(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 409 941 A2

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
25.01.2012 Bulletin 2012/04

(51) Int Cl.:
B65H 54/38 *(2006.01)*

(21) Application number: **11172887.9**

(22) Date of filing: **06.07.2011**

(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

(30) Priority: **21.07.2010 JP 2010164187**

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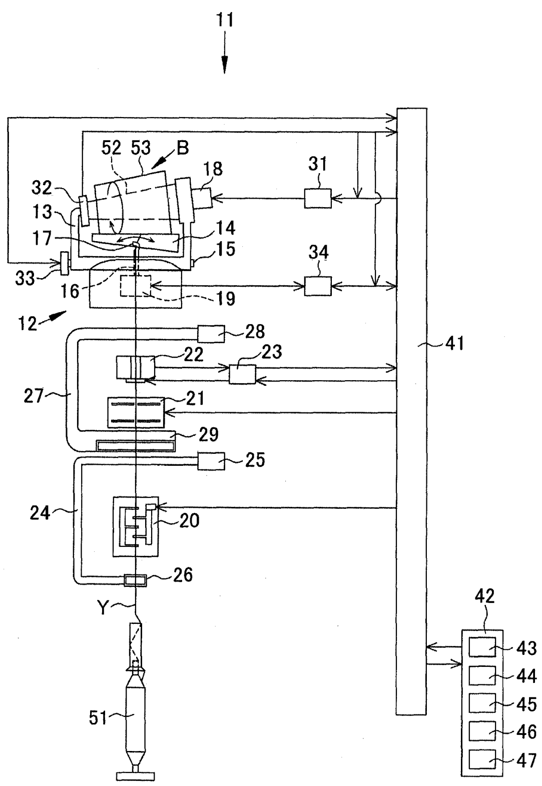
(54) Yarn winding device

(57) A yarn winding device includes a winding angle setting section (44), a traverse width setting section (45), a creeping pattern setting section (46), an average width calculating section (47), and a creeping control section. The average width calculating section (47) calculates an average traverse width of a traverse guide (17) in accordance with a set traverse width set by the traverse width setting section (45) and a creeping pattern set by the creeping pattern setting section (46). The creeping control section controls driving of at least one of a bobbin driving and rotating section (18) and a traverse driving section (19) such that a winding angle of a yarn (Y) at the average traverse width calculated by the average width calculating section (47) becomes a standard winding angle (WA1), and the traverse guide (17) follows the creeping pattern set by the creeping pattern setting section (46).

FIG. 1



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a yarn winding device for winding a yarn around a winding bobbin.

2. Description of the Related Art

[0002] Conventionally, in a yarn winding device for winding a yarn around a winding bobbin while traversing the yarn, a creeping control of changing a traverse width in a pulsatile manner with a progress in winding of the yarn is performed to prevent a saddle bag from being formed at an end of a package. For example, Japanese Unexamined Patent Publication No. 2007-230708 discloses a yarn winding device for accurately controlling a package shape and a density of a yarn layer by controlling the traverse width according to a degree of progress in winding of the yarn around the winding bobbin.

[0003] Meanwhile, there is also known a yarn winding device for producing a package while avoiding ribbon winding by a step precision control. The step precision control is a winding method as described below. That is, a winding ratio is maintained constant while maintaining a winding angle, at which the yarn is wound around the winding bobbin, within a constant range close to a predetermined winding angle (standard winding angle). When the winding ratio approaches a critical winding ratio (winding ratio at which ribbon winding occurs), the winding angle is abruptly changed (traverse jump) from a state of constant winding ratio to prevent the winding ratio from reaching the critical winding ratio. The state is thereafter returned to the state of constant winding ratio. The step precision control is a winding method of repeating such series of control. In the present specification, the "standard winding angle" refers to an overall winding angle in one stroke of traverse and does not refer to an instantaneous winding angle.

[0004] There is also known a yarn winding device for producing a package by combining the step precision control and the creeping control. In such a yarn winding device, the traverse width is reduced and the winding angle is reduced during the creeping control, and the winding ratio is maintained constant before and after the change of the traverse width. The ribbon winding thus can be avoided while suppressing the saddle bag at the end of the package.

BRIEF SUMMARY OF THE INVENTION

[0005] The inventors have recognized that, , when simultaneously performing the step precision control and the creeping control, for example, the standard winding angle in the step precision control is set to 14 degrees, and winding speed, traverse speed, and the like of the yarn are set such that the standard winding angle (14 degrees) becomes the winding angle when traversing at a maximum traverse width. If the traverse width is reduced by the creeping control under such a setting, the winding angle is required to be reduced to maintain the state of constant winding ratio. Thus, the winding angle during the creeping control becomes an angle (e.g., 13 degrees) smaller than the standard winding angle. As a result, the winding density on the inner side other than the end of the package is increased, and the winding density of the package becomes higher than the desired winding density. In particular, when soft winding (winding in which the winding density is low and even) suited for dyeing is being demanded, a package in which the winding density is higher than the desired winding density becomes a defective package.

[0006] When simultaneously performing the step precision control and the creeping control as described above, by setting the standard winding angle of the step precision control to an angle (e.g., 15 degrees) slightly larger than the desired winding angle, the winding angle at which the traverse width is reduced by the creeping control becomes slightly large and the winding density can be prevented from becoming high. However, an operator is required to take the creeping control into consideration and perform a special standard winding angle setting operation each time. Such a setting operation requires time and effort of the operator. Furthermore, the winding angle of the package to be produced may not be the desired winding angle due to a mistake in the setting operation of the operator.

[0007] An object of the present invention is to provide a yarn winding device for preventing a winding density on an inner side other than an end of a package from increasing higher than a desired winding density even when creeping control is performed.

[0008] According to a first aspect of the invention, a yarn winding device includes a traverse guide, a traverse driving section, a bobbin driving and rotating section, a winding angle setting section, a traverse width setting section, a creeping pattern setting section, an average width calculating section, and a creeping control section. The traverse guide is adapted to be engaged with and to traverse a yarn to be wound around a winding bobbin. The traverse driving section drives the traverse guide. The bobbin driving and rotating section drives and rotates the winding bobbin. The winding angle setting section sets a standard winding angle of the yarn to be wound around the winding bobbin. The traverse width setting section sets a traverse width of the traverse guide according to a winding width of the winding bobbin as a set traverse width. The creeping pattern setting section sets a creeping pattern for temporarily reducing the traverse width of the traverse guide accompanying a progress in winding of the yarn with respect to the set traverse width set by the traverse width setting section. The average width calculating section calculates an average traverse width of the traverse guide in accordance with the set traverse width set by the traverse width setting section and the creeping pattern set by the creeping pattern setting section. The creeping control section controls driving of at least one of the bobbin driving and rotating section and the traverse driving section such that a winding angle of the yarn at the average traverse width calculated by the average width calculating section becomes the standard winding angle, and the traverse guide follows the creeping pattern set by the creeping pattern setting section.

[0009] A second aspect of the invention is the yarn winding device according to the first aspect, wherein when temporarily reducing the traverse width of the traverse guide in accordance with the creeping pattern, the creeping control section is adapted to control the driving of the traverse driving section such that traverse speed of the traverse guide at the average traverse width is slower than traverse speed of the traverse guide at the set traverse width.

[0010] A third aspect of the invention is the yarn winding device according to the first aspect, wherein when temporarily reducing the traverse width of the traverse guide in accordance with the creeping pattern, the creeping control section is adapted to control the driving of the bobbin driving and rotating section such that peripheral speed of the winding bobbin at the average traverse width is higher than peripheral speed of the winding bobbin at the set traverse width.

[0011] A fourth aspect of the invention is the yarn winding device according to the first aspect, wherein when temporarily reducing the traverse width of the traverse guide in accordance with the creeping pattern, the creeping control section is adapted to control the driving of the traverse driving section and the bobbin driving and rotating section such that travelling speed of the yarn to be wound around the winding bobbin is equal to travelling speed of the yarn before reduction in the traverse width of the traverse guide.

