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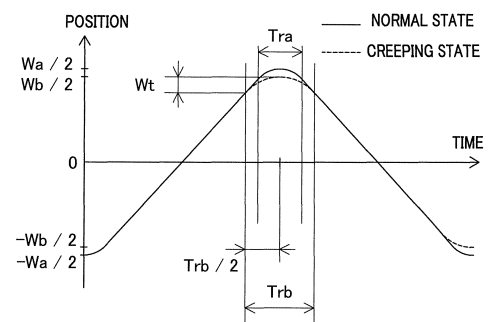
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(54) **YARN WINDING DEVICE AND YARN WINDING METHOD**

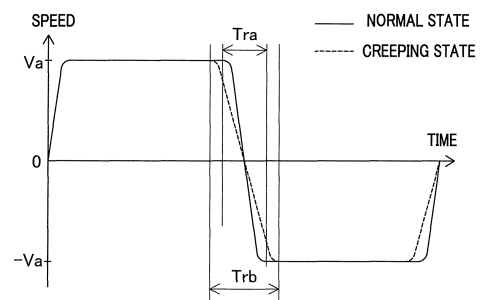
(57) The present invention suppresses a winding ratio from being changed and suppresses the shape of the surface of a package from being poor, even when creeping is performed during precision winding. A yarn winding device includes: a guide driving unit which reciprocally drives a traverse guide and is able to change a reversal position of the traverse guide during a winding operation of winding a yarn; and a controller. A controller is capable of performing: first reversal control in which the traverse guide running outward in a traverse direction at a predetermined speed is decelerated, the running direction of the traverse guide is reversed to inward at a predetermined first reversal position, and then the traverse guide is re-accelerated to the predetermined speed; and second reversal control in which the traverse guide running outward in the traverse direction at the predetermined speed is decelerated, the running direction of the traverse guide is reversed to inward at a second reversal position which is on the inner side of the first reversal position, and then the traverse guide is re-accelerated to the predetermined speed. During precision winding, the controller arranges a second reversal time (T_{rb}) in the second reversal control to be longer than a first reversal time (T_{ra}) in the first reversal control.

FIG.7

(a) RELATIONSHIP BETWEEN POSITION OF TRAVERSE GUIDE AND TIME



(b) RELATIONSHIP BETWEEN SPEED OF TRAVERSE GUIDE AND TIME



Description

[Technical Field]

[0001] The present invention relates to a yarn winding device and a yarn winding method.

[Background Art]

[0002] Patent Literature 1 discloses a yarn winding device configured to wind a yarn onto a bobbin while traversing the yarn by a traverse guide, so as to form a package. The yarn winding device includes a bobbin driving motor configured to rotationally drive the bobbin, a guide driving mechanism configured to reciprocate the traverse guide by means of a guide driving motor, and a controller configured to control the bobbin driving motor and the guide driving motor. A way of winding a yarn by such a yarn winding device is precision winding in which the ratio of the number of rotations of the bobbin to the number of traversal per unit time (i.e., winding ratio) is controlled to be constant. In the precision winding, the winding ratio is typically arranged to be a value slightly different from an integer, in order to prevent the formation of a ribbon (i.e., to prevent the yarn from being repeatedly wound on the same path on the surface of the package). With this arrangement, in the precision winding, the formation of a ribbon is avoided and the yarn is regularly wound in a parallel manner, as the path of the yarn wound on the surface of the package is gradually shifted. As a result, the yarn is easily unwound from the completed package, and the density of the package is easily controlled in accordance with the use of the package.

[0003] Meanwhile, Patent Literature 2 discloses a traverse unit capable of performing creeping with which the formation of a saddle bag on a package is suppressed. The saddle bag is a problem that an amount of a yarn wound at an end portion of the surface of a package in the axial direction is larger than an amount of the yarn wound on other parts of the surface, because, for example, it is typically difficult to swiftly reverse (i.e., change the direction of) the traverse guide. The formation of a saddle bag may deteriorate the shape of the package and/or may cause the density of the package to be irregular. The creeping is an action to temporarily narrow the width (traverse width) of a reciprocal movement range of the traverse guide during the formation of the package. With this arrangement, the amount of the yarn wound at the end portion in the axial direction of the package is decreased as compared to cases where the creeping is not performed, with the result that the formation of the saddle bag is suppressed.

[Citation List]

[Patent Literatures]

[0004]

[Patent Literature 1] Japanese Unexamined Patent Publication No. H3-115060

[Patent Literature 2] Japanese Unexamined Patent Publication No. S57-13058

[Summary of Invention]

[Technical Problem]

[0005] When the creeping is performed during the precision winding in the yarn winding device of Patent Literature 1, the following problem may occur. (The problem will be detailed in the embodiment below.) For example, when the traverse width in the creeping is simply narrowed as compared to the traverse width in normal traversal (hereinafter, in the normal state), the traverse cycle becomes inconsistent and hence the winding ratio becomes inconsistent. On this account, on the surface of the package, the position where the yarn is actually wound is deviated from the desired position, with the result that the shape of the surface of the package is poor. In order to prevent the occurrence of this problem, it is necessary to perform the creeping without changing the traverse cycle. However, for example, if one tries to achieve a constant winding ratio by simply differentiating the traveling speed of the traverse guide between the normal state and the creeping state, the angle (helix angle) between the yarn and the surface of the package becomes disadvantageously different between the normal state and the creeping state. As a result, the shape of the surface of the package is poor.

[0006] An object of the present invention is to suppress a winding ratio from being changed and to suppress the shape of the surface of a package from being poor, even when creeping is performed during precision winding.

[Solution to Problem]

[0007] According to a first aspect of the invention, a yarn winding device is configured to form a package by winding a running yarn onto a rotating bobbin while the yarn is traversed by a traverse guide and performing precision winding in which a winding ratio which is a ratio of the rotation number of the bobbin to the number of times of reciprocal movement of the traverse guide per unit time to be constant, the yarn winding device comprising: a guide driving unit which is configured to reciprocate the traverse guide in a predetermined traverse direction and is able to change a reversal position of the traverse guide during a winding operation of winding the yarn; and a control unit, the control unit being capable of performing: first reversal control in which the guide driving unit is controlled so that the traverse guide running outward in the traverse direction at a predetermined speed is decelerated, the running direction of the traverse guide is reversed to inward at a predetermined first reversal position, and then the traverse guide is re-accelerated to the predetermined speed; and second reversal control in

which the guide driving unit is controlled so that the traverse guide running outward in the traverse direction at the predetermined speed is decelerated, the running direction of the traverse guide is reversed to inward at a second reversal position which is on the inner side of the first reversal position, and then the traverse guide is re-accelerated to the predetermined speed, during the precision winding, as compared to a first reversal time which is between start of deceleration to completion of re-acceleration in the first reversal control, a second reversal time which is between start of deceleration of the traverse guide and completion of re-acceleration in the second reversal control being arranged to be long.

[0008] As a preparation for properly perform the precision winding while performing the creeping, the winding ratio must be arranged to be identical between a case where the traverse guide is reversed at the first reversal position (hereinafter, this case may be referred to as a normal state) and a case where the traverse guide is reversed at the second reversal position (hereinafter, this case may be referred to as a creeping state). In order to arrange the winding ratio to be identical between the states, when, for example, the rotation number of the bobbin is constant, it is necessary to arrange the movement cycle of the traverse guide to be identical between the normal state and the creeping state in which the width of the movable range of the traverse guide is narrow as compared to the normal state.

[0009] In the aspect of the present invention, the second reversal time is longer than the first reversal time. As the reversal time in the creeping state is actively elongated, the movement cycle of the traverse guide is arranged to be long in the creeping state. This makes it possible to arrange the movement cycle of the traverse guide to be identical between the normal state and the creeping state. It is therefore possible to prevent the winding ratio from being varied.

[0010] In addition to the above, because the traverse cycle in the creeping state is adjustable by adjusting the second reversal time as described above, the running speed of the traverse guide is arranged to be identical between the normal state and the creeping state when the reversal is not performed. It is therefore possible to arrange the angles of the yarn wound onto the surface of the package to be identical. It is therefore possible to suppress the shape of the surface of the package from being poor.

[0011] As described above, it is possible to suppress the winding ratio from being changed and to suppress the shape of the surface of the package from being poor, even when the creeping is performed during the precision winding.

[0012] According to a second aspect of the invention, the yarn winding device of the first aspect is arranged so that, in the second reversal control, the controller arranges the width of a region in which the traverse guide moves in the traverse direction during the second reversal time to be long as the distance between the first reversal po-

sition and the second reversal position is long in the traverse direction.

[0013] In order to suppress the shape of the surface of the package from being poor while suppressing a variation of the winding ratio, the second reversal time must be arranged to be long as the distance between the first reversal position and the second reversal position is long (i.e., as the traverse width is narrow in the creeping state). Provided that the width of a region where the traverse guide moves in the traverse direction during the second reversal time (hereinafter, a reversal region) is constant, the traverse guide is disadvantageously kept in a region in the vicinity of the second reversal position for a long time in the second reversal control, when the second reversal time is long. As a result, the yarn tends to be wound onto a narrow region on the surface of the package, in a concentrated manner. As a result, a level difference tends to be formed on the surface of the package, and hence an adverse effect such as yarn stitching of the yarn may occur on, for example, the shape of the package.

[0014] In the aspect of the present invention, the reversal region is wide when the distance between the first reversal position and the second reversal position is long. In other words, when the second reversal time becomes long as the traverse width in the creeping state is narrowed, the region in which the traverse guide is movable in the second reversal control becomes wide. On this account, it is possible to avoid a problem that the traverse guide is left in a narrow region in the traverse direction for a long time. It is therefore possible to suppress the yarn from being wound onto a narrow region on the surface of the package in a concentrated manner.

[0015] According to a third aspect of the invention, the yarn winding device of the first or second aspect is arranged such that, in the second reversal control, the controller controls the guide driving unit so that the traverse guide is positioned at the second reversal position in the traverse direction when a time that is a half of the second reversal time elapses from the start of the deceleration of the traverse guide.

[0016] In the second reversal control, for example, the traverse guide may be rapidly decelerated and reach the second reversal position, and may be gently re-accelerated. In this case, however, the shape of the reversed portion of the yarn wound onto the surface of the package may be significantly different between a case where the traverse guide is decelerated and a case where the traverse guide is re-accelerated. On this account, the shape of the reversed portion of the yarn on the surface of the package may not be symmetrical, and the reversed portion may not be neatly shaped. According to the aspect of the present invention, the time from the start of the deceleration of the traverse guide to the arrival of the traverse guide at the second reversal position is arranged to be equal to the time from the departure of the traverse guide from the second reversal position to the completion of the re-acceleration of the traverse guide. On this ac-

count, the reversed portion of the yarn is shaped to be symmetrical about the central axis of the wound package. (In other words, the reversed portion is neatly formed in shape.) It is therefore possible to suppress the shape of the reversed portion of the surface of the package from being poor.

[0017] According to a fourth aspect of the invention, the yarn winding device of any one of the first to third aspects further includes a bobbin driving unit which is configured to rotationally drive the bobbin, the control unit including a storage unit which is configured to store information of the relationship between a rotational angle of the bobbin and a position in the traverse direction of the traverse guide, and the bobbin driving unit and the guide driving unit being controlled based on the information stored in the storage unit.

[0018] In the aspect of the present invention, control is performed based on information of the relationship between the rotational angle of the bobbin and the position of the traverse guide. This makes it possible to simplify the complicated operation of performing the creeping while maintaining the winding ratio to be constant, as compared to, for example, control utilizing a complicated mechanical structure. Furthermore, it is possible to easily adjust the position and/or speed, etc. of the traverse guide in the second reversal control by rewriting the information.

[0019] According to a fifth aspect of the invention, the yarn winding device of any one of the first to fourth aspects is arranged so that the guide driving unit includes a driving source capable of driving forward and reverse.

[0020] For example, in a typical cam-type traverse unit, a motor configured to rotate in one direction is employed as a driving source, and a structure for performing creeping is a complicated mechanical structure. For this reason, it is difficult to finely control the creeping in the cam-type traverse unit. According to the aspect of the present invention, it is possible to cause the traverse guide to reciprocate by driving the driving source forward and backward. For this reason, the position and timing of the reversal of the traverse guide, etc. can be finely controlled by the controller. Fine control of the creeping can therefore be easily done.

[0021] According to a sixth aspect of the invention, the yarn winding device of the fifth aspect is arranged so that the guide driving unit includes a belt member to which the traverse guide is attached, the belt member being reciprocally driven by the driving source.

