 62 may merely use the local maximal value exceeding the preset or calculated threshold value among such plurality of local maximal values. That is, the return position estimation section 62 may merely use the local maximal value (predetermined local maximal value) which meets a predetermined condition. In the return positions which are estimated by the return position estimation section 62, the return position closest to the current position of the yarn 20 is detected as the reference position Ps (step S103 in Fig. 9). The return position which appears once before the reference position Ps is used as a boundary of a distance interval

for which the latest traverse traveling distance calculation section 64 calculates the latest traverse traveling distance L, together with the reference position Ps (step S104). Specifically, in the step S103, the reference position detection section 63 detects the return position closest to the current position as the reference position Ps. In the step S104, the latest traverse traveling distance calculation section 64 calculates the latest traverse traveling distance L by counting the pulse signal S5 that is input from the yarn speed detection section 48 between the two return positions closest to the current position.

[0084] The return position estimation section 62 estimates the return position based on the data indicating the periodic change in the yarn speed V after smoothing by the moving-average method, as described above. Therefore, since the return position estimation section 62 is less likely to be affected by the fine irregular fluctuation occurring in the yarn speed V, the return position can be estimated with high accuracy.

[0085] Next, the current traverse ratio calculation section 65 calculates the traveling distance of the yarn 20 from the reference position Ps to the current position of the yarn 20 by counting the pulse signal S5 that is input from the yarn speed detection section 48, and obtains the current traverse ratio shown in Fig. 8 by dividing the obtained traveling distance by the latest traverse traveling distance L (step S105 in Fig. 9).

[0086] Next, the prohibition determination section 72 included in the cutting position adjustment section 70 examines whether or not the current traverse ratio that is obtained in the step S105 is within the range of the prohibition traverse ratio (0% to 3%, 45% to 60%, or 85% to 100%) in which the prohibition traverse ratio calculation section 71 calculates in the step S101 (step S106). When the current traverse ratio is within the range of the prohibition traverse ratio, the cutting prohibition signal S7 is output to the cutter operation command section 52 (step S107), and otherwise the cutting permission signal S8 is output to the cutter operation command section 52 (step S108). After that, in either case, the process returns to the step S102 and repeats the above-described processes.

[0087] As described above, the current traverse ratio substantially indicates the current traverse position. The prohibition traverse ratio calculation section 71 is a ratio calculated by converting the length in the cutting prohibition traverse range in Fig. 7 into the traverse ratio. Therefore, it can be said that the above-described step S106 is to substantially determine whether or not the estimated current traverse position is within the cutting prohibition traverse range.

[0088] According to a flow shown in Fig. 9, the cutting position adjustment section 70 repeatedly performs a process in which the signal that is output to the cutter operation command section 52 is switched between the cutting prohibition signal S7 and the cutting permission signal S8 in response to a change of the current traverse position that is estimated in the traverse position estimation

tion section 60, in one cycle of traverse as a unit.

[0089] Here, in a case where the yarn defect detection signal S4 accompanying with detection of the yarn defect detected by the yarn defect detection section 47 is input, the cutter operation command section 52 shown in Fig. 3 immediately outputs the cutter operation command signal S3 to a driving mechanism of the cutter 46 when the cutting permission signal S8 is input from the cutting position adjustment section 70. On the other hand, even when the above-described yarn defect detection signal S4 is input, and when the cutting prohibition signal S7 is input from the cutting position adjustment section 70, the cutter operation command section 52 waits until the cutting permission signal S8 is input from the cutting position adjustment section 70 and then outputs the cutter operation command signal S3 to the driving mechanism of the cutter 46. Accordingly, since the traveling distance of the yarn to be cut by the cutter 46 is adjusted (extended) as necessary, the yarn 20 can be cut at a position where there is no risk of the end face drop.

[0090] Next, controls performed by the unit control section 50 will be described with reference to Fig. 10. Fig. 10 is a flowchart showing a process performed by the unit control section 50.

[0091] The unit control section 50 generally drives the winding drum 24 to normally rotate the package 30 and winds the yarn 20 into the package 30 (step S201). Meanwhile, the unit control section 50 monitors whether or not a signal indicating that the yarn 20 has cut is input from the control section 45 of the yarn monitoring device 15 to the unit control section 50 (step S202).

[0092] When the signal indicating that the yarn 20 has cut is input from the yarn monitoring device 15 accompanying with detection of the yarn defect by the yarn monitoring device 15, the unit control section 50 controls the drum drive motor 53 to reverse the winding drum 24 in order to draw out a region including the yarn defect that is wound into the package 30 (step S203). Here, the control section 45 of the yarn monitoring device 15 calculates the traveling distance of the yarn 20 from a position of the yarn 20 when the defect of the yarn 20 is detected in the yarn defect detection section 47 to a position of the yarn 20 when the cutter operation command section 52 operates the cutter 46 to cut the yarn 20, by counting the pulse signal S5 that is output by the yarn speed detection section 48, for example, and then outputs to the unit control section 50. In the step S203, the unit control section 50 reverses the package 30 until the yarn 20 having a length that is obtained by adding an appropriate margin to the length calculated as described above is unwound from the package 30. At this time, the unit control section 50 obtains a rotation angle of the winding drum 24 from the rotation sensor 42 and calculates the length of the yarn 20, and thereby monitors reversal of the winding drum 24 so that the yarn 20 having a sufficient length including a portion of the detected yarn defect can be surely unwound from the package 30.

[0093] When the yarn 20 is pulled beyond the length

in which the yarn defect can be removed, the unit control section 50 controls that the drum drive motor 53 is stopped, and that the upper yarn and the lower yarn are joined together by the yarn joining device 14 (step S204). A region including the above-described yarn defect in the upper yarn that is pulled out is removed as waste yarn in a process of yarn joining by the yarn joining device 14. After that, the process returns to the step S201, and winding of the yarn 20 is resumed.

[0094] In the winder unit 10 of this embodiment, when the yarn monitoring device 15 has detected the yarn defect and operation of the cutter 46 has delayed in order to prevent the end face drop, the yarn 20 is additionally wound into the package 30 for delay of cutting of the yarn 20. In this respect, according to control of Fig. 10, after the yarn 20 having the sufficient length including a portion that is additionally wound is unwound by reversal of the package 30, joining operation by the yarn joining device 14 is performed. Therefore, the yarn defect can be surely removed and yarn joining can be performed.

[0095] As described above, in this embodiment, the cutting control section 49 included in the yarn monitoring device 15 controls operations of the cutter 46 for cutting the yarn 20 that is wound into the package 30 while being traversed. The cutting control section 49 includes the yarn speed detection section 48, the traverse position estimation section 60, and the cutting position adjustment section 70. The yarn speed detection section 48 detects the yarn speed V in which the yarn 20 travels. The traverse position estimation section 60 estimates the traverse position of the yarn 20 based on the yarn speed V that is detected by the yarn speed detection section 48. The cutting position adjustment section 70 adjusts a cutting position where the cutter 46 cuts the yarn 20 depending on the traverse position of the yarn 20 that is estimated in the traverse position estimation section 60.

[0096] Accordingly, the end face drop of the yarn 20 can be prevented by adjusting the cutting position where the cutter 46 is operated to cut the yarn 20 depending on the traverse position of the yarn 20, for example, by not cutting the yarn 20 at a position where the end face drop of the yarn 20 may be occurred. Since the traverse position estimation section 60 estimates the traverse position of the yarn 20 based on the yarn speed V that is detected by the yarn speed detection section 48, a simple configuration can be realized as compared with a case of a configuration having a sensor which directly detects the traverse position of the yarn.

[0097] In the cutting control section 49 of this embodiment, the cutting position adjustment section 70 adjusts the traveling distance of the yarn 20 when the cutter 46 is operated, such that the cutter 46 is operated after a traverse position is moved to a center side in a traverse region when the traverse position of the yarn 20 is located at the end portion of the traverse region of the package 30.