[0012] A fifth aspect of the invention is the yarn winding device according to any one of the first to fourth aspects, further including a step precision control section adapted to control the driving of at least one of the traverse driving section and the bobbin driving and rotating section so as to perform a step precision control.

[0013] The present invention has the following effects.

[0014] According to the first aspect of the invention, the driving of at least one of the bobbin driving and rotating section and the traverse driving section is controlled by the creeping control section such that a winding angle of the yarn at the average traverse width calculated by the average width calculating section becomes the standard winding angle, and the traverse guide follows the creeping pattern set by the creeping pattern setting section. Therefore, the difference between the winding angle when traversing with the traverse width reduced by the creeping control and the standard winding angle set in the winding angle setting section can be reduced. As the winding density of the package is not increased while making the end of the package soft with the creeping control, a package in which the winding density at the end of the package and on the inner side portion other than the end is the desired winding density can be formed regardless of whether the creeping control is performed. Since a special setting operation of the standard winding angle by an operator is not necessary when performing the creeping control, the setting operation mistake and the like can be avoided.

[0015] Since the package is sequentially wound at the standard winding angle set before the start of winding of the package, sudden change in winding angle against an intention of the operator does not occur in a middle of the winding of the package. If the sudden change in winding angle against the intention of the operator occurs in the middle of the winding of the package, fluctuation of the winding angle may affect the shape of the package end face. In the present invention, however, since the package is wound at the standard winding angle set before the start of winding of the package, the shape of the package end face is less likely to be degraded by the fluctuation of the winding angle. Furthermore, since the standard winding angle is set before the start of winding of the package, the package can be wound while suppressing the increase of the winding density at the central region of the package even in the case of the cone-winding package in which the winding density changes frequently depending on the traverse position and the diameter of the package.

[0016] According to the second aspect of the invention, when temporarily reducing the traverse width of the traverse guide in accordance with the creeping pattern, the driving of the traverse driving section is controlled such that traverse speed of the traverse guide at the average traverse width is slower than traverse speed of the traverse guide at the set traverse width. Therefore, even when performing the creeping control, the peripheral speed of the winding bobbin is not required to be adjusted, and the productivity of the yarn winding device is not lowered. Thus, the package of the desired winding density can be formed while improving the productivity of the yarn winding device.

[0017] According to the third aspect of the invention, when temporarily reducing the traverse width of the traverse guide in accordance with the creeping pattern, the driving of the bobbin driving and rotating section is controlled such that peripheral speed of the winding bobbin at the average traverse width is higher than peripheral speed of the winding bobbin at the set traverse width. Thus, even if the creeping control is performed by increasing the peripheral speed of the winding bobbin in a situation where the traverse speed of the traverse guide cannot be increased, the yarn winding device can produce a package of the desired winding density.

[0018] According to the fourth aspect of the invention, when temporarily reducing the traverse width of the traverse guide in accordance with the creeping pattern, the driving of the traverse driving section and the bobbin driving and rotating section is controlled such that travelling speed of the yarn to be wound around the winding bobbin is equal to travelling speed of the yarn before reduction in the traverse width of the traverse guide. Thus, the package of the desired winding density can be produced while maintaining the productivity of the package of the yarn winding device.

[0019] According to the fifth aspect of the invention, the yarn winding device further includes the step precision control section adapted to control the driving of at least one of the traverse driving section and the bobbin driving and rotating section so as to perform the step precision control. Thus, the package of the desired winding density can be produced while avoiding ribbon winding by combining the step precision control and the creeping control.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020]

FIG. 1 is a simplified front view and a block diagram illustrating a yarn winding device according to a first embodiment of the present invention;
FIG. 2 is a graph illustrating one example of a content of a creeping control;
FIG. 3 is a flowchart of the creeping control according to the first embodiment;
FIG. 4 is a graph illustrating one example of a content of a step precision control;
FIG. 5 is a view illustrating a relationship between traverse speed and peripheral speed of a winding bobbin according to the first embodiment;
FIG. 6 is a view illustrating a relationship between the traverse speed and the peripheral speed of the winding bobbin according to a second embodiment; and
FIG. 7 is a view illustrating a relationship between the traverse speed and the peripheral speed of the winding bobbin according to a third embodiment.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

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

First Embodiment

[0022] A yarn winding device 11 according to a first embodiment of the present invention will be described with reference to FIG. 1 to FIG. 5.

[0023] The yarn winding device 11 of the present embodiment combines a step precision control and a creeping control to produce a package 53. As illustrated in FIG. 1, the yarn winding device 11 winds a yarn Y of a yarn feeding bobbin 51 around a winding tube 52 while traversing the yarn Y with a traverse device 12 to form a yarn layer, and produces the conical package 53. Although one yarn winding device 11 is illustrated in FIG. 1, a plurality of yarn winding devices 11 may be arranged in a line to form an automatic winder.

[0024] In this specification, the winding tube 52 and the package 53 are collectively referred to as a winding bobbin B. In other words, the winding bobbin B on which the yarn layer is not formed is the winding tube 52, and the winding bobbin B on which the yarn layer is formed is the package 53. The production of the conical package 53 will be described in the present embodiment, but the shape of the package 53 is not limited to a cone shape and may be a cheese shape or other shapes.

[0025] An overview of the yarn winding device 11 will be described first. As illustrated in FIG. 1, the yarn winding device 11 includes a cradle 13 for supporting the winding bobbin B in an attachable/detachable manner, and a contact roller 14 driven and rotated when making contact with a peripheral surface of the winding bobbin B. The cradle 13 is configured to freely swing with a swing shaft 15 as the center, and supports both ends of the winding bobbin B in a freely rotating manner. When the yarn Y is wound around the winding bobbin B and a diameter of the winding bobbin B is increased, the cradle 13 swings so that an appropriate contact between the peripheral surface of the winding bobbin B and the contact roller 14 is maintained.

[0026] The cradle 13 is provided with a winding bobbin drive motor 18 serving as a bobbin driving and rotating section. When the winding bobbin B is set to the cradle 13, a drive shaft of the winding bobbin drive motor 18 is coupled to the winding bobbin B in a relatively non-rotatable manner (so-called direct drive method), and the winding bobbin B is actively rotated and driven by the winding bobbin drive motor 18 to wind the yarn Y.

[0027] The cradle 13 is provided with a winding bobbin rotation speed sensor 32 and a winding bobbin diameter sensor 33. The winding bobbin rotation speed sensor 32 detects rotation speed (number of rotations) of the winding bobbin B. The winding bobbin diameter sensor 33 detects a diameter of the winding bobbin B. The winding bobbin diameter sensor 33 is a rotary encoder or the like, and detects the diameter of the winding bobbin B by detecting a swing angle of the cradle 13.

[0028] The traverse device 12 is arranged in proximity to the contact roller 14. The yarn Y is wound around the winding bobbin B while being traversed by the traverse device 12. The traverse device 12 includes a traverse guide 17 and a traverse guide drive motor 19 serving as a traverse driving section. The traverse guide 17 engages with the yarn Y to traverse the yarn Y. The traverse guide drive motor 19 reciprocates the traverse guide 17 with respect to a direction of the winding width of the winding bobbin B. The traverse guide 17 is arranged at a tip of an arm member 16 configured to freely oscillate. The traverse guide 17 is reciprocated by reciprocating the arm member 16 with the traverse guide drive motor 19 as illustrated with an arrow in FIG. 1. In the present embodiment, a servo motor is used for the traverse guide drive motor 19, but a voice coil motor, a step motor, or the like may also be used.

[0029] The traverse device 12 includes a traverse guide position sensor (not illustrated). The traverse guide 17 is attached to a rotation shaft (rotor) of the traverse guide drive motor 19 via the arm member 16. Therefore, a rotation position of the rotor and a position of the traverse guide 17 correspond with each other. The traverse guide position sensor detects the rotation position of the rotor of the traverse guide drive motor 19 to indirectly detect the position of the traverse guide 17.