[0022] For example, in an arrangement in which a traverse guide is attached to a leading end portion of a swingable arm and the arm is driven in a swinging manner, the traverse guide reciprocates to draw an arc. On this account, it may be difficult to regularly wind the yarn onto the surface of the package even if the precision winding is performed. According to the aspect of the present invention, as the part of the belt member to which the traverse guide is attached is tensioned to be linear and is reciprocated, the traverse guide is easily reciprocated linearly.

Regular winding of the yarn onto the surface of the package is therefore facilitated.

[0023] According to a seventh aspect of the invention, a yarn winding method is a method for forming a package by winding a running yarn onto a rotating bobbin while the yarn is traversed by a traverse guide and performing precision winding in which a winding ratio which is a ratio of the rotation number of the bobbin to the number of times of reciprocal movement of the traverse guide per unit time to be constant, the yarn winding method comprising: a first reversal step in which the traverse guide running outward in a predetermined traverse direction at a predetermined speed is decelerated, the running direction of the traverse guide is reversed to inward at a predetermined first reversal position, and then the traverse guide is re-accelerated to the predetermined speed; and a second reversal step in which the traverse guide running outward in the traverse direction at the predetermined speed is decelerated, the running direction of the traverse guide is reversed to inward at a second reversal position which is on the inner side of the first reversal position, and then the traverse guide is re-accelerated to the predetermined speed, during the precision winding, as compared to a first reversal time which is between start of deceleration to completion of re-acceleration in the first reversal step, a second reversal time which is between start of deceleration of the traverse guide and completion of re-acceleration in the second reversal step being arranged to be long.

[0024] According to this aspect, being similar to the first aspect, it is possible to suppress the winding ratio from being changed and to suppress the shape of the surface of the package from being poor, even when the creeping is performed during the precision winding.

[Brief Description of Drawings]

[0025]

FIG. 1 is a schematic front view of a re-winder of an embodiment.

FIG. 2 shows an electric structure of the re-winder.

FIG. 3(a) is a graph showing the relationship between position of a traverse guide and time. FIG. 3(b) is a graph showing the relationship between speed of the traverse guide and time.

FIGs. 4(a) and 4(b) illustrate precision winding. FIG. 4(c) illustrates creeping.

FIG. 5(a) is a graph showing the relationship between speed of the traverse guide and time. FIG. 5(b) shows the paths of a yarn on the surface of a wound package.

FIG. 6(a) is a graph showing the relationship between speed of the traverse guide and time. FIG. 6(b) shows the paths of a yarn on the surface of a wound package.

FIG. 7(a) is a graph showing the relationship between position of a traverse guide and time. FIG. 7(b) shows the paths of a yarn on the surface of a wound package.

FIG. 8(a) is a graph showing the relationship between position of a traverse guide and time. FIG. 8(b) shows the paths of a yarn on the surface of a wound package.

FIG. 9(a) is a graph showing the relationship between position of a traverse guide and time. FIG. 9(b) shows the paths of a yarn on the surface of a wound package.

FIG. 10(a) is a graph showing the relationship between position of a traverse guide and time. FIG. 10(b) shows the paths of a yarn on the surface of a wound package.

7(b) is a graph showing the relationship between speed of the traverse guide and time.

FIG. 8(a) is a graph showing the relationship between acceleration of the traverse guide and time.

FIG. 8(b) is a graph showing the relationship between the width of a reversal region and a creeping amount.

FIGs. 9(a) and 9(b) show paths of the yarn on the surface of the package.

FIG. 10(a) is a graph showing the relationship between position of a traverse guide and time of a modification.

FIG. 10(b) is a graph showing the relationship between speed of the traverse guide and time.

FIG. 11 is a graph showing the relationship between acceleration of the traverse guide and time of the modification of FIG. 10.

[Description of Embodiments]

[0026] The following will describe an embodiment of the present invention with reference to FIG. 1 to FIG. 9. An up-down direction and a left-right direction shown in FIG. 1 will be used as an up-down direction and a left-right direction of a re-winder 1. A direction orthogonal to both the up-down direction and the left-right direction (i.e., a direction perpendicular to the plane of FIG. 1) is set as a front-rear direction. A direction in which a yarn Y runs will be referred to as a yarn running direction.

(Structure of Re-Winder)

[0027] To begin with, the structure of a re-winder 1 (yarn winding device of the present invention) of the present embodiment will be described with reference to FIG. 1. FIG. 1 is a schematic front view of the re-winder 1. As shown in FIG. 1, the re-winder 1 includes members such as a yarn supplying unit 11, a winding unit 12, a controller 13 (control unit of the present invention). The re-winder 1 is configured to unwind a yarn Y from a yarn supply package Ps supported by the yarn supplying unit 11, re-wind the yarn Y back to a winding bobbin Bw (a bobbin of the present invention) by the winding unit 12, so as to form a wound package Pw (a package of the present invention). To be more specific, the re-winder 1 is used for, for example, re-winding a yarn Y wound on a yarn supply package Ps in a more beautiful manner, and for forming a wound package Pw with desired density.

[0028] The yarn supplying unit 11 is, for example, attached to a front surface of a lower portion of a base 14 which vertically extends. The yarn supplying unit 11 is arranged to support the yarn supply package Ps which is formed by winding the yarn Y onto a yarn supplying bobbin Bs. The yarn supplying unit 11 is therefore able to supply the yarn Y.

[0029] The winding unit 12 is configured to form the wound package Pw by winding the yarn Y onto the wind-

ing bobbin Bw. The winding unit 12 is provided at an upper portion of the base 14. The winding unit 12 includes members such as a cradle arm 21, a winding motor 22 (a bobbin driving unit of the present invention), a traverse unit 23, and a contact roller 24.

[0030] The cradle arm 21 is, for example, supported by the base 14 to be swingable. The cradle arm 21 supports the winding bobbin Bw to be rotatable in such a way that, for example, the left-right direction is the axial direction of the winding bobbin Bw. At a leading end portion of the cradle arm 21, a bobbin holder (not illustrated) is rotatably attached to hold the winding bobbin Bw. The winding motor 22 is configured to rotationally drive the bobbin holder. The winding motor 22 is, for example, a typical AC motor in which the rotation number is variable. The winding motor 22 is therefore able to change the rotation speed of the winding bobbin Bw. The winding motor 22 is electrically connected to the controller 13 (see FIG. 2).

[0031] The traverse unit 23 is configured to traverse the yarn Y in the axial direction of the winding bobbin Bw (the left-right direction in the present embodiment). The traverse unit 23 is provided immediately upstream of the wound package Pw in the yarn running direction. The traverse unit 23 includes a traverse motor 31 (a guide driving unit of the present invention), an endless belt 32 (a belt member of the present invention), and a traverse guide 33.

[0032] The traverse motor 31 is, for example, a typical AC motor. The traverse motor 31 is a driving source configured to be able to rotate forward and backward and is arranged so that the rotation number is variable. The traverse motor 31 is electrically connected to the controller 13 (see FIG. 2). The endless belt 32 is a belt member to which the traverse guide 33 is attached. The endless belt 32 is wound onto pulleys 34 and 35 which are separated from each other in the left-right direction and a driving pulley 36 connected to the rotational shaft of the traverse motor 31, and is substantially triangular in shape when wound onto the pulleys. The endless belt 32 is reciprocally driven by the traverse motor 31. The traverse guide 33 is attached to the endless belt 32 and is provided between the pulley 34 and the pulley 35 in the left-right direction. The traverse guide 33 linearly and reciprocally runs in the left-right direction as the endless belt 32 is reciprocally driven by the traverse motor 31 (see arrows in FIG. 1). As a result, the traverse guide 33 traverses the yarn Y in the left-right direction. Hereinafter, the left-right direction may be referred to as a traverse direction. In the traverse unit 23 arranged as described above, the width (traverse width) of the movable range of the traverse guide 33 during a winding operation of winding the yarn Y is changeable by controlling, for example, a timing to switch the rotational direction of the rotational shaft of the traverse motor 31.

[0033] The contact roller 24 makes contact with the surface of the wound package Pw to adjust the shape of the wound package Pw by applying a contact pressure

to the surface. The contact roller 24 makes contact with the wound package Pw and is rotated by the rotation of the wound package Pw.

[0034] Between the yarn supplying unit 11 and the winding unit 12, a yarn guide 15, a guide roller 16, and a tension sensor 17 are provided in this order from the upstream to the downstream in the yarn running direction. The yarn guide 15 is provided, for example, on an extension of the central axis of the yarn supplying bobbin Bs, and guides the yarn Y unwound from the yarn supply package Ps to the downstream side in the yarn running direction. The guide roller 16 guides the yarn Y having been guided by the yarn guide 15 further to the downstream side in the yarn running direction. The guide roller 16 is provided on the front surface of the base 14 and above the yarn guide 15. The guide roller 16 is rotationally driven by a roller driving motor 18, for example. The roller driving motor 18 is, for example, a typical AC motor in which the rotation number is variable. The roller driving motor 18 is therefore able to change the rotation speed of the guide roller 16. The roller driving motor 18 is electrically connected to the controller 13 (see FIG. 2). In the present embodiment, the yarn Y is tensioned by a speed difference between the circumferential speed of the guide roller 16 and the circumferential speed of the wound package Pw.

[0035] The tension sensor 17 is provided between the wound package Pw and the guide roller 16 in the yarn running direction and is configured to detect the tension of the yarn Y. The tension sensor 17 is electrically connected to the controller 13 (see FIG. 2) and sends a result of detection of the tension to the controller 13.

[0036] The controller 13 includes members such as CPU, a ROM, and a RAM (storage unit 19). The storage unit 19 stores, for example, parameters such as an amount of the wound yarn Y, a winding speed, and the magnitude of tension applied to the yarn Y. The controller 13 controls components by using the CPU and a program stored in the ROM, based on the parameters stored in the RAM (storage unit 19), etc.

[0037] In the re-winder 1 arranged as described above, the yarn Y unwound from the yarn supply package Ps runs toward the downstream side in the yarn running direction. The running yarn Y is wound onto the rotating winding bobbin Bw while being traversed in the left-right direction (traverse direction) by the traverse guide 33 (winding operation of winding the yarn).

(Control of Movement of Traverse Guide)

[0038] Basic control of movement of the traverse guide 33 by the controller 13 will be described with reference to FIGs. 3(a) and 3(b). FIG. 3(a) is a graph showing the relationship between position of the traverse guide 33 and time in the traverse direction. FIG. 3(b) is a graph showing the relationship between speed of the traverse guide 33 and time in the traverse direction.

[0039] The storage unit 19 (see FIG. 2) of the controller

13 stores information regarding the traverse width. The controller 13 controls the traverse motor 31 based on the information stored in the storage unit 19. With this arrangement, the endless belt 32 is reciprocally driven and the traverse guide 33 reciprocates in the traverse direction.

[0040] In the graph shown in FIG. 3(a), the horizontal axis indicates time whereas the vertical axis indicates position of the traverse guide 33 in the traverse direction. For convenience, in the left-right direction, a direction leftward of the center of the region (traverse region) where the traverse guide 33 reciprocates will be regarded as a positive direction of the vertical axis of the graph. A direction rightward of the center of the traverse region will be regarded as a negative direction of the vertical axis of the graph.

[0041] For example, provided that the traverse width is W, the traverse guide 33 reciprocates within a region between $-W/2$ and $W/2$ in the traverse direction as shown in FIG. 3(a). To be more specific, for example, at a predetermined time point (the left end of the graph of FIG. 3(a)), the traverse guide 33 is at the right end (i.e., the position $-W/2$). After a predetermined time (T) elapses, the traverse guide 33 moves to the left end (the position $W/2$). Thereafter, the traverse guide 33 is reversed rightward and reaches the right end again. As this operation is repeated, the traverse guide 33 reciprocates.

[0042] In the graph shown in FIG. 3(b), the horizontal axis indicates time whereas the vertical axis indicates speed of the traverse guide 33 in the traverse direction. The following will describe a specific example. When the traverse guide 33 is at the right end (the position $-W/2$), the speed of the traverse guide 33 is zero. The controller 13 controls the traverse motor 31 to accelerate the traverse guide 33 to a predetermined speed (V). Thereafter, the controller 13 maintains the speed of the traverse guide 33 to be constant until the traverse guide 33 reaches a position close to the left end (the position $W/2$). When the traverse guide 33 reaches the position close to the left end, the controller 13 controls the traverse motor 31 to perform reversal control as described below. That is to say, the controller 13 decelerates the traverse guide 33 running leftward (outward in the traverse direction), and reverses the running direction of the traverse guide 33 to rightward (inward in the traverse direction) at the position $W/2$. Thereafter, the controller 13 accelerates the traverse guide 33 to a predetermined speed again (as indicated by $-V$ in FIG. 3(b)). In the present embodiment, the time between the start of the deceleration of the traverse guide 33 and the completion of the re-acceleration in the reversal control is referred to as a reversal time (T_r in FIGs. 3(a) and 3(b)).