[0098] Accordingly, the end face drop of the yarn 20 can be prevented with a simple control to increase the

traveling distance of the yarn 20 when the cutter 46 is operated.

[0099] In the cutting control section 49 of this embodiment, the traverse position estimation section 60 estimates the traverse position based on characteristics of the yarn speed V that is detected by the yarn speed detection section 48.

[0100] Accordingly, the cutting position where the yarn 20 is cut can be adjusted to an appropriate position with a simple configuration, as compared with a case of a configuration in which the traverse position is directly detected by a position sensor or the like that is arranged in the traverse region.

[0101] In this embodiment, the package 30 formed by the winder unit 10 which winds the yarn 20, has a cone shape whose diameter increases from one end to the other end in an axial direction. The traverse position estimation section 60 included in the cutting control section 49 estimates the traverse position based on the traveling distance of the yarn 20 when an extremal value (local maximal value) appears in a process of periodically increasing and decreasing the yarn speed V that is detected by the yarn speed detection section 48.

[0102] Accordingly, the traverse position can be appropriately estimated by utilizing periodic increase and decrease in the yarn speed V when the yarn 20 is wound to form the package 30 having the cone shape.

[0103] In the cutting control section 49 of this embodiment, the traverse position estimation section 60 includes the data smoothing section 61 adapted to smooth the data indicating the periodic change in the yarn speed V that is detected by the yarn speed detection section 48. The traverse position estimation section 60 estimates the traverse position based on the traveling distance of the yarn 20 when the extremal value (local maximal value) appears in a process of periodically increasing and decreasing the yarn speed V after the data smoothing section 61 smooths the data.

[0104] Accordingly, since errors caused by a fine irregular fluctuation which occurs in the yarn speed V can be suppressed, the traverse position can be accurately estimated.

[0105] In the cutting control section 49 of this embodiment, the data smoothing section 61 smooths the data indicating the periodic change in the yarn speed V by the moving-average method.

[0106] Accordingly, points of a moving average are appropriately defined, and thereby tendency of increase and decrease in the yarn speed V which appears depending on the traverse positions can be appropriately grasped while suppressing the errors caused by the fine irregular fluctuation occurring in the yarn speed V. As a result, the traverse position can be accurately estimated. The yarn speed V can be also smoothed with a simple calculation.

[0107] In the cutting control section 49 of this embodiment, the traverse position estimation section 60 estimates the traverse position of the yarn 20 based on the

traveling distance (latest traverse traveling distance L) during at least two latest timings at which the local maximal value of the yarn speed V has appeared.

[0108] Accordingly, the traverse position of the yarn 20 can be appropriately estimated based on the traveling distance of the yarn 20. With reference to the traveling distance of the yarn 20 when the local maximal value appears in the yarn speed V, a cycle of increase and decrease in the yarn speed V can be easily and clearly grasped, and thereby the yarn traveling distance corresponding to one cycle (one traverse) of increase and decrease in the yarn speed V can be accurately obtained. Furthermore, the traveling distance of the yarn 20 corresponding to one traverse may be changed as increasing the diameter of the package 30. However, in this embodiment, since the traverse position of the yarn 20 is estimated based on, for example, the traveling distance of the yarn 20 (latest traverse traveling distance L) in one cycle of the latest increase and decrease in the yarn speed V, an estimation accuracy of the traverse position can be stabilized.

[0109] The cutting control section 49 of this embodiment includes the prohibition determination section 72 adapted to determine whether or not the cutter 46 can be operated and to output a command signal for instructing the cutter operation command section 52 to operate or not to operate the cutter 46, based on the traverse position of the yarn 20 that is estimated by the traverse position estimation section 60. The prohibition determination section 72 determines whether or not the cutter 46 can be operated based on a prohibited range representing a range (0% to 3%, 45% to 60%, 85% to 100%) in which the yarn cutting is prohibited in one cycle of traverse, and a traveling distance of the yarn 20 detected from the latest yarn travel position (reference position) where the local maximal value of the yarn speed V has appeared to the current position, with reference to a traveling distance (latest traverse traveling distance L) of the yarn 20 that has detected during the latest one cycle of increase and decrease in the yarn speed V, and a traveling distance of the yarn 20 when the local maximal value of the yarn speed V has appeared.

[0110] Accordingly, whether or not the cutter 46 can be operated is appropriately and easily determined by detecting the traveling distance where the yarn 20 has traveled from the latest travel position of the yarn 20 at which the local maximal value of the yarn speed V has appeared to the current position, and checking whether or not such traveling distance is within a range of the traveling distance where the yarn cutting is prohibited in the prohibited range. This can prevent the end face drop of the yarn 20. Furthermore, the traveling distance of the yarn 20 corresponding to one traverse is changed as increasing the diameter of the package 30, however, in this embodiment, whether or not the cutter 46 can be operated is determined based on the traveling distance (latest traverse traveling distance L) of the yarn 20 in the latest one cycle in which the yarn speed V increases and

decreases. Therefore, the end face drop of the yarn 20 can be stably prevented without being affected by an increase in the diameter of the package 30.

[0111] The cutting control section 49 of this embodiment is configured to change the length of the cutting prohibition traverse range (see Fig. 7) that is a range where the yarn cutting is prohibited at the end portion of the traverse region of the package 30. In a case that the traverse position that is estimated in the traverse position estimation section 60 is within the cutting prohibition traverse range when the yarn defect detection signal S4 is input, the cutting position adjustment section 70 adjusts the traveling distance of the yarn 20 when the cutter 46 is operated such that the cutter 46 is operated after the traverse position of the yarn 20 is moved and deviated from the cutting prohibition traverse range.

[0112] Accordingly, since the cutter 46 is operated to cut the yarn 20 after delaying (after traveling the yarn 20) until the traverse position of the yarn 20 reaches a position deviated from the cutting prohibition traverse range, the end face drop of the yarn 20 can be surely prevented. Since the length of the cutting prohibition traverse range can be changed by software, the operator can appropriately change the length of the cutting prohibition traverse range in consideration of physical properties of the yarn 20, etc. This can improve convenience.

[0113] The yarn monitoring device 15 of this embodiment includes the above-described yarn cutting control section 49, and further includes the yarn defect detection section 47 adapted to detect a defect of the yarn 20. When the defect of the yarn 20 is detected, the yarn defect detection section 47 outputs the yarn defect detection signal S4 as an operation signal of the cutter 46 to the yarn cutting control section 49.

[0114] Accordingly, when the yarn defect detection section 47 detects the defect of the yarn 20, the yarn 20 can be cut by the cutter 46 at the traveling distance of the yarn 20 that is adjusted such that the end face drop of the yarn 20 does not occur.

[0115] The yarn monitoring device 15 of this embodiment includes a cutting device (in this embodiment, the cutter 46).

[0116] Accordingly, communication of control signals from detection of the defect of the yarn 20 to operation of the cutter 46 is easily completed in the yarn monitoring device 15, which can simplify a configuration.

[0117] In the yarn monitoring device 15 of this embodiment, the cutting device is the cutter 46.

[0118] Accordingly, the yarn 20 can be cut with a simple configuration.

[0119] The winder unit 10 of this embodiment includes the above-described yarn monitoring device 15, and further includes the yarn feed part 28 and the package forming part 31. The yarn feed bobbin 21 is supported in the yarn feed part 28. The package forming part 31 winds the yarn 20 of the yarn feed bobbin 21 in the yarn feed part 28, to form the package 30. The yarn monitoring device 15 is arranged between the yarn feed part 28 and

the package forming part 31.

[0120] Accordingly, the winder unit 10 with a simple configuration that is less likely to occur the end face drop of the yarn 20.