[0030] In a yarn travelling path between the yarn feeding bobbin 51 and the contact roller 14, a tension applying device 20, a yarn splicing device 21, and a yarn clearer 22 are arranged in this order from the yarn feeding bobbin 51 side. The tension applying device 20 applies an appropriate tension to the yarn Y. The yarn clearer 22 detects a thickness of the yarn Y passing through a detecting section by a sensor, and analyzes a signal from the sensor by an analyzer 23 to detect a yarn defect such as slub. The yarn clearer 22 is provided with a cutter for immediately cutting the yarn Y when the yarn defect is detected. The yarn splicing device 21 splices a lower yarn from the yarn feeding bobbin 51 and an upper yarn from the winding bobbin B after the yarn clearer 22 detects the yarn defect and cuts the yarn, or after yarn breakage of the yarn Y from the yarn feeding bobbin 51.

[0031] A lower yarn catching and guiding section 24 for sucking and catching the lower yarn from the yarn feeding bobbin 51 and guiding the same to the yarn splicing device 21 is arranged upstream of the yarn splicing device 21. An upper yarn catching and guiding section 27 for sucking and catching the upper yarn from the winding bobbin B and guiding the same to the yarn splicing device 21 is arranged downstream of the yarn splicing device 21. The lower yarn catching and guiding section 24 is formed in a pipe shape, and is arranged capable of swinging in a vertical direction with a shaft 25 as the center. A suction hole 26 is formed at a distal end side of the lower yarn catching and guiding section 24. The upper yarn catching and guiding section 27 is also formed in a pipe shape, and is arranged capable of swinging in the vertical direction with a shaft 28 as the center. A mouth 29 is arranged at the distal end side of the upper yarn catching and guiding section 27. The lower yarn catching and guiding section 24 and the upper yarn catching and guiding section 27 are respectively connected to a negative pressure source to cause the suction hole 26 and the mouth 29 to generate a sucking force.

[0032] A configuration for controlling an operation of the yarn winding device 11 will now be described. In the present embodiment, as illustrated in FIG. 1, the winding bobbin drive motor 18 for driving the winding bobbin B and the traverse guide drive motor 19 for driving the traverse guide 17 are separately and independently arranged. The driving of the winding bobbin B and the traverse guide 17 is thus separately and independently controlled. The winding bobbin B and the traverse guide 17 are separately and independently controlled. When winding the yarn Y around the winding bobbin B, the winding bobbin B and the traverse guide 17 are separately and independently controlled to perform control combining the step precision control and the creeping control.

[0033] The yarn winding device 11 is provided with a unit control section 41 for individually controlling the yarn winding device 11. The unit control section 41 is connected with a winding bobbin drive control section 31 and a traverse control section 34. The winding bobbin drive control section 31 controls drive and stop of the winding bobbin drive motor 18 in accordance with a control signal from the unit control section 41. The traverse control section 34 controls drive and stop of the traverse guide drive motor 19 in accordance with a control signal from the unit control section 41. The unit control section 41 is connected to a machine control section 42. The machine control section 42 collectively controls a plurality of yarn winding devices 11 that configure the automatic winder.

[0034] The unit control section 41, the machine control section 42, the winding bobbin drive control section 31, and the traverse control section 34 respectively include a Central Processing Unit (CPU) serving as an operating section, and a Read Only Memory (ROM), a Random Access Memory (RAM) or the like serving as a storage device, and the like. The ROM of the winding bobbin drive control section 31 and the traverse control section 34 respectively store control software for causing hardware such as the CPU arranged in the winding bobbin drive control section 31 and the traverse control section 34 to operate as a step precision control section and a creeping control section.

[0035] A rotation speed signal of the winding bobbin B detected by the winding bobbin rotation speed sensor 32 is transmitted to the unit control section 41, the winding bobbin drive control section 31, and the traverse control section 34. A diameter signal of the winding bobbin B detected by the winding bobbin diameter sensor 33 is transmitted to the unit control section 41, and transferred from the unit control section 41 to the winding bobbin drive control section 31 and the traverse control section 34. A position signal of the traverse guide 17 detected by the traverse guide position sensor is transmitted to the traverse control section 34. Peripheral speed of the winding bobbin B is calculated by the unit control section 41 from the rotation speed signal and the diameter signal of the winding bobbin B.

[0036] The machine control section 42 includes a winding speed setting section 43, a winding angle setting section 44, a traverse width setting section 45, a creeping pattern setting section 46, and an average width calculating section 47. The winding speed setting section 43 sets winding speed of the yarn Y. The winding angle setting section 44 sets a standard winding angle WA1 of the yarn Y to be wound around the winding bobbin B. The traverse width setting section 45 sets a traverse width of the traverse guide 17 according to a winding width of the winding bobbin B. The creeping pattern setting section 46 sets a creeping pattern (frequency of creeping operation, creeping width, and the like) in which the traverse width of the traverse guide 17 is temporarily reduced accompanying a progress in winding of the yarn Y with respect to the traverse width set by the traverse width setting section 45. The average width calculating section 47 calculates an average traverse width of the traverse guide 17 in accordance with the traverse width set by the traverse width setting section 45 and the creeping pattern set by the creeping pattern setting section 46.

[0037] The machine control section 42 transmits the set information and the calculation result to the unit control section 41 of the yarn winding device 11. The unit control section 41 transmits the received set information and the calculation result to the winding bobbin drive control section 31 and the traverse control section 34. The winding bobbin drive control section 31 that received the set information and the calculation result controls the drive and stop of the winding bobbin drive motor 18 so as to wind the yarn Y at the winding speed set by the winding speed setting section 43. The traverse control section 34 controls the drive and stop of the traverse guide drive motor 19 so that the winding angle of the yarn Y becomes the standard winding angle WA1 at the average traverse width calculated by the average width calculating section 47 and so as to follow the creeping pattern set by the creeping pattern setting section 46.

[0038] Next, the control combining the step precision control and the creeping control in the yarn winding device 11 of the present embodiment will be described.

[0039] First, the creeping control will be described. FIG. 2 is a graph illustrating one example of the content of the creeping control. A horizontal axis indicates the position of the traverse guide 17, and a vertical axis indicates the time. Setting of the creeping control is performed by setting the traverse width (maximum traverse width) of the traverse guide 17 corresponding to the winding width of the winding bobbin B, the creeping pattern (creeping cycle, creeping width, creeping time), and the like. The traverse control section 34 controls the traverse guide drive motor 19 to reciprocate the traverse guide 17 so as to obtain the maximum traverse width. The traverse control section 34 also controls the traverse guide drive motor 19 so as to temporarily reduce the traverse width of the traverse guide 17 every creeping cycle.

[0040] Next, description is made according to a flowchart of FIG. 3. An operator operates the winding speed setting section 43 of the machine control section 42 to set the winding speed (e.g., 1000 m/min.) of the yarn Y (step S101), and operates the winding angle setting section 44 to set the standard winding angle WA1 (e.g., 14 degrees) of the yarn Y to be wound around the winding bobbin B (step 5102) .

[0041] In step S103, the operator operates the traverse width setting section 45 to set the traverse width (e.g., 152 mm) of the traverse guide 17 according to the winding width of the winding bobbin B. Here, the operator may directly input and set the set the traverse width of the traverse guide 17. Alternatively, the operator may input the winding width of the winding bobbin B to the traverse width setting section 45, and the traverse width setting section 45 may calculate the traverse width of the traverse guide 17 corresponding to the winding width of the winding bobbin B by considering a traverse delay (response delay of traverse guide drive motor 19) or the like to set such a traverse width as the set traverse width.

[0042] In step S104, the operator operates the creeping pattern setting section 46 to set the creeping pattern for temporarily reducing the traverse width of the traverse guide 17 accompanying the progress in winding of the yarn Y with respect to the set traverse width set by the traverse width setting section 45. Specifically, the cycle of the creeping operation, the creeping width (e.g., 5 mm to an inner side from the traverse end in the maximum traverse width), the creeping time, and the like are set.