(Precision Winding and Creeping)

[0043] The following will describe the precision winding and the creeping with reference to FIGs. 4(a) to 4(c). FIGs. 4(a) and 4(b) illustrate the precision winding, in

each of which a wound package Pw is exploded in the rotational direction. For convenience, as shown in FIGs. 4(a) and 4(b), a rotational angle of the wound package Pw at the upper end of each figure is regarded as 0 degree, whereas a rotational angle at the lower end of each figure is regarded as 360 degrees. FIG. 4(c) illustrates the creeping.

[0044] To begin with, the following will describe the precision winding. The precision winding is a way of winding with which the ratio (winding ratio) of the rotation number of the winding bobbin Bw to the number of times of reciprocal movement of the traverse guide 33 per unit time is maintained to be constant. This makes it possible to control the relationship between the rotational angle of the winding bobbin Bw and the position of the traverse guide 33 in the traverse direction, irrespective of the diameter of the wound package Pw.

[0045] The storage unit 19 (see FIG. 2) of the controller 13 stores, for example, information (a table and a calculation formula) of the relationship between the rotational angle of the winding bobbin Bw and the position of the traverse guide 33 in the traverse direction. As a specific example, the storage unit 19 stores the rotational angles of the winding bobbin Bw in association with the positions where acceleration and deceleration of the traverse guide 33 in the traverse direction start and the reversal position of the traverse guide 33 in the traverse direction. The storage unit 19 stores a calculation formula by which the speed and/or acceleration of the traverse guide 33 is calculated based on information of the rotational angle of the winding bobbin Bw and information of the position of the traverse guide 33. The controller 13 controls the winding motor 22 and the traverse motor 31 based on the information stored in the storage unit 19. In the present embodiment, the controller 13 controls the winding motor 22 so that the rotation number of the winding bobbin Bw is maintained to be constant. As a first example, as shown in FIG. 4(a), when the winding ratio is 5, the winding bobbin Bw rotates five times while the traverse guide 33 reciprocates once. In other words, as shown in FIG. 4(a), the yarn Y is wound for an amount corresponding to five rotations of the wound package Pw, while the traverse guide 33 reciprocates once.

[0046] As described above, when the winding ratio is an integer, it is disadvantageous in that the yarn Y is repeatedly wound onto the same path on the surface of the wound package Pw (i.e., a ribbon is formed). In order to avoid this problem, in reality, the winding ratio is set at a value slightly different from an integer (e.g., $5+\alpha$) as shown in FIG. 4(b). With this arrangement, in the precision winding, the formation of a ribbon is avoided and the yarn Y is regularly wound in a parallel manner, as the path of the yarn wound on the surface of the wound package Pw is gradually shifted. As a result, the yarn Y is easily unwound from the wound package Pw in a posterior process, and the density of the package is easily controlled in accordance with the use of the wound package Pw.

[0047] Now, the creeping will be described. The creeping is an action to temporarily change the traverse width during the winding operation of winding the yarn Y, for the purpose of suppressing the formation of a saddle bag on the wound package Pw. The saddle bag is a problem that an amount of a yarn wound at an end portion of the surface of the wound package Pw in the axial direction is larger than an amount of the yarn wound on other parts of the surface, because, for example, it is typically difficult to swiftly reverse the traverse guide 33. As a result, a level difference tends to be formed on the surface of the wound package Pw, with the result that yarn stitching of the yarn Y may occur. Furthermore, the formation of a saddle bag may deteriorate the shape of the wound package Pw and/or may cause the density of the wound package Pw to be irregular.

[0048] As described above, the traverse unit 23 is arranged to drive, by the traverse motor 31, the endless belt 32 to which the traverse guide 33 is attached, in a reciprocal manner. On this account, as the controller 13 controls the traverse motor 31, it is possible to change the reversal position of the traverse guide 33 at will. For example, as shown in FIG. 4(c), the controller 13 is able to switch the traverse width between a predetermined first width (Wa) and a second width (Wb) that is narrower than the first width (i.e., able to perform the creeping). Hereinafter, a state in which the traverse width is equal to the first width will be referred to as a normal state whereas a state in which the traverse width is equal to the second width will be referred to as a creeping state. The distance between the reversal position of the traverse guide 33 in the normal state and the reversal position of the traverse guide 33 in the creeping state is $\Delta W = (W_a - W_b)/2$. Hereinafter, this distance will be referred to as a creeping amount. The controller 13 is able to change the creeping amount by controlling the traverse motor 31. The creeping amount is typically about 5 to 20 mm but is not limited to this range. The controller 13 is able to perform the creeping at a desired timing. For example, as shown in FIG. 4(c), the controller 13 performs the creeping once while the traverse guide 33 reciprocates three times. As compared to cases where the creeping is not performed, the creeping makes it possible to reduce the amount of the yarn wound at the end portion in the axial direction of the wound package Pw, and therefore to suppress the formation of saddle bag.

[0049] If the creeping is performed while the precision winding is performed, the following problem may occur. The following will specifically describe the problem with reference to FIGs. 5(a) and 5(b) and FIGs. 6(a) and 6(b). FIG. 5(a) is a graph similar to that of FIG. 3(b) and shows the relationship between speed of the traverse guide 33 and time when the traverse width is simply narrowed (as described below) during the creeping. FIG. 5(b) is an enlarged view of the left end portion of the wound package Pw and shows the paths of the yarn Y on the surface of the wound package Pw when the traverse width is simply narrowed during the creeping. FIG. 6(a) is a graph

similar to that of FIG. 3(b) and shows the relationship between speed of the traverse guide 33 and time when the traversal speed is simply decreased (as described below) during the creeping. FIG. 6(b) is an enlarged view of the left end portion of the wound package Pw and shows the paths of the yarn Y on the surface of the wound package Pw when the traversal speed is simply decreased during the creeping. In the graphs shown in FIG. 5(a) and FIG. 6(a), solid lines indicate the traversal speed in the normal state whereas dotted lines indicate the traversal speed in the creeping state.

[0050] To begin with, a case where the traverse width is simply narrowed in the creeping state as compared to the normal state will be described. When the traverse width is simply narrowed, as shown in FIG. 5(a), only a timing to perform the reversal control is changed without changing the above-described reversal time (T_r) and the traversal speed (V) when the reversal control is not performed. In this case, in the creeping state, the traverse width is narrowed by simply reversing the traverse guide 33 at a timing earlier than the reversal in the normal state. As a result, the traverse cycle is shortened in the creeping state as compared to the normal state. On this account, the precision winding is not properly done, and hence the yarn Y runs on the surface of the wound package Pw along the paths shown in FIG. 5(b). In other words, yarn parts Y1 and Y2 which are parts of the yarn Y wound onto the wound package Pw in the normal state are reversed at points 101 and 102 on an end face Pw1 of the wound package Pw, respectively. Furthermore, a yarn part Y3 which is a part of the yarn Y wound onto the wound package Pw in the creeping state is reversed at a point 103 which is positioned inward of the points 101 and 102 by ΔW in the traverse direction. Assume that a reversal position when the traverse width of the yarn Y3 being wound is identical with the traverse width in the normal state is a point 104. The point 103 is positionally different from the point 104 in the rotational direction such that the point 103 is formed in the wound package Pw at a smaller rotational angle (i.e., at an earlier timing) than the point 104. To put it differently, the yarn part Y3 is wound at a location significantly deviated from a path 105 where the yarn Y is wound when the creeping is not performed. As a result, the shape of the surface of the wound package Pw is poor.

[0051] Now, a case where the traversal speed is simply decreased in the creeping state as compared to the normal state will be described. When the traversal speed is simply decreased, as shown in FIG. 6(a), the traversal speed when the reversal control is not performed is decreased as compared to the normal state, without changing the reversal time (T_r) and the timing to perform the reversal control. For example, if the traversal speed in the normal state is V_a and the traversal speed in the creeping state is V_b , V_b is smaller than V_a . In this case, the winding ratio is maintained to be constant because the traverse cycle is identical between the normal state and the creeping state. In the case above, furthermore,

the yarn part Y3 which is wound in the creeping is reversed at a point 106 as shown in FIG. 6(b). The point 106 is at the same position as the above-described point 104 in the rotational direction. However, in this case, the angle (helix angle) between the yarn Y and the wound package Pw becomes disadvantageously different between the normal state and the creeping state, on account of the change of the traversal speed. To put it differently, the yarn parts Y1 and Y2 which are parts of the yarn Y wound onto the wound package Pw in the normal state are not parallel to the yarn part Y3 which is a part of the yarn Y wound onto the wound package Pw in the creeping state. As a result, the shape of the surface of the wound package Pw is poor. Under this circumstance, in order to suppress the winding ratio from being changed and to suppress the shape of the surface of wound package Pw from being poor even when the creeping is performed during the precision winding, the controller 13 performs control as described below in the present embodiment.

(Details of Yarn Winding Method Using Reversal Control)

[0052] The yarn winding method performed by the controller 13 by using the above-described reversal control will be detailed with reference to FIGs. 7(a) and 7(b), FIGs. 8(a) and 8(b), and FIGs. 9(a) and 9(b). FIG. 7(a) is a graph showing the relationship between position of the traverse guide 33 and time in the traverse direction. FIG. 7(b) is a graph showing the relationship between speed of the traverse guide 33 and time in the traverse direction. FIG. 8(a) is a graph showing the relationship between acceleration of the traverse guide 33 and time in the traverse direction. FIG. 8(b) is a graph showing the relationship between the later-described width of a reversal region and a creeping amount. FIG. 9(a) and FIG. 9(b) are similar to FIG. 5(b) and FIG. 6(b) and show the paths of the yarn Y on the surface of the wound package Pw. The descriptions below assume that the rotation number of the wound package Pw is constant.

[0053] To begin with, as the reversal control in the normal state (first reversal control), the controller 13 performs the following control. In the first reversal control, the controller 13 reverses the traverse guide 33 at the first reversal position ($W_a/2$ in FIG. 7(a)) in the traverse direction (first reversal step). In the first reversal control, the time between the start of the deceleration of the traverse guide 33 and the completion of the re-acceleration is referred to as a first reversal time (T_{ra}). In addition to the above, as the reversal control (second reversal control) in the creeping state, the controller 13 performs the following control. In the second reversal control, the controller 13 reverses the traverse guide 33 at the second reversal position ($W_b/2$ in FIG. 7(a)) in the traverse direction (second reversal step). In the second reversal control, the time between the start of the deceleration of the traverse guide 33 to the completion of the re-acceleration is referred to as a second reversal time (T_{rb}). A

region in which the traverse guide 33 moves in the traverse direction in a period between the start of deceleration and the completion of re-acceleration is referred to as a reversal region. The width of the reversal region in the second reversal control is referred to as W_t , for example (see FIG. 7(a)).

[0054] As shown in FIG. 7(a), the controller 13 arranges the second reversal time to be longer than the first reversal time ($Trb > Tra$). To put it differently, in the second reversal control, the controller 13 gently accelerates and decelerates the traverse guide 33 as compared to the first reversal control. To be more specific, as compared to the maximum value (A_a) of the acceleration during the first reversal time in the first reversal control, the maximum value (A_b) of the acceleration during the second reversal time in the second reversal control is arranged to be small (see FIG. 8(a)). In other words, as compared to a time average of the acceleration during the first reversal time in the first reversal control, a time average of the acceleration during the second reversal time in the second reversal control is arranged to be small.

[0055] As a result, the traverse cycle is arranged to be identical between the normal state and the creeping state even when the traverse width is different between the normal state and the creeping state (see FIG. 7(a)). A variation in the winding ratio is therefore suppressed. In addition to the above, the controller 13 arranges the traversal speed when the reversal control is not performed to be identical between the normal state and the creeping state (see FIG. 7(b)). Furthermore, in the second reversal control, the controller 13 controls the traverse motor 31 so that the traverse guide 33 is at the second reversal position when a time ($Trb/2$) that is a half of the second reversal time elapses from the start of the deceleration of the traverse guide 33.