[0121] The winder unit 10 of this embodiment includes the winding drum 24, the yarn joining device 14, and the unit control section 50. The winding drum 24 comes in contact with the package 30 and drives the package 30 to rotate in order to wind the yarn 20 from the yarn feed part 28 into the package 30. The yarn joining device 14 performs yarn joining operation between the yarn 20 from the yarn feed part 28 and the yarn 20 from the package forming part 31 when the cutter 46 was operated to cut the yarn 20. The control section 45 controls the winder unit 10. The control section 45 controls the winding drum 24 such that the package 30 is reversed until the yarn 20 is pulled out of the package 30 over a length longer than or equal to the traveling distance of the yarn 20 from a position of the yarn 20 when the defect of the yarn 20 is detected in the yarn defect detection section 47 to a position where the cutter 46 is operated to cut the yarn 20, and then causes the yarn joining device 14 to perform yarn joining operation.

[0122] That is, in the winder unit 10 having the above-described yarn monitoring device 15, even when the yarn defect detection section 47 detects the defect of the yarn 20, a timing of the operation of the cutter 46 may be delayed for preventing the end face drop. In this respect, according to the configuration of this embodiment, even when the yarn 20 is additionally wound into the package 30 for the length delayed in the operation of the cutter 46, the yarn joining device 14 performs the yarn joining operation after the sufficient length of the yarn 20 including the additional length is pulled out of the package 30. Therefore, the defect of the yarn 20 that is detected by the yarn defect detection section 47 can be surely removed.

[0123] While a preferred embodiment of the present invention has been described above, the above-described configuration can be modified, for example, as follows.

[0124] In the above-described embodiment, the return position estimation section 62 estimates that the traverse position of the yarn 20 is located at the large diameter end (the other end) of the package 30, with a traveling distance of the yarn 20 when the yarn speed V reaches the local maximal value in the data of the yarn speed V. However, instead of the above, the return position estimation section 62 may estimate that the traverse position of the yarn 20 is located at the small diameter end (one end) of the package 30, with a traveling distance of the yarn 20 when the yarn speed V reaches the local minimal value. In this case, the latest traverse traveling distance L can be calculated by counting the pulse signal S5 that is input from the yarn speed detection section 48 between at least two latest travel positions of the yarn 20 where the local minimal value of the yarn speed V appears. The plurality of local minimal values may appear in one

traverse stroke. However, in such case, the return position estimation section 62 may merely use the local minimal value (predetermined local minimal value) that satisfies a predetermined condition among the plurality of local minimal values.

[0125] In the above-described embodiment, the cutting prohibition traverse range where the yarn cutting by the cutter 46 is prohibited can be changed by the operator using the cutting prohibition traverse range setting section. However, the cutting prohibition traverse range may not be changed. Alternately, instead of the above, the cutting prohibition traverse range may be automatically changeable depending on a winding condition of the yarn 20, the yarn speed V, physical properties of the yarn 20, the type of yarn defect, and the like.

[0126] When the irregular fluctuation occurred in the yarn speed V that is detected by the yarn speed detection section 48 is small, the data smoothing section 61 may be omitted.

[0127] In the above-described embodiment, although the shape of the package 30 is a cone shape, this is not limited thereto. For example, instead of the cone shape, the package may have a cheese shape. In this case, the traverse position estimation section 60 can estimate the traverse position by detecting the tendency of change in the yarn speed in one traverse caused by, for example, a configuration of a traverse groove that is formed in the winding drum for driving the cheese-shaped package.

[0128] In the above-described embodiment, the package 30 comes in contact with the winding drum 24 that is driven in rotation. Thereby, the package 30 is driven in rotation and then the yarn 20 is wound. However, an aspect in which the yarn 20 is wound into the package 30 is not limited to the above-described configuration. For example, instead of the above-described configuration, the package may be driven directly by a motor. Instead of traversing of the yarn 20 by the traverse groove 27 of the winding drum 24, the yarn may be traversed by reciprocatingly driving the traverse guide.

[0129] Adjustment of an operation position of the cutter 46 is not limited to the yarn cutting due to detection of the yarn defect detected by the yarn defect detection section 47, and can be applied to various yarn cutting, for example, when the cutter 46 is used to cut the yarn 20 by a forced cutting command signal that is input from the unit control section 50 to the yarn monitoring device 15.

[0130] In the above-described embodiment, as shown in Fig. 2, the width in the left-right direction (longitudinal direction width) of the suction mouth 34 is approximately equal to that of the package 30 (width of an outer circumferential surface). However, instead of the above, the width in the longitudinal direction of the suction mouth (its suction port) can be configured narrower than the width of the outer circumferential surface of the package. In this case, it is desirable to set the cutting prohibition traverse range such that a width in the traverse width, especially in an area which allows the yarn cutting is approximately same as the width in the longitudinal direc-

tion of the suction mouth. Specifically, for example, when the width of the suction mouth in the longitudinal direction is 3 inches, and when the width (traverse width) on the outer circumferential surface of the package 30 is 6 inches, the length from each of the ends to 1.5 inches (approximately 38mm) is set as the cutting prohibition traverse range. With this configuration, even when the width in the longitudinal direction of the suction mouth (its suction port) is small, the yarn end can be suctioned and captured with a short notting time. As such, when the width in the longitudinal direction of the suction mouth (its suction port) is narrowed, there is an advantage in which the energy (negative pressure) required to suction and capture the upper yarn with the suction mouth can be reduced.

[0131] In the above-described embodiment, the cutter 46 is included in the yarn monitoring device 15, however, this is not limited thereto. The cutter may be provided separately from the yarn monitoring device.

[0132] In the above-described embodiment, the cutting device is the cutter 46, however, this is not limited thereto. The cutting device may be any device capable of separating one yarn 20 into two yarns.

[0133] In the above-described embodiment, the cutting position adjustment section 70 outputs either the cutting permission signal S8 or the cutting prohibition signal S7 to the cutter operation command section 52, however, this is not necessarily limited thereto. For example, instead of the above, the cutting position adjustment section 70 may output only the cutting permission signal S8, and the cutter operation command section 52 may determine that cutting is prohibited while the cutting permission signal S8 is not output.

[0134] In the above-described embodiment, the yarn 20 is traversed by being driven the winding drum 24 in rotation, however, this is not limited thereto. For example, instead of the above, the yarn 20 may be traversed by a traverse arm. In this case, since the irregular fluctuation in the yarn speed V is reduced, data smoothing may be omitted.

[0135] The yarn speed V may be detected in a place other than the yarn monitoring device 15.

[0136] In the above-described embodiment, the prohibited range where cutting of the yarn 20 is prohibited in the calculated traverse ratio is set, however, this is not limited thereto. Without calculating the traverse ratio, the traveling distance of the yarn 20 where cutting of the yarn 20 is prohibited is directly calculated and set as the prohibited range.

[0137] In the above-described embodiment, control is performed based on the traveling distance of the yarn 20, and the yarn 20 is cut at the traveling distance where the end face drop is less likely to occur. In such control, there is an advantage in which it is not necessary to consider the change in the yarn speed V. However, instead of the above, the control may be performed based on the cutting timing of the yarn 20, and then the yarn 20 may be cut at a timing when the end face drop is less likely

to occur.

[0138] The traverse traveling distance may be calculated by calculating the traveling distance between each of the latest three or more times of the travel positions of the yarn 20 where the local maximal value of the yarn speed V appears, and by taking an average of each calculated traveling distance. Alternatively, the traverse traveling distance may be calculated by calculating the traveling distance between each of the latest three or more times of the travel positions of the yarn 20 where the local minimal value of the yarn speed V appears, and by taking an average of each traveling distance.