[0043] In step S105, the average traverse width (e.g., 148.4 mm) of the traverse guide 17 is calculated by the average width calculating section 47 in accordance with the set traverse width set by the traverse width setting section 45 and the creeping pattern set by the creeping pattern setting section 46.

[0044] After the setting and the calculation from step S101 to step S105 are completed, the machine control section 42 transmits the set information and the calculation result to the unit control section 41 of the yarn winding device 11. The unit control section 41 transmits the received set information and the calculation result to the winding bobbin drive control section 31 and the traverse control section 34. The winding bobbin drive control section 31 that received the set information and the calculation result controls the driving of the winding bobbin drive motor 18 such that the yarn Y is wound at the winding speed set by the winding speed setting section 43. The traverse control section 34 controls the driving of the traverse guide drive motor 19 so that the winding angle of the yarn Y becomes the standard winding angle WA1 at the average traverse width calculated by the average width calculating section 47 and so as to follow the creeping pattern set by the creeping pattern setting section 46, and starts the winding of the yarn Y (step S106), and performs the creeping control (step S107).

[0045] Next, the step precision control performed in combination with the creeping control during the winding of the yarn Y will be described. As illustrated in FIG. 3, the step precision control is performed with the creeping control during the winding of the yarn Y (step S108). FIG. 4 is a graph illustrating one example of the content of the step precision control. The horizontal axis indicates the diameter of the winding bobbin B, and the vertical axis indicates the winding angle. The winding ratio indicated with a solid line is a critical winding ratio at which large ribbon winding may occur, and the winding ratio indicated with a chain dashed line is a critical winding ratio at which small ribbon winding, not quite as the large ribbon winding, may occur.

[0046] While continuing the winding of the yarn Y, the traverse control section 34 controls the driving of the traverse guide drive motor 19 such that the winding angle at which the yarn Y is wound becomes the standard winding angle WA1, and more precisely, such that the winding angle of the yarn Y is maintained within a constant range including the standard winding angle WA1 while changing the winding angle. In this case, the traverse guide 17 is driven at traverse speed appropriate for the peripheral speed of the winding bobbin B. Specifically, as illustrated in FIG. 4, the traverse control section 34 controls the driving of the traverse guide drive motor 19 so as to avoid the critical winding ratio that form the small ribbon winding while the winding angle, at which the yarn Y is wound, is maintained within a predetermined range close to the standard winding angle WA1 . In such control, the yarn Y is wound while the winding ratio is maintained constant, and when the winding ratio approaches the critical winding ratio, the winding angle is abruptly changed (traverse jump) to avoid the critical winding ratio to pass the winding angle at which the ribbon winding may occur. After the occurrence of ribbon winding is avoided, the yarn Y is again wound while maintaining the winding ratio constant.

[0047] FIG. 5 is a view illustrating a relationship between the traverse speed and the peripheral speed of the winding bobbin B according to the present embodiment, and illustrates a relationship of the control of the winding bobbin drive motor 18 and the traverse guide drive motor 19. In FIG. 5, the horizontal axis indicates the traverse speed and the vertical axis indicates the peripheral speed of the winding bobbin B. Coordinates indicated by the distal end of the arrow 1 in Fig. 5 indicate values of the traverse speed and the peripheral speed of the winding bobbin B when the traverse guide 17 is being reciprocated at the set traverse width. The length of the arrow 1 indicates the winding speed of the yarn Y.

[0048] Coordinates indicated by the distal end of the arrow 2 in Fig. 5 indicate values of the traverse speed and the peripheral speed of the winding bobbin B when the traverse guide 17 is being reciprocated at the average traverse width narrower than the set traverse width by the creeping control. An angle formed by the vertical axis and the arrow 2 is the standard winding angle WA1. The length of the arrow 2 indicates the winding speed of the yarn Y. According to the creeping control, at least one of the winding bobbin drive motor 18 and the traverse guide drive motor 19 is controlled to maintain the winding ratio constant in the step precision control even when the traverse width becomes the average traverse width that is narrower than the set traverse width. In the present embodiment, control is performed so that the winding ratio is constant even if the traverse width becomes narrower than the set traverse width by reducing the traverse speed without changing the peripheral speed of the winding bobbin B.

[0049] As illustrated in FIG. 3, the control combining the step precision control and the creeping control described above is performed until the package 53 is fully wound (NO in step S109), and the winding of the yarn Y is terminated when the package 53 is fully wound (YES in step 5109).

[0050] The yarn winding device 11 according to the first embodiment described above has the following effects.

[0051] The driving of the winding bobbin drive motor 18 or the traverse guide drive motor 19 is controlled by the winding bobbin drive control section 31 and the traverse control section 34 forming the creeping control section so that the winding angle of the yarn Y becomes the standard winding angle WA1 at the average traverse width calculated by the average width calculating section 47 and so that the traverse guide 17 follows the creeping pattern set by the creeping pattern setting section 46. Therefore, a difference between the winding angle when traversing with the traverse width reduced by the creeping control and the standard winding angle WA1 set by the winding angle setting section 44 becomes smaller. Since a winding density of the package 53 is not increased while the end of the package 53 is softened by the creeping control, the package 53 can be produced in which the winding density at the end of the package 53 and the inner side portion has the desired winding density irrespective of presence and absence of the creeping control. A special setting operation of the standard winding angle WA1 by the operator is not necessary when performing the creeping control, and hence a mistake in the setting operation, or the like can be avoided.

[0052] The driving of the winding bobbin drive motor 18 or the traverse guide drive motor 19 is controlled so as to combine the step precision control and the creeping control by the winding bobbin drive control section 31 and the traverse control section 34 forming the step precision control section. The yarn winding device 11 thus can produce the package 53 of desired winding density while avoiding ribbon winding.

[0053] When temporarily reducing the traverse width of the traverse guide 17 according to the creeping pattern, the driving of the traverse guide drive motor 19 is controlled such that the traverse speed of the traverse guide 17 at the average traverse width is slower than the traverse speed of the traverse guide 17 at the set traverse width. Thus, even when performing the creeping control, the peripheral speed of the winding bobbin B is not required to be adjusted and productivity of the yarn winding device 11 is not lowered. Therefore, the package 53 of desired winding density can be produced while the productivity of the yarn winding device 11 is improved.

[0054] Since the package 53 is sequentially wound at the standard winding angle WA1 set before start of winding of the package 53, sudden change in the winding angle against an intention of the operator does not occur during the winding of the package 53. If sudden change in the winding angle against the intention of the operator is made during the winding of the package 53, a fluctuation of the winding angle may affect the shape of the end face of the package 53. However, in the present embodiment, the shape of the end face of the package 53 is less likely to degrade by the fluctuation of the winding angle since the package 53 is wound at the standard winding angle WA1 set before the start of winding of the package 53. Furthermore, since the standard winding angle WA1 is set before the start of winding of the package 53, the package can be wound while suppressing the increase of the winding density at a central region of the package even in the case of the cone-winding package in which the winding density changes frequently depending on the traverse position and the diameter of the package 53.

Second Embodiment

[0055] The yarn winding device 11 according to a second embodiment of the present invention will be described with reference to FIG. 6. The yarn winding device 11 according to the present embodiment produces the package 53 by combining the step precision control and the creeping control. However, the yarn winding device 11 of the second embodiment differs greatly from the first embodiment in that the driving of the winding bobbin drive motor 18 is controlled so as to temporarily increase the peripheral speed of the winding bobbin B when the traverse width is made narrower than the set traverse width by the creeping control. Other configurations and controls are similar to the first embodiment, and thus the detailed description will be omitted.

