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(54) **CROSS WINDING PACKAGE, METHOD FOR PRODUCING CROSS WINDING PACKAGE, AND YARN WINDING APPARATUS**

(57) A cross winding package (100) of a cross winding package includes a cone-shaped winding bobbin (120) and a yarn layer (110). The winding bobbin (120) has a taper-shaped winding surface inclined from a central axis (C) by a first angle (θ). The yarn layer (110) is wound up around the winding bobbin (120) having a surface of the wound yarn with the same inclination as the winding surface of the winding bobbin (120). The yarn layer (110) includes a first yarn layer (111) that contacts the winding bobbin (120) and has a first traverse width (W1), a second yarn layer (112) that is on the first yarn layer (111) and has a second traverse width (W2) that decreases partially or entirely along with increase in distance from the first yarn layer (111), and a third yarn layer (113) that is on the second yarn layer (112) and has a third traverse width (W3). The first traverse width (W1) and the third traverse width (W3) satisfy the relationship of $W1 \times 1/2 \leq W3 \leq W1 \times 2/3$. This cross winding package has a low unraveling tension.

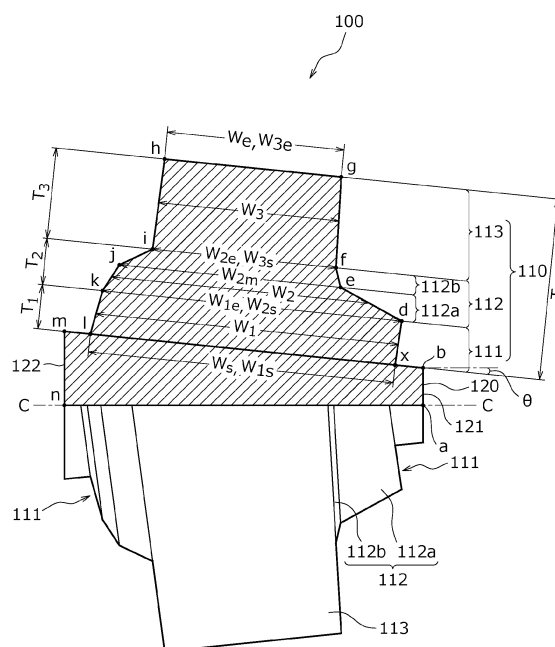


FIG. 2

Description

TECHNICAL FIELD

[0001] The present disclosure relates to a cross winding package, a method for producing a cross winding package, and a yarn winding apparatus.

BACKGROUND ART

[0002] There is known a cone-shaped cross winding package, in which a yarn layer is formed on a winding bobbin having a taper-shaped winding surface by winding a yarn using a yarn winding apparatus. The yarn winding apparatus for producing the cone-shaped cross winding package forms the yarn layer within a traverse width by traversing the yarn while rotating the winding bobbin. As such yarn winding apparatuses, there are an arm traverse type winding apparatus (JP2009-214984A1), a belt traverse type winding apparatus (JP2007-161449A1), and the like.

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0003] A conventional cone-shaped cross winding package has a problem that when unraveling the yarn of the cross winding package, unraveling tension becomes larger as the diameter of the cross winding package becomes larger, and hence a yarn break may occur in a process of unraveling the yarn of the cross winding package.

[0004] It is an object of the present disclosure to provide a cross winding package having small variation in unraveling tension regardless of the diameter of the cross winding package.

TECHNICAL SOLUTION

[0005] A cross winding package of the present disclosure includes a cone-shaped winding bobbin having a taper-shaped winding surface inclined from a central axis by a first angle, and a yarn layer wound up around the winding package, having a surface of the wound yarn with the same inclination as the winding surface. The yarn layer includes a first yarn layer that contacts the winding bobbin and has a first traverse width W1, a second yarn layer 112 that is on the first yarn layer and has a second traverse width W2, which decreases partially or entirely along with increase in distance from the first yarn layer, and a third yarn layer that is on the second yarn layer and has a third traverse width W3. The first traverse width W1 and the third traverse width W3 satisfy the following relationship:

$$W1 \times 1/2 \leq W3 \leq W1 \times 2/3.$$

[0006] In the above sentences, "decreases partially" means "decreases in any parts and is constant in the other parts along with increase in distance from the first yarn layer 111".

[0007] The cross winding package of the present disclosure includes the third yarn layer having a small traverse width on the top surface, and can prevent unraveling tension from becoming high when the cross winding package has a large diameter. In this way, when the cross winding package has a small diameter and no problem about the unraveling tension, yarn winding quantity is not decreased, but if the cross winding package has a large diameter that may cause high unraveling tension, the yarn winding quantity is decreased so as to prevent the unraveling tension from becoming high. Regardless of the diameter of the cross winding package, a variation in the unraveling tension is reduced, and a decreasing rate of the yarn quantity wound as the cross winding package can be minimized.

[0008] The third yarn layer thickness T3 may be more than the second yarn layer thickness T2, and the third yarn layer thickness T3 may be more than the first yarn layer thickness T1.

[0009] The first traverse width W1 of the first yarn layer may be constant regardless of a distance from the winding surface of the winding bobbin or may decrease along with increase in distance from the winding surface of the winding bobbin. A first traverse width W1e of the first yarn layer adjacent to the second yarn layer may be 90% or more and 100% or less of a first traverse width W1s of the first yarn layer adjacent to the winding bobbin.

[0010] A second traverse width W2e of the second yarn layer adjacent to the third yarn layer may be 50% or more and 90% or less of a second traverse width W2s of the second yarn layer adjacent to the first yarn layer.

[0011] The third traverse width W3 of the third yarn layer may be constant regardless of the distance from the surface of the winding bobbin or may decrease along with increase in distance from the second yarn layer. A third traverse width W3e on the outer surface of the third yarn layer may be 90% or more and 100% or less of a third traverse width W3s of the third yarn layer adjacent to the second yarn layer.

[0012] The first traverse width W1e of the first yarn layer adjacent to the second yarn layer may be equal to the second traverse width W2s of the second yarn layer adjacent to the first yarn layer.

[0013] The second traverse width W2e of the second yarn layer adjacent to the third yarn layer may be equal to the third traverse width W3s of the third yarn layer adjacent to the second yarn layer. In other words, the traverse width of the yarn layer may be continuous.

[0014] The first yarn layer thickness T1 may be more than the second yarn layer thickness T2.

[0015] When an end face of each yarn layer on a small diameter side of the cone-shaped winding bobbin is referred to as a small diameter side end face of each yarn layer, while an end face of each yarn layer on a large

diameter side of the cone-shaped winding bobbin is referred to as a large diameter side end face of each yarn layer, in a cross-sectional view including the central axis of the cone-shaped winding bobbin, a large diameter side end face of the third yarn layer may be perpendicular to the winding surface of the cone-shaped winding bobbin.

[0016] When an end face of each yarn layer on a small diameter side of the cone-shaped winding bobbin is referred to as a small diameter side end face of each yarn layer, while an end face of each yarn layer on a large diameter side of the cone-shaped winding bobbin is referred to as a large diameter side end face of each yarn layer, in a cross-sectional view including the central axis of the cone-shaped winding bobbin, the large diameter side end face or the small diameter side end face of the second yarn layer may have a changing inclination angle with respect to a direction perpendicular to the winding surface.

[0017] When an end face of each yarn layer on a small diameter side of the cone-shaped winding bobbin is referred to as a small diameter side end face of each yarn layer, while an end face of each yarn layer on a large diameter side of the cone-shaped winding bobbin is referred to as a large diameter side end face of each yarn layer, in a cross-sectional view including the central axis of the cone-shaped winding bobbin, an inclination angle of a small diameter side end face of the second yarn layer may be different from that of a large diameter side end face of the same with respect to a direction perpendicular to the winding surface.

[0018] A method for producing a cross winding package of the present disclosure includes the steps of preparing a cone-shaped winding bobbin having a taper-shaped winding surface inclined from a central axis by a first angle, and winding up a yarn around the winding bobbin and forming a yarn layer having a surface of the wound yarn with the same inclination as the winding surface. The step of winding up a yarn and forming the yarn layer includes the steps of (a) forming a first yarn layer with a first traverse width W1 on the winding bobbin, (b) forming a second yarn layer on the first yarn layer, with a second traverse width W2 that decreases partially or entirely along with increase in distance from the first yarn layer, and (c) forming a third yarn layer on the second yarn layer, with a third traverse width W3.

[0019] The first traverse width W1 and the third traverse width W3 satisfy the following relationship:

$$W1 \times 1/2 \leq W3 \leq W1 \times 2/3.$$

[0020] In the method for producing a cross winding package, the layers may be formed in such a manner that the third yarn layer thickness T3 is more than the second yarn layer thickness T2, and that the third yarn layer thickness T3 is more than the first yarn layer thickness T1.