DESCRIPTION OF THE REFERENCE NUMERALS

[0139]

15	yarn monitoring device	
20	yarn	20
30	package	
46	cutter	
47	yarn defect detection section	25
48	yarn speed detection section	
52	cutter operation command section (cutting device operation command section)	30
60	traverse position estimation section	
70	cutting position adjustment section	35

Claims

1. A yarn cutting control device which controls an operation of a cutting device for cutting a yarn that is wound into a package while being traversed comprising:
 - a yarn speed detection section adapted to detect a yarn speed in which a yarn travels;
 - a traverse position estimation section adapted to estimate a traverse position of the yarn based on the yarn speed that is detected by the yarn speed detection section; and
 - a cutting position adjustment section adapted to adjust a cutting position where the cutting device cuts the yarn depending on the traverse position of the yarn that is estimated by the traverse position estimation section.
2. The yarn cutting control device according to claim 1, wherein
 - the cutting position adjustment section adjusts a traveling distance of the yarn at a time of operating the cutting device such that the cutting device is operated after the traverse position is moved to a center side in a traverse region in a case that the traverse position of the yarn is located at an end portion of the traverse region of the package.
3. The yarn cutting control device according to claim 1 or 2, wherein
 - the traverse position estimation section estimates the traverse position based on characteristics of the yarn speed that is detected by the yarn speed detection section.
4. The yarn cutting control device according to claim 1 or 2, wherein
 - the package has a cone shape whose diameter increases from one end to the other end in an axial direction,
 - the traverse position estimation section estimates the traverse position based on the traveling distance of the yarn when an extremal value appears in a process of periodically increasing and decreasing the yarn speed that is detected by the yarn speed detection section.
5. The yarn cutting control device according to claim 4, wherein
 - the traverse position estimation section includes a yarn speed smoothing section adapted to smooth data indicating periodic change in the yarn speed that is detected by the yarn speed detection section,
 - the traverse position estimation section estimates the traverse position based on the traveling distance of the yarn when an extremal value appears in a process of periodically increasing and decreasing the yarn speed after the yarn speed smoothing section smooths the data.
6. The yarn cutting control device according to claim 5, wherein
 - the yarn speed smoothing section smooths the data indicating periodic change in the yarn speed by a moving-average method.
7. The yarn cutting control device according to any one of claims 4 to 6, wherein
 - the traverse position estimation section estimates the traverse position of the yarn based on a traveling distance between at least two latest yarn travel positions where a local maximal value of the yarn speed appears or a traveling distance between at least two latest yarn travel positions where a local minimal value of the yarn speed appears.
8. The yarn cutting control device according to claim 7 further comprising:

- a prohibition determination section adapted to determine whether or not the cutting device can be operated and to output a command signal for instructing a cutting device operation command section to operate or not to operate the cutting device, based on the traverse position of the yarn that is estimated by the traverse position estimation section, wherein the prohibition determination section determines whether or not the cutting device can be operated based on a traverse traveling distance that is a traveling distance of the yarn that is detected during a latest one cycle of increase and decrease in the yarn speed, a prohibited range representing a range where a yarn cutting is prohibited in one cycle of traverse with reference to a traveling distance of the yarn when the local maximal value or the local minimal value of the yarn speed appears, and a traveling distance of the yarn that is detected from a latest yarn travel position where the local maximal value or the local minimal value of the yarn speed appears to the current position.
9. The yarn cutting control device according to any one of claims 1 to 8, wherein
 a length of a cutting prohibition traverse range that is a range where the yarn cutting is prohibited at an end portion of the traverse region of the package is changeable,
 the cutting position adjustment section adjusts the traveling distance of the yarn when the cutting device is operated such that the cutting device is operated after the traverse position of the yarn is moved and deviated from the cutting prohibition traverse range in a case that the traverse position that is estimated in the traverse position estimation section is within the cutting prohibition traverse range when a yarn cutting signal requiring the yarn cutting is input to the yarn cutting control device.
10. A yarn monitoring device including the yarn cutting control device according to any one of claims 1 to 9, further comprising:
 a yarn defect detection section adapted to detect a defect of the yarn, wherein
 the yarn defect detection section outputs a yarn defect detection signal as the yarn cutting signal requiring the yarn cutting, to the yarn cutting control device, upon detection of the defect of the yarn.
11. The yarn monitoring device according to claim 10, wherein
 the cutting device is provided.
12. The yarn monitoring device according to claim 11,
- wherein
 the cutting device is a cutter.
13. A yarn winding device including the yarn monitoring device according to any one of claims 10 to 12 comprising:
 a yarn feed part in which a yarn feed bobbin is supported; and
 a package forming part adapted to wind a yarn of the yarn feed bobbin in the yarn feed part to form a package, wherein
 the yarn monitoring device is arranged between the yarn feed part and the package forming part.
14. The yarn winding device according to claim 13 comprising:
 a winding drum which comes in contact with the package and drives the package to rotate in order to wind the yarn from the yarn feed part into the package;
 a yarn joining device which performs a yarn joining operation between the yarn from the yarn feed part and the yarn from the package forming part when the cutting device has operated to cut the yarn; and
 a control section which controls the yarn winding device, wherein
 the control section controls the winding drum such that the package is reversed until the yarn is pulled out of the package over a length longer than or equal to the traveling distance of the yarn from a yarn position when the defect of the yarn has detected in the yarn defect detection section to a position where the cutting device is operated to cut the yarn, and then causes the yarn joining device to perform the yarn joining operation.