[0056] FIG. 6 is a view illustrating a relationship between the traverse speed and the peripheral speed of the winding bobbin B, and illustrates a relationship of the control between the winding bobbin drive motor 18 and the traverse guide drive motor 19. In FIG. 6, the horizontal axis indicates the traverse speed and the vertical axis indicates the peripheral speed of the winding bobbin B. Coordinates indicated by the distal end of the arrow 1 in FIG. 6 indicate values of the traverse speed and the peripheral speed of the winding bobbin B in a state in which the traverse guide 17 is being reciprocated at the set traverse width. The length of the arrow 1 indicates the winding speed of the yarn Y.

[0057] Coordinates indicated by the distal end of the arrow 3 of FIG. 6 indicate values of the traverse speed and the peripheral speed of the winding bobbin B in a state in which the traverse guide 17 is being reciprocated at the average traverse width narrower than the set traverse width by the creeping control. An angle formed by the vertical axis and the arrow 3 is the standard winding angle WA1. The length of the arrow 3 indicates the winding speed of the yarn Y. Even in a state in which the traverse width becomes the average traverse width narrower than the set traverse width by the creeping control, at least one of the winding bobbin drive motor 18 and the traverse guide drive motor 19 is controlled so as to maintain the winding ratio constant in the step precision control. In the present embodiment, the peripheral speed of the winding bobbin B is increased and the traverse speed is not changed, whereby control is performed to maintain the winding ratio constant even in a state in which the traverse width is made narrower than the set traverse width.

[0058] The yarn winding device 11 according to the second embodiment described above has the following effects.

[0059] When temporarily reducing the traverse width of the traverse guide 17 according to the creeping pattern, the driving of the winding bobbin drive motor 18 is controlled by the winding bobbin drive control section 31 so that the peripheral speed of the winding bobbin B at the average traverse width is higher than the peripheral speed of the winding bobbin at the set traverse width. Thus, the yarn winding device 11 can produce a package of the desired winding density even if the creeping control is performed by increasing the peripheral speed of the winding bobbin B in a situation where the traverse speed of the traverse guide 17 cannot be increased.

Third Embodiment

[0060] A yarn winding device 11 according to a third embodiment of the present invention will be described with reference to FIG. 7. The yarn winding device 11 according to the present embodiment controls the peripheral speed of the winding bobbin B and the traverse speed of the traverse guide 17 so that travelling speed of the yarn Y to be wound around the winding bobbin B becomes equal to the travelling speed of the yarn Y before reduction in the traverse width of the traverse guide 17 in a state in which the traverse width is made narrower than the set traverse width by the creeping control. Other configurations and controls of the yarn winding device 11 of the third embodiment are similar to the first embodiment, and thus the detailed description will be omitted.

[0061] FIG. 7 is a view illustrating a relationship between the traverse speed and the peripheral speed of the winding bobbin B according to the present embodiment, and illustrates a relationship between the controls of the winding bobbin drive motor 18 and the traverse guide drive motor 19. In FIG. 7, the horizontal axis indicates the traverse speed and the vertical axis indicates the peripheral speed of the winding bobbin B. Coordinates indicated by the distal end of the arrow 1 in FIG. 7 indicate values of the traverse speed and the peripheral speed of the winding bobbin B in a state in which the traverse guide 17 is being reciprocated at the set traverse width. The length of the arrow 1 indicates the winding speed of the yarn Y.

[0062] Coordinates indicated by the distal end of the arrow 4 of FIG. 7 indicate values of the traverse speed and the peripheral speed of the winding bobbin B in a state in which the traverse guide 17 is being reciprocated at the average traverse width narrower than the set traverse width by the creeping control. An angle formed by the vertical axis and the arrow 4 is the standard winding angle WA1. By the creeping control, the winding bobbin drive motor 18 and the traverse guide drive motor 19 are controlled so that the travelling speed of the yarn Y to be wound around the winding bobbin B becomes equal to the travelling speed of the yarn Y before reduction in the traverse width of the traverse guide 17 even in a state in which the traverse width becomes the average traverse width narrower than the set traverse width. The length of the arrow 4 indicates the winding speed of the yarn Y. The length of the arrow 1 and the length of the arrow 4 are equal, and absolute values of the winding speed of the yarn Y are equal.

[0063] The yarn winding device 11 according to the third embodiment described above has the following effects.

[0064] When temporarily reducing the traverse width of the traverse guide 17 according to the creeping pattern, the driving of the winding bobbin drive motor 18 and the traverse guide drive motor 19 is controlled such that the travelling speed of the yarn Y to be wound around the winding bobbin B becomes equal to the travelling speed of the yarn Y before reduction in the traverse width of the traverse guide 17. The package 53 of the desired winding density thus can be produced while maintaining the productivity of the package 53 of the yarn winding device 11.

[0065] The embodiments of the present invention have been described above, but the present invention is not limited to the above-described embodiments, and various modifications may be made. For example, the control combining the step precision control and the creeping control is performed in the first, second, and third embodiments, but a winding method other than the step precision control such as precision winding or random winding (winding method in which the traverse speed is constant at constant winding speed, where the winding ratio is changed with change in diameter of the winding bobbin B) and the creeping control may be combined. Alternatively, the yarn winding device 11 may perform only the creeping control.

[0066] The configuration for controlling the operation of the yarn winding device 11 is not limited to the embodiments. For example, the winding bobbin drive control section 31 and the traverse control section 34 may be arranged in the unit control section 41. The average width calculating section 47 arranged in the machine control section 42 may be arranged in the winding bobbin drive control section 31 and the traverse control section 34. The winding speed setting section 43, the winding angle setting section 44, the traverse width setting section 45, the creeping pattern setting section 46, and the average width calculating section 47 arranged in the machine control section 42 may be arranged in the unit control section 41.

[0067] The winding bobbin B is directly driven by the winding bobbin drive motor 18, but the winding bobbin B may be driven by making a drive roller to contact with the surface of the winding bobbin B. The shape of the contact roller 14 is a cone shape in which the diameters of both ends are different, but may be a cylindrical shape in which the diameters of both ends are the same.

[0068] The traverse device 12 is configured such that a longitudinal direction of the arm member 16 is parallel to an installing direction (vertical direction) of the yarn winding device 11, but may be configured such that the longitudinal direction of the arm member 16 is perpendicular to the installing surface of the yarn winding device 11. The traverse device 11 is configured to reciprocate the arm member 16 by the traverse guide drive motor 19, but an endless timing belt may be arranged in proximity to the contact roller 14, the traverse guide 17 may be attached to the timing belt, and the timing belt may be reciprocated by a pulse motor, for example.

[0069] The technical scope of the present invention described above is not limited to the embodiments described above, and is not limited to the shapes of the embodiments described above. The technical scope of the present invention widely extends to the entire scope of the technical concept truly intended by the present invention which should become apparent from the present specification and the matters described in the drawings.

Claims

1. A yarn winding device comprising:

a traverse guide (17) adapted to be engaged with and to traverse a yarn to be wound around a winding bobbin;
a traverse driving section (19) adapted to drive the traverse guide (17);
a bobbin driving and rotating section (18) adapted to drive and rotate the winding bobbin;
a winding angle setting section (44) adapted to set a standard winding angle of the yarn to be wound around the winding bobbin;
a traverse width setting section (45) adapted to set a traverse width of the traverse guide (17) according to a winding width of the winding bobbin as a set traverse width;
a creeping pattern setting section (46) adapted to set a creeping pattern for temporarily reducing the traverse width of the traverse guide (17) accompanying a progress in winding of the yarn with respect to the set traverse width set by the traverse width setting section (45);
an average width calculating section (47) adapted to calculate an average traverse width of the traverse guide (17) in accordance with the set traverse width set by the traverse width setting section (45) and the creeping pattern set by the creeping pattern setting section (46); and
a creeping control section (31, 34) adapted to control driving of at least one of the bobbin driving and rotating section (18) and the traverse

driving section (19) such that a winding angle of the yarn at the average traverse width calculated by the average width calculating section (47) becomes the standard winding angle, and the traverse guide (17) follows the creeping pattern set by the creeping pattern setting section (46).