[0056] As a result of the control described above, the yarn Y is wound onto the wound package Pw as shown in FIG. 9(a). In other words, a part (yarn part Y3) of the yarn Y wound onto the wound package Pw in the creeping state is reversed at a point 107 in the traverse direction. The point 107 is at the same position as the above-described point 104 in the rotational direction. In the second reversal control (i.e., when the traverse guide 33 moves in the above-described reversal region), the yarn part Y3 is wound onto the wound package Pw so as to form an arc on the surface (see a hatched region 201 in FIG. 9(a)). Because the traversal speed when the reversal control is not performed is identical between the normal state and the creeping state, the helix angle when the reversal control is not performed is identical between the normal state and the creeping state. Therefore, on the inner side of the region 201 in the traverse direction, the yarn part Y3 is wound along the above-described path 105. For this reason, in the present embodiment, the precision winding is properly done and it is possible to suppress the shape of the surface of the wound package Pw from being poor.

[0057] As described above, the traverse guide 33 is at

the second reversal position when a time ($Trb/2$) that is a half of the second reversal time elapses from the start of the deceleration of the traverse guide 33. On this account, the reversed portion of the yarn part Y3 is symmetrical about the central axis of the wound package Pw in shape. In other words, the reversed portion of the yarn part Y3 is neatly formed.

[0058] The controller 13 arranges the width of the reversal region in the traverse direction to be long when the creeping amount is large (see FIG. 8(b)). For example, when the creeping amount is $\Delta W1$ which is larger than ΔW , the controller 13 arranges the width of the reversal region to be W_{t1} which is wider than W_t (see FIGs. 9(a) and 9(b)). In other words, when the second reversal time becomes long as the traverse width in the creeping state is narrowed, the region in which the traverse guide 33 is movable in the traverse direction in the second reversal control becomes wide. It is therefore possible to avoid a problem that the traverse guide 33 is left in a narrow region in the traverse direction for a long time. Furthermore, with the arrangement above, the arc formed by the yarn part Y3 when it is wound onto the wound package Pw is large (see a region 202 in FIG. 9(b)).

[0059] As described above, the second reversal time is longer than the first reversal time. As the reversal time in the creeping state is actively elongated, the movement cycle of the traverse guide 33 is arranged to be long in the creeping state. This makes it possible to arrange the movement cycle of the traverse guide 33 to be identical between the normal state and the creeping state. It is therefore possible to prevent the winding ratio from being varied.

[0060] In addition to the above, because the traverse cycle in the creeping state is adjustable by adjusting the second reversal time as described above, the running speed of the traverse guide 33 is arranged to be identical between the normal state and the creeping state when the reversal is not performed. It is therefore possible to arrange the angles of the yarn Y wound onto the surface of the wound package Pw to be identical. It is therefore possible to suppress the shape of the surface of the wound package Pw from being poor.

[0061] In addition to the above, the width of the reversal region in the traverse direction is arranged to be long when the creeping amount is large. In other words, when the second reversal time becomes long as the traverse width in the creeping state is narrowed, the region in which the traverse guide 33 is movable in the second reversal control becomes wide. On this account, it is possible to avoid a problem that the traverse guide 33 is left in a narrow region in the traverse direction for a long time. It is therefore possible to suppress the yarn Y from being wound onto a narrow region on the surface of the wound package Pw in a concentrated manner.

[0062] In addition to the above, the time from the start of the deceleration of the traverse guide 33 to the arrival of the traverse guide 33 at the second reversal position

is arranged to be equal to the time from the departure of the traverse guide 33 from the second reversal position to the completion of the re-acceleration. On this account, the reversed portion of the yarn Y is shaped to be symmetrical about the central axis of the wound package Pw. (In other words, the reversed portion is neatly formed in shape.) It is therefore possible to suppress the shape of the reversed portion of the surface of the wound package Pw from being poor.

[0063] In addition to the above, the controller 13 performs control based on information of the relationship between the rotational angle of the winding bobbin Bw and the position of the traverse guide 33. This makes it possible to simplify the complicated operation of performing the creeping while maintaining the winding ratio to be constant, as compared to, for example, control utilizing a complicated mechanical structure. Furthermore, it is possible to easily adjust the position, speed, etc. of the traverse guide 33 in the second reversal control by re-writing the information.

[0064] The traverse motor 31 is configured to be able to rotate forward and backward. It is therefore possible to cause the traverse guide 33 to reciprocate by driving the traverse motor 31 forward and backward. For this reason, the position and timing of the reversal of the traverse guide 33, etc. can be finely controlled by the controller. Fine control of the creeping can therefore be easily done.

[0065] In addition to the above, as the part of the endless belt 32 to which the traverse guide 33 is attached is tensioned to be linear and is reciprocated, the traverse guide 33 is easily reciprocated linearly. Regular winding of the yarn Y onto the surface of the wound package Pw is therefore facilitated.

[0066] The following will describe modifications of the above-described embodiment. The members identical with those in the embodiment above will be denoted by the same reference numerals and the explanations thereof are not repeated.

(1) In the embodiment above, the controller 13 gently accelerates and decelerates the traverse guide 33 in the second reversal control as compared to the first reversal control. The disclosure, however, is not limited to this arrangement. For example, as shown in FIGs. 10(a) and 10(b) and FIG. 11, the controller 13 may arrange the maximum value of the acceleration in the second reversal time in the second reversal control to be identical with the maximum value of the acceleration in the first reversal time in the first reversal control. The controller 13 may stop the traverse guide 33 at the second reversal position in the traverse direction for a predetermined time and then accelerate the traverse guide 33 again. In this way, the second reversal time may be arranged to be longer than the first reversal time. Provided that the second reversal control of the embodiment above is control A whereas the second reversal con-

trol in the modification above (see FIGs. 10(a) and 10(b) and FIG. 11) is control B, the controller 13 may perform control as described below. The controller 13 may perform only the control A or the control B as the second reversal control during the winding operation. Alternatively, the controller 13 may perform the control A and the control B in combination during the winding operation. To be more specific, the controller 13 may repeatedly perform the control A and the control B in a predetermined pattern, as the second reversal control. For example, the controller 13 may perform the control A and the control B alternately.

(2) While in the embodiment above the width of the reversal region of the traverse guide 33 in the traverse direction is arranged to be wide as the creeping amount is large, the disclosure is not limited to this arrangement. The width of the reversal region may be constant irrespective of the creeping amount.

(3) In the embodiment above, in the second reversal control, the controller 13 controls the traverse motor 31 so that the traverse guide 33 is at the second reversal position when a time that is a half of the second reversal time elapses from the start of the deceleration of the traverse guide 33. However, the disclosure is not limited to this arrangement. For example, in the second reversal control, the controller 13 may rapidly decelerate the traverse guide 33 and then gently re-accelerate the traverse guide 33. Alternatively, in the second reversal control, the controller 13 may gently decelerate the traverse guide 33 and then rapidly re-accelerate the traverse guide 33.

(4) In the embodiment above, the storage unit 19 of the controller 13 stores both a table and a calculation formula as information of the relationship between the rotational angle of the winding bobbin Bw and the position in the traverse direction of the traverse guide 33. The disclosure, however, is not limited to this arrangement. For example, the storage unit 19 may store only a calculation formula for calculating the position and/or speed of the traverse guide 33, etc. based on the rotational angle of the winding bobbin Bw. In other words, during the winding operation, the controller 13 may always calculate the position and/or speed of the traverse guide 33, etc. based on the rotational angle of the winding bobbin Bw and the calculation formula. Alternatively, the storage unit 19 may store only a table as information of the relationship between the rotational angle of the winding bobbin Bw and the position, speed, and acceleration of the traverse guide 33.

(5) While in the embodiment above the traverse guide 33 is attached to the endless belt 32, the disclosure is not limited to this arrangement. For example, the traverse guide 33 may be attached to a leading end portion of an arm that is driven in a swinging manner (see Japanese Unexamined Patent Publi-

cation No. 2007-153554). Alternatively, the traverse guide 33 may be reciprocated by, for example, a linear motor.

(6) While in the embodiment above the traverse guide 33 is driven by a driving source which is able to drive forward and reverse, the disclosure is not limited to this arrangement. For example, the re-winder 1 may include a cam-type traverse unit which is driven by a driving source that is a motor rotationally driving in one direction.

(7) While in the embodiment above the rotation number of the winding bobbin Bw is constant, the disclosure is not limited to this arrangement. As long as the winding motor 22 and the traverse motor 31 are controlled so that the winding ratio is maintained to be constant in consideration of the precision winding, the controller 13 may change the rotation number of the winding bobbin Bw during the winding operation.

(8) The present invention can be applied to not only the re-winder 1 but also to various types of yarn winding devices.

[Reference Signs List]

[0067]

1	re-winder (yarn winding device)	
13	controller (control unit)	
19	storage unit	30
22	winding motor (bobbin driving unit)	
31	traverse motor (guide driving unit)	
32	endless belt (belt member)	
33	traverse guide	
Bw	winding bobbin (bobbin)	35
Pw	wound package (package)	
Y	yarn	

Claims

1. A yarn winding device which is configured to form a package by winding a running yarn onto a rotating bobbin while the yarn is traversed by a traverse guide and performing precision winding in which a winding ratio which is a ratio of the rotation number of the bobbin to the number of times of reciprocal movement of the traverse guide per unit time to be constant, the yarn winding device comprising:

a guide driving unit which is configured to reciprocate the traverse guide in a predetermined traverse direction and is able to change a reversal position of the traverse guide during a winding operation of winding the yarn; and a control unit, the control unit being capable of performing:

first reversal control in which the guide driving unit is controlled so that the traverse guide running outward in the traverse direction at a predetermined speed is decelerated,

the running direction of the traverse guide is reversed to inward at a predetermined first reversal position, and then the traverse guide is re-accelerated to the predetermined speed; and

second reversal control in which the guide driving unit is controlled so that the traverse guide running outward in the traverse direction at the predetermined speed is decelerated, the running direction of the traverse guide is reversed to inward at a second reversal position which is on the inner side of the first reversal position, and then the traverse guide is re-accelerated to the predetermined speed,

during the precision winding, as compared to a first reversal time which is between start of deceleration to completion of re-acceleration in the first reversal control,

a second reversal time which is between start of deceleration of the traverse guide and completion of re-acceleration in the second reversal control being arranged to be long.

2. The yarn winding device according to claim 1, wherein, in the second reversal control, the controller arranges the width of a region in which the traverse guide moves in the traverse direction during the second reversal time to be long as the distance between the first reversal position and the second reversal position is long in the traverse direction.
3. The yarn winding device according to claim 1 or 2, wherein, in the second reversal control, the controller controls the guide driving unit so that the traverse guide is positioned at the second reversal position in the traverse direction when a time that is a half of the second reversal time elapses from the start of the deceleration of the traverse guide.
4. The yarn winding device according to any one of claims 1 to 3, further comprising a bobbin driving unit which is configured to rotationally drive the bobbin, the control unit including a storage unit which is configured to store information of the relationship between a rotational angle of the bobbin and a position in the traverse direction of the traverse guide, and the bobbin driving unit and the guide driving unit being controlled based on the information stored in the storage unit.