Fig.1

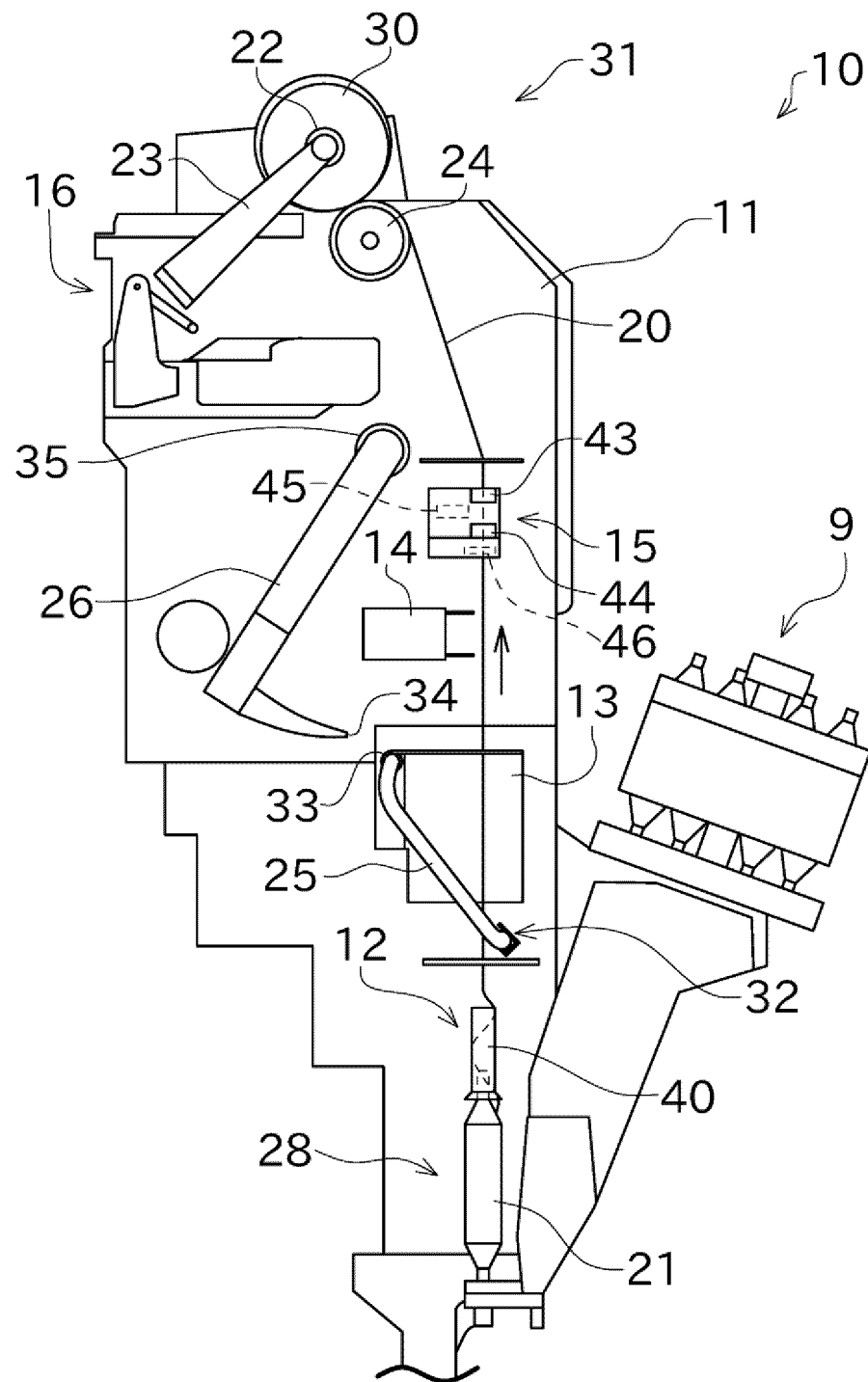


Fig.2

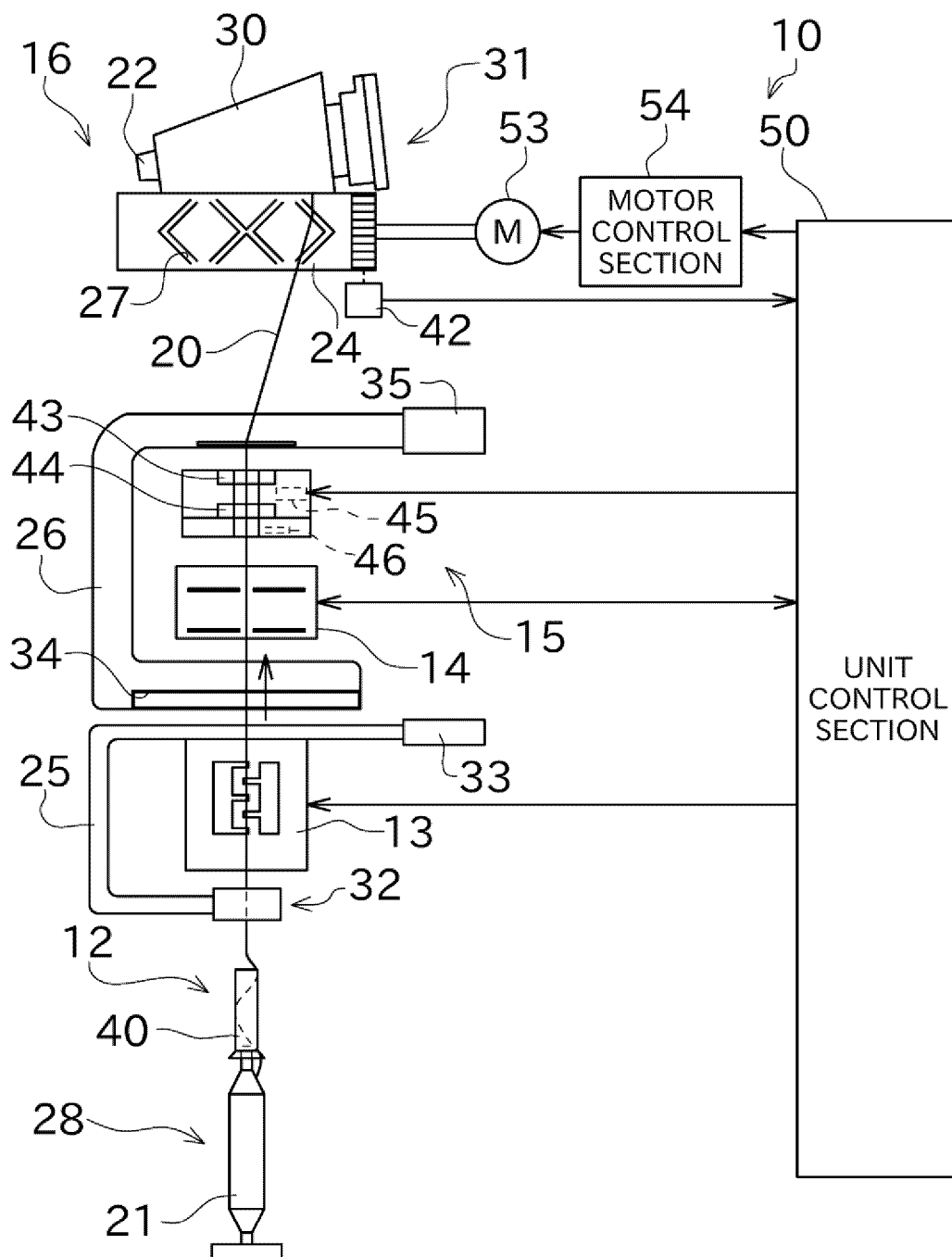


Fig.3

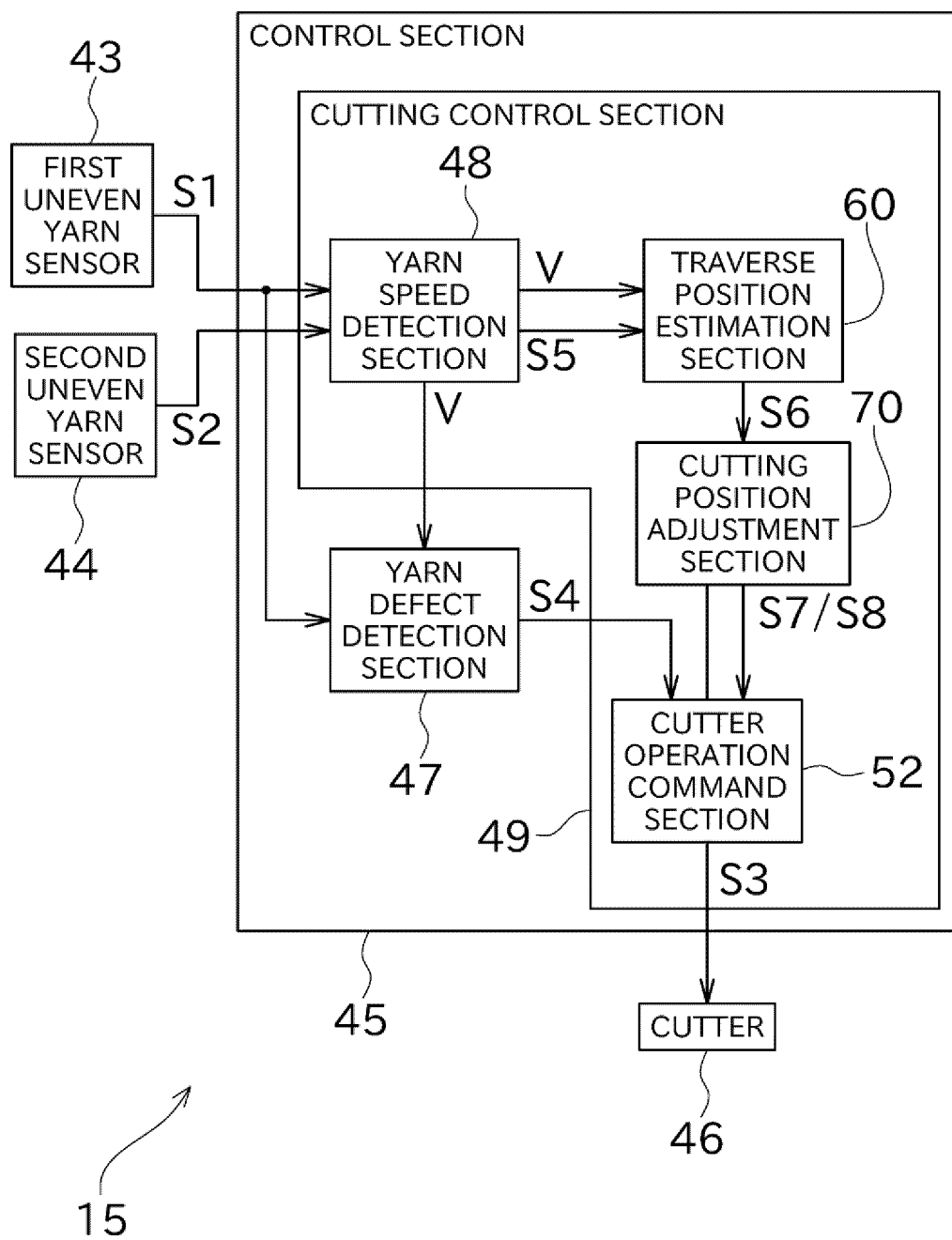


Fig.4

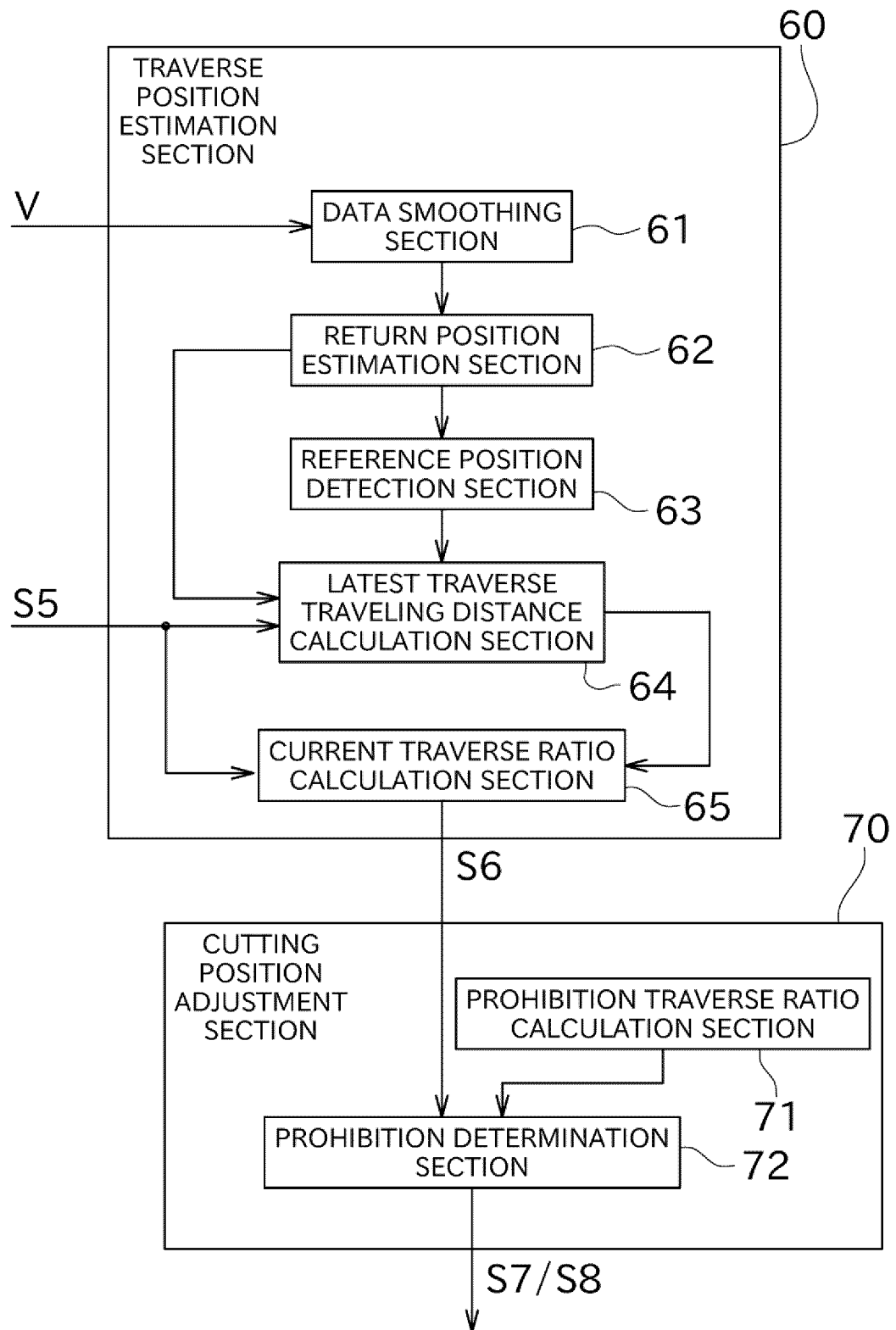


Fig.5

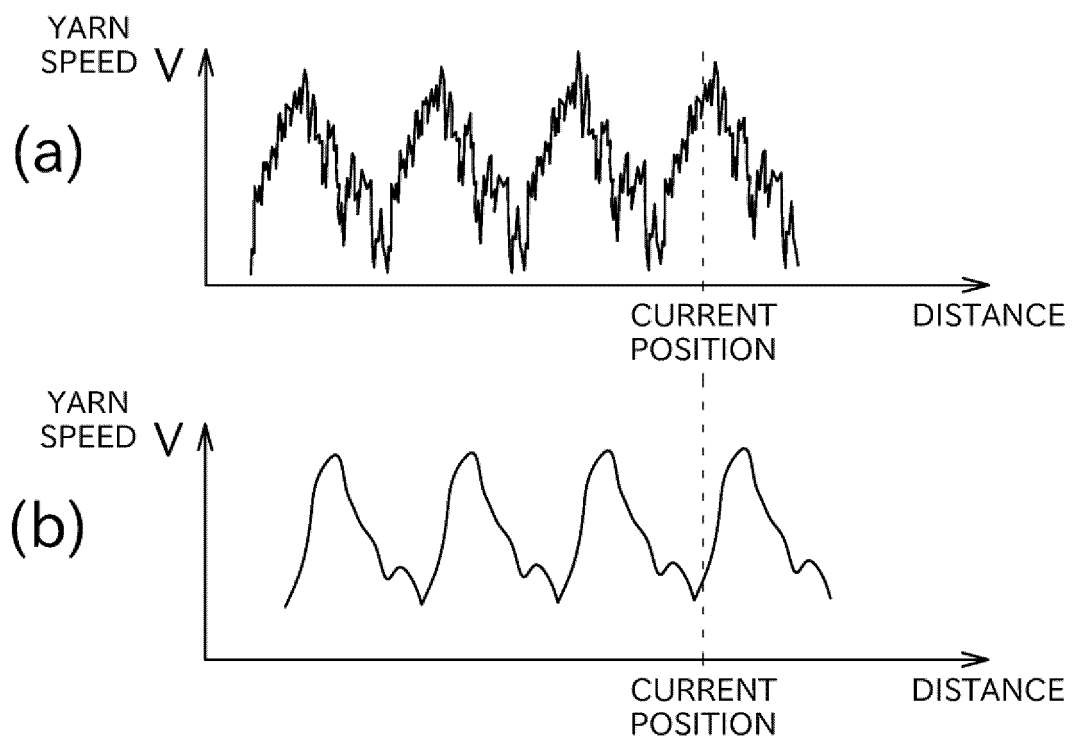


Fig.6

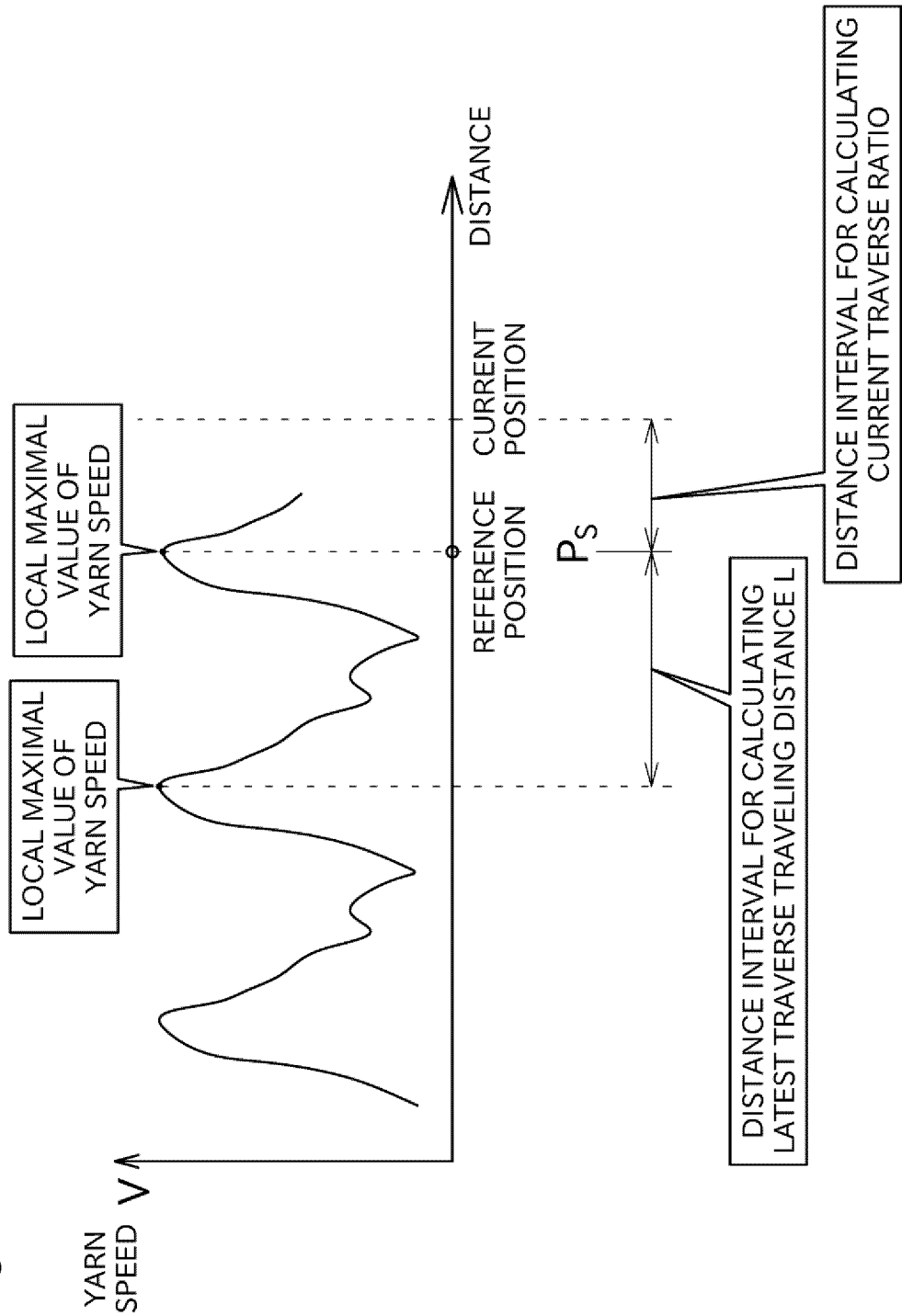


Fig.7

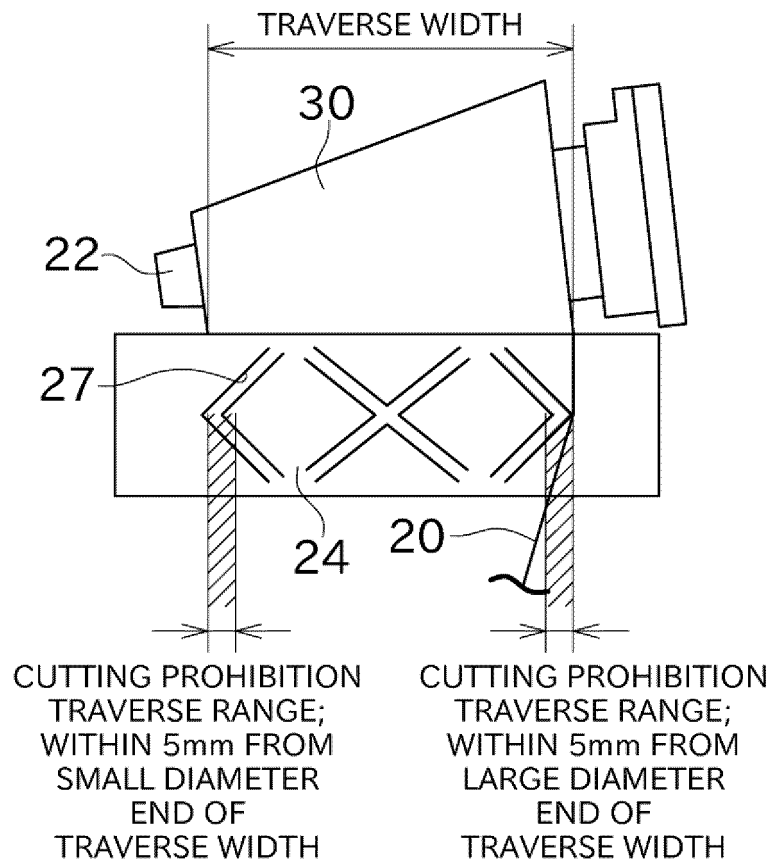


Fig.8

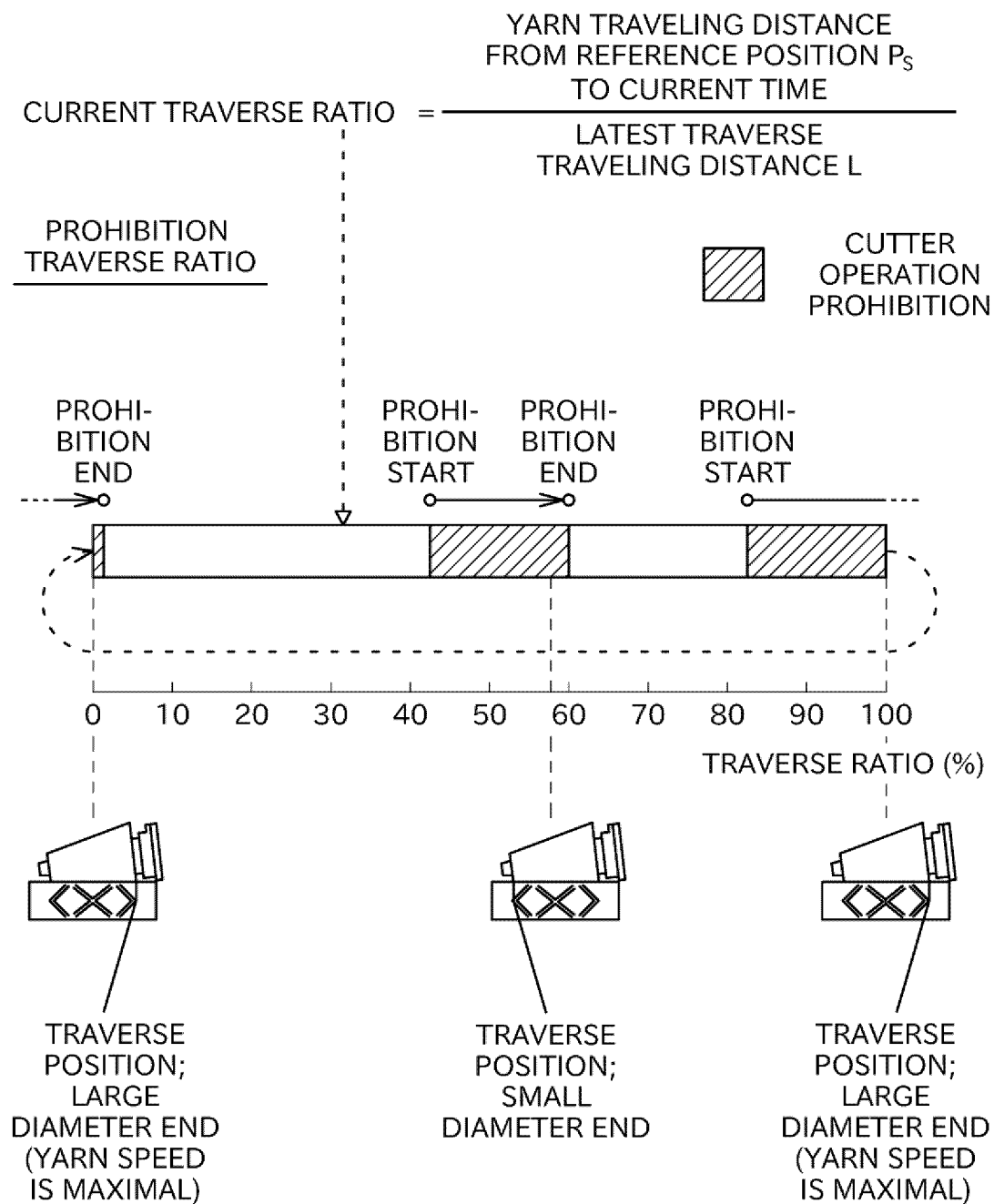


Fig.9

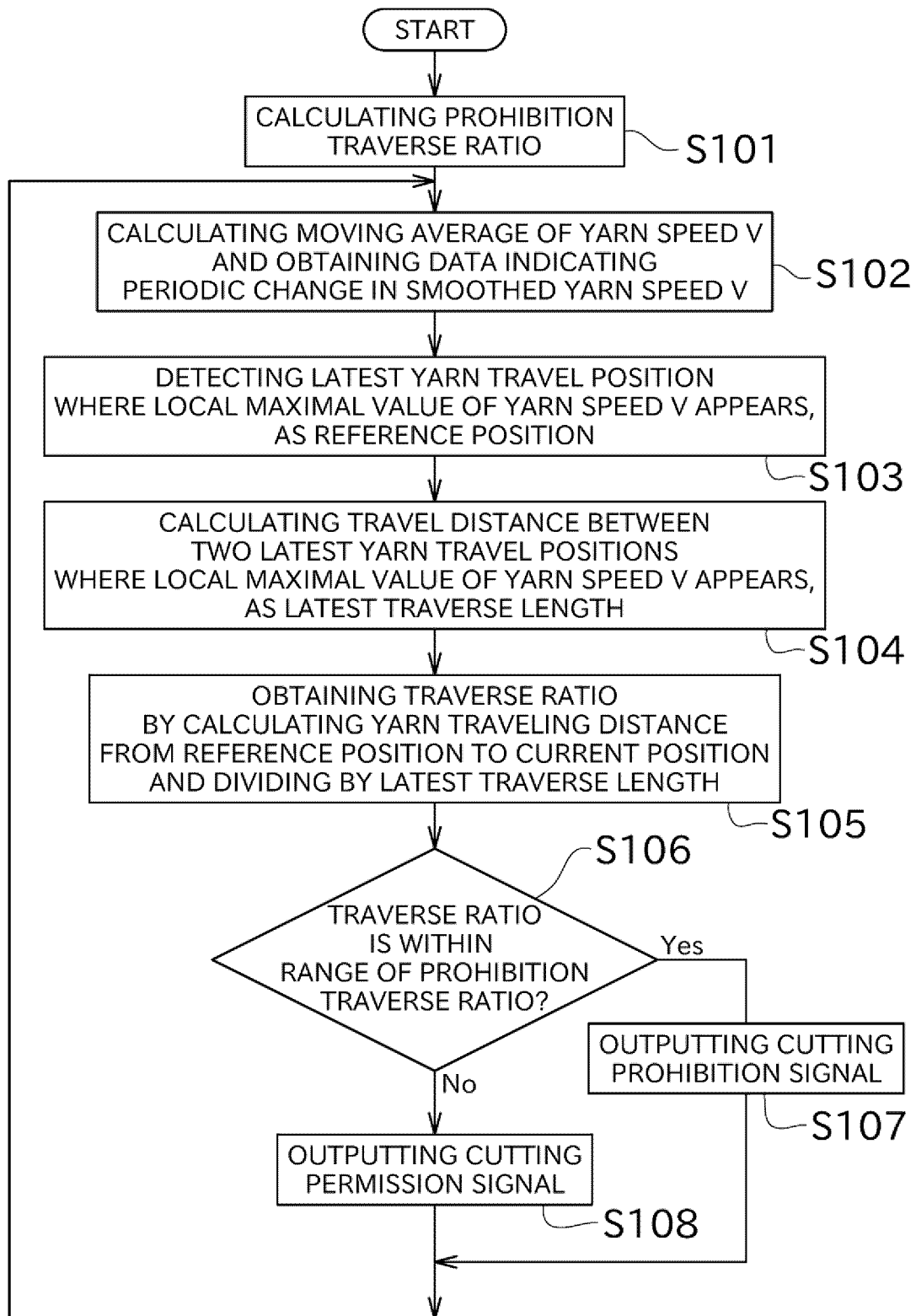