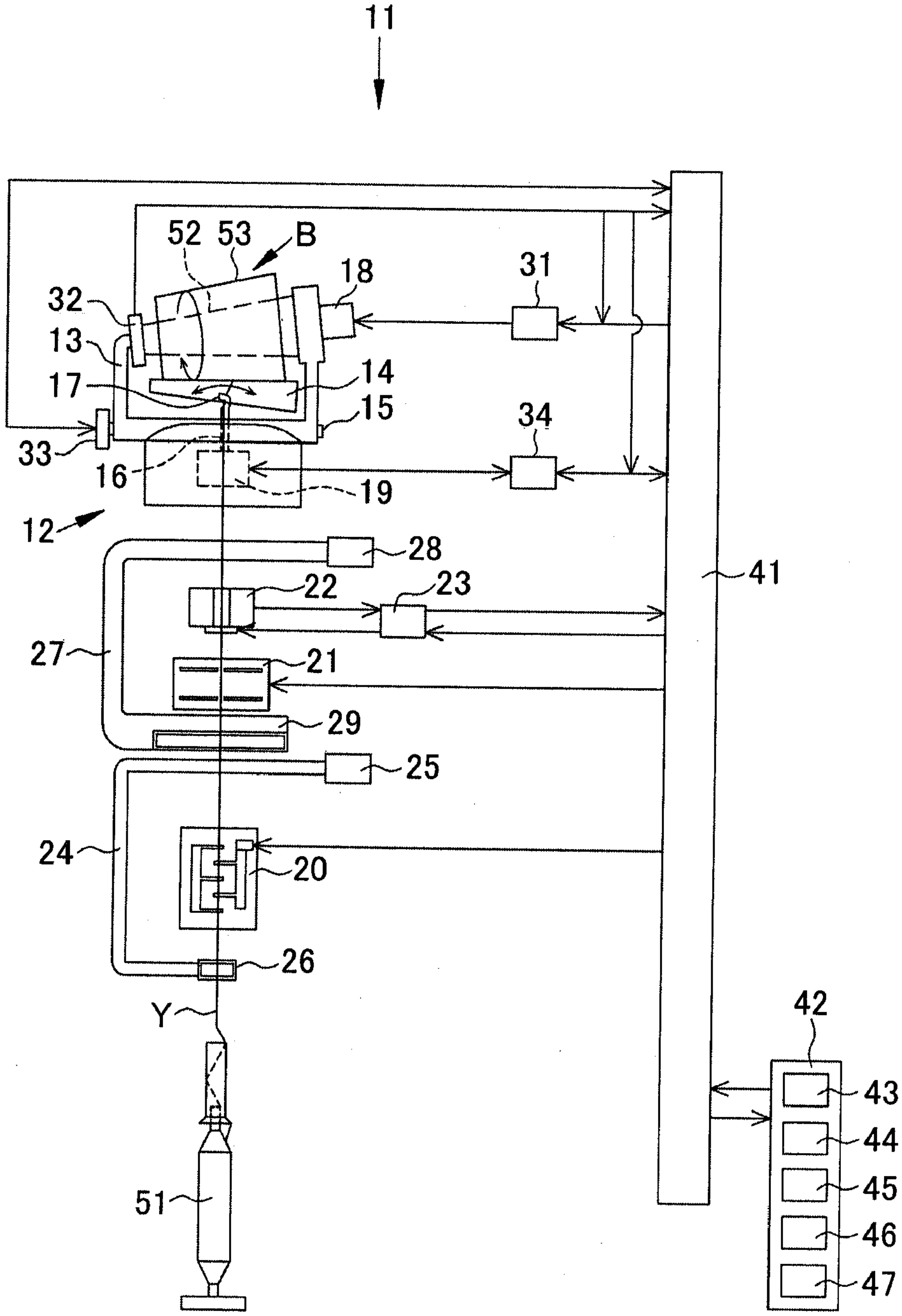
2. The yarn winding device according to claim 1, wherein when temporarily reducing the traverse width of the traverse guide (17) in accordance with the creeping pattern, the creeping control section (31, 34) is adapted to control the driving of the traverse driving section (19) such that traverse speed of the traverse guide (17) at the average traverse width is slower than traverse speed of the traverse guide (17) at the set traverse width.

3. The yarn winding device according to claim 1, wherein when temporarily reducing the traverse width of the traverse guide (17) in accordance with the creeping pattern, the creeping control section (31, 34) is adapted to control the driving of the bobbin driving and rotating section (18) such that peripheral speed of the winding bobbin at the average traverse width is higher than peripheral speed of the winding bobbin at the set traverse width.

4. The yarn winding device according to claim 1, wherein when temporarily reducing the traverse width of the traverse guide (17) in accordance with the creeping pattern, the creeping control section (31, 34) is adapted to control the driving of the traverse driving section (19) and the bobbin driving and rotating section (18) such that travelling speed of the yarn to be wound around the winding bobbin is equal to travelling speed of the yarn before reduction in the traverse width of the traverse guide (17).

5. The yarn winding device according to any one of claim 1 through claim 4, further comprising a step precision control section (31, 34) adapted to control the driving of at least one of the traverse driving section (19) and the bobbin driving and rotating section (18) so as to perform a step precision control.

FIG. 1


11
52
53
B
18
31
32
13
17
14
15
34
33
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19
12
28
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23
41
27
21
29
25
24
20
26
Y
42
43
44
45
51
46
47