5. The yarn winding device according to any one of claims 1 to 4, wherein, the guide driving unit includes a driving source capable of driving forward and reverse. 5
6. The yarn winding device according to claim 5, wherein, the guide driving unit includes a belt member to which the traverse guide is attached, the belt member being reciprocally driven by the driving source. 10
7. A yarn winding method for forming a package by winding a running yarn onto a rotating bobbin while the yarn is traversed by a traverse guide and performing precision winding in which a winding ratio which is a ratio of the rotation number of the bobbin to the number of times of reciprocal movement of the traverse guide per unit time to be constant, the yarn winding method comprising: 15
- a first reversal step in which the traverse guide running outward in a predetermined traverse direction at a predetermined speed is decelerated, the running direction of the traverse guide is reversed to inward at a predetermined first reversal position, and then the traverse guide is re-accelerated to the predetermined speed; and a 20
- second reversal step in which the traverse guide running outward in the traverse direction at the predetermined speed is decelerated, the running direction of the traverse guide is reversed to inward at a second reversal position which is on the inner side of the first reversal position, and then the traverse guide is re-accelerated to the predetermined speed, 25
- during the precision winding, as compared to a first reversal time which is between start of deceleration to completion of re-acceleration in the first reversal step, a second reversal time which is between start of deceleration of the traverse guide and completion of re-acceleration in the 30
- second reversal step being arranged to be long. 35
- 40
- 45
- 50
- 55

FIG.1

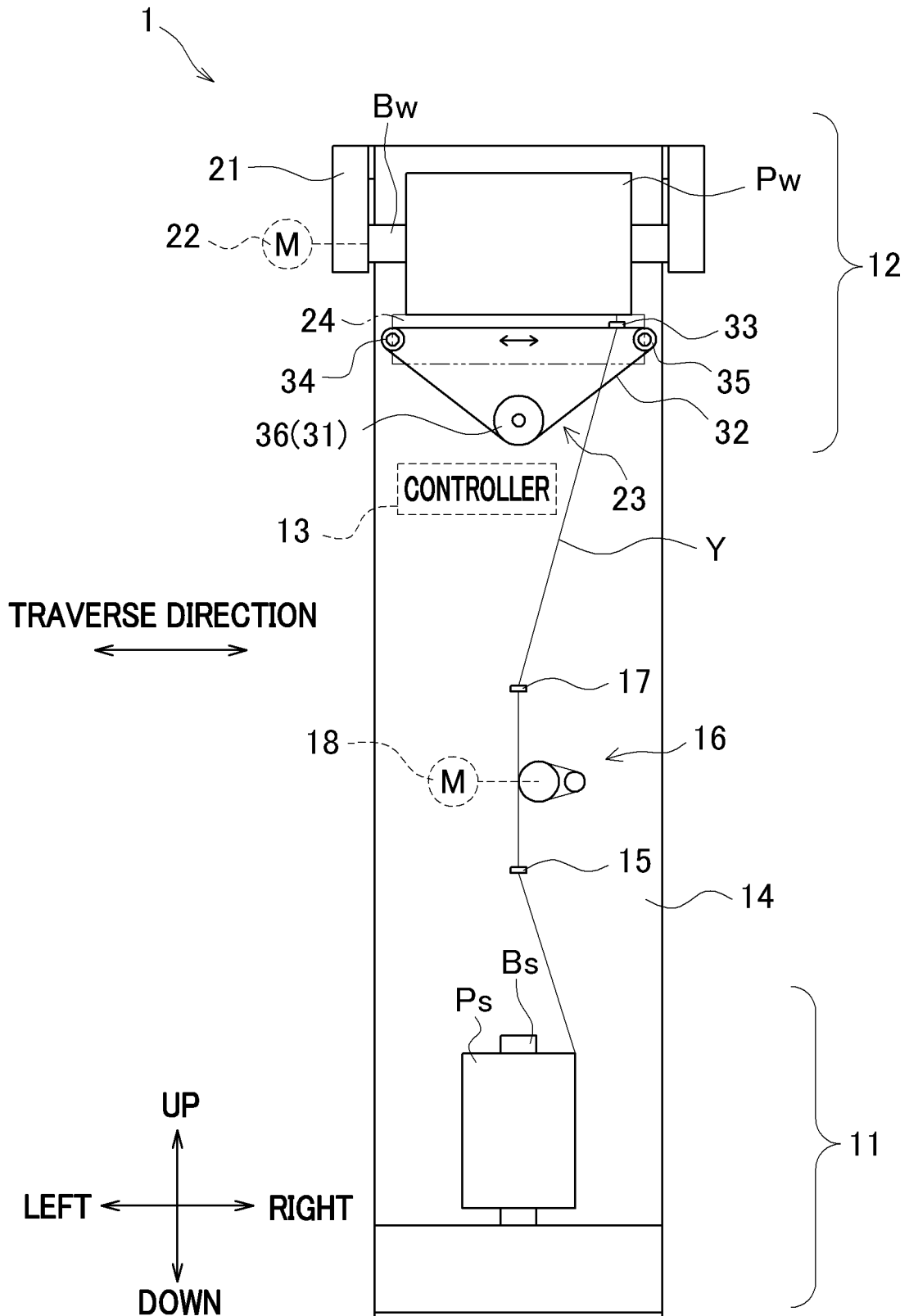


FIG.2

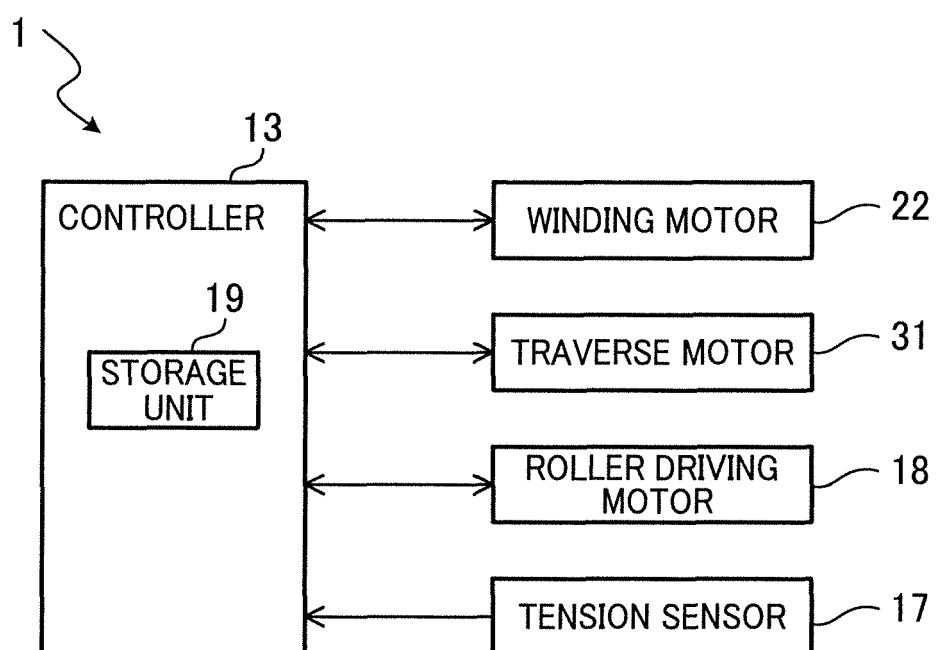
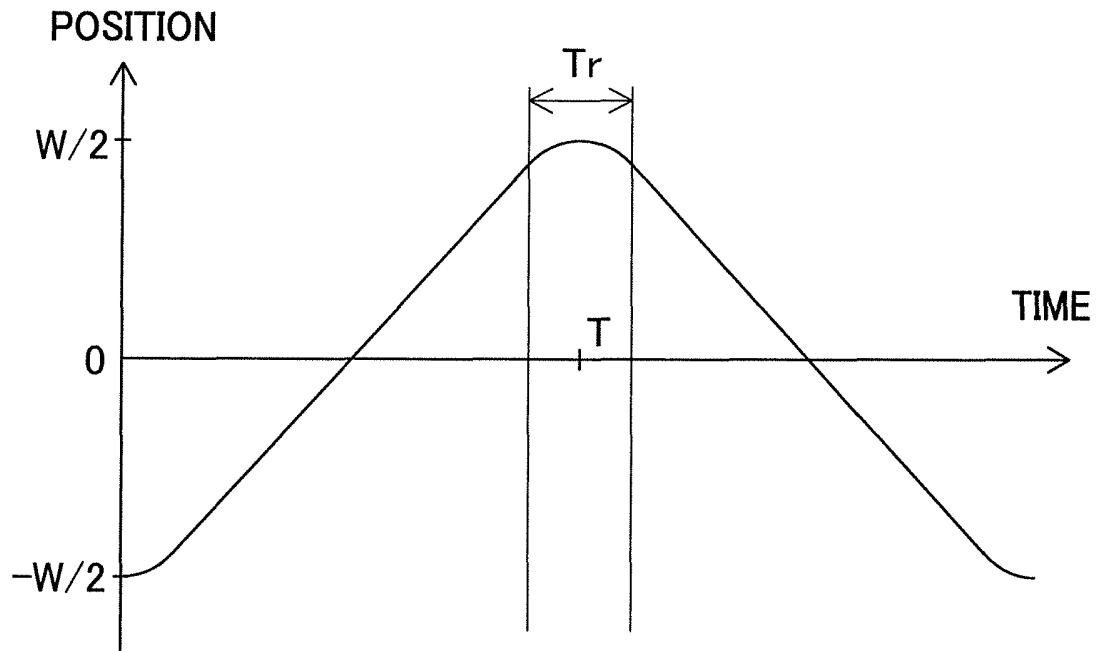