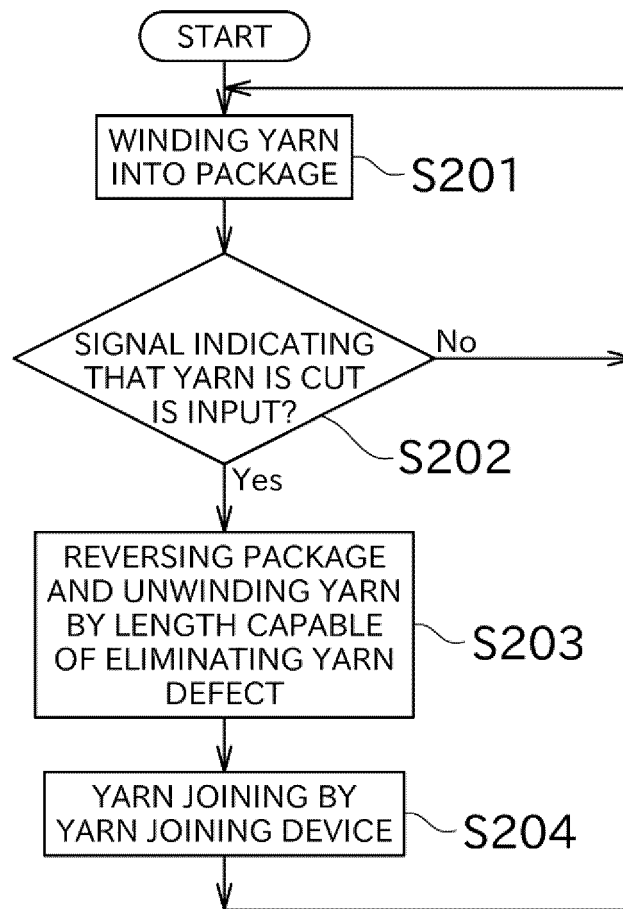


Fig.10



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2017/047267

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. B65H63/00 (2006.01) i, B65H54/28 (2006.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int. Cl. B65H54/28, B65H61/00-63/08, B65H69/06, D01H1/00-17/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan 1922-1996

Published unexamined utility model applications of Japan 1971-2018

Registered utility model specifications of Japan 1996-2018

Published registered utility model applications of Japan 1994-2018

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 4042271 B2 (MURATA MACHINERY LTD.) 06 February 2008, (Family: none)	1-14
A	JP 2014-024652 A (MURATA MACHINERY LTD.) 06 February 2014, & EP 2690044 A2 & CN 103572438 A	1-14

☒ Further documents are listed in the continuation of Box C.☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

Date of mailing of the international search report

Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2017/047267

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5547138 A (SAVIO MACCHINE TESSILI S. R. L.) 20 August 1996, & EP 631962 A2	1-14

Form PCT/ISA/210 (continuation of second sheet) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 4042271 B [0005]