[0021] A yarn winding apparatus of the present disclo-

sure is an apparatus for producing a cross winding package including a cone-shaped winding bobbin having a taper-shaped winding surface inclined from a central axis by a first angle, and a yarn layer being wound up around the winding bobbin having a surface of the wound yarn with the same inclination as the winding surface. The yarn winding apparatus includes a traverse yarn guide for traversing a yarn to be wound up on the winding bobbin, a traverse yarn guide drive unit for driving the traverse yarn guide, and a control unit for controlling the traverse yarn guide drive unit.

[0022] The control unit performs a control of (a) forming a first yarn layer with a first traverse width W1 on the winding bobbin, (b) forming a second yarn layer on the first yarn layer, with a second traverse width W2 that decreases partially or entirely along with increase in distance from the first yarn layer, and (c) forming a third yarn layer on the second yarn layer, with a third traverse width W3. The first traverse width W1 and the third traverse width W3 satisfy the following relationship:

$$W1 \times 1/2 \leq W3 \leq W1 \times 2/3.$$

[0023] The control unit may control in such a manner that the third yarn layer thickness T3 is more than the second yarn layer thickness T2, and that the third yarn layer thickness T3 is more than the first yarn layer thickness T1.

ADVANTAGEOUS EFFECTS

[0024] The cross winding package of the present disclosure can have relatively small unraveling tension even in a stage where the diameter of the cross winding package is large. Therefore, maximum tension when unraveling the cross winding package can be reduced, and hence damage to the yarn can be reduced.

BRIEF DESCRIPTION OF DRAWINGS

[0025]

Fig. 1 is a diagram illustrating a structure of a yarn winding apparatus 10.

Fig. 2 is a diagram illustrating a structure of a cross winding package 100, in which with respect to a central axis C of a winding bobbin 120, one side is a cross-sectional view including the central axis C, and the other side is an external view. In Fig. 2, points a to n are points on the cross-sectional view.

Fig. 3 is a flowchart illustrating a process of a method for producing the cross winding package.

Fig. 4 is a diagram illustrating a relationship between a traverse width and a yarn layer thickness (a distance from a surface of the winding bobbin) in cross winding packages S1 and P1.

Fig. 5 is a diagram illustrating a relationship between

the traverse width and the yarn layer thickness (the distance from the surface of the winding bobbin) in cross winding packages S2 and P2.

Fig. 6 is a diagram illustrating time dependency of unraveling tension of the cross winding packages S1 and P1 when unraveling the cross winding packages. In the horizontal axis, time 0 is a time when the unraveling is finished, and as the time increases, real time goes back so that the diameter of the cross winding package increases.

Fig. 7 is a diagram illustrating time dependency of the unraveling tension of the cross winding packages S2 and P2 when unraveling the cross winding packages. In the horizontal axis, time 0 is the time when the unraveling is finished, and as the time increases, real time goes back so that the diameter of the cross winding package increases.

Fig. 8A is a diagram illustrating schematically an unraveling tension measurement of the cross winding package according to a comparative example.

Fig. 8B is a diagram illustrating schematically the unraveling tension measurement of the cross winding package according to an example.

DESCRIPTION OF EMBODIMENTS

1. First Embodiment

(1) Yarn Winding Apparatus 10

[0026] The yarn winding apparatus 10 of a first embodiment is an apparatus that winds up a yarn on a surface of a winding bobbin so as to form a yarn layer. In other words, it is a cross winding package production apparatus. The yarn winding apparatus 10 can traverse and wind a yarn 20 to make a cross winding package, while controlling a traverse width as a winding width of the cross traverse winding package to be formed and a traverse position as a control position to realize the winding width. As the yarn winding apparatus that can control the traverse widths and the traverse positions, there are an arm traverse type winding apparatus and a belt traverse type winding apparatus. The yarn winding apparatus 10 of this embodiment is the arm traverse type winding apparatus as illustrated in Fig. 1.

[0027] The yarn winding apparatus 10 winds up the yarn 20 unwound from a yarn feeding bobbin 21 onto the winding bobbin 120. The yarn winding apparatus 10 includes, in order from the yarn feeding bobbin 21 to the winding bobbin 120, a balloon controller 12, a tension applying device 13, a splicer device 14, a clearer (yarn quality measuring device) 15, and a cross winding package forming device 16.

[0028] The balloon controller 12 includes a regulating member 40. The regulating member 40, which covers a core tube of the yarn feeding bobbin 21, is descended along with unraveling of the yarn from the yarn feeding bobbin 21, so as to assist the unraveling of the yarn from

the yarn feeding bobbin 21. The regulating member 40 contacts a balloon formed at an upper part of the yarn feeding bobbin 21 by rotation and centrifugal force of the yarn unraveled from the yarn feeding bobbin 21, and applies an appropriate tension to the balloon, so as to assist the unraveling of the yarn. A sensor to detect a chase part of the yarn feeding bobbin 21 is disposed in a vicinity of the regulating member 40. When this sensor detects the descending chase part, the regulating member 40 can be descended to follow the chase part, using a stepping motor (not shown), for example. Instead of the stepping motor, an air cylinder may be used.

[0029] The tension applying device 13 applies a predetermined tension to the running yarn 20. As the tension applying device 13, for example, a gate type can be used, in which movable comb teeth 37 are disposed with respect to fixed comb teeth 36. The movable comb teeth 37 can be rotated by a rotary type solenoid 38, for example, so that the comb teeth are engaged or released. This tension applying device 13 can apply a constant tension to the yarn 20 to be wound up, so that the quality of the cross winding package 100 can be improved. Further, other than the gate type described above, a disc type can be used as the tension applying device 13, for example. In addition, instead of the solenoid 38, a stepping motor may be used.

[0030] The splicer device 14 splices a lower yarn on the side of the yarn feeding bobbin 21 and an upper yarn on the side of the cross winding package 100, when cutting the yarn due to a yarn defect detected by the clearer 15, or when a yarn break occurs during unraveling from the yarn feeding bobbin 21. As the splicer device for splicing the upper yarn and the lower yarn, a mechanical type, a type using fluid such as compressed air, or the like can be used.

[0031] The clearer 15 includes a clearer head 49 and an analyzer 52. The clearer head 49 is provided with a sensor for detecting the thickness of the yarn 20. The analyzer 52 processes a yarn thickness signal from the sensor. The clearer 15 is configured to detect a yarn defect such as a slub by monitoring the yarn thickness signal from the sensor. In a vicinity of the clearer head 49, a cutter 39 is disposed to promptly cut the yarn 20 when the clearer 15 detects a yarn defect.

[0032] A lower yarn guiding pipe 25 is disposed below the splicer device 14, and an upper yarn guiding pipe 26 is disposed above the same. The lower yarn guiding pipe 25 catches the lower yarn on the side of the yarn feeding bobbin 21 and guides it to the splicer device 14. The upper yarn guiding pipe 26 catches the upper yarn on the side of the cross winding package 100 and guides it to the splicer device 14. In addition, the lower yarn guiding pipe 25 and the upper yarn guiding pipe 26 are configured to be capable of rotating about shafts 33 and 35, respectively. A suction inlet 32 is formed at a distal end of the lower yarn guiding pipe 25, and a suction mouth 34 is formed at a distal end of the upper yarn guiding pipe 26. The lower yarn guiding pipe 25 and the upper yarn guid-

ing pipe 26 are connected to appropriate negative pressure sources, respectively, and suction air flows are generated at the suction inlet 32 and the suction mouth 34, so that yarn ends of the upper yarn and the lower yarn can be sucked and caught, respectively.

[0033] The cross winding package forming device 16 includes a cradle 23, a traverse device 27, and a contact roller 29. The cradle 23 supports the winding bobbin 120 in an attachable and detachable manner. The winding bobbin 120 may be a paper tube or a plastic core tube. The traverse device 27 is an arm type traverse device for traversing the yarn 20. The contact roller 29 contacts the circumferential surface of the winding bobbin 120 or the circumferential surface of the cross winding package 100 and can rotate to follow the same.

[0034] The cradle 23 is configured to be capable of rotating about a rotation shaft 48, and is configured to be capable of absorbing increase in yarn layer diameter when the yarn 20 is wound up onto the winding bobbin 120, by rotation of the cradle 23. In addition, the cradle 23 and the traverse device 27 are configured to be capable of forming the cone-shaped cross winding package 100 as illustrated in the diagram.

[0035] A cross winding package drive motor 41 is attached to the cradle 23 at the part sandwiching the winding bobbin 120. The cross winding package drive motor 41 drives the winding bobbin 120 to rotate, so that the yarn 20 is wound up. When the winding bobbin 120 is supported by the cradle 23, the motor shaft of the cross winding package drive motor 41 is connected to the winding bobbin 120 in a manner not allowing them to relatively rotate (a so-called direct drive method). The operation of the cross winding package drive motor 41 is controlled by a cross winding package drive controller 42, which is configured to receive an operation signal from a unit controller 50, so as to control operation and stop of the cross winding package drive motor 41.