FIG.3

(a) RELATIONSHIP BETWEEN POSITION OF TRAVERSE GUIDE AND TIME



(b) RELATIONSHIP BETWEEN SPEED OF TRAVERSE GUIDE AND TIME

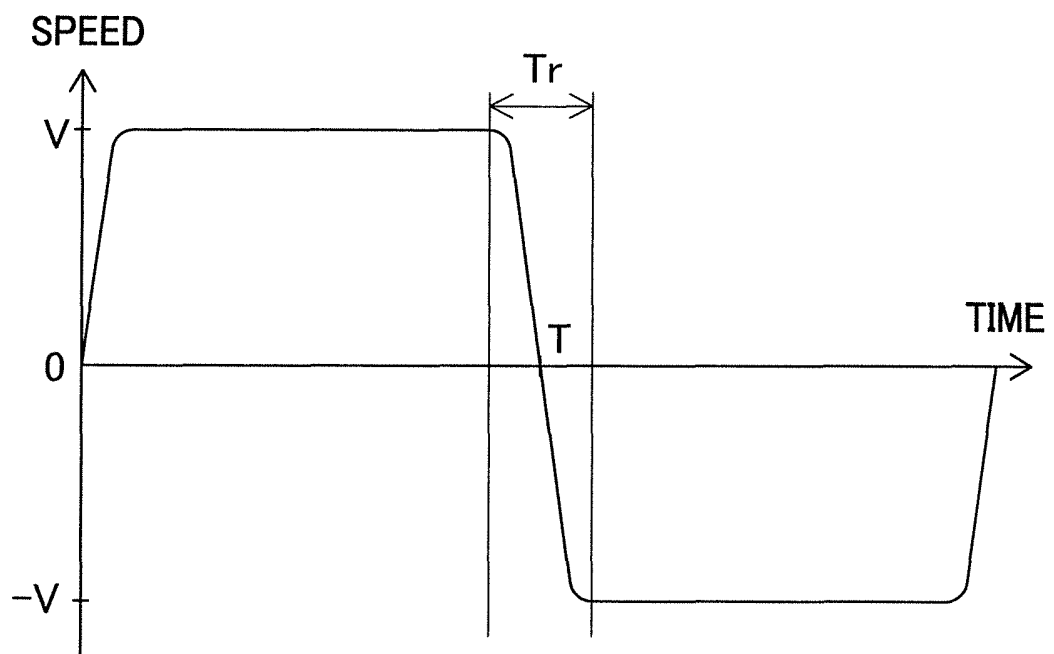


FIG.4

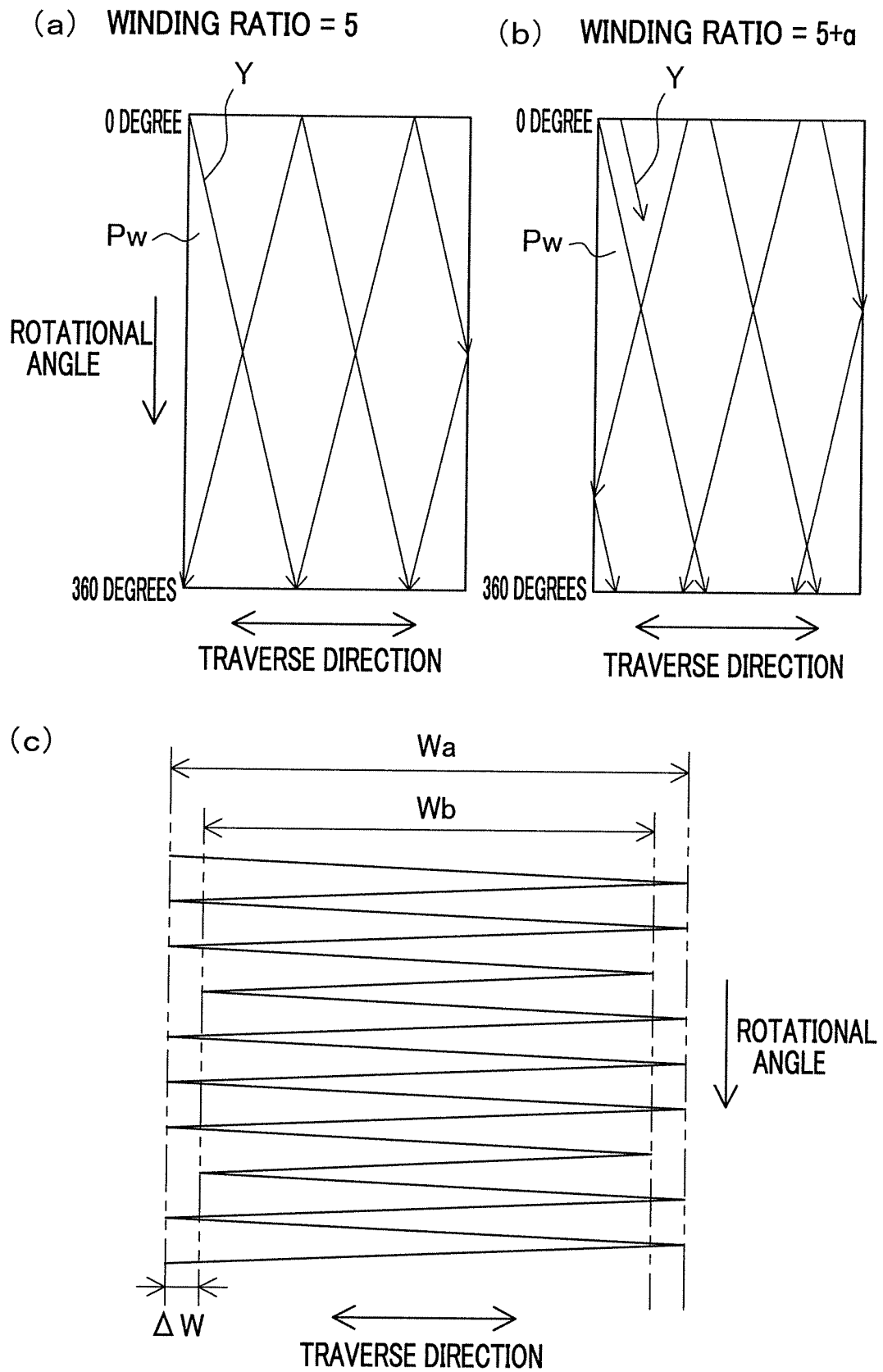
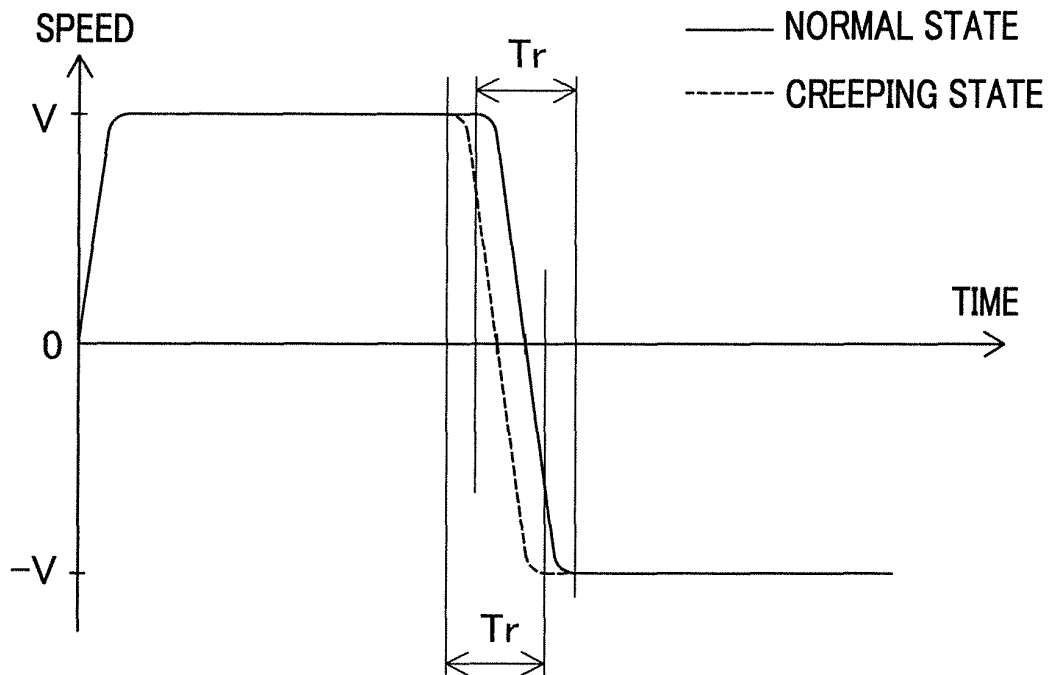


FIG.5

(a) REFERENCE:RELATIONSHIP BETWEEN SPEED OF TRAVERSE GUIDE AND TIME



(b) REFERENCE:PATHS OF YARN ON SURFACE OF WOUND PACKAGE

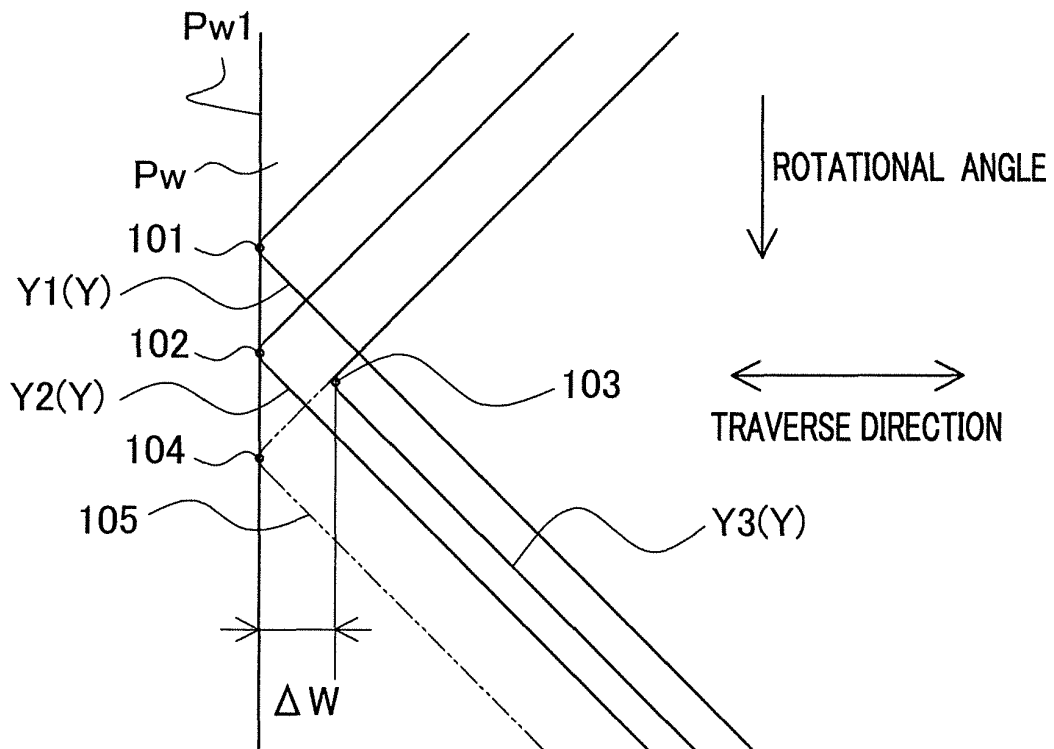
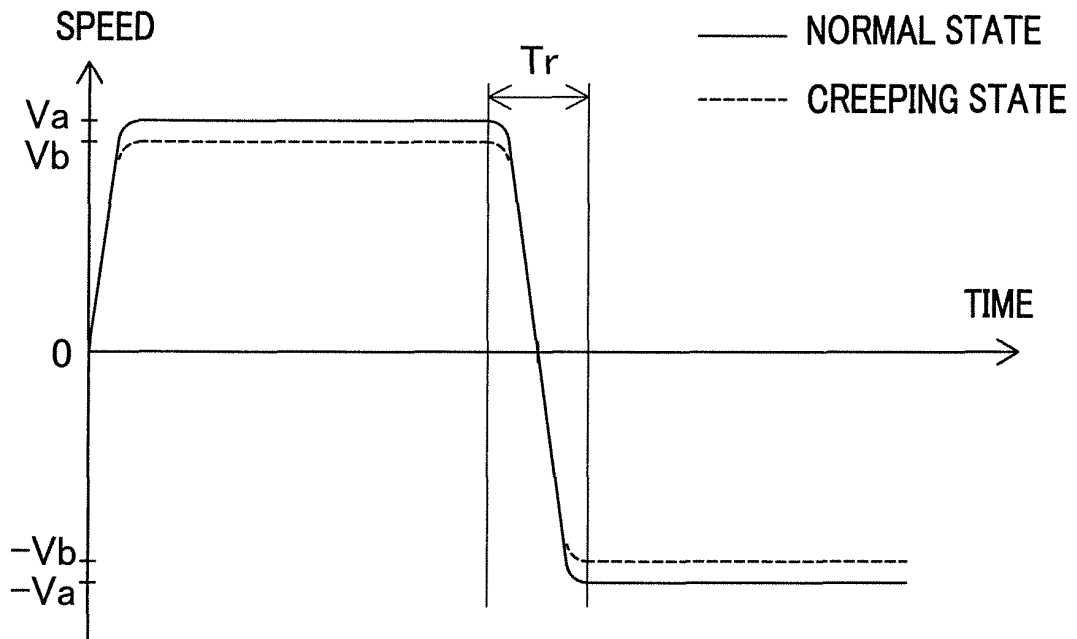


FIG.6

(a) REFERENCE:RELATIONSHIP BETWEEN SPEED OF TRAVERSE GUIDE AND TIME



(b) REFERENCE:PATHS OF YARN ON SURFACE OF WOUND PACKAGE

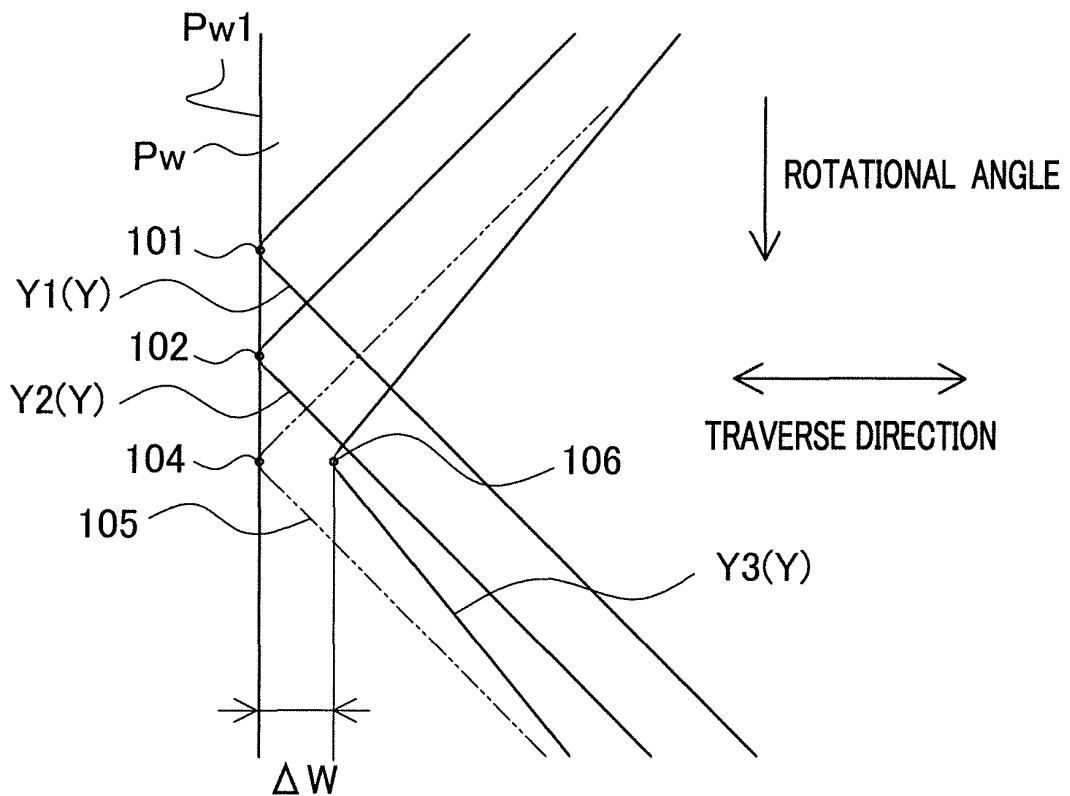
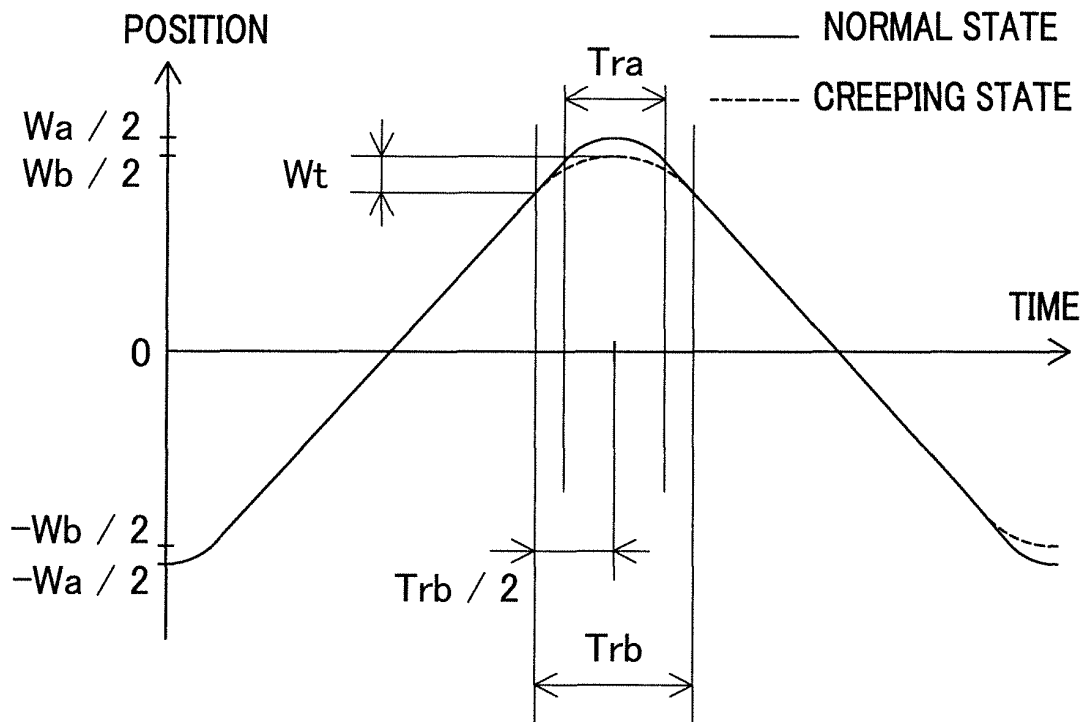