FIG. 2

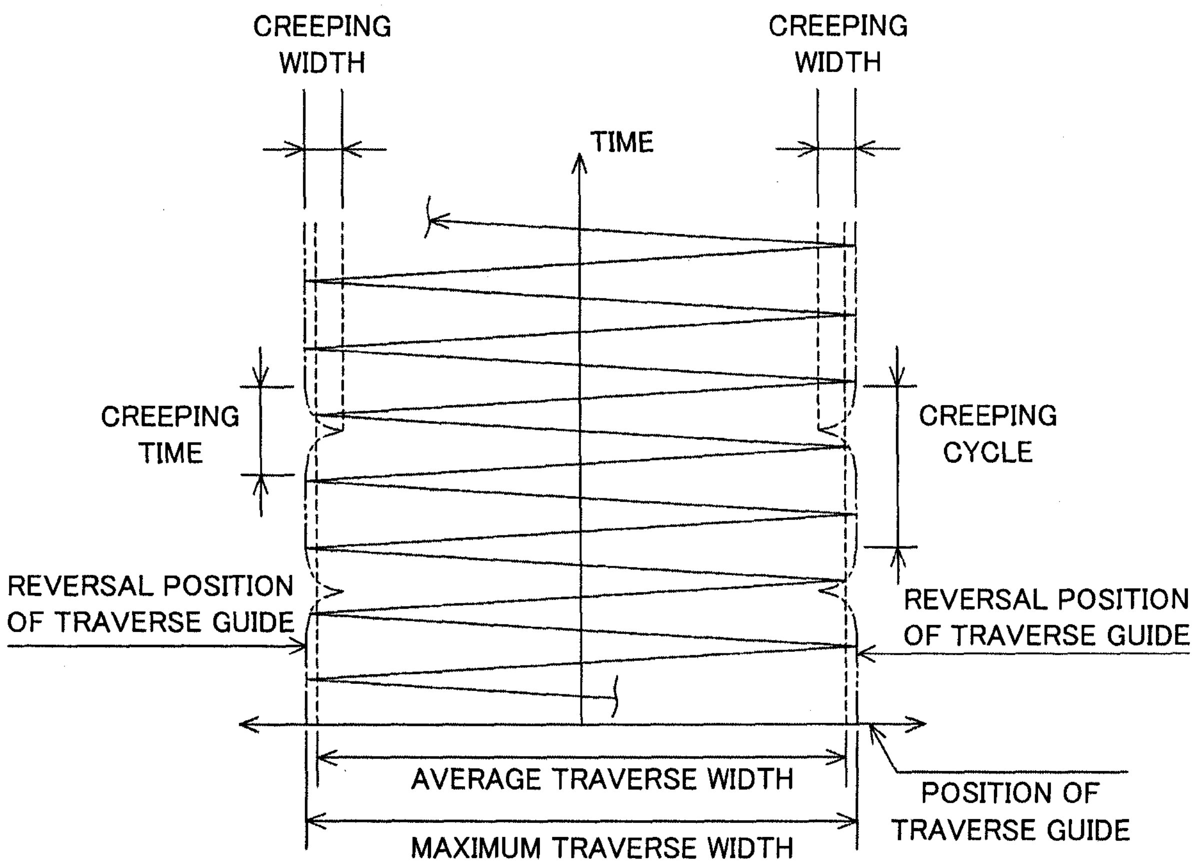

CREEPING WIDTH
CREEPING WIDTH
TIME
CREEPING TIME
CREEPING CYCLE
REVERSAL POSITION OF TRAVERSE GUIDE
REVERSAL POSITION OF TRAVERSE GUIDE
AVERAGE TRAVERSE WIDTH
MAXIMUM TRAVERSE WIDTH
POSITION OF TRAVERSE GUIDE

FIG. 3

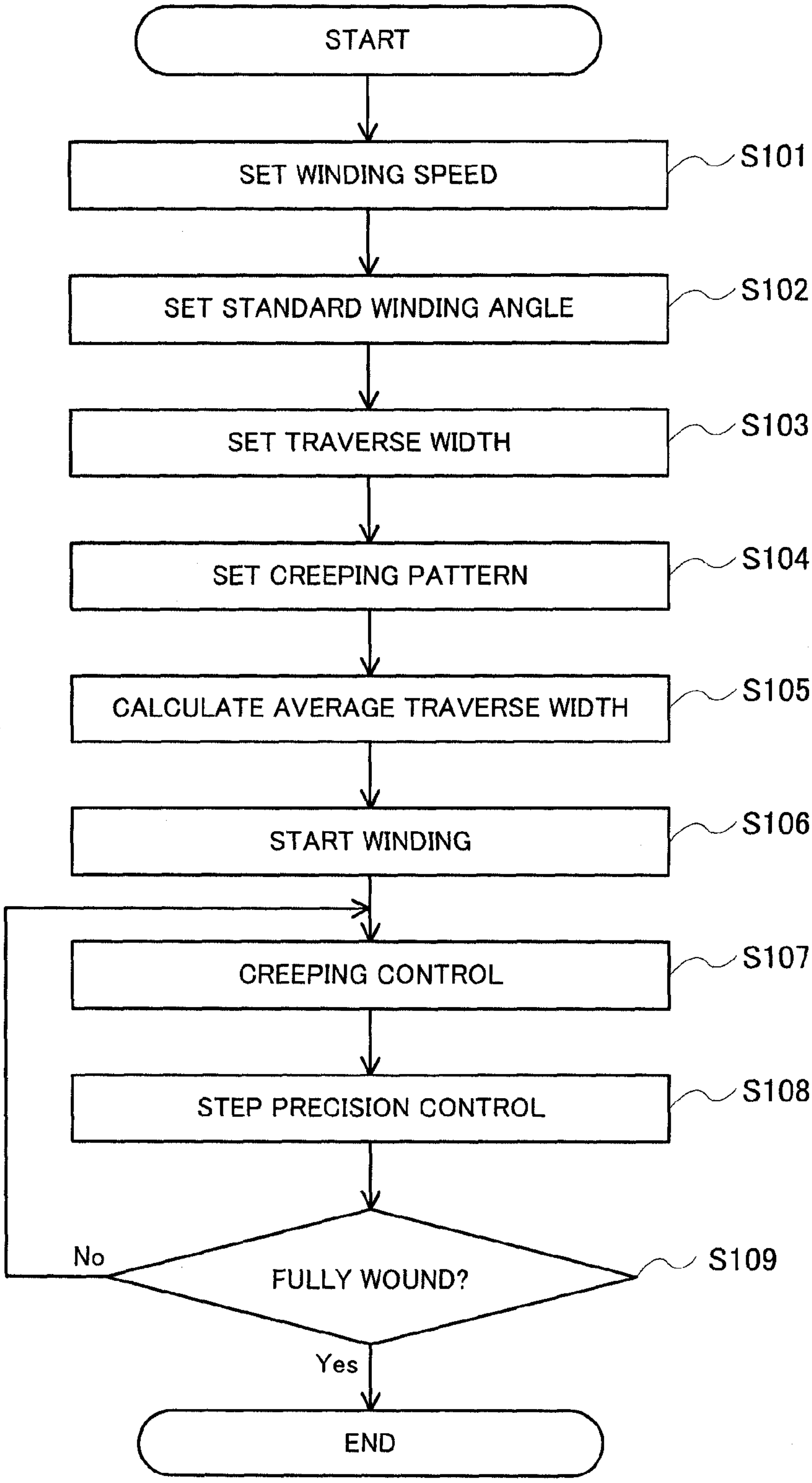

START
SET WINDING SPEED
S101
SET STANDARD WINDING ANGLE
S102
SET TRAVERSE WIDTH
S103
SET CREEPING PATTERN
S104
CALCULATE AVERAGE TRAVERSE WIDTH
S105
START WINDING
S106
CREEPING CONTROL
S107
STEP PRECISION CONTROL
S108
FULLY WOUND?
S109
No
Yes
END