[0036] A cross winding package rotation sensor 43 is attached to the cradle 23. The cross winding package rotation sensor 43 is configured to detect rotation of the winding bobbin 120 attached to the cradle 23 (rotation of a yarn layer 110 formed on the winding bobbin 120). A rotation detection signal of the winding bobbin 120 is sent from the cross winding package rotation sensor 43 to the cross winding package drive controller 42 and the unit controller 50. Further, the rotation detection signal is input to a traverse controller 46 described later.

[0037] The rotation shaft 48 is provided with an angle sensor (a cross winding package diameter acquisition unit) 44 for detecting angle (rotation angle) of the cradle 23. The angle sensor 44 is constituted of a rotary encoder, for example, and is configured to send an angle signal corresponding to the angle of the cradle 23 to the unit controller 50. Along with increase in the winding diameter of the cross winding package 100, the angle of the cradle 23 changes. Therefore, by detecting the rotation angle of the cradle 23 with the angle sensor 44, the yarn layer diameter of the cross winding package 100 can be de-

tected. In this way, by controlling the traverse device 27 in accordance with the yarn layer diameter of the cross winding package, yarn traverse can be appropriately performed. In addition, the diameter of the yarn layer 110 obtained by the angle sensor 44 is transferred from the unit controller 50 to the cross winding package drive controller 42.

[0038] The traverse device 27 includes an elongated arm member 28 configured to be capable of rotating about a spindle, a hook-shaped traverse guide (traverse yarn guide) 11 formed at a distal end of the arm member 28, and a traverse guide drive motor (a traverse yarn guide drive unit) 45 that drives the arm member 28. The traverse guide drive motor 45 is constituted of a servo motor and is configured to turn the arm member 28 in a reciprocating manner as illustrated in Fig. 1 by an arrow, so as to traverse the yarn 20.

[0039] The operation of the traverse guide drive motor 45 is controlled by the traverse controller 46. The traverse controller 46 is constituted of hardware using a dedicated microprocessor, and is configured to control operation and stop of the traverse guide drive motor 45 when receiving a signal from the unit controller 50.

[0040] The traverse device 27 is provided with a traverse guide position sensor 47 constituted of a rotary encoder. The traverse guide position sensor 47 detects a turning position of the arm member 28 (therefore, a position of the traverse guide 11) and sends the position signal to the traverse controller 46.

[0041] In this embodiment, as illustrated in Fig. 1, the cross winding package drive motor 41 and the traverse guide drive motor 45 are disposed separately, and the winding bobbin 120 and the traverse guide 11 are driven (controlled) separately and individually. In this way, traverse of the yarn 20 is flexibly changed and controlled so that the yarn 20 can be wound around the winding bobbin 120.

[0042] The traverse controller 46 controls operation of the traverse guide drive motor 45 so as to control taper winding.

[0043] The yarn winding apparatus 10 further includes a control unit. The control unit includes the unit controller 50, the traverse controller 46, and the cross winding package drive controller 42.

[0044] The unit controller 50 is equipped with a CPU, a RAM, a ROM, and an I/O port. The ROM stores a program for controlling individual portions of the yarn winding apparatus 10. The I/O port is connected to the traverse controller 46, the cross winding package drive controller 42, individual portions of the yarn winding apparatus 10, and a setting unit 64, which can communicate control information interactively with each other.

[0045] A plurality of the yarn winding apparatuses 10 may be aligned to form a set of automatic winders (yarn winders). The set of automatic winders may include a control unit for controlling the unit controllers 50 of the plurality of yarn winding apparatuses 10. Further, the control unit, which controls the unit controllers 50 of the

plurality of yarn winding apparatuses 10, may be provided with the setting unit 64. The setting unit 64 may be provided to the control unit and each of the unit controllers 50.

[0046] The setting unit 64 is configured to communicate various information with the unit controller 50 of each of the yarn winding apparatuses 10 and to be capable of performing central management of the plurality of yarn winding apparatuses 10. The setting unit 64 includes a display and input keys that are not shown in the diagram, and can send various setting values to the unit controllers 50.

(2) Cross Winding Package 100

[0047] The cross winding package 100 of this embodiment includes the winding bobbin 120 and the yarn layer 110 as illustrated in Fig. 2.

[0048] The winding bobbin 120 is a cone-shaped winding bobbin having a taper-shaped winding surface. As illustrated in the cross-sectional view of Fig. 2, a winding surface b-m is inclined from a central axis C by a first angle θ . The first angle θ may be 3 degrees or more and 6 degrees or less. The winding bobbin 120 has a small diameter side end face 121 and a large diameter side end face 122.

[0049] The yarn layer 110 is formed by winding up the yarn so that the surface of the wound yarn has the same inclination (the first angle θ) as the winding surface of the winding bobbin 120. Therefore, as illustrated in the cross-sectional view of Fig. 2, the outer circumferential surface as the outermost surface of the yarn layer 110 is inclined from the central axis C of the winding bobbin 120 by the first angle θ .

[0050] The traverse width W of the yarn layer 110 monotonically decreases in the direction of thickness T from the face contacting the winding bobbin 120 to the top surface of the yarn layer 110. Therefore, a traverse width W_e of the top surface of the yarn layer 110 is smaller than a traverse width W_s of the face of the yarn layer 110 contacting the winding bobbin 120. The thickness T of the yarn layer 110 can be within a range of 20 mm or more and 130 mm or less. It is preferably 60 mm or more and 130 mm or less for a purpose of increasing the yarn winding quantity.

[0051] The yarn layer 110 includes a first yarn layer 111, a second yarn layer 112, and a third yarn layer 113.

[0052] The first yarn layer 111 is formed on the winding bobbin 120. The first yarn layer 111 has a first traverse width W_1 that is constant regardless of a distance from the winding bobbin 120 or decreases along with increase in distance from the winding bobbin 120. A first traverse width W_{1e} of the first yarn layer 111 adjacent to the second yarn layer 112 is 90% or more and 100% or less of the first traverse width W_{1s} of the first yarn layer 111 adjacent to the winding bobbin 120.

[0053] The thickness T1 of the first yarn layer 111 may be 10 mm or more and 60 mm or less. If the thickness

T1 of the first yarn layer 111 is less than 10 mm, it is difficult to increase the entire yarn quantity of the yarn layer 110. If the thickness T1 of the first yarn layer 111 is more than 60 mm, it is difficult to appropriately generate the unravel balloon for decreasing the unraveling tension. For this reason, when using a thinner yarn, the thickness T1 of the first yarn layer 111 should be smaller, for example 40 mm or less.

[0054] The second yarn layer 112 is formed on the first yarn layer 111. The second traverse width W_2 of the second yarn layer 112 decreases along with increase in distance from the first yarn layer 111. A second traverse width W_{2e} of the second yarn layer 112 adjacent to the third yarn layer 113 is 50% or more and 90% or less of a second traverse width W_{2s} of the second yarn layer 112 adjacent to the first yarn layer 111. A decreasing rate of the second traverse width W_2 of the second yarn layer 112 is larger than a decreasing rate of the first traverse width W_1 of the first yarn layer 111 and than a decreasing rate of the third traverse width W_3 of the third yarn layer 113. Here, the decreasing rate of the traverse width W means a rate of decreasing of the traverse width W with respect to the same length in the direction of the thickness T. Note that in Fig. 2, the second traverse width W_2 of the second yarn layer 112 is entirely decreased along with increase in distance from the first yarn layer 111. However, the second traverse width W_2 may be decreased in any parts and constant in the other parts along with increase in distance from the first yarn layer 111.

[0055] The second yarn layer 112 may be constituted of two or more yarn layers. For instance, in the cross winding package 100 illustrated in Fig. 2, the second yarn layer 112 is constituted of two layers, i.e. a fourth yarn layer 112a that contacts the first yarn layer 111 and a fifth yarn layer 112b that contacts the third yarn layer 113. In Fig. 2, the decreasing rate of the traverse width W_2 of the fourth yarn layer 112a is larger than the decreasing rate of the traverse width W_2 of the fifth yarn layer 112b. On the contrary, the decreasing rate of the traverse width W_2 of the fourth yarn layer 112a may be smaller than the decreasing rate of the traverse width W_2 of the fifth yarn layer 112b.

[0056] In the second yarn layer 112, the decreasing rate of the traverse width W_2 may be different between the small diameter side and the large diameter side of the winding bobbin 120. In the cross winding package 100 of Fig. 2, on an end face d-e of the second yarn layer 112 on the small diameter side, the decreasing rate of the traverse width W_2 is large, and a steep slope is formed in the direction of the central axis C of the winding bobbin 120. In contrast, on an end face k-j of the same on the large diameter side, the decreasing rate of the traverse width W_2 is small, and a gentle slope is formed. In addition, in Fig. 2, in the second yarn layer 112, a bending point e on the small diameter side end face and a bending point j on the large diameter side end face are both on the boundary between the fourth yarn layer 112a and the fifth yarn layer. The bending point on the small

diameter side end face and the bending point on the large diameter side end face may not be on the same boundary between yarn layers. In other words, the bending point on the small diameter side end face and the bending point on the large diameter side end face may be disposed at positions having different distances from the surface of the first yarn layer 111.