FIG.7

(a) RELATIONSHIP BETWEEN POSITION OF TRAVERSE GUIDE AND TIME



(b) RELATIONSHIP BETWEEN SPEED OF TRAVERSE GUIDE AND TIME

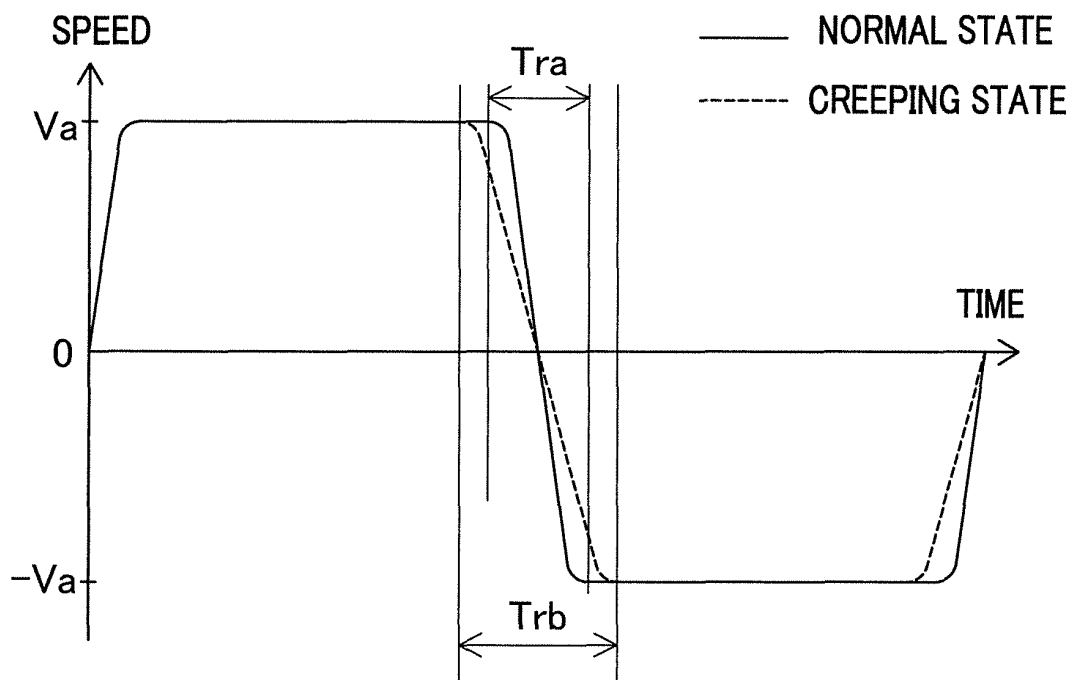
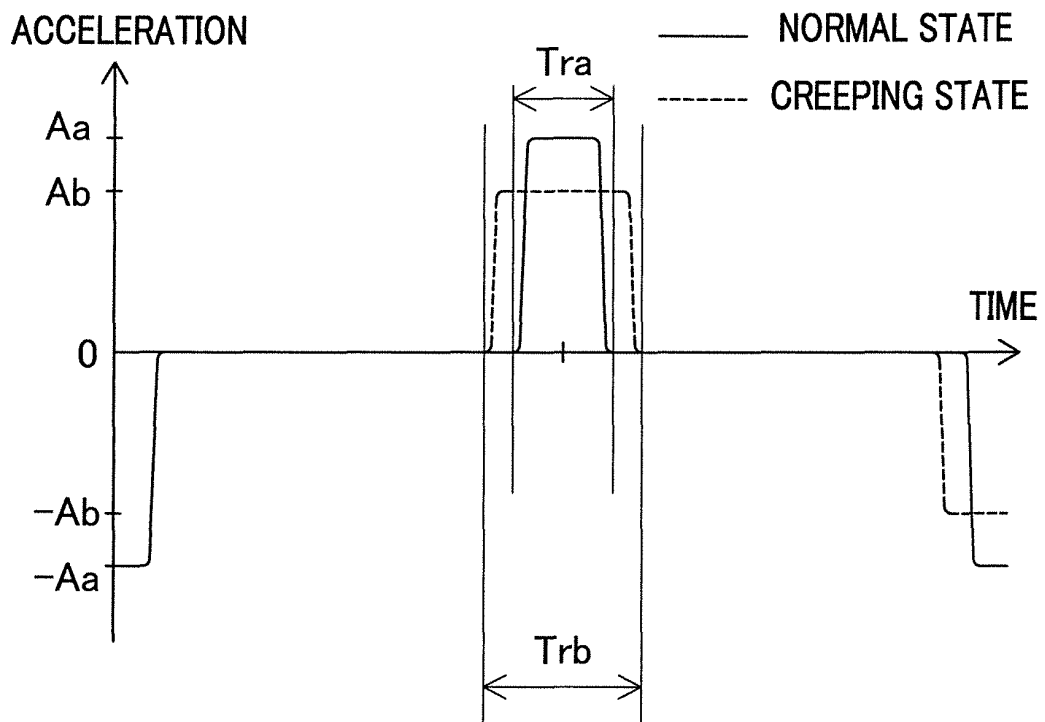