FIG. 4

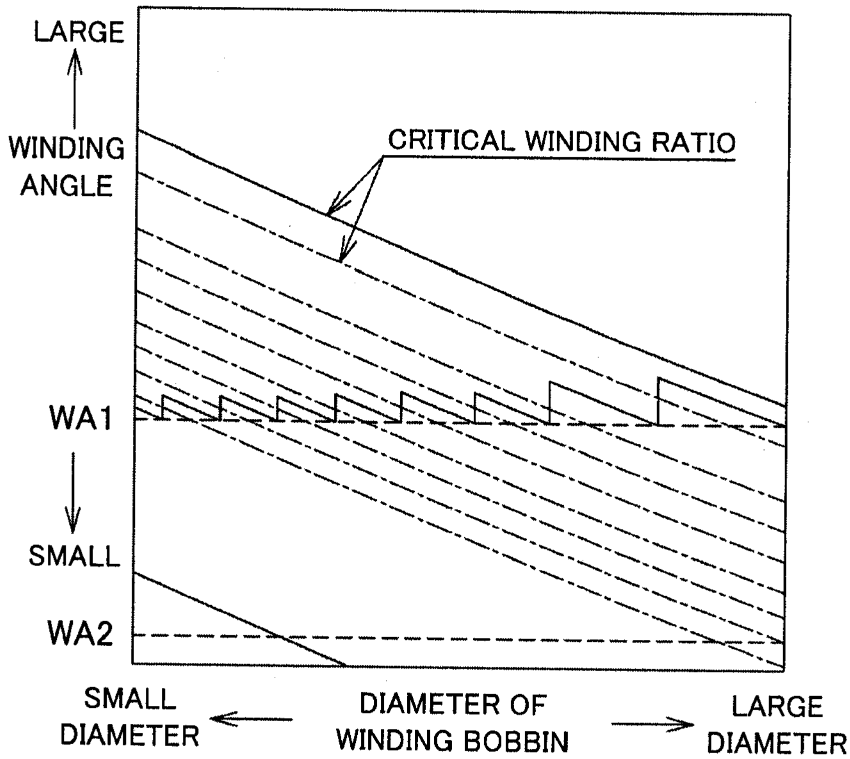

LARGE
WINDING ANGLE
SMALL
WA1
WA2
CRITICAL WINDING RATIO
SMALL DIAMETER
DIAMETER OF WINDING BOBBIN
LARGE DIAMETER

FIG. 5

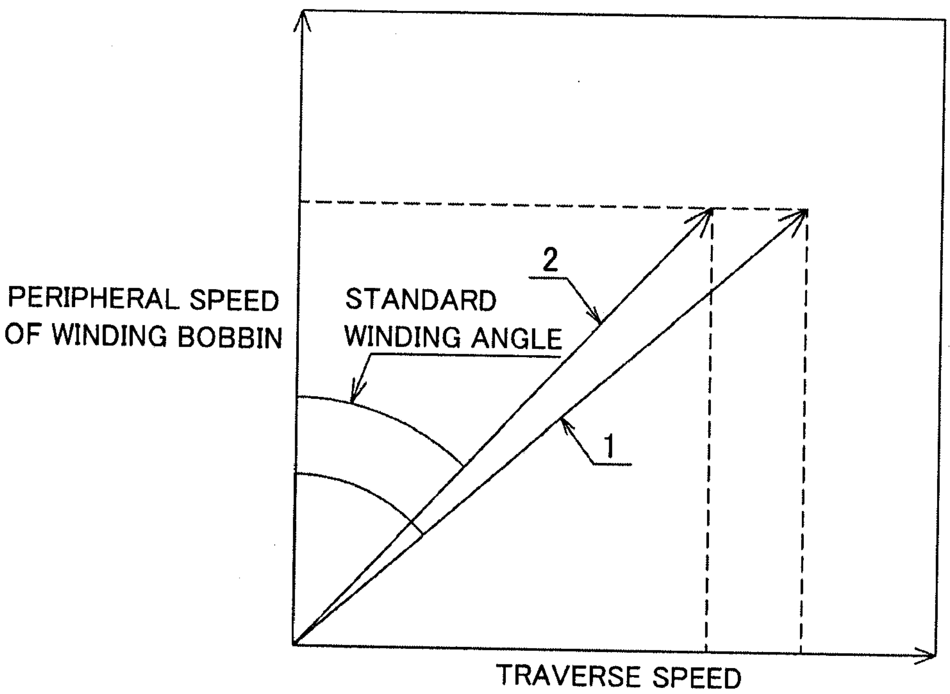

PERIPHERAL SPEED
OF WINDING BOBBIN
STANDARD
WINDING ANGLE
2
1
TRAVERSE SPEED

FIG. 6

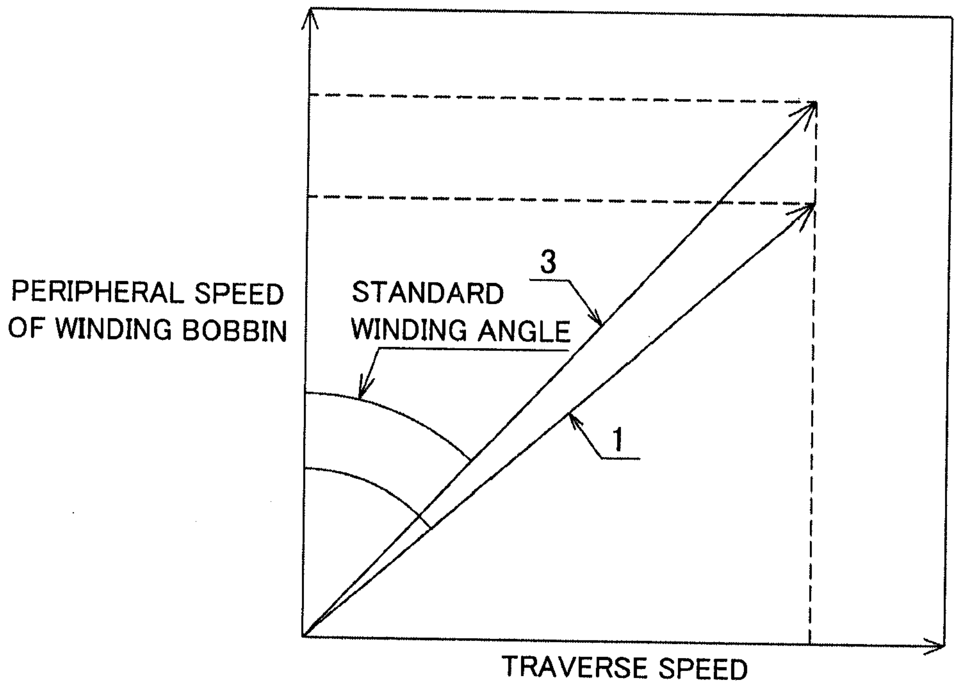
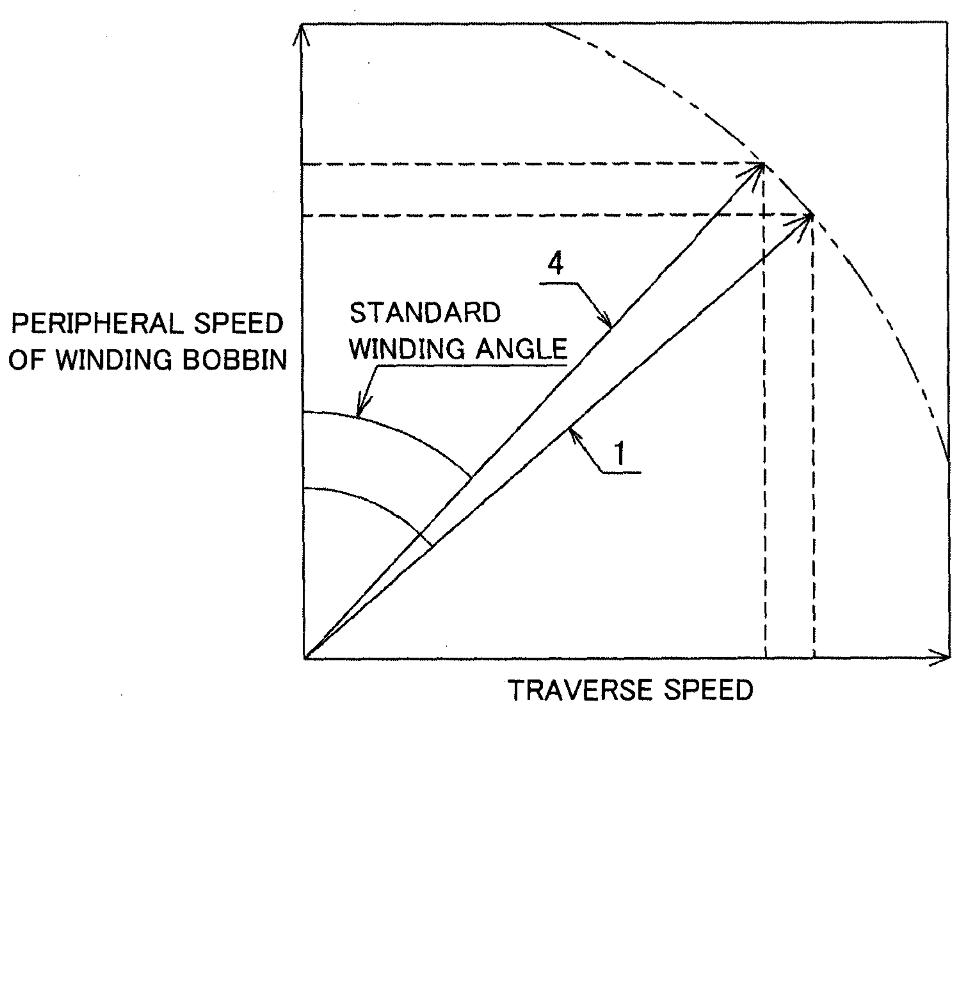

PERIPHERAL SPEED
OF WINDING BOBBIN
STANDARD
WINDING ANGLE
3
1
TRAVERSE SPEED

FIG. 7


PERIPHERAL SPEED
OF WINDING BOBBIN
STANDARD
WINDING ANGLE
4
1
TRAVERSE SPEED

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2007230708 A **[0002]**