[0057] The third yarn layer 113 is formed on the second yarn layer 112. The third traverse width W3 of the third yarn layer 113 is constant regardless of distance from the second yarn layer 112 or decreases along with increase in distance from the second yarn layer 112. A third traverse width W3e (We) of the top surface of the third yarn layer 113 is 90% or more and 100% or less of a third traverse width W3s of the third yarn layer 113 adjacent to the second yarn layer 112.

[0058] In the cross-sectional view of Fig. 2, an end face h-i of the third yarn layer 113 on the large diameter side of the winding bobbin 120 is formed perpendicular to the winding surface b-m of the winding bobbin 120. Here, "perpendicular" means not only a completely perpendicular case but also a substantially perpendicular case forming an angle of 85 degrees or more and 95 degrees or less, more preferably, 87 degrees or more and 93 degrees or less.

[0059] Similarly, in the cross-sectional view of Fig. 2, an end face g-f of the third yarn layer 113 on the small diameter side of the winding bobbin 120 is formed perpendicular to the winding surface b-m of the winding bobbin 120. Here, "perpendicular" means not only a completely perpendicular case but also a substantially perpendicular case forming an angle of 85 degrees or more and 95 degrees or less, more preferably, 87 degrees or more and 93 degrees or less.

[0060] The first traverse width W1 and the third traverse width W3 satisfy the relationship of the following inequality (1):

$$W1 \times 1/2 \leq W3 \leq W1 \times 2/3 \dots (1).$$

[0061] If the third traverse width W3 is not a half of the first traverse width W1 or more, it is difficult to increase the entire yarn quantity of the yarn layer 110. In addition, when the third traverse width W3 is 2/3 of the first traverse width W1 or less, the unravel balloon can be appropriately generated so that the unraveling tension can be a low value.

[0062] Note that as described above, in one cross winding package 100, the first traverse width W1 or the third traverse width W3 may not be constant. In that case, in the above inequality (1), the first traverse width W1s adjacent to the winding bobbin 120 may be used as the first traverse width W1, and the third traverse width W3e on the top surface of the third yarn layer 113 may be used as the third traverse width W3.

[0063] In addition, the thickness T3 of the third yarn layer 113 is more than the thickness T2 of the second

yarn layer 112. The thickness T3 of the third yarn layer 113 is more than the thickness T1 of the first yarn layer 111. The thickness T1 of the first yarn layer 111 is more than the thickness T2 of the second yarn layer 112.

[0064] In the cross winding package 100 illustrated in Fig. 2, the first traverse width W1e of the first yarn layer 111 adjacent to the second yarn layer 112 is equal to the second traverse width W2s of the second yarn layer 112 adjacent to the first yarn layer 111. Further, the second traverse width W2e of the second yarn layer 112 adjacent to the third yarn layer 113 is equal to the third traverse width W3s of the third yarn layer 113 adjacent to the second yarn layer 112. In other words, in the cross winding package 100 illustrated in Fig. 2, the traverse width W continuously changes from the side of the yarn layer 110 contacting the winding bobbin 120 to the top surface of the yarn layer 110. The traverse width W may not continuously change. For instance, it may discontinuously change between the first yarn layer 111 and the second yarn layer 112, or between the second yarn layer 112 and the third yarn layer 113.

(3) Method for Producing Cross Winding Package

[0065] A method for producing the cross winding package 100 of this embodiment is described with reference to a flowchart of Fig. 3. The yarn feeding bobbin 21 around which the yarn 20 is wound and the winding bobbin 120 are set to the yarn winding apparatus 10. Then, the yarn 20 is wound up onto the winding bobbin 120, so that the yarn layer 110 is formed. Specifically, the process of forming the yarn layer 110 includes the steps of:

- (a) forming the first yarn layer 111 with the first traverse width W1 on the winding bobbin 120;
- (b) forming the second yarn layer 112 on the first yarn layer 111, with the second traverse width W2 that decreases partially or entirely along with increase in distance from the first yarn layer; and
- (c) forming the third yarn layer 113 on the second yarn layer 112, with the third traverse width W3.

[0066] In the above description, the yarn layer 110, the first yarn layer 111, the second yarn layer 112, and the third yarn layer 113 are described above in "(2) Cross Winding Package 100".

[0067] In the yarn winding apparatus 10, in order to set the traverse widths and the traverse positions of the yarn layer 110, an operator inputs these values to the setting unit 64, so as to design a shape of the cross winding package.

[0068] Specific design examples of the cross winding package are illustrated in Figs. 4 and 5. In Figs. 4 and 5, the vertical axis shows the "yarn layer", which indicates the thickness T of the yarn layer 110, or the distance from the surface of the winding bobbin 120. The horizontal axis shows the "traverse width", which indicates the traverse width and the traverse position. For instance, a

position at the traverse width of 0 mm means a position on the line that passes a point x closest to the small diameter side end face 121 on the surface of the yarn layer 110 contacting the winding bobbin 120, and is perpendicular to the surface b-m of the winding bobbin 120, in the cross-sectional view of the cross winding package 100 illustrated in Fig. 2. Similarly, a position at the traverse width of 155 mm means a position on the line that passes a point 1 closest to the large diameter side end face 122 on the surface of the yarn layer 110 contacting the winding bobbin 120, and is perpendicular to the surface b-m of the winding bobbin 120, in the cross-sectional view of the cross winding package 100 illustrated in Fig. 2.

[0069] Fig. 4 illustrates design examples of the traverse widths W and the traverse positions of the yarn layer 110 in a cross winding package S1 as an example of the present disclosure and a cross winding package P1 as a comparative example. The cross winding package P1 of the comparative example use the same type and quantity of the yarn. A difference between them is designing the traverse widths W and the traverse positions of the yarn layer 110, i.e. the shape of the yarn layer 110, as a result.

[0070] In the cross winding package S1 of Fig. 4, a part of the yarn layer 110 having the thickness T from 0 mm to 25 mm is the first yarn layer 111, a part of the same having the thickness T from 25 mm to 50 mm is the second yarn layer 112, and a part of the same having the thickness T from 50 mm to 90 mm is the third yarn layer 113. In the first yarn layer 111 and the third yarn layer 113, the traverse width W is constant. In the cross-sectional view of the cross winding package 100, the small diameter side end face and the large diameter side end face of the first yarn layer 111 are perpendicular to the surface of the winding bobbin 120. Similarly, the small diameter side end face and the large diameter side end face of the third yarn layer 113 are perpendicular to the surface of the winding bobbin 120.

[0071] In the cross winding package S1, the second yarn layer 112 having the yarn layer thickness T from 25 mm to 50 mm consists of two layers, i.e. the fourth yarn layer 112a having the yarn layer thickness T from 25 mm to 40 mm and the fifth yarn layer 112b having the yarn layer thickness T from 40 mm to 50 mm. Along with increase in the thickness T, the traverse width W of the second yarn layer 112 decreases, and its changing rate discontinuously changes at the thickness T of 40 mm. The small diameter side end face and the large diameter side end face of the second yarn layer 112 have slope changing points. In the cross winding package S1, the changing rate (decreasing rate) of the traverse width W2 of the second yarn layer 112 is larger on the small diameter side end face than on the large diameter side end face. In addition, the traverse width W changes continuously from the position having the thickness T of 0 mm of the yarn layer 110 to the position on the top surface

having the thickness T of 90 mm. Therefore, the distance between the small diameter side end face of the third yarn layer 113 and the small diameter side end face of the first yarn layer 111 is larger than the distance between the large diameter side end face of the third yarn layer 113 and the large diameter side end face of the first yarn layer 111.

[0072] The cross winding package P1 of the comparative example has the constant traverse width W and the constant traverse position.

[0073] Fig. 5 illustrates a design example of the traverse widths W and the traverse positions of the yarn layer 110 in the cross winding packages S2 and P2 using a yarn different from that in Fig. 4 (a yarn thicker than that in Fig. 4). The cross winding package S2 of the example and the cross winding package P2 of the comparative example use the same type and quantity of the yarn. A difference between them is designing the traverse widths W and the traverse positions of the yarn layer 110, i.e. the shape of the yarn layer 110, as a result.

[0074] In the cross winding package S2 of Fig. 5, a part of the yarn layer 110 having the thickness T from 0 mm to 40 mm is the first yarn layer 111, a part of the same having the thickness T from 40 mm to 65 mm is the second yarn layer 112, and a part of the same having the thickness T from 65 mm to 138 mm is the third yarn layer 113. In the first yarn layer 111 and the third yarn layer 113, the traverse width W is constant. In the cross-sectional view of the cross winding package 100, the small diameter side end face and the large diameter side end face of the first yarn layer 111 are perpendicular to the surface of the winding bobbin 120. Similarly, the small diameter side end face and the large diameter side end face of the third yarn layer 113 are perpendicular to the surface of the winding bobbin 120.