FIG.8

(a) RELATIONSHIP BETWEEN ACCELERATION OF TRAVERSE GUIDE AND TIME



(b) RELATIONSHIP BETWEEN WIDTH OF REVERSAL REGION AND CREEPING AMOUNT

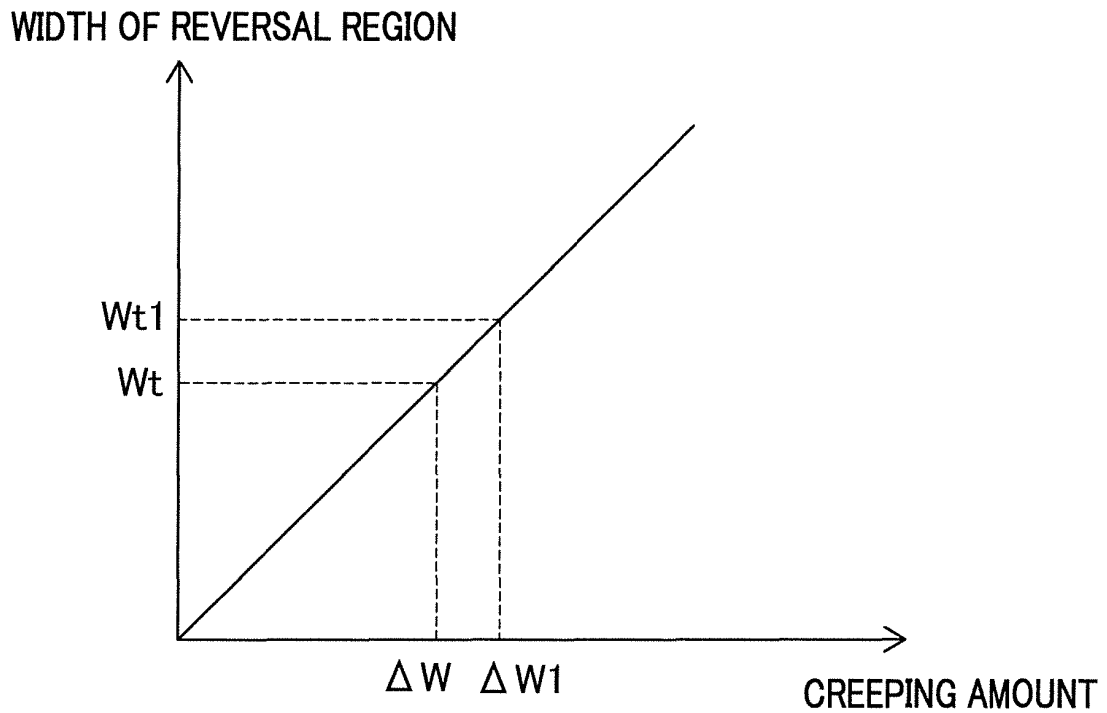


FIG.9

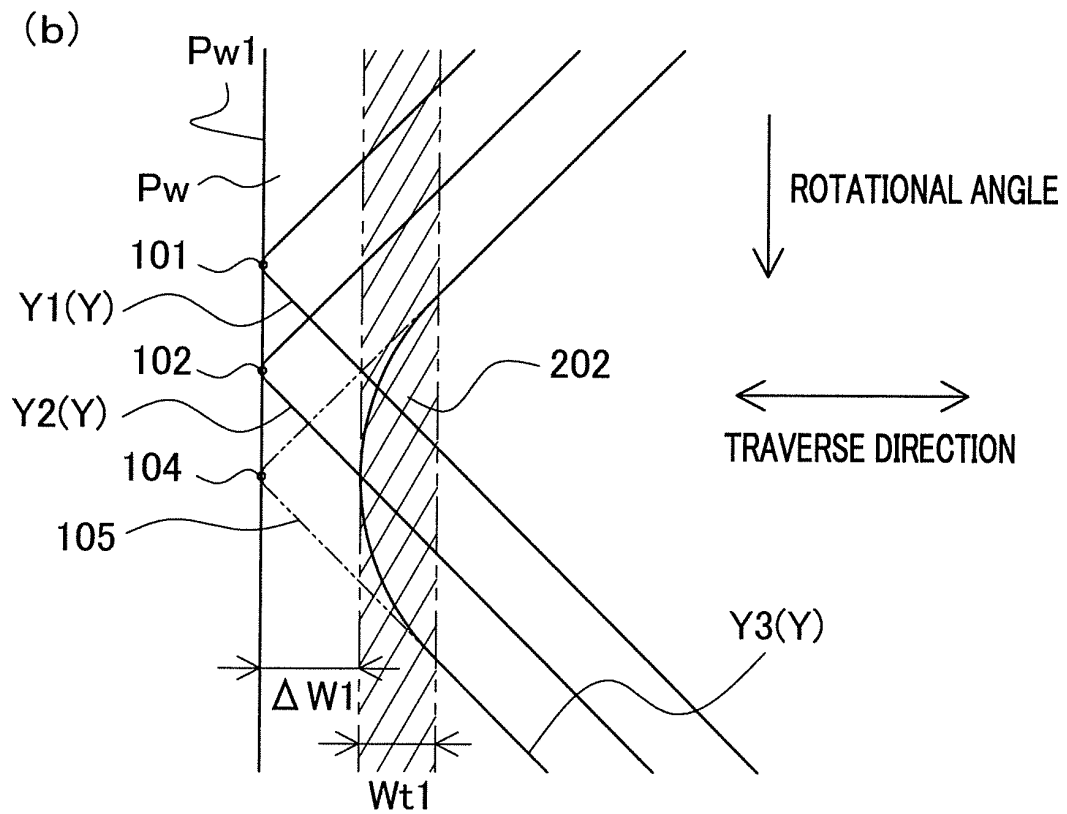
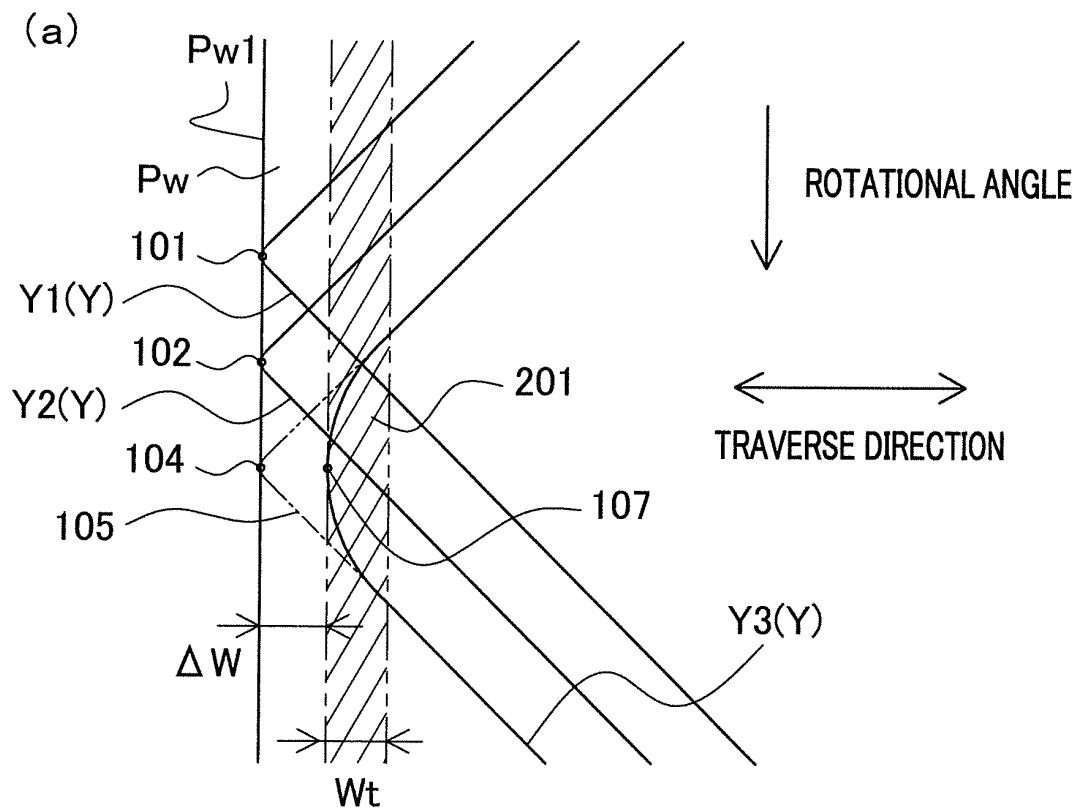
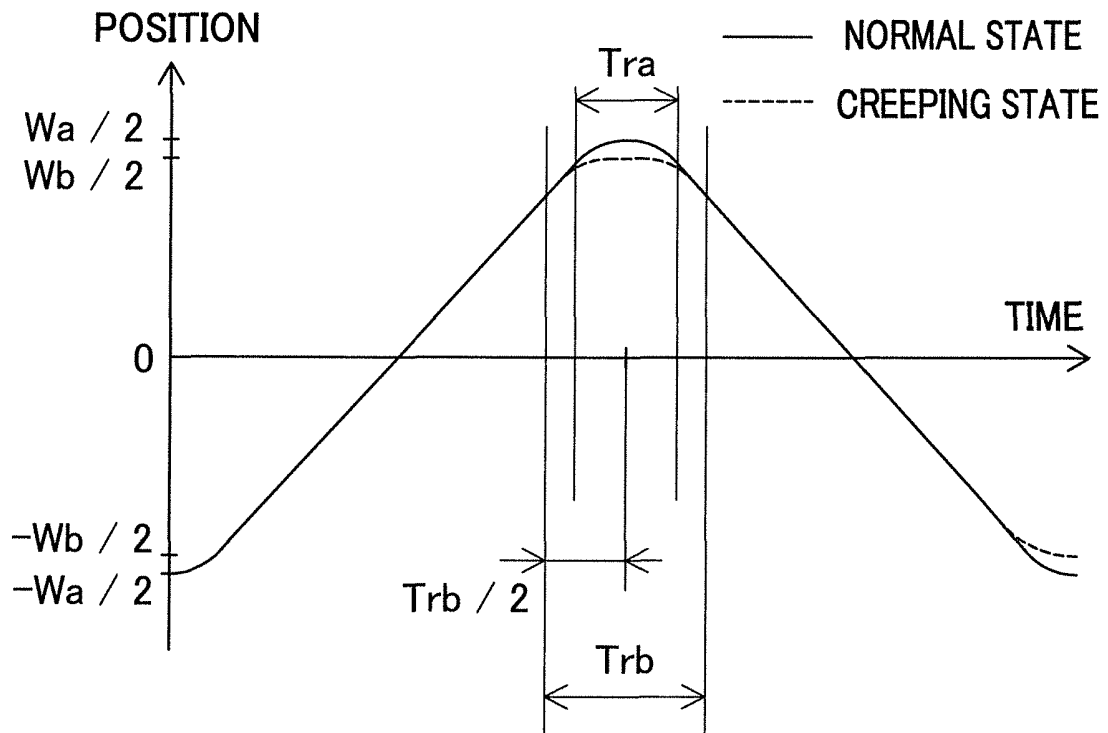


FIG.10

(a) RELATIONSHIP BETWEEN POSITION OF TRAVERSE GUIDE AND TIME



(b) RELATIONSHIP BETWEEN SPEED OF TRAVERSE GUIDE AND TIME

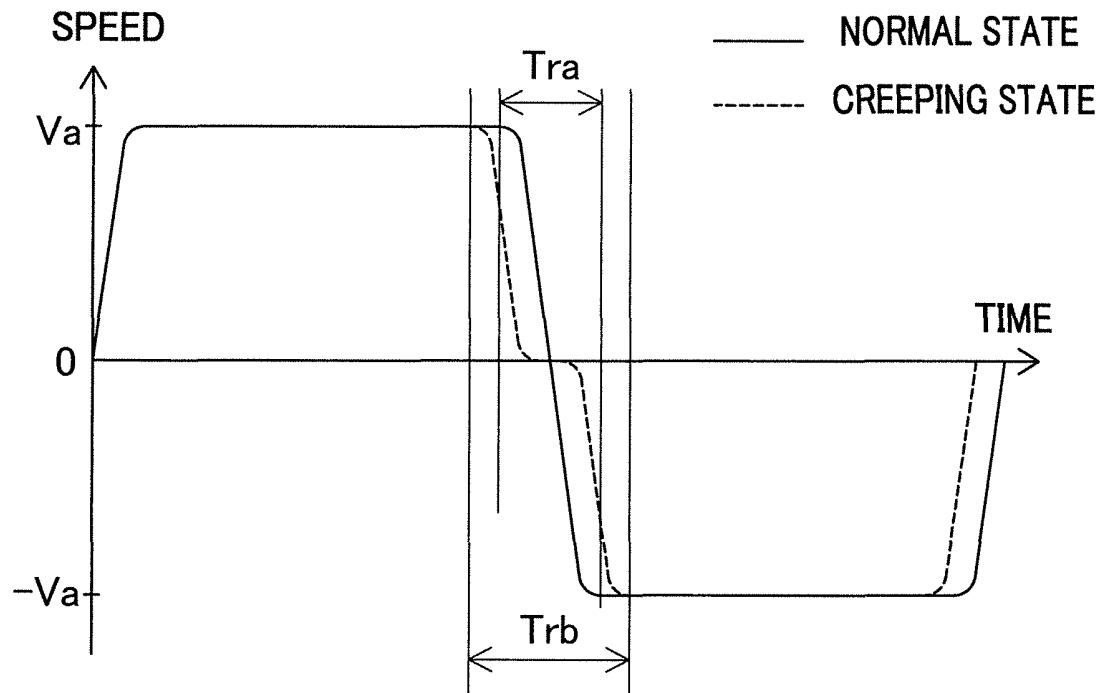
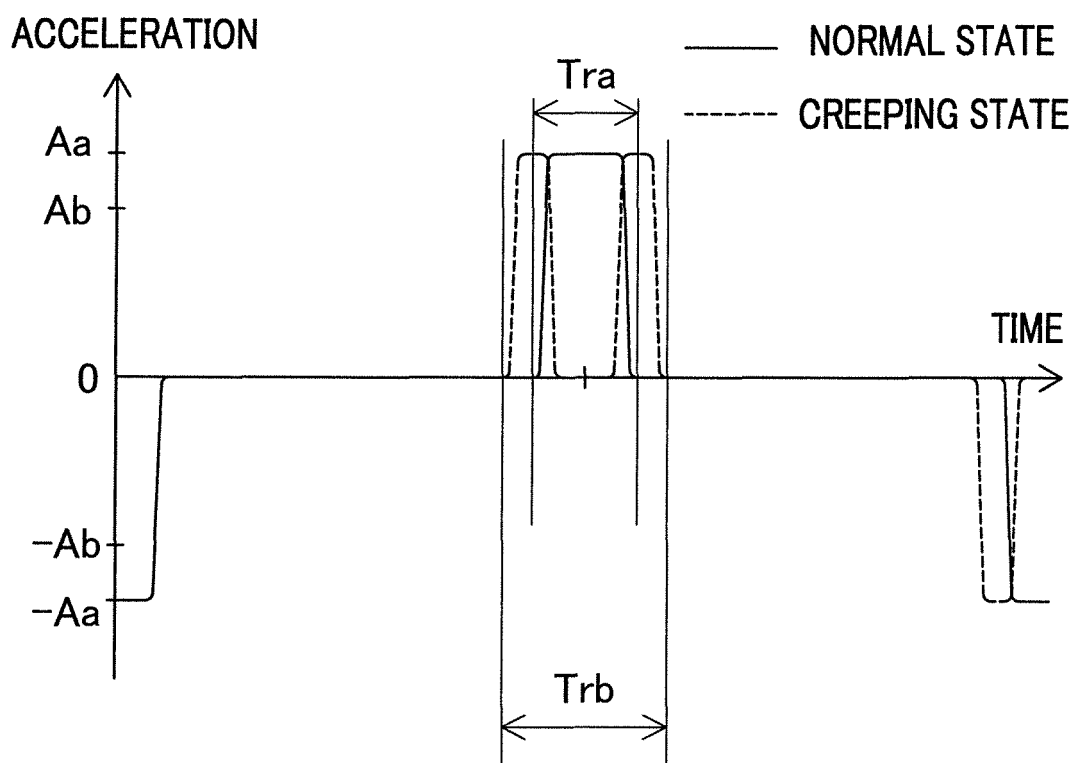


FIG.11

RELATIONSHIP BETWEEN ACCELERATION OF TRAVERSE GUIDE AND TIME



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2019/031771

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl. B65H54/38 (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. B65H54/38

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	1971-2019
Registered utility model specifications of Japan	1996-2019
Published registered utility model applications of Japan	1994-2019

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.
X	JP 2017-24909 A (SAURER GERMANY GMBH & CO KG) 02 February 2017, paragraphs [0013], [0022]-[0028], fig. 1-3 & DE 102015009191 A1, paragraphs [0013], [0022]-[0028], fig. 1-3 & CN 106348090 A	1-7



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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Date of the actual completion of the international search
28.08.2019

Date of mailing of the international search report
10.09.2019

Name and mailing address of the ISA/
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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP H3115060 A [0004]
- JP S5713058 A [0004]
- JP 2007153554 A [0066]