[0075] Along with increase in the thickness T, the traverse width W of the second yarn layer 112 of the cross winding package S2 decreases. The changing rate (decreasing rate) of the traverse width W2 of the second yarn layer 112 on the small diameter side end face is different from that on the large diameter side end face. Also in the cross winding package S2, similarly to the cross winding package S1, the distance between the small diameter side end face of the third yarn layer 113 and the small diameter side end face of the first yarn layer 111 is larger than the distance between the large diameter side end face of the third yarn layer 113 and the large diameter side end face of the first yarn layer 111.

[0076] The cross winding package P2 of the comparative example has the constant traverse width W and the constant traverse position.

(4) Measurement of Unraveling Tension

[0077] As to the cross winding packages S1, S2, P1, and P2 illustrated in Figs. 4 and 5, the unraveling tension was measured, and the result is described below.

[0078] Figs. 8A and 8B schematically illustrate a meas-

urement of the unraveling tension. Fig. 8A illustrates a case of using a conventional cross winding package, and Fig. 8B illustrates a case of using the cross winding package of this embodiment. As illustrated in Fig. 8A or 8B, in the measurement of unraveling tension, the tension is measured while unraveling the yarn from the small diameter side of the winding bobbin. The unraveling speed is 1,200 m/min, and the measurement of unraveling tension is performed continuously while the entire yarn wound as the cross winding package is being unraveled.

[0079] Figs. 6 and 7 illustrate results of the measurement of unraveling tension. In Figs. 6 and 7, the vertical axis indicates the measured value of unraveling tension, and the horizontal axis indicates time of unraveling. The value of unraveling tension changes, and a measured point in Fig. 6 or 7 is an average value of a predetermined period at the time. In the horizontal axis, time 0 indicates the time when the unraveling is finished, and the positive direction on the time axis indicates that real time goes back from the time when the unraveling is finished. At time 0, the yarn layer thickness T is 0. As going in the positive (right) direction on the time axis, the yarn layer thickness T is larger in the measurement.

[0080] As illustrated in Fig. 6, in the cross winding package S1 of this example, the unraveling tension has a low value in each case of large diameter or small diameter, but in the cross winding package P1 of the comparative example, the unraveling tension is large particularly on the large diameter side (time is approximately 5,000 seconds or more).

[0081] Also in the case of Fig. 7 using the thicker yarn than in the case of Fig. 6, the same tendency as in Fig. 6 is observed. In the cross winding package S2 of this example, in the case of large diameter (time is approximately 5,000 seconds or more), the unraveling tension shows a smaller value than in the cross winding package P1 of the comparative example.

[0082] Next considered is the reason why the cross winding package S1 or S2 of this example shows low unraveling tension as described above.

[0083] As illustrated in Fig. 8A, in the cross winding package of the comparative example that has a constant traverse width, when the yarn layer has a large diameter in particular, as the yarn is unraveled on the large diameter side of the winding bobbin, friction occurs on the surface of the yarn layer (the cross winding package) on the small diameter side of the position where the yarn is unraveled, causing high unraveling tension. In Figs. 8A and 8B, the thick line part on the circumferential surface of the cross winding package indicates the part where the friction occurs when the yarn is unraveled. In addition, there is another problem that the unravel balloon is hardly generated appropriately. In contrast, in the cross winding package of this embodiment, the thickness T1 of the first yarn layer 111 on the inner side is thin, and the traverse width W3 of the third yarn layer 113 on the outer side is small. Therefore, in the cross winding package of this embodiment, as illustrated in Fig. 8B, when unraveling

the third yarn layer 113 on the outer side, the rubbing area of the yarn is small, and hence the unraveling tension can be controlled to be low. In addition, there is also a merit that the unravel balloon can be appropriately formed.

2. Features of Embodiment

[0084] The embodiment described above can also be described as follows.

[0085] The cross winding package 100 of the present disclosure includes the cone-shaped winding bobbin 120 and the yarn layer 110. The winding bobbin 120 has the taper-shaped winding surface inclined from the central axis C by the first angle θ .

[0086] The yarn layer 110 is wound up around the winding bobbin 120 having the surface of the wound yarn with the same inclination as the winding surface of the winding bobbin 120. The yarn layer 110 includes the first yarn layer 111 that contacts the winding bobbin 120 and has the first traverse width W1, the second yarn layer 112 that is on the first yarn layer 111 and has the second traverse width W2 that decreases partially or entirely along with increase in distance from the first yarn layer, and the third yarn layer 113 that is on the second yarn layer 112 and has the third traverse width W3.

[0087] In the above sentences, "decreases partially" means "decreases in any parts and is constant in the other parts along with increase in distance from the first yarn layer 111"

[0088] The first traverse width W1 and the third traverse width W3 satisfy the following relationship:

$$W1 \times 1/2 \leq W3 \leq W1 \times 2/3 \dots (1).$$

[0089] In addition, the thickness T3 of the third yarn layer 113 may be more than the thickness T2 of the second yarn layer 112. The thickness T3 of the third yarn layer 113 may be more than the thickness T1 of the first yarn layer 111.

3. Other Embodiments

[0090] Although the embodiment of the present invention is described above, the present invention is not limited to the embodiment but can be variously modified within the scope of the invention without deviating from the scope of the claims.

[0091] The yarn winding apparatus of the present disclosure can be applied to an automatic winder in which a plurality of yarn winding apparatuses are aligned and used. In addition, the cross winding package of the present disclosure can be applied to textile machinery for manufacturing various textiles.

Claims

1. A cross winding package (100) comprising:

a cone-shaped winding bobbin (120) having a taper-shaped winding surface inclined from a central axis by a first angle (θ); and
 a yarn layer (110) being wound up around the winding bobbin, having a surface of the wound yarn with the same inclination as the winding surface, wherein
 the yarn layer (110) includes a first yarn layer (111) that contacts the winding bobbin and has a first traverse width (W1), a second yarn layer (112) that is on the first yarn layer and has a second traverse width (W2) that decreases partially or entirely along with increase in distance from the first yarn layer, and a third yarn layer (113) that is on the second yarn layer and has a third traverse width (W3), and
 the first traverse width (W1) and the third traverse width (W3) satisfy the following relationship:

$$W1 \times 1/2 \leq W3 \leq W1 \times 2/3.$$

2. The cross winding package according to claim 1, wherein

the third yarn layer has a thickness (T3) more than a thickness (T2) of the second yarn layer, and
 the third yarn layer thickness (T3) is more than a thickness (T1) of the first yarn layer.

3. The cross winding package according to claim 1, wherein

the first traverse width (W1) of the first yarn layer (111) is constant regardless of a distance from the winding surface of the winding bobbin (120) or decreases along with increase in distance from the winding surface of the winding bobbin (120), and a first traverse width (W1e) of the first yarn layer adjacent to the second yarn layer (112) is 90% or more and 100% or less of a first traverse width (W1s) of the first yarn layer adjacent to the winding bobbin (120),
 a second traverse width (W2e) of the second yarn layer adjacent to the third yarn layer (113) is 50% or more and 90% or less of a second traverse width (W2s) of the second yarn layer adjacent to the first yarn layer (111), and
 the third traverse width (W3) of the third yarn layer is constant regardless of a distance from the winding bobbin (120) or decreases along with increase in distance from the second yarn

layer (112), and a third traverse width (W3e) of an outer surface of the third yarn layer is 90% or more and 100% or less of a third traverse width (W3s) of the third yarn layer adjacent to the second yarn layer (112).

4. The cross winding package according to claim 3, wherein

the first traverse width (W1e) of the first yarn layer adjacent to the second yarn layer (112) is equal to the second traverse width (W2s) of the second yarn layer adjacent to the first yarn layer (111), and
 the second traverse width (W2e) of the second yarn layer adjacent to the third yarn layer (113) is equal to the third traverse width (W3s) of the third yarn layer adjacent to the second yarn layer (112).

5. The cross winding package according to any one of claims 1 to 4, wherein the first yarn layer thickness (T1) is more than the second yarn layer thickness (T2).

6. The cross winding package according to any one of claims 1 to 5, wherein

an end face of each yarn layer on a small diameter side of the cone-shaped winding bobbin (120) is referred to as a small diameter side end face of each yarn layer, while an end face of each yarn layer on a large diameter side of the cone-shaped winding bobbin is referred to as a large diameter side end face of each yarn layer, and
 in a cross-sectional view including a central axis (C) of the cone-shaped winding bobbin, the large diameter side end face of the third yarn layer (113) is perpendicular to the winding surface of the cone-shaped winding bobbin (120).

7. The cross winding package according to any one of claims 1 to 6, wherein

an end face of each yarn layer on a small diameter side of the cone-shaped winding bobbin (120) is referred to as a small diameter side end face of each yarn layer, while an end face of each yarn layer on a large diameter side of the cone-shaped winding bobbin is referred to as a large diameter side end face of each yarn layer, and
 in a cross-sectional view including the central axis (C) of the cone-shaped winding bobbin, the large diameter side end face or the small diameter side end face of the second yarn layer (112) has a changing inclination angle with respect to

a direction perpendicular to the winding surface.

8. The cross winding package according to any one of claims 1 to 7, wherein

an end face of each yarn layer on a small diameter side of the cone-shaped winding bobbin (120) is referred to as a small diameter side end face of each yarn layer, while an end face of each yarn layer on a large diameter side of the cone-shaped winding bobbin (120) is referred to as a large diameter side end face of each yarn layer, and

in a cross-sectional view including the central axis (C) of the cone-shaped winding bobbin (120), an inclination angle of the small diameter side end face of the second yarn layer (112) is different from that of the large diameter side end face of the same with respect to a direction perpendicular to the winding surface.

9. A method for producing a cross winding package, comprising the steps of:

preparing a cone-shaped winding bobbin (120) having a taper-shaped winding surface inclined from a central axis (C) by a first angle (θ); and winding up a yarn around the winding bobbin (120) and forming a yarn layer (110) having a surface of the wound yarn with the same inclination as the winding surface, wherein the step of winding up a yarn and forming the yarn layer (110) includes the steps of:

- (a) forming a first yarn layer (111) with a first traverse width (W1) on the winding bobbin (120);
- (b) forming a second yarn layer (112) on the first yarn layer (111), with a second traverse width (W2) that decreases partially or entirely along with increase in distance from the first yarn layer; and
- (c) forming a third yarn layer (113) on the second yarn layer (112), with a third traverse width (W3), and

the first traverse width (W1) and the third traverse width (W3) satisfy the following relationship:

$$W1 \times 1/2 \leq W3 \leq W1 \times 2/3.$$

10. The method according to claim 9, wherein the third yarn layer has a thickness (T3) more than a thickness (T2) of the second yarn layer, and the third yarn layer thickness (T3) is more than a thickness (T1) of the first yarn layer.

11. A yarn winding apparatus (10) for producing a cross winding package (100) including a cone-shaped winding bobbin (120) having a taper-shaped winding surface inclined from a central axis (C) by a first angle (θ), and a yarn layer (110) being wound up around the winding bobbin (120) having a surface of the wound yarn with the same inclination as the winding surface, the apparatus comprising:

a traverse yarn guide (11) for traversing a yarn to be wound up around the winding bobbin; a traverse yarn guide drive unit (45) for driving the traverse yarn guide; and a control unit (46) for controlling the traverse yarn guide drive unit (45), wherein the control unit is configured to:

- (a) form a first yarn layer (111) with a first traverse width (W1) on the winding bobbin (120);
- (b) form a second yarn layer (112) on the first yarn layer (111), with a second traverse width (W2) that decreases partially or entirely along with increase in distance from the first yarn layer; and
- (c) form a third yarn layer (113) on the second yarn layer (112), with a third traverse width (W3), and

the first traverse width (W1) and the third traverse width (W3) satisfy the following relationship:

$$W1 \times 1/2 \leq W3 \leq W1 \times 2/3.$$

12. The apparatus according to claim 11, wherein the control unit (46) is configured to form the first, the second and the third yarn layers, on condition that the third yarn layer has a thickness (T3) more than a thickness (T2) of the second yarn layer, and that the third yarn layer thickness (T3) is more than a thickness (T1) of the first yarn layer.

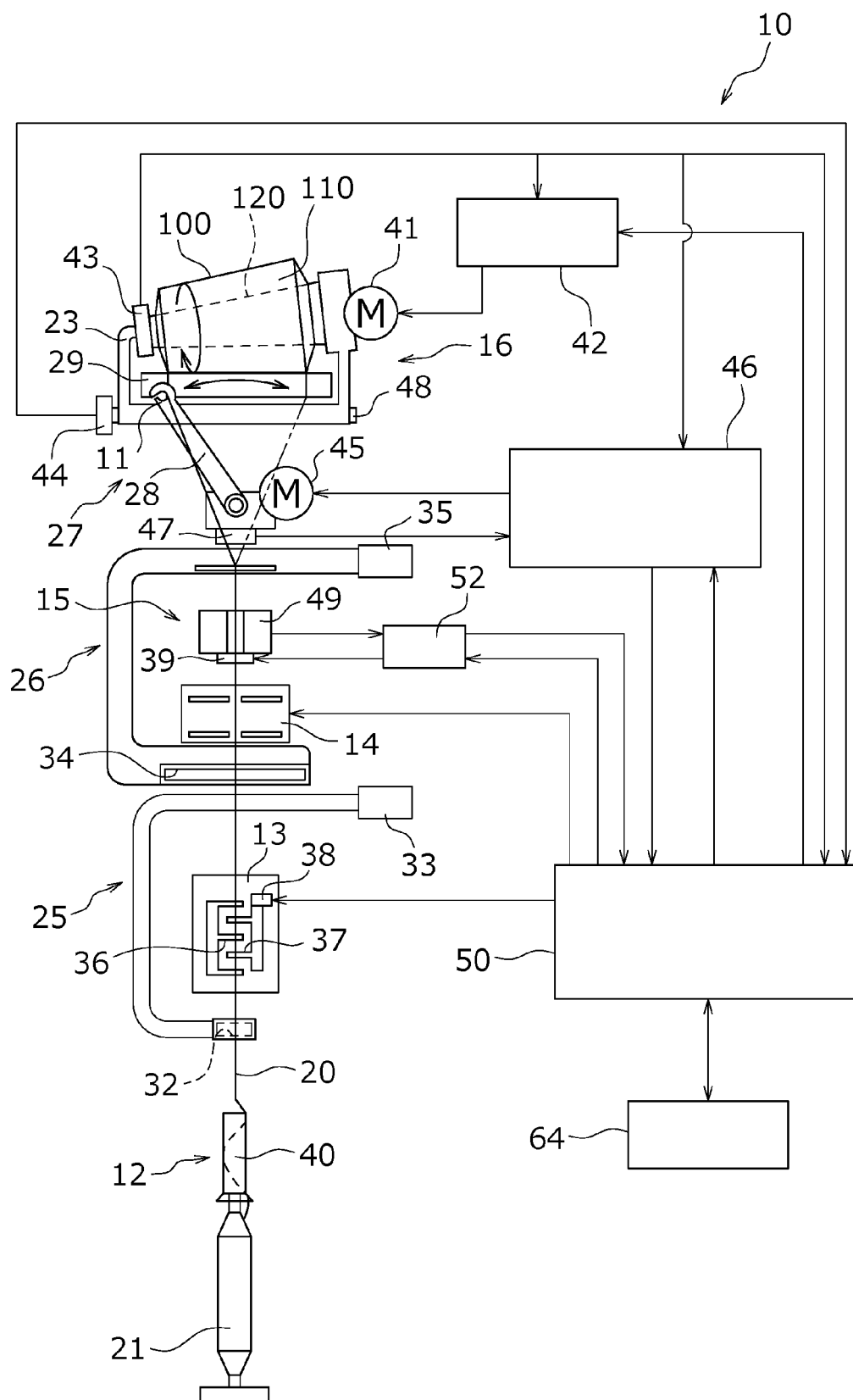


FIG. 1

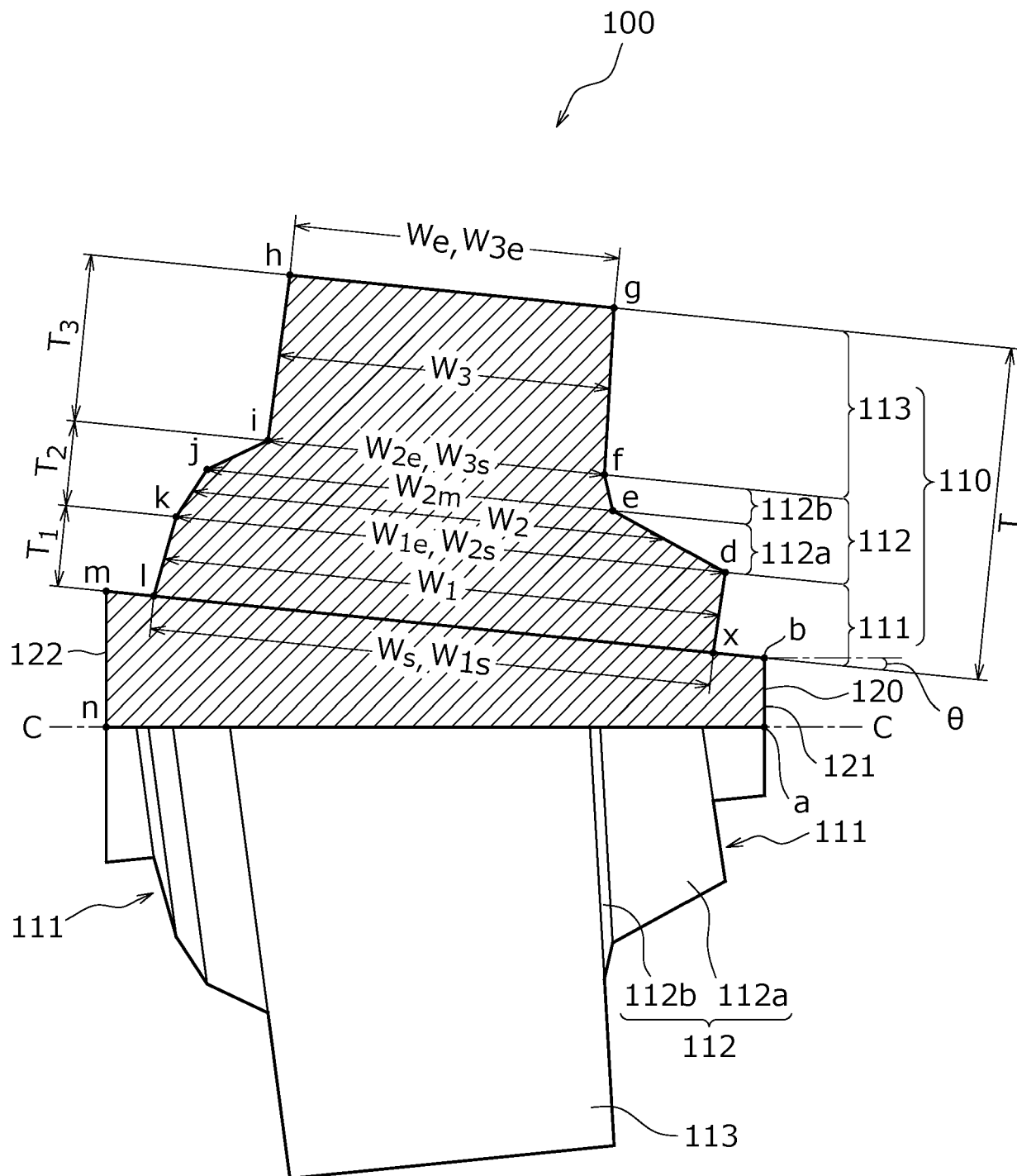


FIG. 2

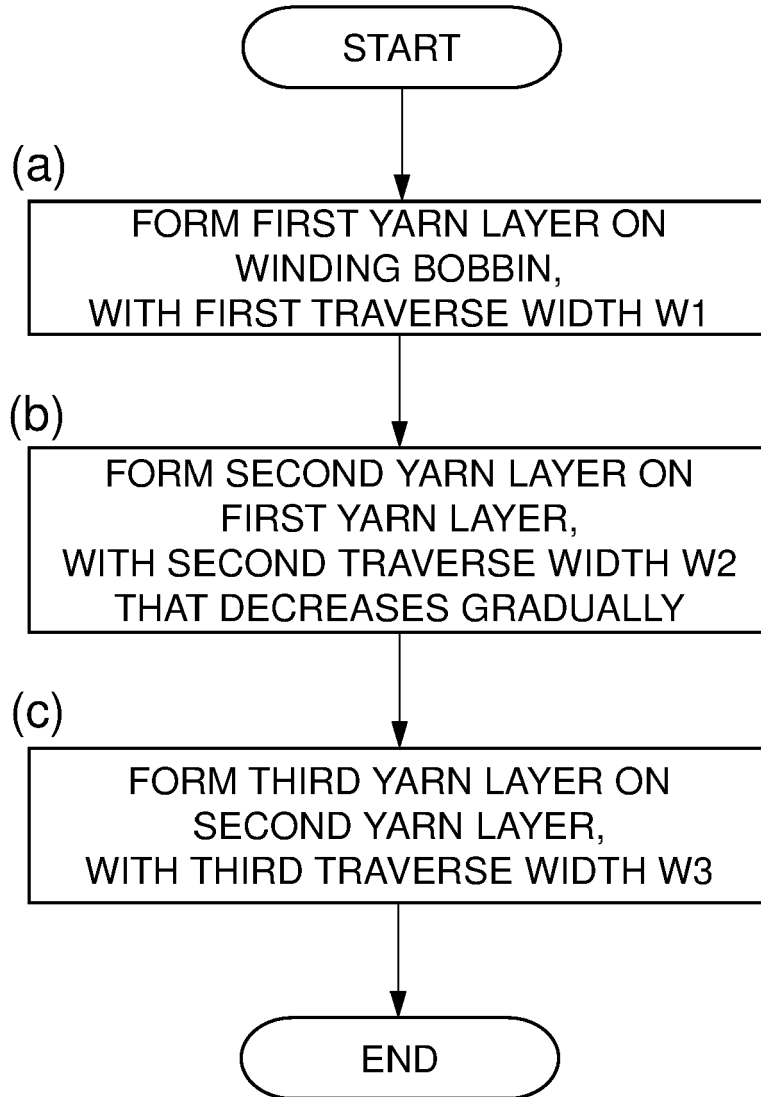


FIG. 3

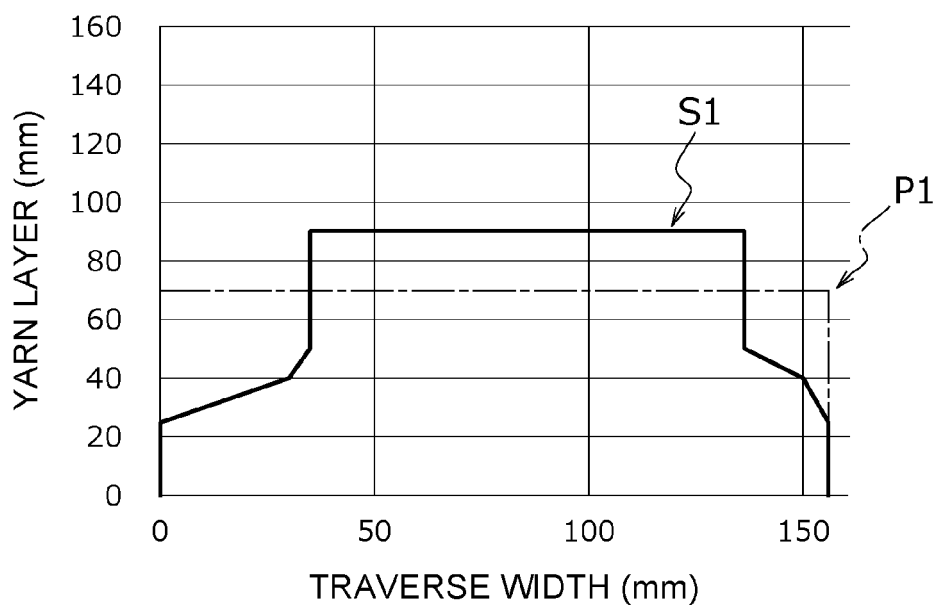


FIG. 4

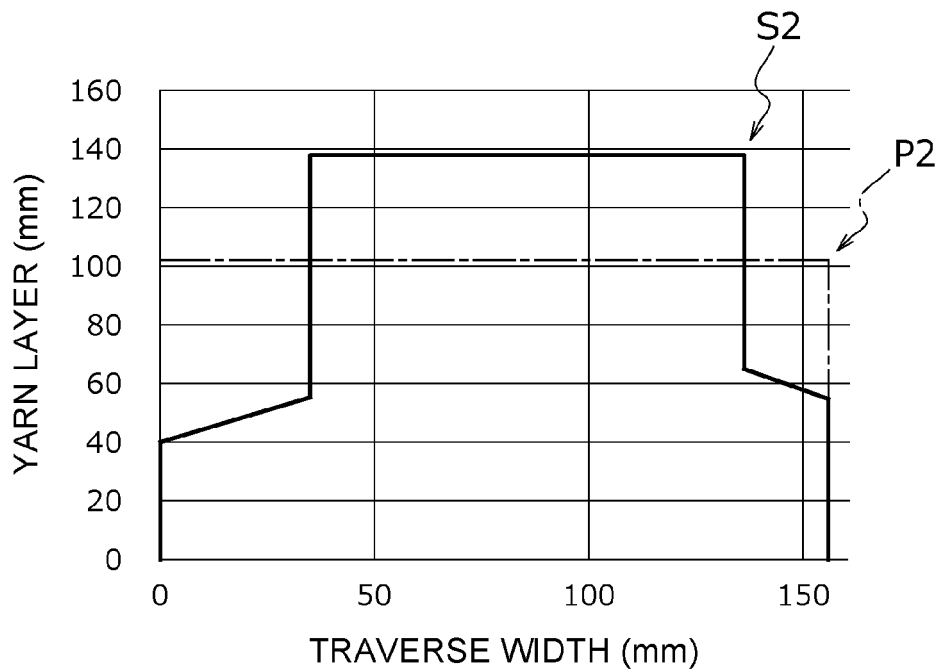


FIG. 5

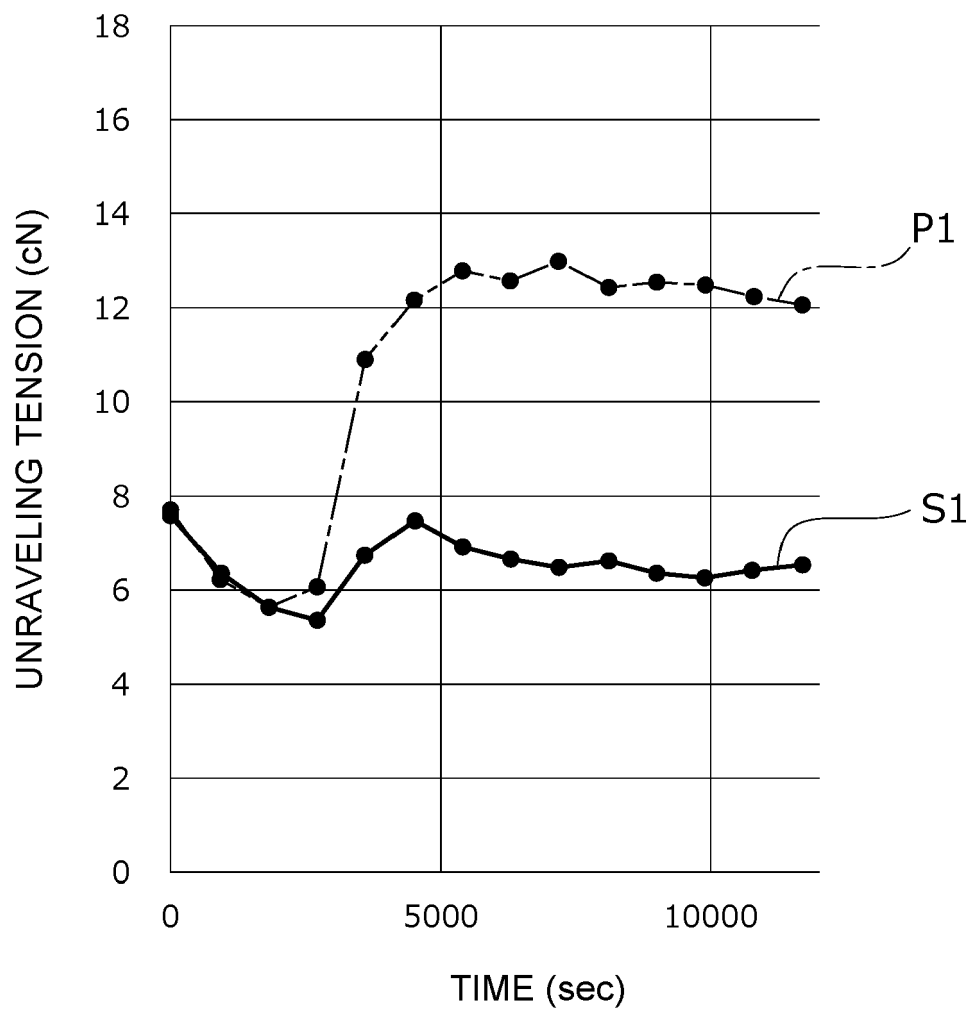


FIG. 6

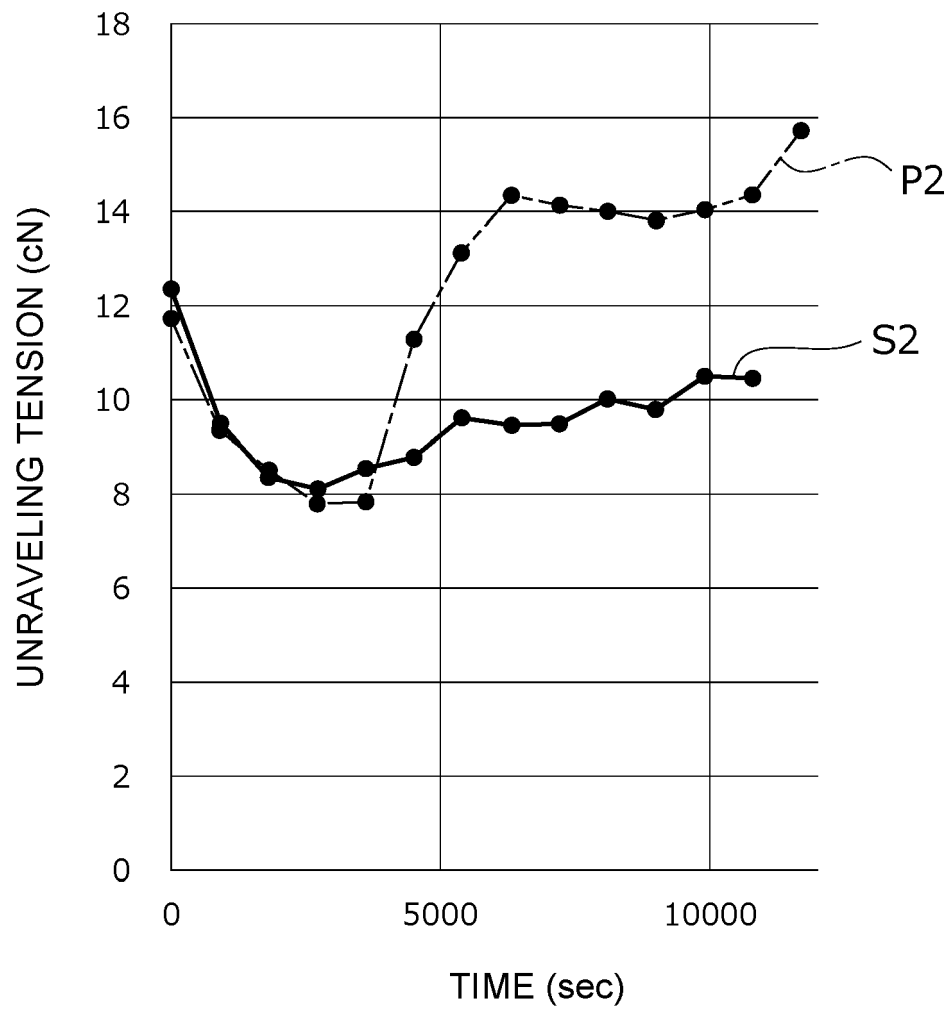


FIG. 7

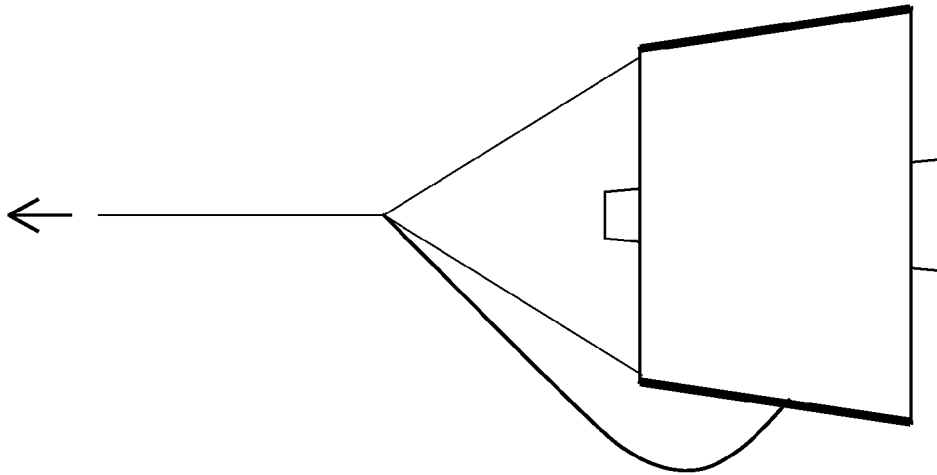


FIG. 8A

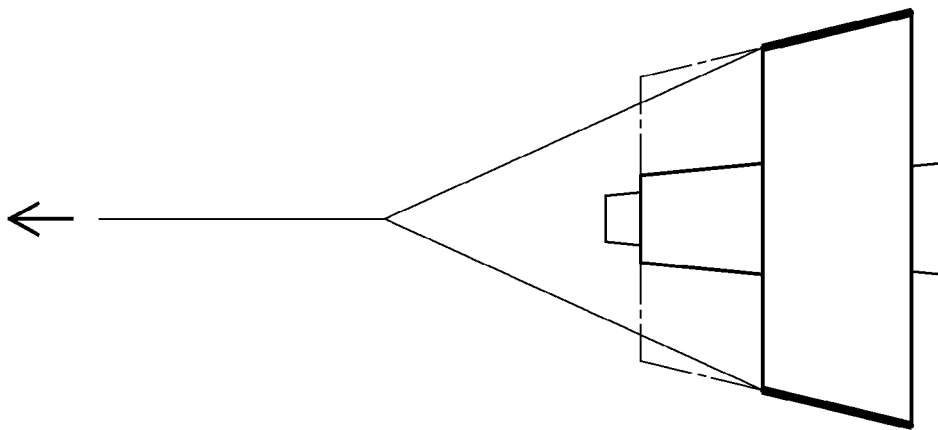


FIG. 8B



EUROPEAN SEARCH REPORT

Application Number

EP 22 19 8085

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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			B65H
The present search report has been drawn up for all claims			

1

EPO FORM 1503 03.82 (P04C01)

Place of search	Date of completion of the search	Examiner
The Hague	14 February 2023	Pussemier, Bart
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO.

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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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